Totowa – West Paterson Sewerage Authority

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Dept. Environmental Protection
Division Water Resources

Sludge Management Plan
Step I Document

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Science
Engineering
Design

Gateway "80" Office Park
Wayne, New Jersey 07470

August, 1978

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1.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

1.1 Summary

The Totowa-West Paterson Sewerage Authority has been developing a comprehensive wastewater management program in conjunction with the Water Pollution Control Act Amendments of 1972 (Public Law 92-500) and the Clean Water Act of 1977. Facilities planning activities have addressed the development of collection, treatment and disposal plans for this regional area. Alternative treatment and disposal methods were identified for the liquid and solid fractions of the waste stream in the report titled "Wastewater Management Study Facilities Plan for Totowa - West Paterson Sewerage Study Group, April 1975, Revised November 1975."

In early 1977 The U.S. Environmental Protection Agency (EPA) requested that additional studies be conducted regarding the processing of sewage solids and the disposal of the residual sludge. These studies were limited and directed to further evaluations of land application, landfill, composting and resource recovery options. These studies were undertaken with the compliance of interim guidelines and criteria as established by the Office of Sludge Management and Industrial Pretreatment (OSMIP) of the New Jersey Department of Environmental Protection (NJDEP). Furthermore, compliance with a 1981 ocean disposal abatement schedule was mandatory.

Based on an approved scope of work and budget, a Step I Grant Amendment was offered in support of the preparation of this Sludge Management Plan Study. The work effort was presented to EPA in May 1977 in a document titled "Step One Phase Proposal."

A compilation of existing resources was prepared to provide the basic data for alternative sludge management systems development and evaluation. Existing and projected sludge quantities were developed for the municipal wastewater treatment facilities within the TWPSA region. Also accounted for were septic systems within the Boroughs of Totowa and West Paterson. Industrial and institutional sludge generation sources were also reported. The quality of the sludge was also established based upon available limited quality data in conjunction with a literature research. Basically characterized as a domestic sludge, the material would be amenable to land disposal techniques.

Land disposal techniques (or ultimate disposal alternatives) were developed and included land application, landfilling and marketing. The study area was expanded, for the purpose of evaluating land-based disposal alternatives, to include Passaic County and Morris County. Agricultural lands in Morris County were evaluated for potential land application areas; the results had indicated that potential land application sites were located in Washington Township. Vacant lands in Passaic County were evaluated for potential land application areas; no suitable areas were located in the County. Reclaimable disturbed lands, specifically gravel pits, in Passaic and Morris Counties were evaluated as potential landfill sites. Of the 79 gravel pit sites considered, twelve exhibited potential. Two other sites, one in Totowa and one in West Paterson, exhibited potential as sludge processing sites. The only existing landfill in the study area reported a lack of capacity to accommodate sludge wastes from the TWPSA region.

Marketing studies performed for PQA indicated four groups as potential markets for sludge products. The four groups consisted of private organizations, municipal governments, independent authorities and state agencies. General responses from these groups indicate a lack of familiarity of the products and their detailed composition, however, most were willing to try the products. Other responses indicated a concern that labor costs for use of sludge products would have to be competitive with the use of commercial products. Also, the quality of the sludge product must be consistent in nutrient content and workability. Potential market outlets indicated that consultation with the county agricultural agent was necessary prior to experimenting with a sludge product.

Basic sludge treatment options were studied and included such processes as composting (static-pile and mechanized aerobic), anaerobic digestion and incineration. Nineteen alternative sludge management systems were developed through a combination of the above sludge treatment options and land disposal alternatives. Included in these alternative systems were alternatives involving the use of existing incinerators owned and operated by the Two Bridges Sewerage Authority and the Township of Wayne. Interest had been expressed by these two authorities for receiving sludges from outside municipalities and authorities.

Costs were developed for the components of each system alternate which include transportation costs from regional treatment facilities to land disposal areas. Subsequent to the establishment of alternative systems and their costs, an environmental and socio-economic assessment were performed. Ranking of alternatives were developed based on the cost analysis and also on the environmental and socio-economic assessments. Costs for use of incinerators at the Two Bridges Sewerage Authority and the Township of Wayne were reported at $175/dry ton and $300/dry ton, respectively.

Results of the cost analysis ranking and the assessments evaluation rankings indicate that composting of sludge wastes with marketing of the compost product to be most cost-effective, environmentally sound and socio-economically beneficial. Incineration of sludges at the Two Bridges Sewerage Authority's facility was also ranked in the top third of all alternatives. Alternatives utilizing land application as a disposal option ranked in the middle third of all alternatives. Alternatives utilizing landfilling were ranked in the bottom third.

Implementation of alternatives involving marketing of sludge products may be difficult since marketing potentials are highly variable. Establishing and maintaining the markets are activities to be undertaken and uncertainty as to their actualization must be considered. Landfill options may also be difficult to implement due to NJDEP policies which tend to discourage the use of landfills. Also, some problems would be anticipated by owners of potential landfill sites and local residents and public officials. Implementation of land application options may encounter the same difficulties as with landfills with regards to land owners, local residents and public officials. Other difficulties with implementing land application options would include the level of control and monitoring the TWPSA would have on the disposal operation itself.

The most implementable sludge treatment processes tend to be those which may be located at the TWPSA regional wastewater treatment facilities. Such processes include anaerobic digestion, incineration, and the mechanized aerobic composting operation. The mechanized aerobic composting operation is the most cost-effective and implementable process, provided markets for sludge products are available. Anaerobic digestion with land application is a cost-effective alternative in the absense of a compost market.

1.2 Conclusions and Recommendations

Based on the findings developed during this study, it is concluded that sludge treatment by the mechanized aerobic composting process offers the most flexibility with regards to the disposal of the compost product. Furthermore, this may be the most environmentally sound and socio-economically beneficial option for a long term commitment.

Since many uncertainties exist concerning the ultimate disposal options of land application, marketing, and landfilling, this plan recommends that negotiations with the Two Bridges Sewerage Authority be continued in the event that a short term agreement for the disposal of TWPSA sludges becomes necessary. A short term agreement for a maximum of five years would result in an immediate compliance with the 1981 ocean disposal abatement schedule.

Furthermore, a five year period will provide additional time to evaluate and obtain viable markets for a composted sludge product, and to investigate more fully the viability and feasibility of landfilling or land application; expending resources and effort on a more detailed site specific analysis if necessary.

Finally, a sludge management plan will be shortly undertaken for the Wanaque Valley Regional Sewerage Authority in northern Passaic County. A five year commitment will provide ample time for the TWPSA to also consider an expanded regional approach, either a total or partial involvement, to the disposal of their sludge wastes.

2.0 INTRODUCTION

2.1 Events Leading to Report

A sludge management plan was presented to the Totowa-West Paterson Sewerage Authority (TWPSA) in a planning report titled "Wastewater Management Study Facilities Plan" as prepared by Pandullo, Chrisbacher and Associates in August 1974. This plan involved the incineration of dewatered sludges generated by the Totowa-West Paterson Sewerage Authority's wastewater treatment facilities.

In January 1977 a report prepared by Pandullo Quirk Associates and titled "Step One Document" was issued which upgraded the August 1974 work effort to comply with PL 92-500 requirements. This "Step One Document" did not explore any new sludge management issues in any substantial fashion. Incineration of dewatered sludges, therefore, remained as the choice sludge management process.

A letter to the TWPSA, expressing concern regarding the inflationary rise of the cost for operating and maintaining incinerators, was issued by the USEPA. Furthermore, the Authority was requested to reevaluate sludge disposal alternatives with additional consideration to be given to such alternatives as composting, landfilling and land application.

In response to this request by EPA, Pandullo Quirk Associates submitted to the TWPSA in May, 1977 a "Step One Phase Proposal" for the re-evaluation of the sludge management alternatives involving incineration, composting, landfilling and land application. Final authorization to proceed with the proposed re-evaluation was received in April of 1978.

This report, therefore, is responsive to present Authority sludge management planning requirements.

2.2 TWPSA Sludge Management Requirements

The TWPSA is required, by the regulations and requirements promulgated within PL 92-500 and by the USEPA, to develop a twenty (20) year sludge management plan that is cost-effective, environmentally sound and implementable. Furthermore, EPA mandates have eliminated ocean dumping as a viable sludge management Alternative beyond December 31, 1981.

The TWPSA must also develop a sludge management plan that complies with the regulations set forth in the "Interim Guidelines for the Preparation of 201 Sludge Management Plans." These regulations were established by the State of New Jersey, Department of Environmental Protection, Division of Water Resources, Office of Sludge Management and Industrial Pretreatment. These interim guidelines were developed to also insure that land-based alternatives to ocean dumping of sludge will be available on or before December 31, 1981.

Presently, TWPSA's sludge disposal techniques involve ocean disposal. Therefore, a sludge management plan developed for the TWPSA must satisfy the disposal needs of the Authority for a twenty year planning period while complying with EPA's abatement schedule of current ocean disposal practices.

2.3 Sludge Management Plan Report Objectives

The primary objective of this report is to provide a plan to the TWPSA by which the treatment and disposal of sludge wastes is accomplished in a cost effective, environmentally sound and implementable manner, and that this plan complies with the 1981 ocean disposal abatement schedule.

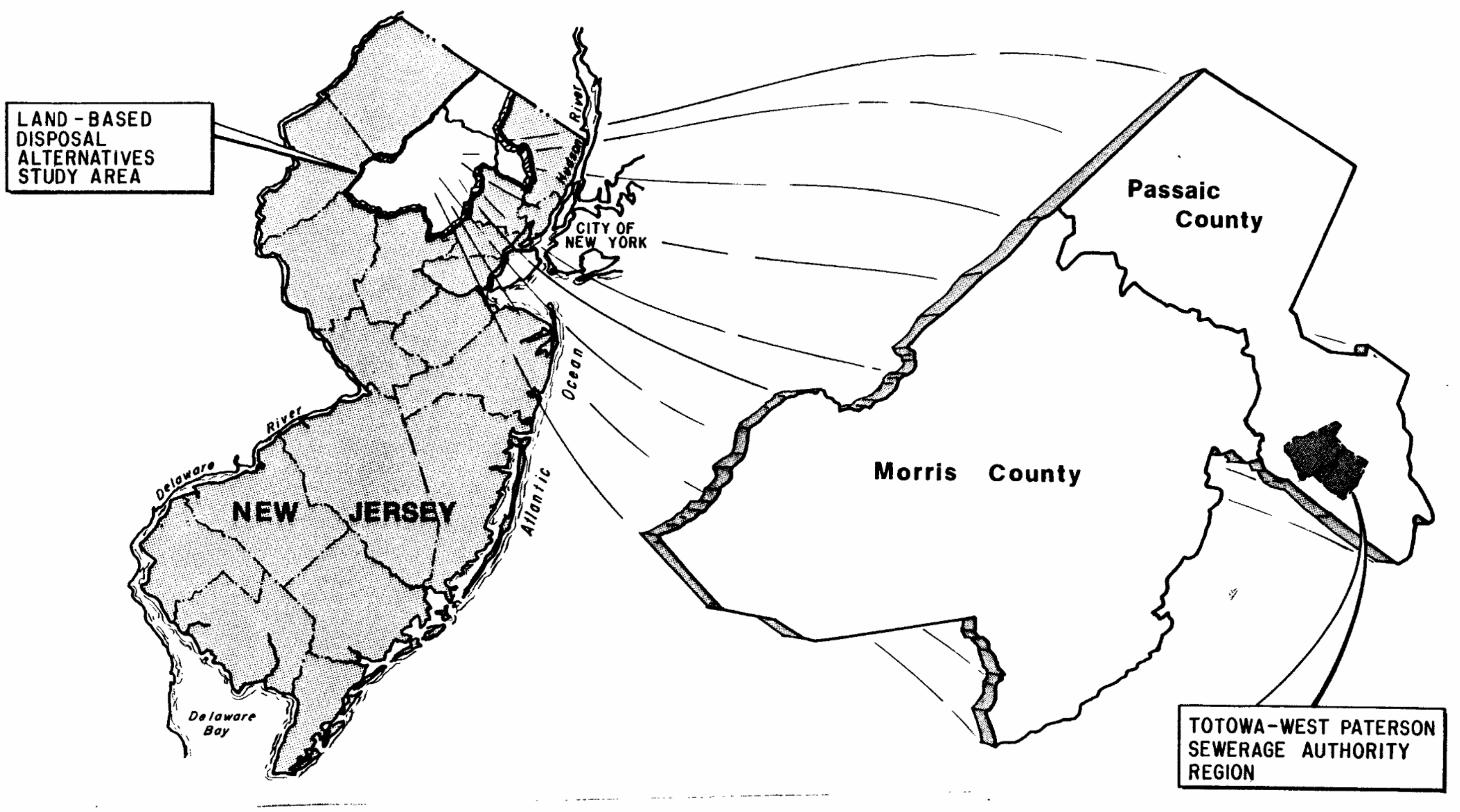
The systematic order, in which sludge management generally proceeds, commences with the generation of sludges through the efficient operation of watewater treatment processes. Collected sludges are then treated through some form of reduction and stabilization process before finally being disposed. This report will first investigate the disposal options that may be available to the TWPSA and applicable to their specific problems. Once disposal options are explored, then sludge treatment processes which will result in a treated sludge that is amenable to the potential disposal options would be investigated.

With the elimination of ocean disposal as a viable disposal option, it is necessary for this report to investigate land-based alternatives involving land application or landfilling of treated sludges. The "Phase 2 Report of Technical Investigation of Alternatives for New York-New

Jersey Metropolitan Area Sewage Sludge Disposal Management Program" prepared for the Interstate Sanitation Commission (ISC) in June of 1976 recommended that wastewater treatment plants (including the TWPSA's plants in Totowa and West Paterson) "apply their sludge to agricultural land in Morris County during the growing season and landfill sludge cake at other times."

This report, therefore, will objectively evaluate and update the ISC recommendation to determine if agricultural land in Morris County is available and if indeed this concept is feasible and viable for the TWPSA to undertake. Furthermore, the investigation of the feasibility and viability of land application will be expanded to include also Passaic County and in particular the Boroughs of Totowa and West Paterson. Figure 1 presents the relative location of the Totowa-West Paterson Sewerage Authority region within the land-based disposal alternatives study area of Morris County and Passaic County.

A second investigation of landfilling as a viable alternative involves consideration of existing landfills that are allowed to dispose sludge wastes and also consideration of constructing new landfills. In order that the construction of new landfills be beneficial, it is the objective of this report to consider the reclamation of barren or otherwise reclaimable land. Therefore, this report effort will limit the consideration of new sites to inactive gravel pits



LOCATION MAP-TWPSA REGION
TWPSA SLUDGE MANAGEMENT PLAN

FIGURE 1

TOTOWA-WEST PATERSON SEWERAGE AUTHORITY

Pandullo Quirk Associates

August, 1978

which may be utilized as landfills and which may be reclaimed for a future beneficial use (i.e., park, golf course, etc.). Gravel pits in both Passaic County and Morris County would be investigated.

A third land-based disposal alternative which is non-land consumptive involves the marketing of a sludge product or the free dispensation of the sludge product to the general public. This report will evaluate, in general, potential markets or outlets for a sludge product or for energy and resource recovery and to determine if any markets or outlets are suitable and available for the TWPSA Sludge Management Plan.

Once disposal alternatives are established, the report work effort will investigate the sludge treatment processes which will produce a sludge product that is amenable to the particular disposal alternative. The investigation will consider but not be limited to incineration, composting and anaerobic digestion. This report will attempt to determine if incineration alternatives proposed in the "Wastewater Management Study Facilities Plan" remain a viable alternative. Is composting of sludge waste to produce a soil conditioner economically viable and implementable to the TWPSA? What will be the economic, technological and environmental limitations imposed on the TWPSA?

Understanding that the TWPSA's problem of sludge treatment and disposal is not unique, this report will evaluate other sludge management plans within the study area. These other sludge management plans may be in existence or may be in the planning stages. Nevertheless, it may be conceivable that consideration of a joint venture, in total or in part, between TWPSA and another authority or municipality may be possible.

3.0 RESOURCE INVENTORY

3.1 Socio-Economic Resources

3.1.1 Existing Land Use - Borough of West Paterson

The following is obtained from the preliminary draft of the "Comprehensive Plan for West Paterson: Land Use," (prepared by R.P. Brown Associates and included here with the permission of RBA):

Over 35% of the Borough's land is devoted to residential use. Four hundred and seventy-one acres, or almost 25 per cent of the total area is in the single family residential category.

Other residential uses include two, three and more family homes and apartments. Two family homes occupy 100 acres and are found primarily in the northwest quadrant of the Borough. This category represents 5.5% of the total area. Apartments occupy 69 acres or about 3.6% of the total. The apartments are of the garden type and are concentrated in roughly the center of the Borough, off of Overmount Drive.

Most commercial uses in West Paterson are interspersed either along McBride Avenue or Route 46. Although there are a variety of uses in both areas, Route 46 primarily contains highway oriented establishments while most of the businesses along McBride Avenue are retail stores and shops. Other smaller commercial areas are found along Great Notch Road and on Rifle Camp Road at its intersection with Mountain Avenue and Overmount Avenue. The focus of office development in the Borough is the New Jersey Bank site. Altogether, commercial uses occupy a total of 92 acres or 4.8 per cent of the Borough's area.

Industrial development is concentrated in the southwestern corner of the Borough, close to Route 46. This category constitutes 121 acres, or 6.3 per cent of the Borough area.

Other uses in West Paterson include public and quasi-public, recreation and public open space uses, vacant land and streets. The public and quasi-public category encompasses a wide range of land uses. It includes such facilities as the Borough's municipal building, library, public schools, parks and churches. This category represents almost 5 per cent of the Borough area. An additional 6.5% is taken up by streets.

Over a quarter of West Paterson is set aside for recreation and public open spaces. These areas are located predominantly along the eastern edge of the Borough and include part of Garret Mountain Park, Rifle Camp Park and land belonging to the Passaic County Water Commission.

Only about 13 per cent of the Borough, or 242 acres, remains in vacant land. The largest amount of this land is found in the eastern and southeastern portions of town.

parcels large enough for significant development as yet exist.

3.1.2 Future Land Use - Borough of West Paterson

Given the built-up nature of the Borough as well as the relative lack of available vacant land, future land use in West Paterson Borough is not expected to alter significantly from the established pattern of development. Vacant parcels of developable land between the two County Parks and in the southern part of the Borough south and west of the reservoir can be expected to eventually develop as low-density residences, consistent with the character of surrounding development. McBride Avenue will most likely remain as the local retail spine of the Borough as conversions of residences to small businesses continue, while highway-oriented businesses will be confined to frontage along Route 46.

Vacant land adjacent to the Squirrelwood Road interchange of Interstate Route 80 is slated for planned unit development, or other similar mixed use, which might comprise an office-commercial complex to augment the existing New Jersey Bank site. The large, mostly vacant Berkeley School site just south of this office site is slated for possible residential or office development in the long-range future, given a phasing out of the school facility. All such possible development is consistent with the Borough's policy of increasing tax ratables in West Paterson. Industrial land uses can be expected to remain confined to the southwestern portion of the Borough on either side of Lackawanna Avenue west of Browertown Road. County parkland on West Paterson's eastern section will continue to provide the major public open spaces in the Borough.

3.1.3 Existing Land Use - Borough of Totowa

As in most communities, the predominant land use in Totowa is residential, comprising just over 50% of the Borough's land area. The higher density areas, which are made up of a mixture of older single and two family homes as well as newer duplexes, are grouped mostly in the eastern end of the Borough south of Union Boulevard and east of Totowa Road. Small-lot single family residential development prevails in the eastern-central portion of the Borough just east of the Union Boulevard interchange of Route 80 and Lackawanna Avenue and south of Minisink Road and Barnert Avenue. It can also be found just northwest of the Training School and east of Riverview Drive. Larger lot, lower density development comprises the remaining residentially-developed areas. These areas can be found mostly in the northern portion of Totowa above Barnert Avenue and east of Totowa Road, although there are smaller pockets of low-density single family homes scattered such as at the intersection of Riverview Drive and Union Boulevard.

The next largest category of land use is public institutional land, comprising almost one quarter of the Borough's acreage. The largest of these are the North Jersey Training

School site in the western portion of Totowa, a portion of the County Golf Course at the Wayne line, and a large cemetery bounded by the bend of the Passaic River, Dewey Avenue and Totowa Road.

The remaining land uses are divided among commercial, industrial, and vacant land. Totowa's arterial-oriented commercial uses are concentrated along Route 46. General business development and offices can be found mostly along Union Boulevard east of Route 80 through the center of the Borough and almost continuously until the cemetery abutting Paterson. Industrial land comprises a substantial proportion of the Borough south and west of the former DL&W Rail Line, especially west of the Riverview Drive above Route 80, and below Route 46, east of Union Boulevard. Smaller concentrations of industry can be found in the northeast portion of the Borough, particularly along Shepherds Lane. Significant parcels of vacant land occur east of the golf course where the Borough bounds Wayne, Haledon and Paterson; east of Totowa Road above Barnert Avenue; along Naakpunkt Brook between Totowa Road and Riverview Drive above the Training School site; and along the former DL&W Rail Line, east of Union Boulevard.

3.1.4 Future Land Use - Borough of Totowa

Due to the built-up nature of the Borough, Totowa's established land use pattern is expected to remain relatively stable. It is anticipated that large-lot single family residential development will eventually deplete much of the remaining vacant land off Huzenga Lane adjacent to the golf course and above Barnert Avenue, further reinforcing the low density development that characterizes Totowa's residential neighborhoods. Recently, there have been additional proposals for higher density residential uses, although they are only preliminary and have only been presented as informal proposals. They include a senior citizens housing development on a parcel just north of the Union Boulevard interchange with Route 80 below Knollwood Road, and a small development of duplexes along Norwood Terrace by the Passaic River where Riverview Drive crosses the Railroad line.

With regard to non-residential land, there has similarly been a preliminary, informal proposal to reduce lot sizes on the predominantly vacant parcel of land along Naakpunkt Brook alluded to earlier. It is hoped that this change would encourage the location of smaller "Research and Development" firms to this section of Totowa. Regarding commercial uses, the Passaic County Planning Board, in its 1973 "Land Use Plan," proposes that general business development be confined to that portion of Union Boulevard between Bogert Street and Hobart Place. This would prevent the piecemeal conversion of buildings to businesses along a main street that often contributes to traffic congestion and blight.

3.1.5 Existing Land Use - Morris County

A recent inventory of land uses was conducted by the Morris County Planning Board. Several conclusions were demonstrated by this inventory, as follows:

1. Only 37% of the land area of the County has been developed.
2. Of all uses, residential uses have been the most predominant, and that among the various residential uses, low density residential use has consumed the greatest land area.
3. The historical importance of agriculture in Morris County, although diminished over the last several decades, was still significantly retained.
4. To the present time, the major concentration of development has been in the eastern and central sections of Morris County.

Viewed historically, the growth of Morris County has proceeded in a logical fashion largely as a result of the following factors: (1) availability of vacant developable land, and (2) proximity to the older and larger economic concentrations of Newark and New York. The pattern of that growth has proceeded east to west, with pressure for development felt first in the areas closest to the urban centers. Presently existing land use reflects that pattern, in that development is both older and more intense in the ring closest to Newark and New York, decreasing in intensity as distance from the Metropolitan area increases. The pattern is usually one of changing uses, with agricultural uses giving way to residential uses, and with commercial and industrial uses added later.

The historical pattern of land use in Morris County has been the development of well-defined towns (Morristown is the best example) with a clustering of commercial and high density residential uses near the center, and lower density residential uses fanning out from them. The development of the towns of Dover, Butler and Boonton has been comparable, where industrial facilities functioned to create a center with decreasingly intense uses around them.

Due to an increasing, highly mobile population, older towns are still visible as centers but there are also great scatterings and discoordinations of land uses. Commercial land uses no longer have any reason to cluster around one another, and they exhibit a dispersed pattern along major roads. Residential facilities no longer have any reason to cluster around commercial facilities, and they too exhibit a dispersed pattern.

The factors which have influenced the growth of Morris County in the past are still present: vacant land, proximity to an urban core, and the existence of a transportation network. Analysis of existing land use gives a fair indication of where such pressures for growth are mostly likely to be felt and what such growth is likely to look like, unless policies governing future land use are altered.

3.1.6 Future Land Use - Morris County

The objectives for the future of Morris County, as recommended by the Morris County Planning Board, are as follows:

1. Location of new economic activities within existing economic concentrations, related to transportation and utilities.
2. The gathering of intensive land uses into clusters, with progressively less intense uses radiating outward from them.
3. Acquisition of sufficient public open space.
4. Adequate water management.
5. Creation of a variety of housing types and densities; provision for lower cost housing.
6. Preservation of Morris County's historical heritage.
7. Coordination of plans with other agencies and governmental levels.

If these foregoing objectives are accepted as desirable, it is evident that they must necessarily alter those projections which were made assuming a continuance of the present trends. Projecting forward any analysis of present trends shows two things clearly: that to a large extent the older town centers are petrifying; and that the greatest pressure for new growth is being felt in the western section of the County, primarily in the Mendhams, Chesters, Washington Township, Mount Olive, and Western Roxbury, where there are large reserves of land suitable, on a strictly physical basis, for all types of development. Population growth estimates for the decade 1970-80, based on current trends, indicate that old centers such as Morristown, Dover and Chatham will grow by less than 7%, while Mendham Township is estimated to grow 70%, Washington Township 74% and Mount Olive over 300%.

As an objective for the future, the Morris County Planning Board is committed to the cluster concept, i.e., that new economic activity be located within existing economic concentrations, that more intensive use be made of lands which are to be used at all, and that in the interest of economy and efficiency, new growth show some coordination with transportation systems and utility networks.

3.1.7 Existing Land Use - Passaic County

For purpose of delineating existing land use, Passaic County was divided into three distinct regions: urban, suburban, and rural. The municipalities in each region are as follows:

- Urban - Clifton, Haledon, Hawthorne, Passaic Paterson, and Prospect Park.
- Suburban - Little Falls, North Haledon, Pompton Lakes, Totowa, Wayne, and West Paterson.
- Rural - Bloomingdale, Ringwood, Wanaque, and West Milford.

The municipalities in each group have common characteristics and differ markedly from the municipalities in the other groups. The main bases for distinction can be found in the difference in the amount of developed land and population densities. The urban areas contain an overwhelming proportion of the County's population (76 percent) on a small portion of the land area (15 percent). In the suburban areas, the proportion of population (18 percent) to land area (21 percent) is more even. Rural areas of the county contain land area (63 percent of the county total) in a proportion ten times that of the county's population share (6 percent).

The following excerpt from the Areawide Land Use Element of the Passaic County Master Plan (Passaic County Planning Board, 1973), prepared by the Planning Association of North Jersey, accurately depicts existing land use:

> "...the rural areas display the least tendency toward total development concentration since the buildings are scattered along the roads and the rugged topography restricts sprawling development. However, the resort developments have real focal points with development concentrated around them. The urban development on the one hand is usually centered around the shopping facilities and the old established industrial areas, while the major development in the northern areas centers around the lakes and ponds. The suburban and developing regions have combined areas of vacant and residential development with spotted commercial sections. One aspect of the rural and suburban development that bears significance is the scattered pockets of established commerce and residence along the valley floors. These pockets have varying problems of age, density and building coverage similar to the urban problems throughout the State. Pompton Lakes, Totowa, Bloomingdale and the lake development in West Milford are examples of where these pockets of dense development exist."

The characteristics which distinguish the three groups of municipalities provided straightforward conclusions about the county's land use. As the proportion of land devoted to residential, commercial, and industrial uses decrease, the

County becomes more rural. At the same time, more rural areas show greater percentages of land which are vacant or devoted to public uses. The major reasons for such large propositions of public vacant land in the northern rural areas are the location of several state parks, numerous reservoirs and watershed properties, and much rugged topography incapable of being developed.

3.1.8 Future Land Use - Passaic County

Formulation of a county land use plan was based in large point on land use planning at the municipal level. Local master plans and zoning ordinances were molded into general land use proposals for the county as a whole. Residential uses are represented by high, medium and low density categories.

Low density residential areas include single and two family homes. Medium density areas represent multi-family area up to sixty units per acre. High density areas include multi-family areas of over sixty dwelling units per area. The predominant land use will be low density residential. High density residential use will be provided only in Paterson and the section of Wayne surrounding the Willowbrook Mall.

Wayne, Clifton, Passaic and Paterson will contain the most significant concentrations of office uses. Proposed industrial uses are located throughout the county with heavy concentrations in Clifton, Paterson, and Wayne. Slightly smaller concentrations are indicated for West Milford and Ringwood.

The upper-County communities of Bloomingdale, Ringwood, Wanaque, and West Milford will continue to contain large conservation and watershed areas. It is likely that most of these will remain undeveloped. It is also expected that continued development of the up-County communities will occur at a very slow rate.

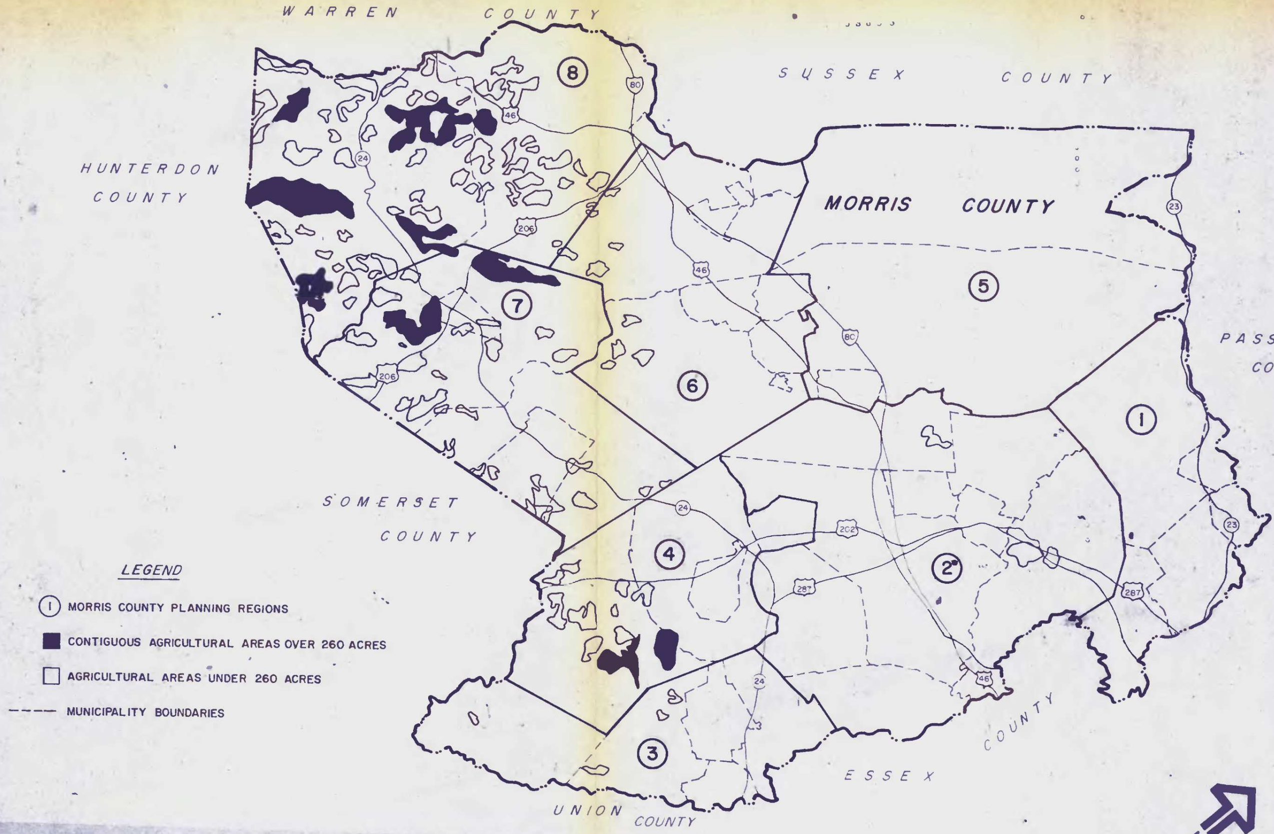
3.1.9 Distribution of Agricultural Land

Agricultural land has steadily declined in importance in terms of the total economic base of Morris County. In 1970, some 25,188 acres were listed in tax assessment records as qualified or active farmlands, less than 1/12 of the entire land area of the County. Undoubtedly, this figure has been reduced even further since 1970.

The nearest agricultural activity of any significance to the jurisdictional territory of TWPSA is located in southwestern Morris County in those areas defined by the Morris County Planning Board as Planning Regions 7 and 8 refer to Figure 2 entitled "Distribution of Agricultural Lands in Morris County." Planning Regions 7 and 8 contain the following municipalities:

Planning Region 7

- Chester Borough
- Chester Township
- Mendham Borough
- Mendham Township



DISTRIBUTION OF AGRICULTURAL LANDS IN MORRIS COUNTY
TWPSA SLUDGE MANAGEMENT PLAN

TOTOWA - WEST PATERSON SEWERAGE AUTHORITY
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Planning Region 8

- Mount Olive Township
- Washington Township

Planning Region 7 contains 7,052 acres of agricultural land and Planning Region 8 contains 14,204 acres of agricultural land. Both regions combined contain over 84 percent of the County total agricultural lands. The ISC Report also identified region 7 and 8 as areas of agricultural significance. Table 1 presents a breakdown of 1970 agricultural acreage in Morris County by Planning Region.

As noted in the discussions of existing land use for Passaic County within report section 3.1.7, a large mass of land is devoted to open spaces as public vacant land. Since no sizable parcels of agricultural land are located in Passaic County, particular attention has been given to the possible use of this vacant land for the purpose of sludge application. Although primary consideration for land application of sludge is given to agricultural lands, the consideration of vacant lands in Passaic County does not eliminate the County entirely as a possible source of viable sludge disposal alternatives.

Figure 3 illustrates the distribution of vacant lands within Passaic County with particular attention given to areas in excess of 260 acres. The largest acreage of vacant land is situated in the rural areas of Passaic County, comprising the municipalities of Bloomingdale, Ringwood,

TABLE 1

AGRICULTURAL ACREAGE BY PLANNING

REGION IN MORRIS COUNTY, 1970

TWPSA SLUDGE MANAGEMENT PLAN

Planning Region Number	Agricultural Area (in Acres)	Per Cent of Total County Agricultural Land
1	277	1.10
2	1,397	5.56
3	160	0.64
4	343	1.35
5	533	2.12
6	1,222	4.85
7	7,052	28.00
8	14,204	56.38
County Total	25,188	100.00

Source: Morris County Planning Board

DISTRIBUTION OF VACANT LANDS IN PASSAIC COUNTY
TWPSA SLUDGE MANAGEMENT PLAN

TOTOWA – WEST PATERSON SEWERAGE AUTHORITY
Pandullo Quirk Associates
August, 1978

FIGURE 3

Wanaque, and West Milford. Most of this vacant land acreage is located on existing potable water watershed areas.

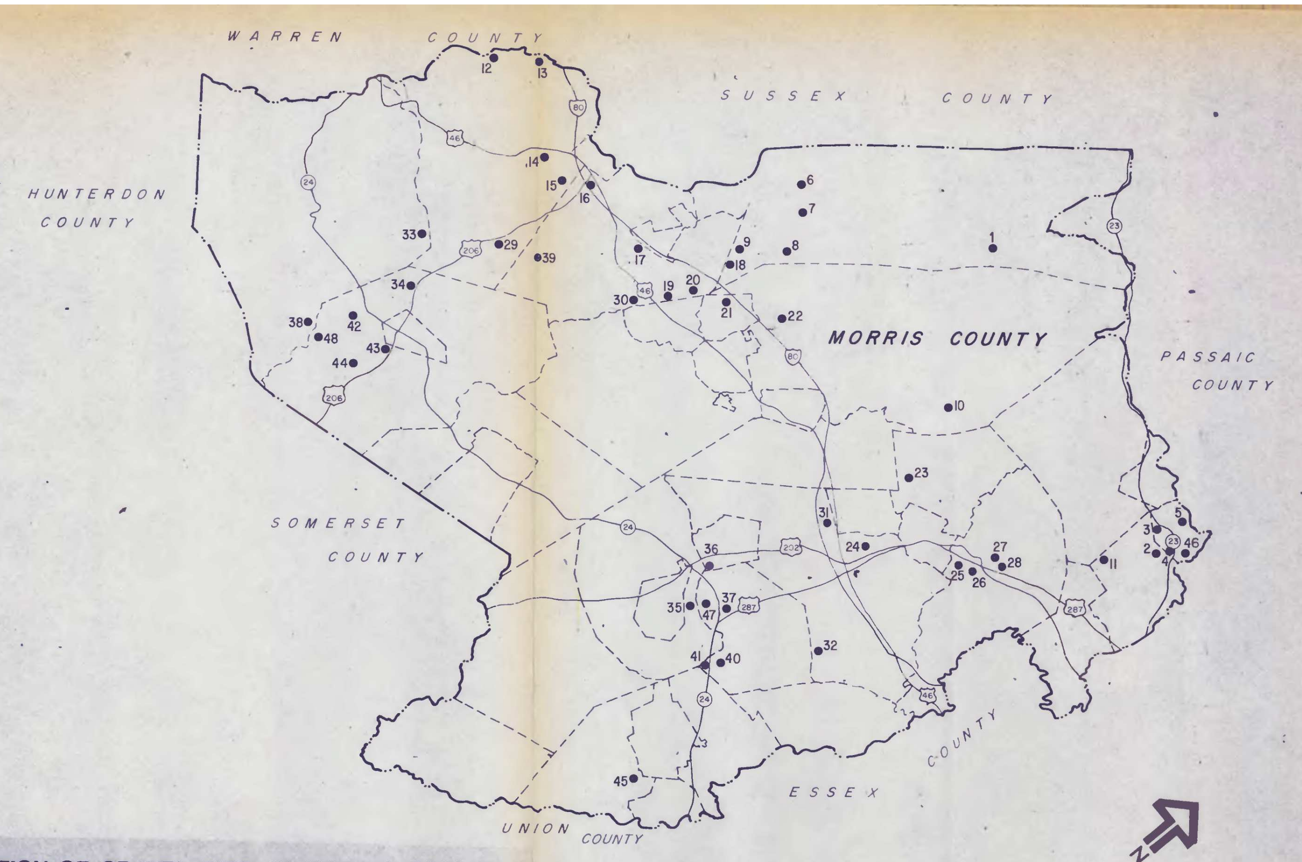
3.1.10 Distribution of Reclaimable Disturbed Areas

Reclaimable disturbed areas were appropriately defined as active or inactive gravel pits as identified in the U.S.D.A. Soil Conservation Service soil classification reports for Morris and Passaic Counties.

Consideration of utilizing an existing disturbed area as a disposal alternative offers two benefits. One, is the alleviation of a sludge management problem. The other is the reclamation of a disturbed area for a beneficial use such as a recreational area.

Approximately 79 reclaimable disturbed areas were located in the study area. Approximately 48 were located in Morris County as shown on Figure 4 entitled "Distribution of Gravel Pits in Morris County" and 31 in Passaic County as shown in Figure 5 entitled "Distribution of Gravel Pits in Passaic County." Of those disturbed areas in Passaic County, Figure reference #78 is located in the southwestern corner of the Borough of West Paterson, while the other Figure reference #79, is located along Rt. 46 and Riverview Drive in Totowa.

As noted on Figures 4 and 5, disturbed areas are distributed fairly uniformly throughout both counties. The smaller pits were generally located in or near urbanized areas, while



DISTRIBUTION OF GRAVEL PITS IN MORRIS COUNTY
TWPSA SLUDGE MANAGEMENT PLAN

TOTOWA-WEST PATERSON SEWERAGE AUTHORITY

Pandullo Quirk Associates

August, 1978

0 10 20
FT IN THOUSANDS

FIGURE 4

DISTRIBUTION OF GRAVEL PITS IN PASSAIC COUNTY
TWPSA SLUDGE MANAGEMENT PLAN

TOTOWA WEST PATERSON SEWERAGE AUTHORITY

Pandullo Quirk Associates

August, 1978

FIGURE 5

larger pits were found in outlying rural and sparsely populated areas of the two counties.

3.2 Environmental Resources

3.2.1 The Natural Resources of Passaic and Morris Counties

Most of northwestern Passaic and Morris Counties are part of the physiographic province known as the New Jersey Highlands--rugged, wooded mountains running northeast-southwest. These mountains are primarily Precambrian granite and gneiss. The valleys carved between these mountains are primarily shale and limestone. The topography of the region lends itself to the formation of streams and rivers in the valleys and ponds and lakes in many of the natural mountain depressions. Various rivers of the Passaic system have been impounded to form reservoirs in this northwestern area. The various rivers in this area include the Rockaway, Wanaque, Pequannock and Musconetcong.

The Highlands give way on the southeast to the mid-New Jersey Piedmont Province. This region is primarily sedimentary rock laid upon deeply eroded Precambrian and Paleozoic formations. Geologic history depicts this area as having once been part of a great estuary of the Atlantic Ocean--hence the gently rolling hills composed of shale and sandstone. The topography is relieved only by three basalt sheets known as the Watchung Mountains. Defined water systems are, therefore, not as common as in the Highlands. Streams and rivers meander and tend to excessive flooding during intense storms.

Aquifer recharge areas generally occur in tracts of unstratified drift and alluvial lands. These generally occur beneath and along streams and rivers, as in the Rockaway River and the Budd Lake/South Branch Raritan systems. Most of the water supply for these counties is via wells-municipal or private. Because the water-layed strata of the Piedmont region is several hundred feet thick, the wells are usually continuously recharged through ground water movement and surface water percolation in the area of the well.

3.2.2 Soils - Requirements for Land Application

In selecting possible sites for sludge application, consideration must be given to the geological and topographical characteristics of the sites and also to the physical and chemical characteristics of the soils. Concern for these characteristics is necessary to insure no adverse affects upon the water quality of the surrounding groundwater and surface water and to insure proper treatment of the applied wastes by the soil. Further concern must be directed to the quality of the waste to be applied, the quantity of the sludge, and the method by which it is to be applied.

Generally, a site is desirable if it exhibits good soil infiltration and percolation, is sloped to offer little or no runoff, contains suitable vegetation to deter erosion, has adequate depth to groundwater, and is safely located away from water wells and surface waters. Also most desirable are soils that are chemically and physically structured to affect removals or containment of nutrients, heavy metals, and solids found in the applied sludge, and to allow suitable aeration within the soil and water movement throughout the soil.

The site for sludge application must be sloped at an incline so that ponding of the sludge does not occur. Such ponding will result in a stagnant situation conducive to anaerobic reactions producing offensive odors and possible unhealthy conditions. The slope of the site, however, must not be inclined such that the sludge will not infiltrate into the soils and thus result in runoff problems.

The geological considerations of possible sludge application sites include the permeability of the soil, the amount of earth cover to any groundwater table, distance of sludge application sites to surface waters, and the frequency of the application site to flooding.

The chemical characteristics of soil which may determine the suitability of the application site include pH and the soils cation exchange capacity (CEC). Soil pH in the neutral range (5.5 to 7.0) will allow the microorganisms in the soil to decompose sludge. pH levels above 6.0 will allow the precipitation of heavy metals to occur, which will result in the soils filtration of these metals thus rendering them inaccessible to plants or crops. A pH less than 5.5 increases the availability of heavy metals to the crops.

An increase in the soil's pH from an acidic condition to a neutral condition greatly increases the cation exchange capacity (CEC) of the soil. This CEC is the ability of the soils to adsorb cationic elements (elements with plus (+) valances). Soils with higher cationic capacity have greater ability of adsorbing metals. Soils with an increase in both organic content and clay content will result in an increase of the CEC. Ranking of soils relative to the CEC ability is that organic soils are ideal, followed by fine, medium and then coarse soils.

Physical characteristics of soil that are of concern for selecting a land application site include texture, structure, soil erodibility, and soil permeability. The physical character of the soil should be such that the permeability allows adequate infiltration without resulting in unmanageable amounts of runoff. The site should have the physical characteristics such as slope and vegetation to allow minimum, if any, soil erodibility. An undesirable soil characteristic is massive subsurface structure that may restrict water movement. This poor subsurface structure may result in poor aeration and drainage.

Generally, loams or sandy loams offer very few limitations to sludge application. As the clay content of soils increase, as exhibited by clays, silty clays, clay loams, and silty clay loams, major limitations such as poor drainage, poor aeration, and slow permeability result. Sands and loamy sands exhibit low cation exchange capacity, low buffer capacity, low phosphate retention capacity, and leaching of nitrates and other soluble elements of sludge.

Table 2 presents a summary of the topographical, geological and physical characteristics of soils suitable for sludge application. These parameters were applied to the soil descriptions contained within the U.S.D.A. Soil Conservation Service cataloging of soils for Passaic and Morris County. As a result of the application of these parameters to the soils within the study area, tabulations of soils which area suitable for Passaic and Morris Counties were developed and presented in Tables 3 and 4 respectively. None of the soils in Passaic County are generally suitable for land application but analysis of specific sites in the soil types listed might show areas which could lend themselves to successful useage.

3.2.3 Surface Waters

Land application, landfill and composting sites may significantly impact nearby surface waters and, therefore, siting requirements must include an evaluation of surface water proximity.

Surface waters to be evaluated include lakes, ponds, rivers and streams. Small streams are as important to consider as larger surface waters as they are tributary to those larger bodies. A pollution impact in a tributary will eventually affect the main body.

TABLE 2

SOIL SUITABILITY FOR SLUDGE APPLICATIONS

TWPSA SLUDGE MANAGEMENT PLAN

Item Affecting Use	Soil Potential				
	Very Good	Good	Moderate	Poor	Very Poor
Drainage class and approximate depth in inches to permanent or fluctuating water table	Well drained >36	Moderately well drained 18-36	Somewhat poorly drained 12-18	Poorly drained 6-12	Very poorly drained <6
Total Water-holding capacity (in H20)/ rooting depth)	>6	4-6	3-4	2-3	<2
Slope (%)	<3	3-8	8-15	15-25	>25
Rooting depth (in. to root restricting horizon)	>40	30-40	20-30	10-20	<10
Trafficability (Unified soil group)	GW,GP,SW, SP,GM,GC, SM,SC,Pt. (drained)	CL with PI<15	ML, CL with PI >15	OH, OL, MH	CH, Pt (undrained)
Permeability class (in./hr. in least permeable horizon)	0.6-2.0	2.0-6.0	>6.0	0.6-0.06	<0.06
Erosion	None to slightly eroded	Slightly eroded	Moderately eroded	Severely eroded	Very severely eroded
Stoniness and rockiness	0	1	2	3	4 and 5
pH in B horizon	>7.0	6.5-7.0	6.0-6.5	5.5-6.0	<5.5
Texture	sil	l, sicl	sl, cl	scl, c	s, (is not irrigated)

TABLE 3

SUITABLE SOILS FOR LAND APPLICATION AND LANDFILLING IN PASSAIC COUNTY
TWPSA SLUDGE MANAGEMENT PLAN

Soil Type	(%) Slope	Horizon (inches)	Texture	Permeability in./hr.	Depth to Ground H20	Cation Exchange Capacity	pH	Limitations for Septic Tank Absorption Fields/Explanation*	Limitations for Landfill/Explanation
BrB	3-5	A 0-8 B 8-30 C 30-60	silt loam sandy to gravelly sandy loam gravelly sandy loam	.6-2.0 .6-2.0 <.2	1-1/2-4′	8	4.5-5.0 4.5-5.5 5.1-6.5	Moderate - seasonal high perched water table above fragipan; slow permeability; special design needed for deep trenches	Moderate - seasonal high perched water table above fragipan; bedrock at depth of 6′ or more
BrA	0-5	A 0-7 B 7-38 C 38-60	gravelly silt loam gravelly loam gravelly loamy sand	.6-2.0 <.2-2.0 >6.0	1-1/2-3′	7	4.5-5.0 4.5-5.5 5.6-6.0	Moderate - seasonal high H20 table at 1-1/2-3′; special design needed for deep trenches; hazard of ground H20 pollution	Moderate - seasonable high H20 table at 1-1/2-3′; hazard of ground H20 pollution
CkB	3-8	A 0-8 B 8-26 C 26-60	silt loam gravelly silt loam very gravelly sand	.6-2.0 .6-2.0 >6.0	>6′	12	4.5-5.5 4.5-5.5 4.5-5.5	Slight - rapid permeability in substratum; hazard of ground H20 pollution	Severe - rapid permeability in substratum; hazard of ground H20 pollution
NkC	3-15	A 0-5 B 5-36 C 36-60	gravelly loam gravelly sandy loam cobbly loamy sand	.6-2.0 .6-6.0 >6.0	>6′	7	4.5-5.0 5.1-5.5 5.1-5.5	Severe - extremely stony; hazard of ground H20 pollution	Severe - extremely stony; hazard of ground H20 pollution
OrC	3-8	A 0-10 B 10-23 C 23-60	sandy loam gravelly sandy loam to gravelly loamy sand very gravelly sand	2.0-6.0 2.0->6.0 >6.0	>6′	4	4.5-5.5 4.5-5.5 4.5-5.5	Slight - rapid permeability in subsoil and substratum; hazard of ground H20 pollution	Severe - rapid permeability in subsoil and substratum; hazard of ground H20 pollution
RhB	3-8	A 0-10 B 10-36 C 36-60	sandly loam gravelly sandy loam gravelly sand	2.0-6.0 2.0-6.0 >6.0	>6′	4	5.1-5.5 5.1-5.5 5.1-5.5	Slight - rapid permeability in subsoil, hazard of ground H20 pollution	Severe - rapid permeability in subsoil; hazard of ground H20 pollution
RmB	3-8	A 0-4 B 4-38 C 38-72	gravelly sandy loam gravelly loam to gravelly loamy sand gravelly sandy loam to gravelly loamy sand	.6-2.0 <.2-2.0 <.2-6.0	1-1/2-2-1/2′	7	4.5-5.5 4.5-5.5 4.5-5.5	Moderate - Slow permeability; deep ditches needed in places; lateral seepage above fragipan; very stony	Moderate - seasonal high H20 table at 1-1/2-2-1/2′ for short periods
RrC	3-15	A 0-4 B 4-38 C 38-72	gravelly sandy loam gravelly loam to gravelly sandy loam gravelly sandy loam to gravelly loamy sand	.6-2.0 <.2-2.0 <.2-6.0	1-1/2-2-1/2′	7	4.5-5.5 4.5-5.5 4.5-5.5	Severe - extremely stony	Severe - extremely stony
RsC	3-15	A 0-4 B 4-38 C 38-72	gravelly sandy loam gravelly loam to gravelly loamy sand gravelly sandy loam to gravelly loamy sand	.6-2.0 <.2-2.0 <.2-6.0	1-1/2-2-1/2′	7	4.5-5.5 4.5-5.5 4.5-5.5	Moderate to Severe - Moderate where very stony; slow permeability; deep ditches needed; severe where extremely stony	Severe - seasonal high H20 table at 1-1/2 - 2-1/2′
SdB	3-8	A 0-4 B 4-60	gravelly fine sandy loam gravelly sandy loam	.6-2.0 <.2-2.0	1-1/2-2′	6	<4.5-5.0 4.5-5.0	Severe - slow permeability	Moderate - very stony
SeB	3-8	A 0-4 B 4-60	gravelly fine sandy loam gravelly sandy loam	.6-2.0 <.2-2.0	1-1/2-2′	6	<4.5-5.0 4.5-5.0	Severe - slow permeability	Severe - extremely stony
SrC	3-15	A 0-4 B 4-60	gravelly fine sandy loam gravelly sandy loam	.6-2.0 <.2-2.0	1-1/2-2′	6	<4.5-5.0 4.5-5.0	Severe - slow permeability	Severe - extremely stony

*These limitations may apply to Land Application areas.

TABLE 4

SUITABLE SOILS FOR LAND APPLICATION AND LANDFILLING IN MORRIS COUNTY
TWPSA SLUDGE MANAGEMENT PLAN

Soil Type	(%) Slope	Horizon (inches)	Texture	Permeability in./hr.	Depth to Ground H2O	Cation Exchange Capacity	pH	Limitations for Septic Tank Absorption Fields/Explanation*	Limitations for Landfill/Explanation
AnB	3-8	A 0-11	gravelly loam	.6-2	>10′	12	6.1-6.5	Moderate - slow permeability in fragipan requires deep trenches	Slight -
		B 11-44	gravelly clay to sandy loam	<.2-2			5.6-6.5		
		C 44-76	gravelly sandy loam	.6-2			6.6-7.3		
BoB	3-8	A 0-6	gravelly loam	.6-2	1-1/2-6′	8	4.5-5.5	Moderate - seasonal high water table perched over fragipan; slow permeability in fragipan	Slight - seasonal high water table at a depth of 1/2 ft. to 2-1/2 ft.; lateral aeepage above fragipan likely in places
		B 6-30	fine sandy loam	.6-2			4.5-5.5		
		30-45	gravelly fine sandy loam	>.2			5.6-7.3		
		C 45-60	gravelly sandy loam	.2-.6			5.6-7.3		
EdB	3-8	A 0-10	gravelly loam	.6-2	>10′	11	4.5-5.5	Slight - granite gneiss bedrock at a depth of 6 to 10 ft. or more	Slight -
		B 10-37	sandy to sandy clay loam	.6-2			4.5-5.5		
		C 37-60	sandy loam	.6-2			4.5-5.5		
NeB	3-8	A 0-8	gravelly silt loam	.6-2	>10′	15	5.6-6	Slight - bedrock at a depth of 6′ or more in most places; stony in places	Slight to Moderate - Hard bedrock at a depth of 6 to 10 ft. or more
		B 8-39	gravelly to cobbly clay loam	.6-2			5.6-6		
		39-54	cobbly clay loam	.6-2			5.6-6		
		C 54-60	sandy loam	.6-2			5.6-6		
Rob	3-8	A 0-8	cobbly sandy loam	.6-2	1-1/2-10′	7	4.5-5.5	Moderate - needs deep ditches in places; lateral seepage above fragipan	Slight -
		B 8-20	gravelly sandy loam	.6-2			4.5-5.5		
		20-40	gravelly sandy loam	<.2			4.5-5.5		
		C 40-60	gravelly sandy loam	.6-2			4.5-5.5		
WaB	3-8	A 0-7	loam	2-6	>10′	16	5.6-6	Slight - hazard of groundwater pollution where bedrock is cavernous	Slight to Severe- severe where bedrock is cavernous
		B 7-20	loam	.6-2			5.6-6		
		C 20-78	silt, clay loam	.6-6.0			6.1-7.3		

*These limitations may apply to Land Application areas.

It is generally recognized that sludge or compost application should not be undertaken within 200 feet of surface waters, nor anywhere within a watershed area. This distance is necessary to prevent possible overland runoff from the site to the water body.

3.2.4 Groundwater

The groundwaters of Passaic and Morris Counties form an integral part of the hydrologic character of the study area. The groundwaters of these areas are used for human consumption, agricultural irrigation and for municipal/industrial purposes. Therefore, pollution of the water table might seriously impact the consumers dependent upon groundwater for consumption. Through lateral seepage of the groundwater, nearby surface waters might also become polluted.

It is important that siting of facilities (land application, landfill and composting sites) avoid areas with high water tables and areas near public or private water wells. To insure protection of user supplies, the land application site should be a minimum of 1,000 feet from the nearest public water supply and 500 feet from the nearest private water supply well. For landfill sites, the Environmental Protection Agency guidelines recommend a minimum of 1/4 mile (1,320 feet) between a site boundary and a water source.

All sludge facility sitings should avoid major aquifer recharge areas. Often the soils associated with recharge areas are such that siting would be eliminated by said constraints.

3.2.5 Ecosystems Associated with Appropriate Soils

Four major land use features were represented on those soils shown as suitable for land application. These land uses include forests, developed areas, agricultural land and old fields.

Upland forests are valuable wildlife habitats that should be maintained. These ecosystems have been substantially altered in past years by clearing for cultivation and various development projects resulting in large acreage reductions. Additional loss of this valuable habitat relative to the siting of a sewerage sludge disposal area would not be justifiable when other less ecologically important sites may be available (e.g., old fields, agricultural land, gravel pit sites).

Developed areas are undesirable for facility siting simply because they are unavailable. Siting near developed areas is not recommended because of the potential odor and aesthetic problems.

Agricultural land provides a potential for land application sites. The use of these areas for land application sites, however, is subject to detailed consideration of sludge characteristics, background levels of nutrients and heavy metals in the receiving soils and the requirements and tolerance level of crops to be grown on these soils. Of course, consideration of groundwater and surface waters, as previously discussed, are important in the site selection process.

Old fields offer a potential for siting of new landfills and land application sites since most of these areas were once cultivated. Similar concerns as noted for the discussion of land application sites are applicable for old field disposal sites (e.g., groundwater and surface waters, nearby development).

While the suitable soils do not include any wetland areas, some of these areas may be located in close proximity to wetland areas. These areas should be completely avoided in the site selection process or adequate buffering should be implemented.

3.2.6 Climate, Meteorology, Air Quality

Climate

The climate in North Jersey has been referred to as "continental" which is characterized by cold winters and moderately hot summers. The variation in average temperature is approximately 40 degrees or more from the coldest to the warmest month. The actual mean average temperature recorded at Little Falls, New Jersey, just south of the Totowa-West Paterson area is 52.6 degrees F. The mean monthly temperature varies from 30.1 degrees F to 74.8 degrees F. New Jersey's position on the Atlantic Coast places it in the midst of the cold air masses moving down from Canada in the winter.

The average annual rainfall in the area for the past 72 years has equalled 49.92 inches, which is slightly higher than the average annual rainfall for the entire State of New Jersey of 44.95 inches. During periods of drought, 30 to 35 inches of rainfall may be the norm whereas excessively wet years may average 70-75 inches. The months of highest precipitation are normally July, August, and September, when heavy thunderstorms occur. The heaviest rains are usually of tropical origin and cause the most extensive flooding problems in poor drainage areas.

Meteorology

The study area of Totowa-West Paterson, being situated between the Second Watchung Mountain Range and Garrett Mountain (First Watchung Mountain Range) is part of an openended valley. Wind movements are affected by these high ranges and outflows can only occur through the Great Notch Area in the south end and through the wider opening between Garrett Mountain and the First Watchung Mountain on the north end. The surrounding areas with other ridge lines existing which tend to isolate the area from the plains of the lower Hudson River and Atlantic Ocean will also tend to modify wind patterns, particularly at the lower valley levels which will affect pressure gradients, temperatures and wind speeds at different locations.

Generally, the valley slope winds experienced in the area are caused by the changing temperature of air over a slope from day to night. During the day the temperature of the air over a slope will be warmer than air at the same level in a valley. The wind direction is usually upwards on the slope while at night the direction and condition reverses itself. This pattern is also true in the valley where air will flow in during the day and will flow out and down the plain at night as the air in the valley cools. Valley winds and slope winds occur in intermittent patterns as they are affected by many other factors. A thorough analysis of wind patterns, ventilation and the effects of stagnant high pressure systems and a low-level subsidence inversion which have occurred at various times in the past in the study area would be recommended if a major incinerator were to be constructed in the area.

Air Quality

A list of the monitoring sites and measurements of air quality for 1975 was obtained from the Bureau of Air Pollution Control of NJDEP. The annual geometric means of suspended particulate measurements in northeastern New Jersey for 1975 show wide variations between relatively proximate stations. The results from the Paterson and Fairlawn monitoring stations, three miles apart, are $3.86\mu g/m^3$, respectively. Totowa-West Paterson is about two miles southwest of Paterson and five miles southwest of Fairlawn.

The use of the Paterson suspended particulates measurements in projecting the suspended particulates in Totowa-West Paterson represents a calculation of the worst possible annual geometric mean suspended particulates in the study area.

The NJDEP forecasted the 1985 particulate emissions from point sources (i.e., factories, incinerators) for Passaic County based on 1971 measurements and projected population and industrial growth. Using the emissions estimated for Passaic County by the NJDEP in 1971 and 1985, the 1975 emissions for the county were interpolated. Point source emissions for Totowa-West Paterson were then calculated by assuming that the proportion of emissions in Passaic County which were attributable to Totowa-West Paterson were equal to the proportion of the county population residing in Totowa-West Paterson.

The projected 1985 annual geometric mean suspended particulates concentration is 39.3 $\mu g/m^3$, which is below current standard levels. An increase of 0.7 $\mu g/m^3$ is within the normal annual fluctuations observed at monitoring stations in northeastern New Jersey.

3.3 Sludge Generation Sources and Existing Landfill Sites

3.3.1 Existing TWPSA Wasetwater Treatment Facilities

Three municipal wastewater treatment facilities currently exist within the TWPSA regional area. Two facilities are owned and operated by the Borough of Totowa and are known as the West End Treatment Plant and the Riverview Treatment Plant. The Borough of West Paterson owns and operates the third facility which is obviously referred to as the West Paterson Treatment Plant.

West End Tretment Plant

The West End Treatment Plant affords secondary treatment of influent wastewaters at a design capacity of 0.375 MGD. This plant consists of an influent pumping station, two primary settling tanks (combined primary settling tank and sludge digestion tank marketed under the name "clarigesters"), one high-rate trickling filter, two secondary settling tanks and a chlorine contact chamber.

The sludge collected within the clarigesters is digested in unheated compartments beneath the primary settling tank. Waste sludge from the secondary settling tank is recycled to the head of the treatment plant to undergo further settling in the primary settling tanks.

Digested sludge is pumped from the digester and transported for ocean dumping by Modern Transport. This current disposal operation is presently under the 1981 abatement schedule established by the USEPA. An estimated 0.336 MGY of liquid sludge (approximately 8% solids) is generated in the plant resulting in the daily disposal of nearly 900 pounds of dry solids.

Riverview Treatment Plant

The Riverview Treatment Plant is a 1.0 MGD designed capacity, secondary treatment plant, incorporating such units as grit removal and comminution, two primary settling tanks, a high rate trickling filter, secondary settling tanks and a chlorine contact chamber.

Sludge collected within the secondary settling tanks is transmitted to the influent of the primary settling for additional settling. Sludge collected within the primary settling tanks is conveyed to primary and secondary sludge digesters followed by vacuum filtration. Ultimate disposal of the approximate daily generation rate of one dry ton of sludge solids (approximately 4% solids) is accomplished by a contracted scavenger with haul to a sanitary landfill.

West Paterson Treatment Plant

The existing West Paterson Treatment Plant has a design capacity of 0.8 MGD. The facility basically consists of two circular primary clarifiers, a standard-rate fixed nozzle trickling filter, two circular secondary clarifiers, and a chlorine contact tank.

Sludge collected at the bottom of the secondary clarifiers is conveyed to the head of the treatment plant for subsequent treatment by the primary treatment processes. Concentrated sludge from the primary clarifiers is conveyed to two anaerobic digesters for stabilization, then to five sludge drying beds for subsequent dewatering. Approximately 5,000 gpd of sludge (approximately 4% solids) are generated by the West Paterson Plant, which results in an estimated daily generation rate of nearly 2,500 pounds of dry solids. During inclement weather and treatment plant overloading, liquid digested sludge is pumped directly from the digesters and is hauled away for ocean disposal. Dewatered sludge from the drying beds is disposed of at a landfill.

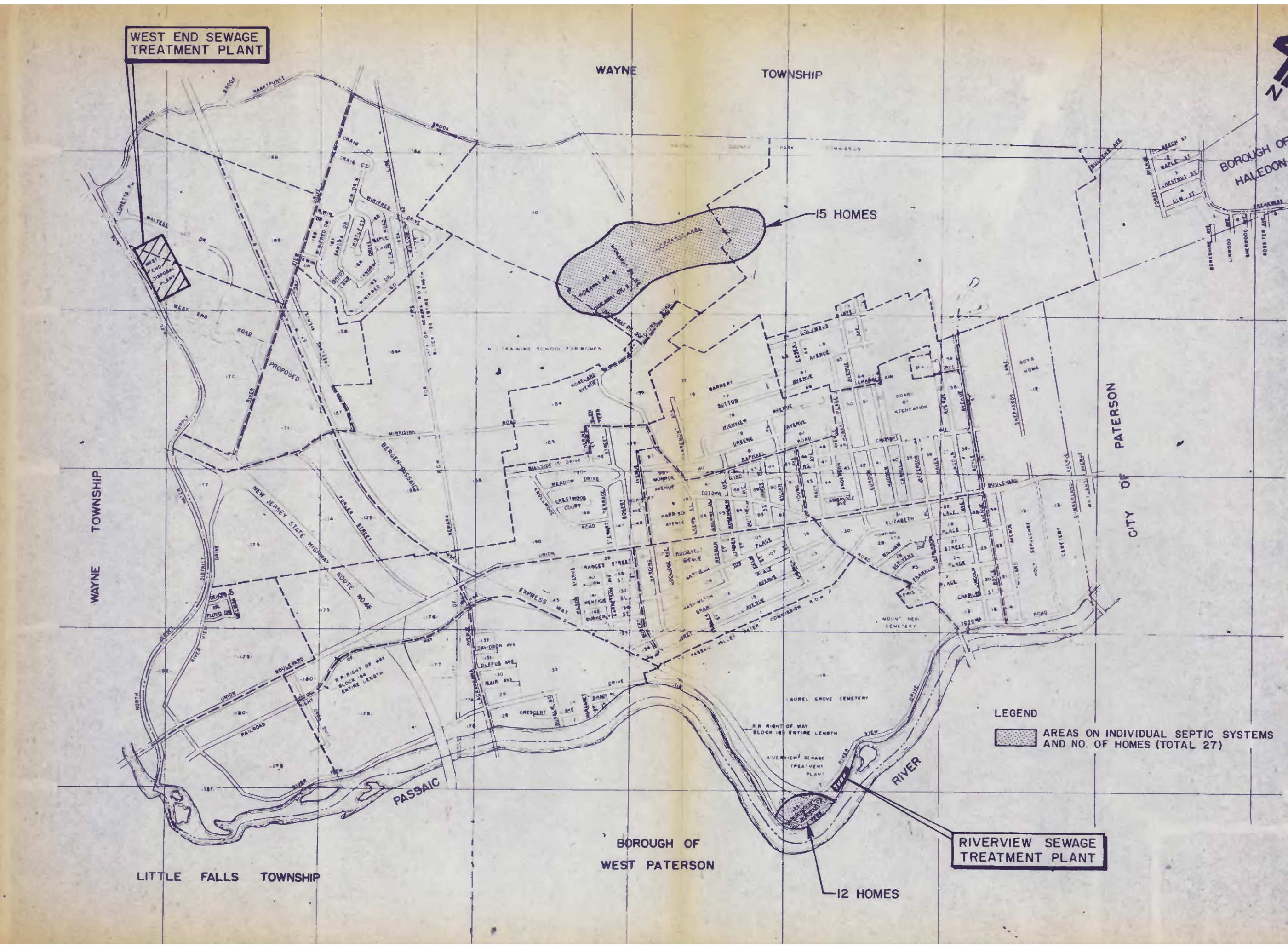
3.3.2 Individual Sewage Disposal Systems

The entire Borough of Totowa is provided sewer service with the exception of 15 homes in the Brookman Lane-Hideway Drive area, and 12 homes in the Norwood Terrace area. These homes are serviced by individual sewage disposal systems, as shown on Figure 6 entitled "Septic Systems Locations-Totowa."

Approximately 330 homes utilize individual sewage disposal systems within the Borough of West Paterson. The locations of these homes are dispersed throughout the western sector of the Borough, as shown on Figure 7 entitled "Septic Systems Locations-West Paterson."

Assuming that all individual disposal systems contain a hydraulic holding capacity of 1,000 gallons, that all systems require periodic cleaning of once every two years, and that the average solids concentration of this clean-out waste is 40,000 mg/l (4% solids), approximately 160 lbs/day of solid wastes would be generated by the individual disposal systems in the TWPSA region.

NJDEP Interim Guidelines for the Preparation of 201 Sludge Management Plans requires that provisions be made for

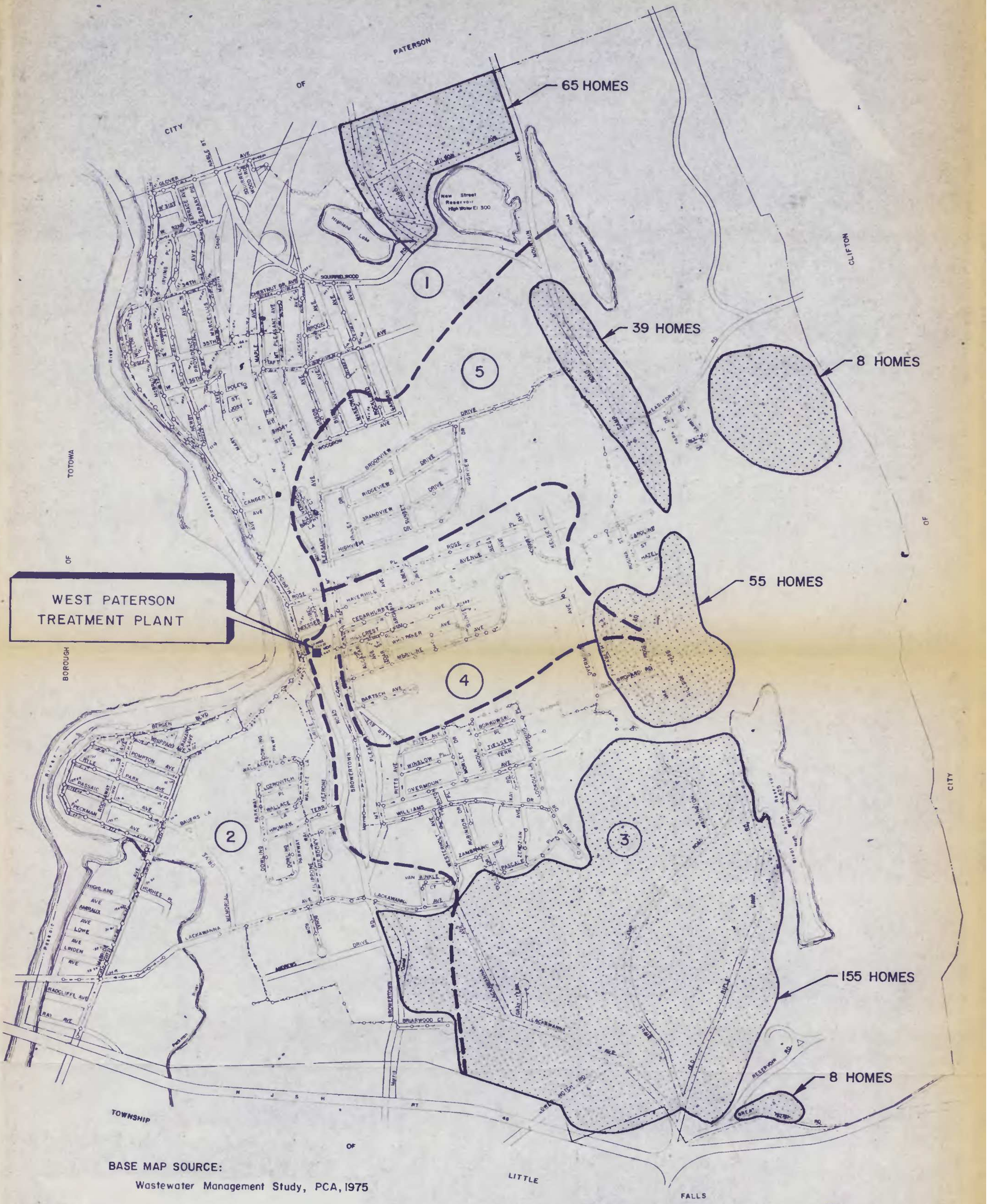


SEPTIC SYSTEMS LOCATION - TOTOWA
TWPSA SLUDGE MANAGEMENT PLAN

TOTOWA WEST PATERSON SEWERAGE AUTHORITY

Pandullo Quirk Associates
August, 1978

FIGURE 6



BASE MAP SOURCE:

Wastewater Management Study, PCA, 1975

LEGEND:

AREAS ON INDIVIDUAL SEPTIC SYSTEMS AND NO. OF HOMES (TOTAL 330)

SEPTIC SYSTEMS LOCATION-WEST PATERSON
TWPSA SLUDGE MANAGEMENT PLAN

TOTOWA WEST PATERSON SEWERAGE AUTHORITY

Pandullo Quirk Associates

August, 1978

0 1000 2000 FT.

adequate treatment and management of all domestic septic tank wastes that will be discharged in the facility planning area. This sludge management plan report suggests that adequate provisions be implemented at the proposed TWPSA's wastewater treatment facilities to handle and treat disposal system pumpages from the area. Such provisions may include a septage waste holding tank or access to a point within the treatment plant site for the direct discharge of septage waste from the pump trucks. It is further suggested that the input of septage waste into a treatment process train be located prior to the preliminary treatment processes such as bar screens, comminution and grit removal. This will insure the safeguard of subsequent plant equipment.

The impact of this additional septage waste on the operations of the wastewater treatment plant processes and the development of a sludge management plan are anticipated to be minimal.

3.3.3 Industrial and Institutional Wastewater Treatment Facilities

Five private wastewater treatment facilities exist within the TWPSA region, of which four are operated by industries. These industries include two chemical operations, one pharmaceutical operation and one baking operation, and are listed below:

Vanguard/Bomont Industries (chemical)
Ungerer Co. (chemical)
Hoffman-LaRoche, Inc. (pharmaceutical)
S.B. Thomas, Inc. (baking)

The fifth private wastewater treatment facility is owned and operated by the North Jersey Training School; sludge production is essentially domestic in character.

Presently, the disposal of generated sludges by these industries is the sole responsibility of each industry. Current disposal practices, as reported by each establishment, involve the use of a contracted scavenger to collect and dispose of the sludge wastes. The exact locations or means of disposal were unknown or unreported.

The inclusion of any industrially generated sludges in the sludge management plan would be feasible provided the waste material is amenable to the selected sludge processes in the proposed sludge management plan.

3.3.4 Existing Landfill Sites

The Morris County Landfill, located in Mount Olive Township is the only landfill situated within the study area and within a twenty mile radius of the TWPSA region. Although this landfill is currently licensed to accept sludges, the landfill operators have reported that the landfill had reached its quota and could not accept additional sludges from the TWPSA region.

3.4 Sludge Quantities and Qualities

3.4.1 Sludge Quantities

Sludges generated by proposed wastewater treatment facilities within the TWPSA region would be produced from the treatment of domestic wastewater collected within the sewered area and from the treatment of collected septic tank wastes. Population forecasts were derived from the report issued for the Northeast 208 Study Area which was prepared by the NJDEP, Division of Water Resources, Office of Areawide Planning, Northeast Basin and dated January 1978. These population forecasts and corresponding sewage flows were utilized to determine the total flows anticipated within the TWPSA region.

Utilization of the solids mass balances with the respective assumptions regarding influent wastewater solids concentration, treatment process selection and removal efficiencies, as contained within the wastewater management study report was the basis for the estimates of sludge quantities generated. All proposed treatment facilities were assumed to consist of primary sedimentation, secondary biological units, secondary sedimentation, and chlorination as minimum wastewater treatment process units.

Table 5 presents the estimated daily sludge quantities for the Borough of Totowa and the Borough of West Paterson for the 20 year sludge management plan study period.

3.4.2 Sludge Qualities

For the purpose of this study, the sludges generated by the municipal wastewater treatment facilities within the TWPSA Region were assumed to exhibit similar characteristics of a domestic sludge. Table 6 presents typical constituent

TABLE 5

ESTIMATED DAILY SLUDGE QANTITIES

TWPSA SLUDGE MANAGEMENT PLAN

(LBS. DRY SOLIDS/DAY)

	YEAR			
	1978	1980	1990	2000
Totowa	3,300	3,360	3,660	3,960
West Paterson	2,760	2,870	3,410	3,960
Totals: (Dry Lbs/Day)	6,060	6,230	7,070	7,920
(Dry Tons/Day)	3.0	3.1	3.5	4.0
(Wet Tons/Day*)	15.0	15.5	16.5	20.0
(Wet Cu.Ft./Day*)	470	485	548	611

*Dewatered sludge containing 20% solids

TABLE 6

TYPICAL CONSTITUENT CHARACTERISTICS OF PRIMARY SLUDGES*

TWPSA SLUDGE MANAGEMENT PLAN

CONSTITUENT	RANGE	TYPICAL
TOTAL DRY SOLIDS**	2.0-7.0	4.0
Volatile Solids	60-80	65
Grease and fats	6.0-30	-
Nitorgen (N)	1.5-4.0	2.5
Phosphorus (P_2O_5)	0.8-2.8	1.6
Potash (K_2O)	0-1.0	0.4
pH	5.0-8.0	6.0

*Reported as % of total dry solids, except where noted.

Source: Wastewater Engineering, Collection, Treatment, Disposal, Metcalf & Eddy, Inc., 1972

**% by weight of total sludge weight.

characteristics that may be exhibited by the TWPSA sludges. Actual characteristics would be determined upon the completion of laboratory analysis of TWPSA sludge.

4.0 DEVELOPMENT OF SLUDGE MANAGEMENT ALTERNATIVES

4.1 Identification of Sludge Management Alternatives

4.1.1 Identification of Land Application Areas

The application of stabilized sludge to the soil is acceptable if certain precautions are taken. Such application of sludge completes a natural cycle of nutrient return to the soil and conserves and utilizes the valuable nutrient source contained in sludge. When practiced carefully, land application of sludge is the ultimate recycle system which provides the best possible medium for immediate degradation of the solids and utilization by plant and animals in the rhizosphere (root zone of soil stratum).

Since the soil matrix is the medium into which the sludge will be disposed, its properties are vital to long-term ecological compatability. Some of the most important characteristics which affect the loading rate of sludge and the uptake of sludge nutrients into plants are: soil cation exchange capacity, pH, soil texture, permeability, thickness, depth to the water table and the frost action potential. Several of these parameters were discussed in Section 3.2.1.

Soil types that have been generally deemed as suitable reservoirs for sludge application in Passaic and Morris Counties were presented on Tables 3 and 4 and were derived from an evaluation of Soil Conservation Service soil maps with the parameters discussed in Section 3.2.1. The location of suitable soil areas as denoted in the Soil Conservation

Service maps were then compared to the map developed for both Morris and Passaic Counties indicating the distribution of agricultural and vacant lands, respectively. Those areas consisting of suitable soils for land application that coincided with existing agricultural and vacant land use were delineated for further evaluation. Further evaluation consisted of a determination of the proximity of the new suitable areas to surface waters and to public water supply sources.

As a result of this aforementioned evaluation, areas that were deemed suitable for land application operations based on existing land use and soil suitability are several agricultural areas located within Washington Township in Morris County.

4.1.2 Additional Considerations for Land Application Alternatives

Once suitable areas have been appropriately determined, additional considerations to utilizing land application is necessary. These considerations may deal with the methods of sludge application, schedules of sludge application, crops to be grown, and problems of nitrate leaching.

Methods of Application

Several methods of land application have been developed. Surface application methods include spray irrigation of liquid sludge and spreading of sludge cake with farm manure spreaders. The incorporation of wastes directly into the soil, however, eliminates odor and pest problems, reduces runoff and minimizes the volitilization of ammonia. Subsurface application techniques are, therefore, potentially less objectionable to the general public.

In the plow furrow cover method, liquid sludge is discharged into open furrows and immediately covered over by a mold board plow which also opens the next furrow. After covering, the soil can be plowed, disced and seeded. A method of trenching is suitable for disposal of large volumes of sludge on marginal land where crop production is secondary to disposal. While trenching has the advantages of subsoil application techniques, it also poses a problem of potential pollution of the groundwater through nitrate leaching. Digested sludge with up to 10% solid matter may be injected directly into the soil by subsoil application. Injection to a depth of 6-8 inches at a rate of 400 gallons per minute can be achieved with equipment that has been adapted for use with farm machinery. Loading rates per acre may be manipulated by regulating the distance between lines.

The amount of sludge which can be applied to the land depends upon the characteristics of the sludge itself, soil characteristics, the application schedule, the type of crop(s) and the land area available for sludge disposal. Amounts of sludge applied would be regulated to insure that excessive amounts of trace elements do not become concentrated in the soil; that excessive amounts of potentially toxic elements are not taken up by the crop; and that nitrate-nitrogen (NO_3-N) in excessive amounts does not leach into the groundwater.

Schedule of Sludge Application

The most restrictions to the scheduling of sludge applications are attributable to access to the land during the late winter and early spring. During a cold winter, the soil may be frozen and therefore inhibit or prevent the injection and degradation of the sludge in the soil. In early springtime, the soil may be too muddy to permit vehicle traffic; or a high water table may limit the depth to which the materials may be injected.

The greatest constraint to land access is expected to occur from January, the coldest month, through March when rainfall combined with melting snow and ice create muddy conditions. Storage facilities should be available, therefore, to hold the sludge which has accumulated from January through March.

It may be possible to apply the sludge onto the land during any month of the year. If sludge distribution machinery can be driven on the land without difficulty, and the soil is not frozen, the sludge can be injected into the soil. If there are no storage facilities, the sludge might be buried in special areas prepared for winter disposal. Burial will require different soil preparation techniques, and crop management may not be appropriate.

In the warmer months which follow winter, biological activity in the soil begins to increase. April is the month in which potentially the greatest application rate will be required. This will be appropriate, since added nutrients available during the beginning of the growing season are more effective in increasing dry weight in a grass crop than if applied later. From May through October biological activity is at a peak, and degradation of the sludge will cease to be a problem. The sludge can then be applied on a schedule that best meets the requirements of manpower and equipment that are available.

Of greater concern than frozen soil or bad weather is the loading rate to insure that soil or crop toxicity does not occur and that excessive nutrients are not leached into the groundwater.

Suitable Crops

The ideal crop to be grown in conjunction with sludge disposal on agricultural land should: (1) be unaffected by the season of the year during which the sludge is applied, (2) have no exacting spacing requirements, (3) have few restrictions regarding equipment movement on the land, (4) be relatively insensitive to the concentrations of sludge nutrients, (5) be easy to grow, (6) have a long growing season, and (7) be of economic value.

Various row crops, grains and grasses meet some of the requirements quite well. Row crops such as corn have been successfully grown utilizing sewage sludge applied between the rows. Large yields have been reported for corn silage which utilizes nitrogen contained in the sludge. Non-row crops like grain and grasses have wide differences in yield and the amount of nutrients they utilize. As a rule, the more the amount of nitrogen applied, the more nitrogen the plants will uptake. Grasses, in particular, are efficient users of nitrogen. In addition, most grasses are either tolerant or very tolerant of metal toxicity.

The harvest of grass for hay or the management for sod would be secondary to application of the sludge, and would be flexible according to the priorities in the work schedule. Bermuda grass, orchard grass or reed canary grass are all commercially feasible possibilities.

Sludge as a Fertilizer Amendment

Municipal waste contains many elements and compounds which may be looked upon as fertilizer amendments for nitrogen (N), phosphorous (P) and potassium (K). Typical sludge contains 2-6% N, 1-3% P and 0.4% K. Under normal circumstances, however, only a fraction of the nutrients found in the soil or sludge are available in a form immediately useable for plant growth. Sludge has been found to be as effective as commercial inorganic fertilizers in regard to plant uptake of nutrients and producing good yields.

Fertilizer applications usually exceed that actually taken up into the plant, and actual plant requirements are often taken as the amount of individual nutrients found in the tissue of normal, healthy plants. Assuming that all the N-P-K required by the plants came from the sludge, there is theoretically not enough P or K in the sludge to meet plant requirements, and there is no reason to expect excess concentration in the soil.

There would, however, be much excess nitrogen in the soil. Nitrogen undergoes complex transformations in the soil, and it is not expected that all nitrogen found in sludge will be in the form of nitrate-nitrogen which is the most common form used in plant nutrition. The total nitrogen in liquid sludge may be up to 50% NH_4-N which can be subsequently converted into nitrate.

Phosphorous is readily precipitated in the soil in relatively immobile form. There may be an accumulation of quantities greater than required by a crop, much like that of heavy metals. Accordingly, there is little risk that excess phosphate will be leached out of the root zone and to the sub-soil.

Potassium typically makes up about 1% of the dry matter of most higher plants but may be taken up to a greater extent in many grass species.

<u>The Problem of Nitrate Leaching</u>

It can only be speculated what will happen to the nitrogen which exists in sewage sludge. Since nitrate is very mobile in the soil, it is readily taken up by plant roots. This is especially true during the growing season which corresponds to the period of sludge application, if sludge produced in the winter is stored until spring. The transformation of organic nitrogen to the nitrate form, however, may far exceed plant requirements. This excess is potentially subject to leaching into the groundwater.

Present standards for drinking water suggest that nitrate should not exceed 10 mg/l. Actual studies of soils show that sludge loading rates of 10 tons per year or less, exhibit little or no problem with excess nitrate concentrations.

4.1.3 Identification of Potential Landfilling Sites

General criteria utilized for the selection of potential landfill sites are similar to those applied to the selection of treatment plant sites with some variation. Because of potential pollution problems caused by landfill leachate, soils with deep water tables that were located out of major groundwater aquifer recharge areas or major watershed areas were required. The vertical percolation and surface runoff of leachate constitute a pollution threat to groudwater and surface waters, respectively.

Within suitable soils areas: forested lands, developed lands and agricultural lands were excluded. Forested areas were not considered because they are valuable as wildlife habitat.

Developed land is simply not available, and agricultural areas are of significant economic value. Land remaining included old fields, barren land and disturbed areas (e.g., gravel pits). Gravel pit sites, a type of disturbed area, were the most dominant in terms of abundance and individual size.

Existing gravel pit sites were inventoried for the Passaic-Morris County area and have been presented previously in Figures 4 and 5. Additional site selection criteria were then utilized to screen existing sites. These criteria included size, distance from surface waters and private/public wells, isolation or buffering from developed areas, and whether the pits were actively in use (preference was given to inactive gravel pits).

The anticipated landfill size required to accommodate sludge disposal for the 20 year planning period is 20 acres. Recommended distance from surface waters and private/public wells is 200 feet and between 100 and 500 feet, respectively. There is no commonly accepted degree of isolation or buffer zone recommended as separation distance between landfill sites and developed areas. Generally, however, the further the site from major developments or the greater the depth of surrounding forest land, providing a buffer, the more attractive the site.

Initial screening of the gravel pit sites on Figures 4 and 5 with regards to the aforementioned general criteria, resulted in the formation of a list of twelve gravel pit sites which may be tentatively classified as potential landfill sites. This list of potential sites is presented in Table 7.

4.1.4 Additional Considerations for Landfilling Alternatives

According to NJDEP "interim" guidelines, a sanitary landfill of sludge, either separately or in conjunction with municipal solid waste, is not acceptable unless it can be clearly demonstrated that due to the sludge characteristics the ultimate disposal of the sludge in a secure landfill (lined) is the only environmentally acceptable method of disposal. To avoid adverse environmental impacts associated with sludge type sanitary landfills, proper site selection, design, constrution and operation are a necessity. In addition, the sludge must be pretreated before disposal to ensure the protection of groundwater underlying the landfill site and to minimize the occurrence of leachates from the sludge.

Design and Operation of Landfills

The sanitary landfill accepting the sludge must be operated in accordance with the NJDEP Rules of the Bureau of Solid Waste Management. A plan must also be developed and implemented by the responsible municipality or private group managing the landfill to provide for adequate monitoring for each sanitary landfill accepting sludge. According to NJDEP, the monitoring program must be specifically designed for applicable local conditions and will include:

TABLE 7

POTENTIAL LANDFILL SITES

TWPSA SLUDGE MANAGEMENT PLAN

Gravel Pit Site Reference Number*	County Location	Township Location	Block/Lot Reference No.	Size in Acres	Land Use Classification	Owner
3	Morris	Riverdale	38/35,10,14,9	17	Vacant	Private
14	Morris	Mt. Olive	148/21, 18	102	Vacant	Select Properties
17	Morris	Roxbury	16/7-1	52	Farm	Private
20	Morris	Roxbury	10/18	86	Vacant	Houdaille Const. Co
39	Morris	Roxbury	47/8,8.1,9	142	Vacant	City Finan-cial Corp.
43	Morris	Chester	20/2	66	Farm	Private
44	Morris	Chester	13/7, 15/45	178	Farm	Private
46	Morris	Riverdale	19/7	24	Vacant	Houdaille Const. Co.
64	Passaic	Wanaque	8/313	276	Vacant	Houdaille Const. Co.
66	Passaic	Bloomingdale	69,70,66,57	38	Vacant	Passaic Crushed Stone
73	Passaic	N. Haledon	24	36	Vacant	Samuel Braen & Sons
74	Passaic	Wayne	21	21	Vacant	Samuel Braen & Sons

*Refer to Figures 4 and 5 for relative locations

- Groundwater observation wells tested for heavy metals, persistent organics, pathogens, and nitrates.
- Where the surface water could be affected by runoff from the landfill, or leachate from the sludge, surface water monitoring should be implemented and tests for BOD, COD, dissolved solids and nitrogen be performed on a regularly scheduled program.

Past disposal practices of landfills in the United States have typically overlooked the leachate problems, frequently favoring the use of cheaper and more remote land areas such as flood plains, quarries, sand and gravel pits and marshlands. These sites have tended to be more socially and politically acceptable, as well as cheaper when the leachate problem is ignored.

Although the composition of leachate may vary from a typical municipal refuse type sanitary landfill comprised of a variety of materials to one receiving only sludge or compost, leachate produced at either site may contribute to groundwater or surface water pollution. The quality of leachate expected from a landfill is not only dependent on the composition of the deposited waste but also on hydrological conditions and characteristics and grade of soil cover.

Lined landfills must be designed for proper elimination of leachates. The leachate could be diverted to a holding pond for later transfer to the regional treatment plant for treatment or recycled through the landfill. The recycle of leachate through the landfill enhances decomposition of landfill materials which speeds up landfill stabiliation. Landfill liners, however, have not been perfected to the extent that containment of leachate is guaranteed. Therefore, even with liners, a monitoring system is necessary to assure landfill integrity.

Surface drainage from the landfill site should be controlled so that it does not freely flow over surrounding land areas and possibly enter nearby surface waters. It is also important to control site runoff to minimize erosion for maintenance of the landfill. These runoff waters may contain harmful pollutants as well as heavy silt loads. Portable drainage canals could be constructed to intercept and remove runoff waters. These waters could be ponded to remove suspended solids before being allowed to enter surface water or land areas.

According to the New Jersey Administrative Code (N.J.A.C. 7:26-2.5) new sanitary landfills shall not be constructed where solid waste is or would be in contact with surface water or groundwater. Although the N.J.A.C. does not recommend a separation distance between landfill and surface waters, the 200 foot separation generally accepted for land application of sewage sludge/compost sites could serve as the minimum for landfill sites.

Gas Emissions From Landfill

Another major concern relative to sanitary landfill of the municipal refuse or sludge/compost waste is that of gases produced by the decomposition of landfill materials. These gases include methane, carbon dioxide, nitrogen, oxygen and hydrogen sulfide. If precautions are not taken to properly vent these gases from the landfill, serious effects on the environment can occur.

Methane becomes highly explosive in concentrations of 5 to 15 percent. In some cases it has moved into nearby sewer pipes and buildings in explosive concentrations. Methane also kills nearby vegetation by excluding oxygen from the root zone.

Carbon dioxide increases the hardness of water. Being soluble in water, carbon dioxide forms carbonic acid, which in turn dissolves minerals, such as calcium, in the waste. The dissolved minerals may then enter nearby wells producing a harder water.

To allow for safe discharge of landfill gas production (particularly methane) eliminating devices should be incorporated in the design. A variety of gas elimination techniques are available (e.g., gravel vents, gravel-filled trenches).

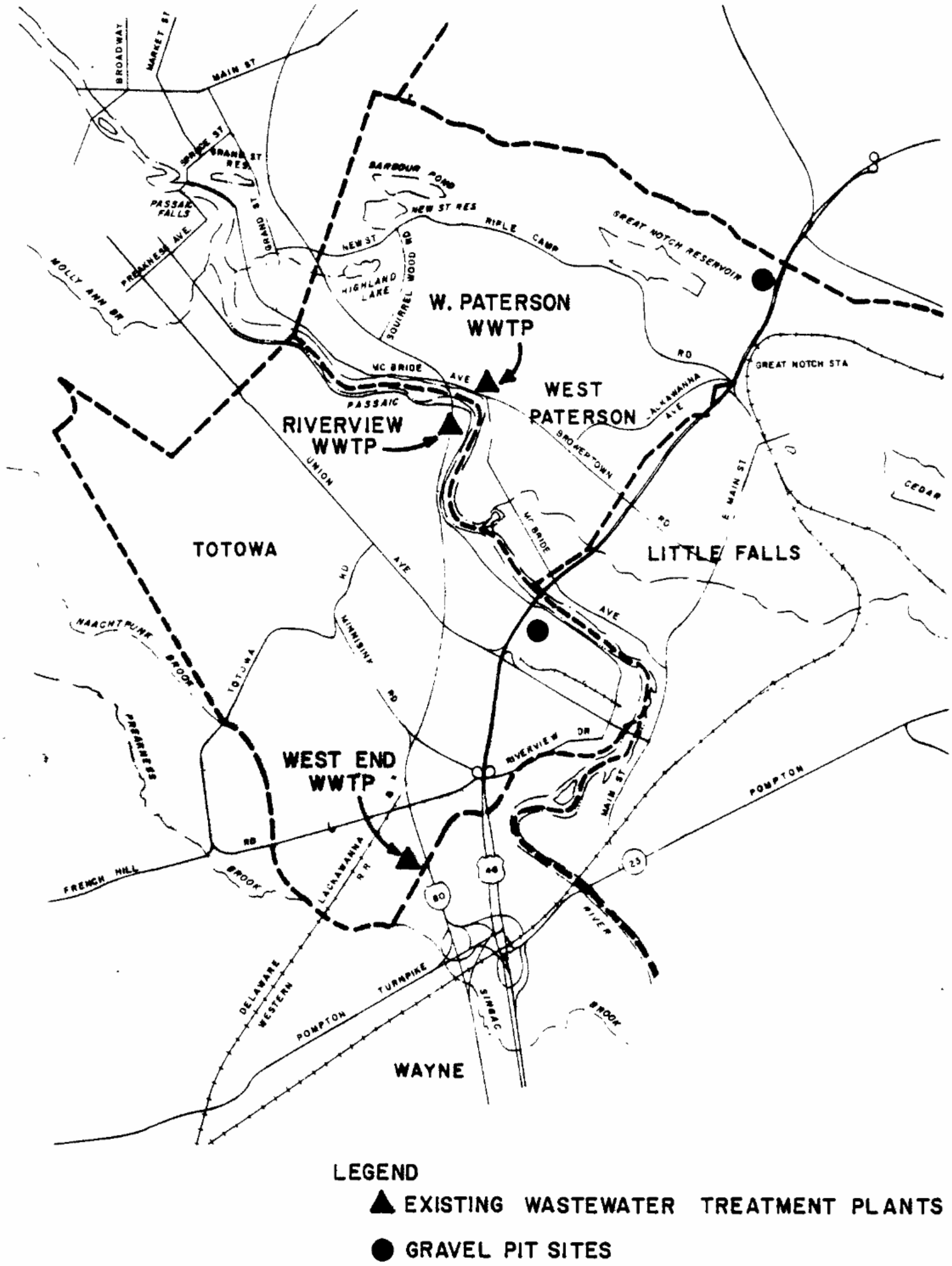
Landscaping and Use After Completion

Completed landfills have been used for recreational purposes such as parks, playgrounds and golf courses. Other uses have included parking lots, storage areas and botanical gardens. One-story rambling type buildings and airport runways for light aircraft have been constructed directly on sanitary landfills. Generally, because of settling and gas problems, construction of buildings on completed landfills has been avoided. However, multi-story buildings can be built over completed landfills using steel and concrete pilings, means of eliminating gases to the atmosphere and not into the building, and special engineering design.

4.1.5 Potential Sludge Processing Sites

Two gravel pit sites were located within the TWPSA region and noted on Figure 5. One site was located in Totowa, just south of State Highway Rt. 46 and along Riverview Drive. The second site is located in West Paterson just south of the Great Notch reservoir and north of Rt. 46. Both sites are shown on Figure 8 entitled "Potential Sludge Processing Sites."

These two sites were eliminated from consideration as potential landfill sites due to inadequate size of the Totowa site, and to existing activity at the West Paterson site. The two sites, however, exhibit sufficient acreage to be further considered as sludge processing sites for such operations as static-pile composting. Although activity currently exists on the West Paterson site, sufficient area is available at the southeastern corner of the site to allow a composting operation.



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POTENTIAL SLUDGE PROCESSING SITES
TWPSA SLUDGE MANAGEMENT PLAN

TOTOWA – WEST PATERSON SEWERAGE AUTHORITY

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0 2500 5000 FT

FIGURE 8

General information concerning these two sites are presented below.

Gravel Pit Site Reference Number (ref. Fig. 5)	Borough Location	Block/Lot Reference Number	Size in Acres	Land Use Classification	Owner
78	W. Paterson	113/5	35.7	Vacant	Private
79	Totowa	179/2	5.8	Vacant	Lordon Investment Corporation

4.1.6 Marketability Anlysis

The development of a comprehensive sludge management plan requires that a marketing study of the stabilized sludge end product be conducted to determine the existence of markets which will act as the ultimate receptors of the material. The marketability analysis performed identified four potential user groups. The groups include (1) private organizations including golf courses, nurseries and turf farms; (2) municipal governments; (3) independent authorities; and (4) state agencies.

The findings of the analysis indicated varied responses from these groups. In general, the lack of familiarity with the products and their detailed composition made it difficult for many of the potential users to comment on their use of any or all of the products. Most, however, did indicate their willingness to try the sludge product. Another expressed concern was that the labor costs associated with use of the sludge product would have to be competitive with that of the application of commercial products. That is the product would have to have a consistent quality, especially nutrient content, and workability must be the same over an extended period of time. Those potential users using fertilizers and soil conditions as part of a commercial operation further indicated a desire to review test reports with their County Agricultural Agent, in order to determine their potential uses for the sludge products.

Responses from municipal works departments differed from private organizations due to their use of negligible amounts of soil conditioners and fertilizers. Some municipalities were small with limited resources, while others did not have any schools, parks or other facilities where such materials could be applied on a regular basis. Still others expressed considerable interest for use at specific project sites.

The State of New Jersey Department of Transportation (NJDOT) had indicted an interest in sludge products in both compost and liquid form. Authorities such as the Garden State Parkway Authority and New Jersey Turnpike Authority indicated less of a need for sludge product than the NJDOT.

Sludge products may be dispensated to local residences for their use on non-edible crops. Uses of sludge products could include supplementing the nutrient requirements of shrubs and trees, lawns and flower gardens. A giveaway program of sludge product has met with much success in the Philadelphia area where a bagged product labeled "Phil-organic" is distributed.

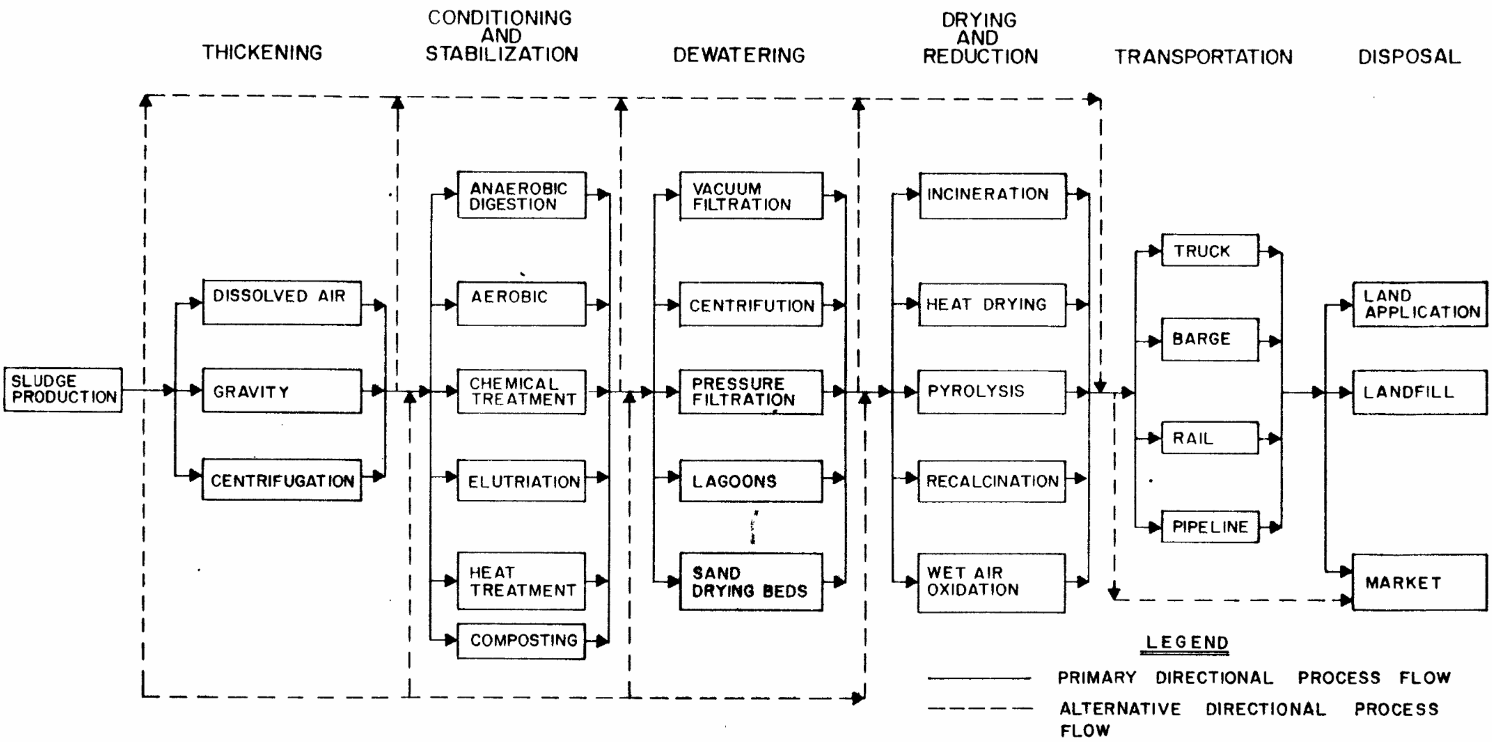
Additional marketability analysis output suggests that a market may exist in the private sector. In order for this market to be realized, a program should be developed, quite possibly by the County Agricultural Agent, in conjunction with the County Extention Service, for educating the private sector (i.e., local residents, area growers) in the value of stabilized sludge. This education process could include distribution of printed material or seminars on the characteristics and chemical composition and use of the sludge product. Sludge product could also be provided to the growers to allow them to determine its applicability to their operations.

PQA will shortly undertake an extensive marketability analysis of northern New Jersey. This is an endeavor that will research the private and public sectors to determine if viable markets exist. The anticipated scope of this analysis is too extensive to be adequately addressed within the budget and time restraints of this management plan study. The results of this extensive marketability analysis, however, will be made available to the TWPSA. The results of this analysis will determine the necessity and extent of further marketing work to be performed by the TWPSA to insure an available outlet for the sludge product.

4.1.7 Sludge Treatment Process Alternatives

Sludge management systems are developed through the compilation of sludge management operations most applicable, feasible or viable for a particular situation. Sludge management operations involve either the thickening; or the conditioning and stabilization; or the dewatering; or the drying and reduction; and the transportation and disposal of wastewater treatment facility generated sludges. The disposal alternatives available to the Totowa-West Paterson Sewerage Authority area were discussed in preceeding sections. Components of the aforementioned sludge management operations are shown on Figure 9, a schematic which is entitled "Alternative Sludge Management Sytem Components." The schematic is arranged to indicate possible sludge treatment, and transportation alternatives that will generate a product amenable to those recommended disposal alternatives. Component processes initially deemed inapplicable for the Totowa-West Paterson Sludge Management area are eliminated from further consideration.

For instance, the processes inapplicable due to the characteristics and quantities of the sludges, primarily included chemical treatment, recalcination, lagoons, and sand drying beds. Those processes that were initially eliminated due to past experience in the operations and maintenance and relative costs for each process within a sludge management operation included dissolved air flotation, centrifugation, elutriation, heat treatment, heat drying and wet air oxidation. Due to geographical characteristics of the study area, the general layout of proposed wastewater treatment facilities and the availability of services, such transportation alternatives as barging, rail, or pipeline were also elimi-



ALTERNATIVE SLUDGE MANAGEMENT SYSTEM COMPONENTS
TWPSA SLUDGE MANAGEMENT PLAN

FIGURE 9

TOTOWA-WEST PATERSON SEWERAGE AUTHORITY

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nated from contention. Importance to the energy intensiveness or the marketability of certain treatment process products eliminated further such items as pyrolysis, and again wet air oxidation. In addition, the utilization of existing facilities led to the elimination of aerobic digestion, centrifugation and pressure filtration. Finally, governmental directives on the Federal level eliminated ocean disposal as a viable alternative.

Through this process of elimination, several sludge treatment, transportation and disposal processes within their respective sludge management operations were further studied as to their viability and feasibility for TWPSA Sludge Management Study. These processes included anaerobic digestion and composting (Conditioning and Stabilization); vacuum filtration (Dewatering); incineration (Drying and Reduction); trucking (Transportation); and land application, landfill, and marketing (Disposal).

Process Descriptions

The processes mentioned above and their associated equipment are state-of-the-art processes which are commercially available. A general description of the process utilized and equipment considered is presented in the following discussions.

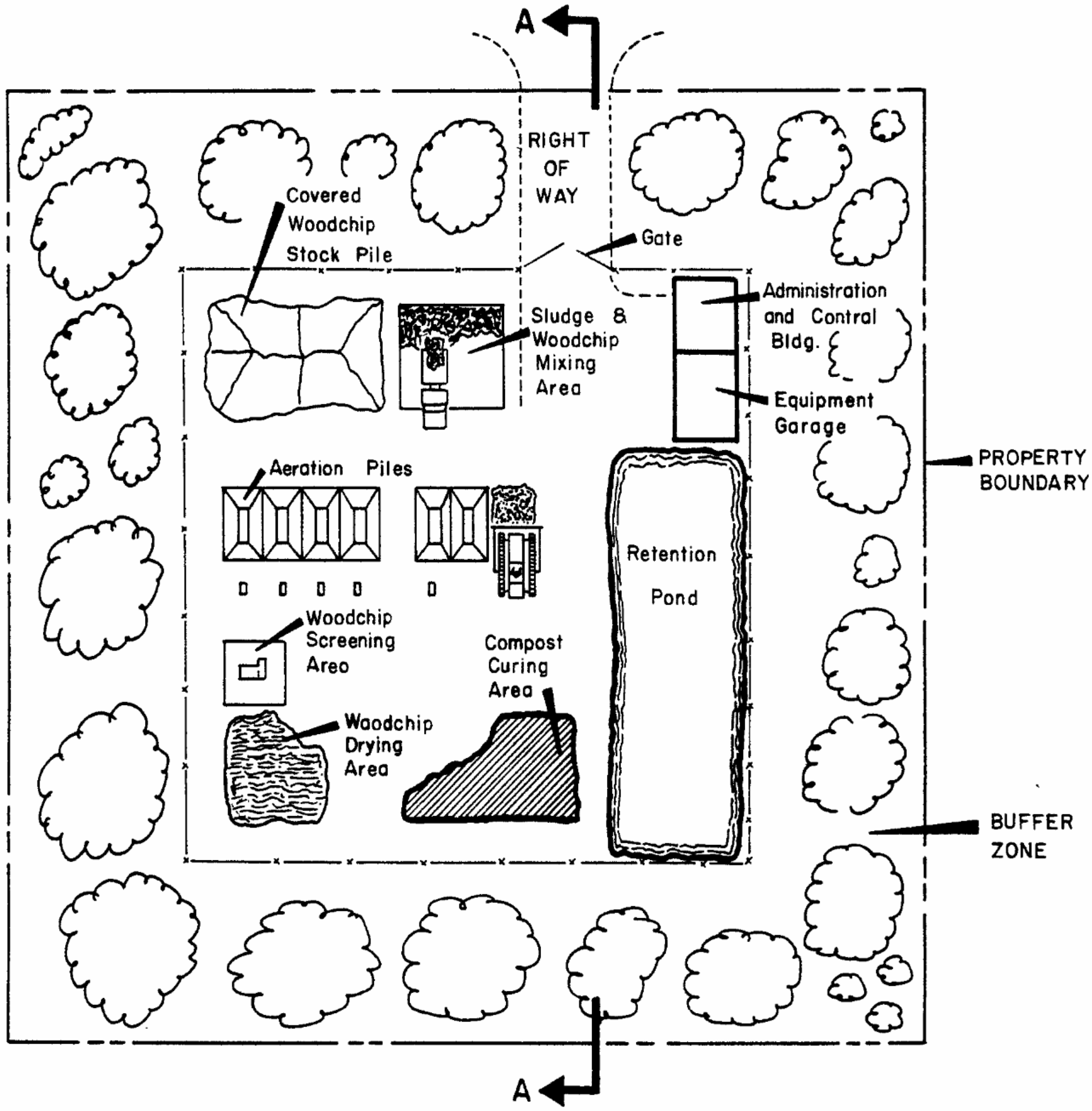
Conditioning and Stabilization: Anaerobic digesters are of the modified "high-rate" dual-stage design and operation. Thickened sludge is introduced into the top of the first tank. Sludge is drawn off at mid-height of the tank and pumped by a sludge heater circulator pump to an external sludge heat exchanger and then returned back to the influent of the digester at the top of the tank. Digested sludge is drawn-off from the bottom of the tank and recirculated to the mid-section of the tank, thus affording mixture of the digester contents. Digested sludge is drawn off from this recirculation line and pump to a second tank which acts as a sludge holding and thickening tank. Supernatent from the second tank is returned to the head of the wastewater treatment stream, while the digested sludge is transmitted to the subsequent process. A reduction of nearly 45% total solids may be anticipated by anaerobic digestion.

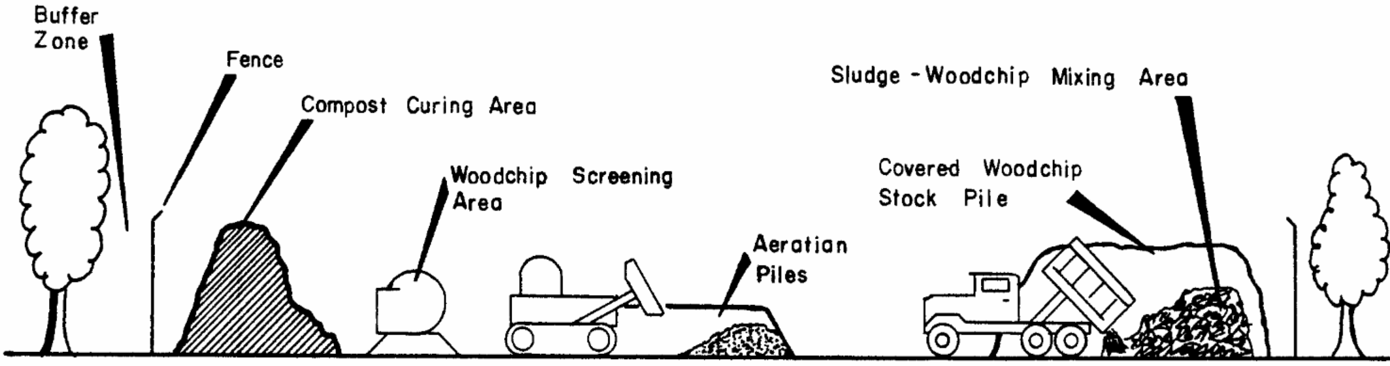
Digester gas, primarily methane, is collected in a center dome on each primary digester tank and routed for fuel either for the sludge heat exchangers or for digester building use. Excess gas may be burned off or used elsewhere.

Two composting processes were considered in this analysis. The first process is similar to the USEPA's Beltsville Maryland static-pile composting operation. Dewatered raw sludges are initially combined with an appropriate volume of bulking material (1:3 sludge: woodchip ratio) by use of front end loaders. This daily sludge cake-woodchip mixture is then piled on a compost pad and covered with nearly 12 inches of screened cured compost.

The compost pad consists of an asphalt pad on which four inch diameter perforated pipe is laid then covered by a layer (12" depth) of either woodchips or unscreened compost. This layer would screen liquids seeping from the pile and would prevent clogging of the pipe. The perforated pipe is attached to a blower, operated in reverse for 10-14 days, to allow air to be drawn through the compost pile and then reversed for 7 to 10 days to conduct air back into the pile. This reversal of blower operation allows the temperature in the cold regions of the pile to increase. All gases collected while air is drawn into the pile is directed into an adjacent small pile of screened compost (approximately less than 0.5 inches in size) to absorb any odors. After 21 days the compost is moved to a stockpile, also situated on the asphalt pad, for about 28 days. The cured compost is screened and the woodchips recovered for reuse. Approximately 25% of the woodchips utilized on a daily basis are unrecoverable. The cured compost material is then ready for any market or would be trucked to a land-fill or land application site. Figure 10 entitled "Static Pile Compost Operation Illustration" is an illustration of a typical static pile composting operation. Approximately 5 acres of land are required to site the static pile composting operation for the conditions exhibited by the TWPSA region.

Runoff and leachate from the compost material and compost pad is collected and transported intermittently to the treatment plant provided the composting site is located





SECTIONAL VIEW A - A

STATIC - PILE COMPOST OPERATION ILLUSTRATION
TWPSA SLUDGE MANAGEMENT PLAN

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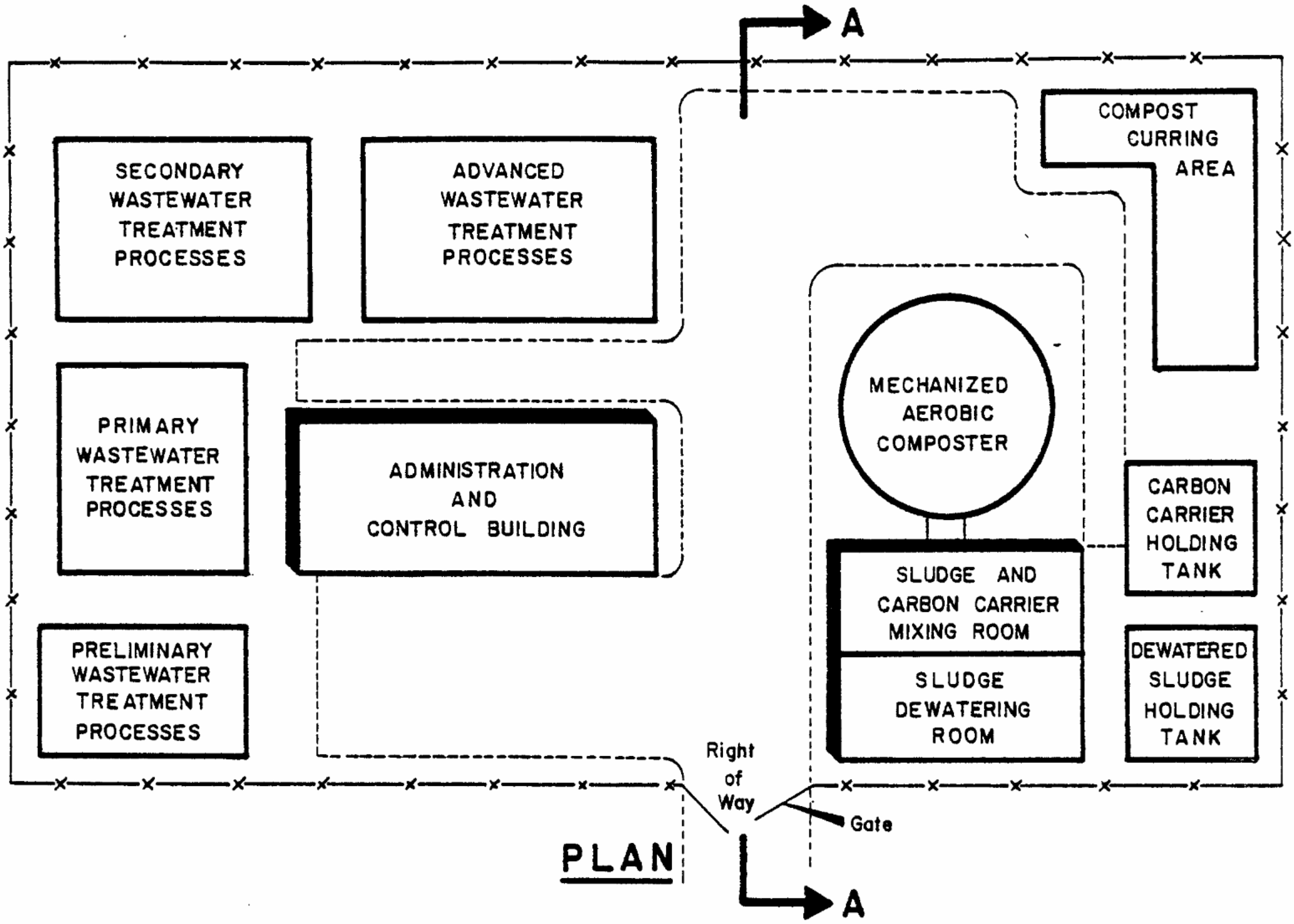
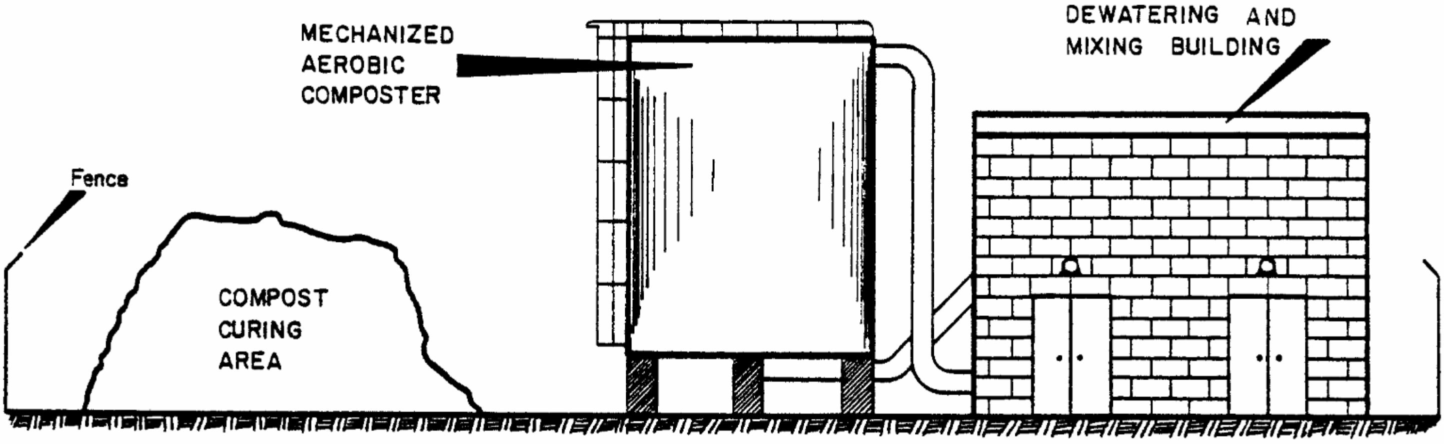
within the TWPSA's jurisdiction. Elsewhere, consideration must be given to providing adequate treatment of this runoff and leachate.

Due to some initial concern that an open composting operation may be esthetically unpleasant, a mechanized aerobic composting process was also considered. This process produces a comparable product to the static-pile composting and is a compact facility requiring very little area, less than one-quarter acre, and can be installed on-site at the treatment plant. This process is a totally enclosed cylindrical digester in which the aerobic-thermophilic reduction of organic matter is performed. Forced air is introduced into the bottom of the digester as waste materials are added at the top. The digester is of continous flow type so that digested material works its way to the bottom of the cylinder and is discharged from the digester as new material is introduced. Figure 11 entitled "Mechanized Aerobic Compost Operation Illustration" illustates the mechanized aerobic composting operation.

A volumetric mixture of sludge cake and sawdust and return compost is introduced into the digester. A counter-current of air flow is established with oxygen levels varying from high at the bottom to low at the top as the microbes utilize the oxygen. The sludge materials are retained within the digester for a period of approxiately 12 days. This allows aerobic micro-organisms present within the organic sludge material to assimilate the waste. Composted product



PLAN



SECTIONAL VIEW A-A

MECHANIZED AEROBIC COMPOST OPERATION TWPSA SLUDGE MANAGEMENT PLAN

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is discharged at the bottom with subsequent curing of the composted material.

The material discharged from the aerobic digester is reported to be free from objectionable odor, will not attract insects or rodents and has been reduced in volume and weight by approximately 50 percent. Air pollution is limited by the digester's explusion of only carbon dioxide and water vapor. Since the digestion operation is fully enclosed, no liquid effluent is discharged from the digester.

Dewatering: Sludge dewatering is accomplished by vacuum filtration. Chemical coagulants are introduced into the sludge wastes prior to dewatering to aid in the dewatering of sludges. The sludge waste is then introduced into the filter and dewatered resulting in a product containing a maximum moisture content of 80% and a minimum solids concentration of 20%. The final product is quite manageable for trucking and disposal. Dewatering of any sludges not treated through an anaerobic digester requires an additional holding tank (whereas in the digester alternative, the second tank is a holding tank). The holding tanks afford a duel purpose as a flow equalizing tank to insure a continuous and steady flow to the presses and as an emergency holding tank in case of unavoidable shutdowns. The design capacity of the sludge holding tank is four days. For the purpose of this study, the existing anaerobic digesters would be recycled as sludge holding tanks, thus eliminating the need for additional expenditures.

Trucking: Dewatered sludges with a minimum solids concentration of 20% would be easily transported by various size dump trucks. This cost-effectiveness analysis will utilize a 25 cubic yard dump truck for the transportation of dewatered sludges. Thickened sludges, exhibiting a solids content of only 5% would be transported by tank trucks, the most common size being tht of a 6000 gallon capacity.

Landfill Disposal: To satisfy state requirements for landfilling of sludges, only secure landfills will be considered. That is, an impervious liner will line the entire landfill site to prevent any possible leachate generated waste to impermeate the soil and infiltrate into groundwaters. Landfilled wastes will be applied on a daily basis in 12 feet depth cells (or 2-6 ft. depth cells) and covered with earth material. Compaction and covering of waste would be performed by a piece of earthmoving equipment, such as a bulldozer, especially built for landfill purposes. Approximately 20 acres of land are required to dispose of sludge product for the 20 year planning period.

Incineration: Dewatered sludge may undergo thermal distribution by a multiple hearth incinerator. This incinerator consists of a cylindrical steel shell with a series of refractory grates around a central shaft.

In a multiple hearth unit, air-cooled rabble arms are attached to the shaft and scrape the sludge around the grate and into a drop to the next lower grate. This is necessary to expose new surface to the hot gases and move the sludge through the drying, burning and air preheating zones of the furnace. Due to the large amount of excess air required for proper incineration operation, these units require auxilliary firing.

Approximately 1,800 to 2,500 Btu will be required to evaporate each pound of water in the sludge. Heat is obtained from the combustion of the volatile matter in the sludge and from burning of auxilliary fuels. Raw sludge has a heat content ranging from 6,500 to 9,500 Btu/lb. of dry solids, while digested sludge has a heat content ranging from 2,500 to 5,500 Btu/lb.

Air pollution is controlled by a wet air scrubber, the water for which would be supplied by the adjacent wastewater treatment facility and returned to the facility for treatment. Pathogen destruction and the reduction of the extent of odor problems are assured by the high temperature maintained in the incinerator.

Land Application Disposal: Land application of sludge wastes would be accomplished through the subsurface injection of sludge by the contour furrow method. This method insures that state regulations concerning subsurface application of sludge are met. Sludge products will be applied throughout the year, weather permitting, except for periods during

January through March. During this period inclement weather may make ground conditions unmanageable for equipment use. Sludge storage during this period can be easily facilitated at the sludge disposal site. Nearly 260 acres of land are required for land application of sludge wastes for the 20 year planning period, at a loading rate of 10 tons/acre/year and an assimilative capacity of soils of 10 years.

Groundwater monitoring wells will be installed to monitor the effects land application of sludges may have on underlying groundwater. Periodic water and soil samples would be collected and analyzed and soil conditions closely monitored.

4.2 Identification of Other Sludge Management Plans

Other sludge management plans within the areas studied for the TWPSA Sludge Management Plan Report were considered. The purpose was to determine the possibility of TWPSA's participation within these plans. The plans that were considered were for the Two Bridges Sewerage Authority (also referred to as the Pequannock-Lincoln Park-Fairfield Sewerage Authority), the Township of Wayne, the Wanaque Valley Regional Sewerage Authority, and the Northeast New Jersey Regional 208 Areawide Wastewter Management Areas.

4.2.1 Two Bridges Sewerage Authority Plan

The Two Bridges Sewerage Authority's (TBSA) sludge management plan involves the use of a fluid bed incinerator. This incineration operation exhibits the capacity to operate at a dry solids loading of 6,000 lbs/hr. The incinerator is expected to be operational about mid-year 1979. Sludge received from outside authorities or municipalities could be transported as a liquid phase with a solids concentration of 4% to 10%, or as a dewatered product with a solids concentration of 20% to 30%.

The TBSA was contacted by PQA on behalf of the TWPSA in August of 1977, with a letter of inquiry into possible arrangements between TBSA and TWPSA for the disposal of TWPSA municipal sludges.

The letter of inquiry was well received by the TBSA and a meeting between TBSA officials and representatives of interested authorities and municipalities was held. The TBSA had confirmed their interest for accepting sludge from the treatment plants and had requested that additional information concerning sludge quantities and quality be supplied to them. TBSA's initial cost estimation for using their incinerator was reported at $150 to $175 per dry ton of solids. A minimum period for which the TBSA would care to contract services was five years.

Information concerning the characteristics and quantities of TWPSA sludges was submitted in April of 1978. Presently, the TBSA is still considering acceptance of sludges from outside communities. Communication with the TBSA is currently ongoing.

4.2.2 The Township of Wayne Plan

Similar to the TBSA plan, the Township of Wayne sludge management plans also involve utilization of two incinerators, specifically of the multiple hearth fashion. These incinerators are located at the Mountain View Water Pollution Control Plant in the Singac section of the Township. Ready access to the plant is available by Route 23 and Dey Road. Combined design capacity of these incinerators is 26.0 MGD, Wayne would only utilize 7.5 MGD.

Likewise with the TBSA, the Township of Wayne was also contacted by PQA on behalf of the TWPSA in August of 1977 by a letter of inquiry into possible arrangements between TBSA and TWPSA for the disposal of TWPSA municipal sludges. As a result of this inquiry, a meeting was held between the representatives of Wayne and PQA to further discuss the possibilities of utilizing Wayne's facilities.

Additional information from Wayne was received in April of 1978 which reported the requirements necessary to utilize the incinerator. Municipal sludges with a solids concentration of 4% to 8% and containing acceptable heavy metal concentrations could be accommodated by the Wayne incinerator. Estimated costs for treatment of raw sludge was projected to be in the magnitude of $270-$300 per ton of dry solids. Communication with the Township of Wayne is presently ongoing.

4.2.3 Wanaque Valley Regional Sewerage Authority Plan

No sludge management has been developed for the Wanaque Valley Regional Sewerage Authority. This Authority is comprised of the following municipalities: Bloomingdale, Butler, West Milford and Kinnelon. A sludge management plan study, however, will be undertaken shortly for the WVRSA.

4.2.4 208 Areawide Wastewater Management Plan

Elements of a 208 plan for the northeast New Jersey region, of which the TWPSA region is a part, are in various stages of completion. The State of New Jersey Department of Environmental Protection's Office of Sludge Management and Industrial Pretreatment is currently preparing a sludge management plan of study for the northeast region. Presently, however, this plan of study has not yet been completed.

4.3 Development of Sludge Management Alternatives

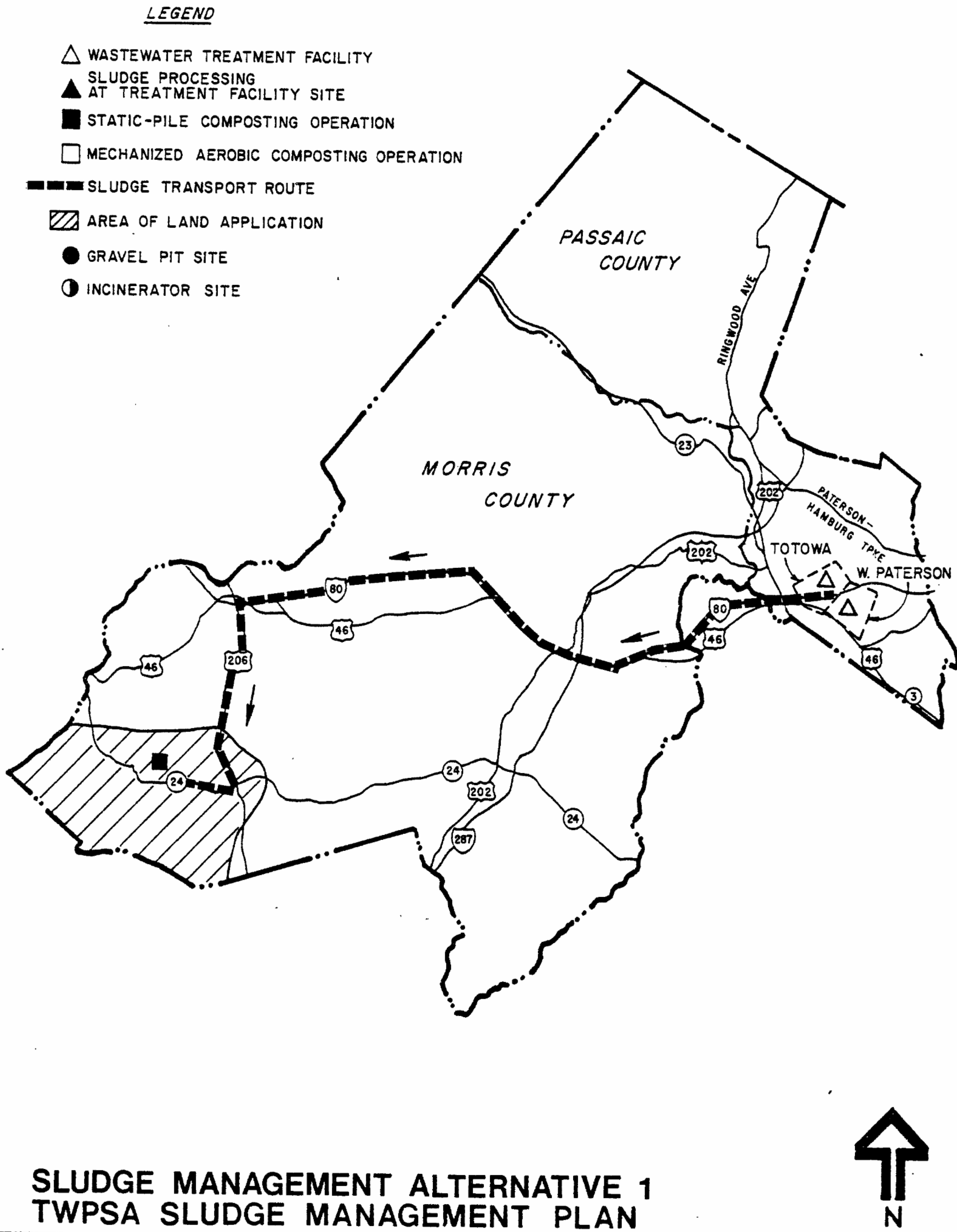
Sections 4.1 and 4.2 have presented and described components of sludge management systems that may be applied to the development of sludge management plans. The components discussed involved sludge disposal options and operations, pertinent sludge treatment processes, and transporation requirements.

Sludge disposal options include marketing, landfilling, or land application of the sludge wastes. Landfilling of sludge wastes is limited to twelve potential sites, six of which are located within 10 miles of the TWPSA region and the remaining six are located within 25 miles of the TWPSA region. Land application of sludge wastes is limited to agricultural lands in Washington Township, Morris County. Sludge wastes may also be disposed at two incinerator sites, one owned and operated by the Two Bridges Sewerage Authority and the other owned and operated by the Township of Wayne.

Treating sludges so that the resulting product is amenable to the above disposal options was also discussed. Such sludge treatment processes include anaerobic digestion, composting and incineration on the TWPSA wastewater treatment facility sites. A mechanized aerobic composting operation may be located at the wastewater treatment plant sites, whereas the static-pile composting operation may be located at external sites within the TWPSA region or at the land application sites.

The most flexible and economical transportation of sludges within the TWPSA region appears to be trucking. Trucking of dewatered sludges is more economical than trucking a liquid sludge, however, certain requirements (such as receiving requirements of a liquid sludge at either TBSA or Wayne incinerators) necessitate the transport of a liquid sludge.

The development of alternative sludge management systems is based on combining the above treatment and disposal operations. These alternative systems are graphically presented in Figures 12 through 25. Alternatives 9 and 13



SLUDGE MANAGEMENT ALTERNATIVE 1
TWPSA SLUDGE MANAGEMENT PLAN

TOTOWA-WEST PATERSON SEWERAGE AUTHORITY

Pandullo Quirk Associates

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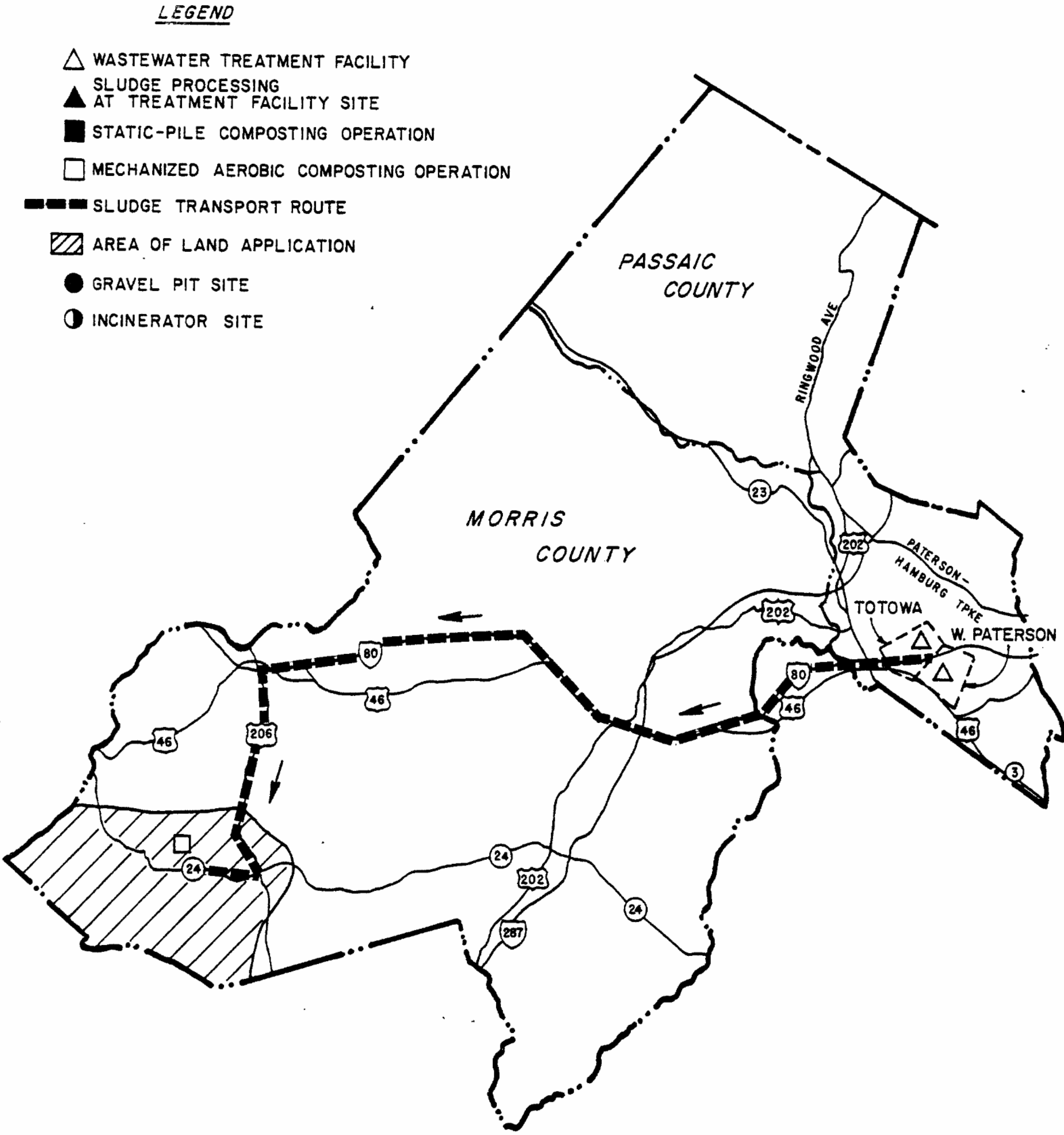
August 1978



SLUDGE MANAGEMENT ALTERNATIVE 1A
TWPSA SLUDGE MANAGEMENT PLAN

TOTOWA–WEST PATERSON SEWERAGE AUTHORITY

Pandullo Quirk Associates

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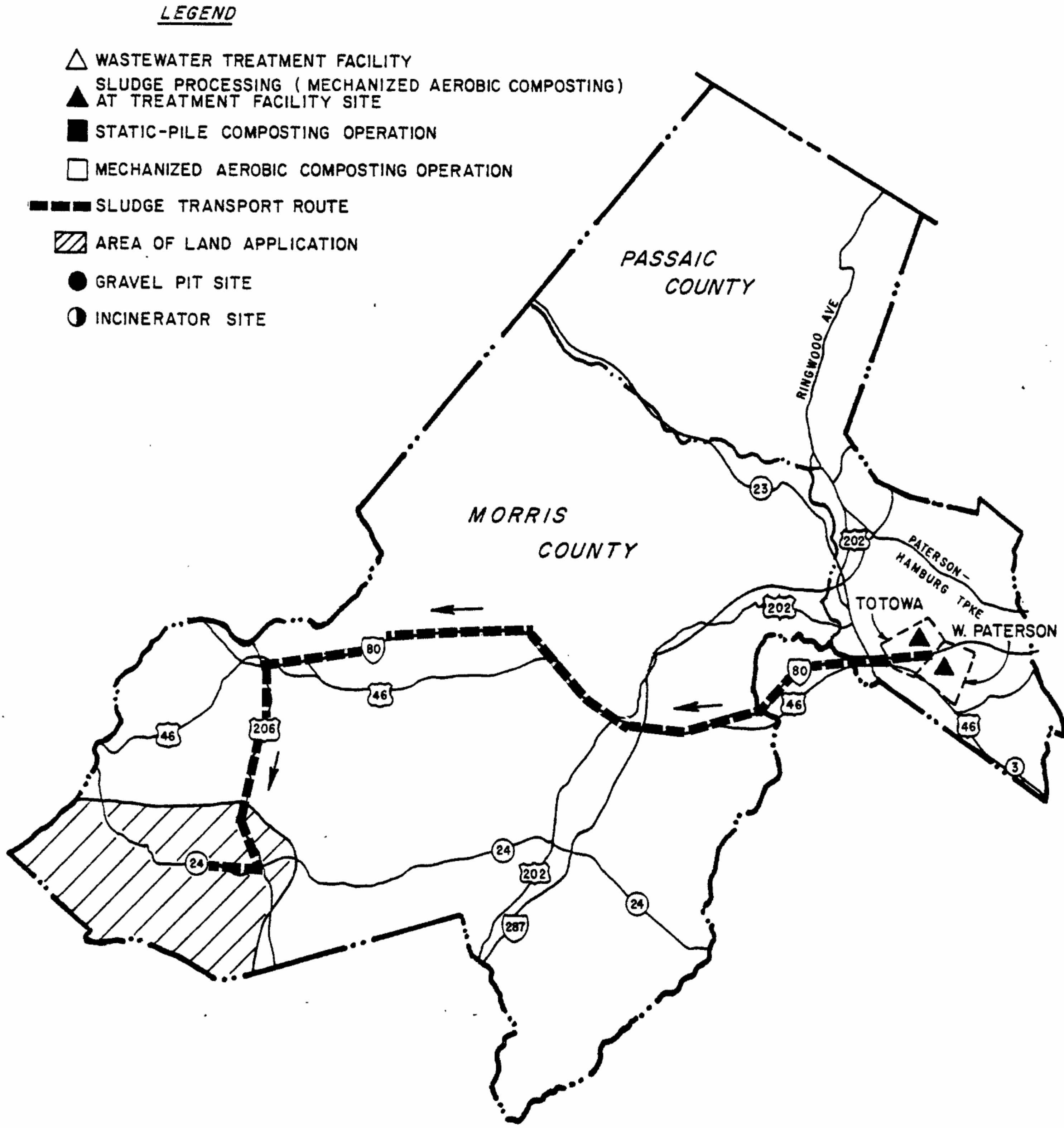
August 1978



SLUDGE MANAGEMENT ALTERNATIVE 2
TWPSA SLUDGE MANAGEMENT PLAN

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TOTOWA- WEST PATERSON SEWERAGE AUTHORITY

Pandullo Quirk Associates

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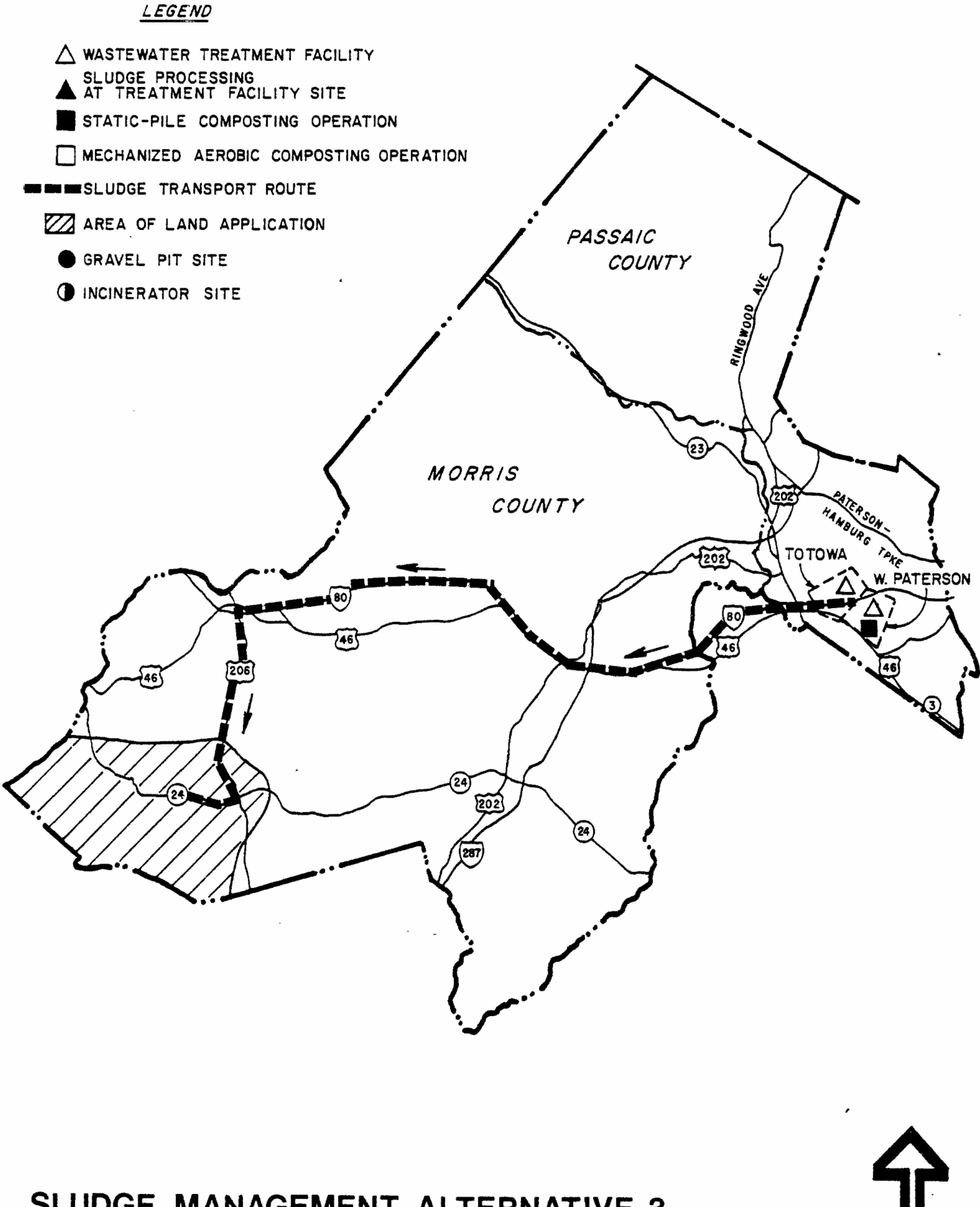
August, 1978



SLUDGE MANAGEMENT ALTERNATIVE 3
TWPSA SLUDGE MANAGEMENT PLAN

TOTOWA-WEST PATERSON SEWERAGE AUTHORITY

Pandullo Quirk Associates

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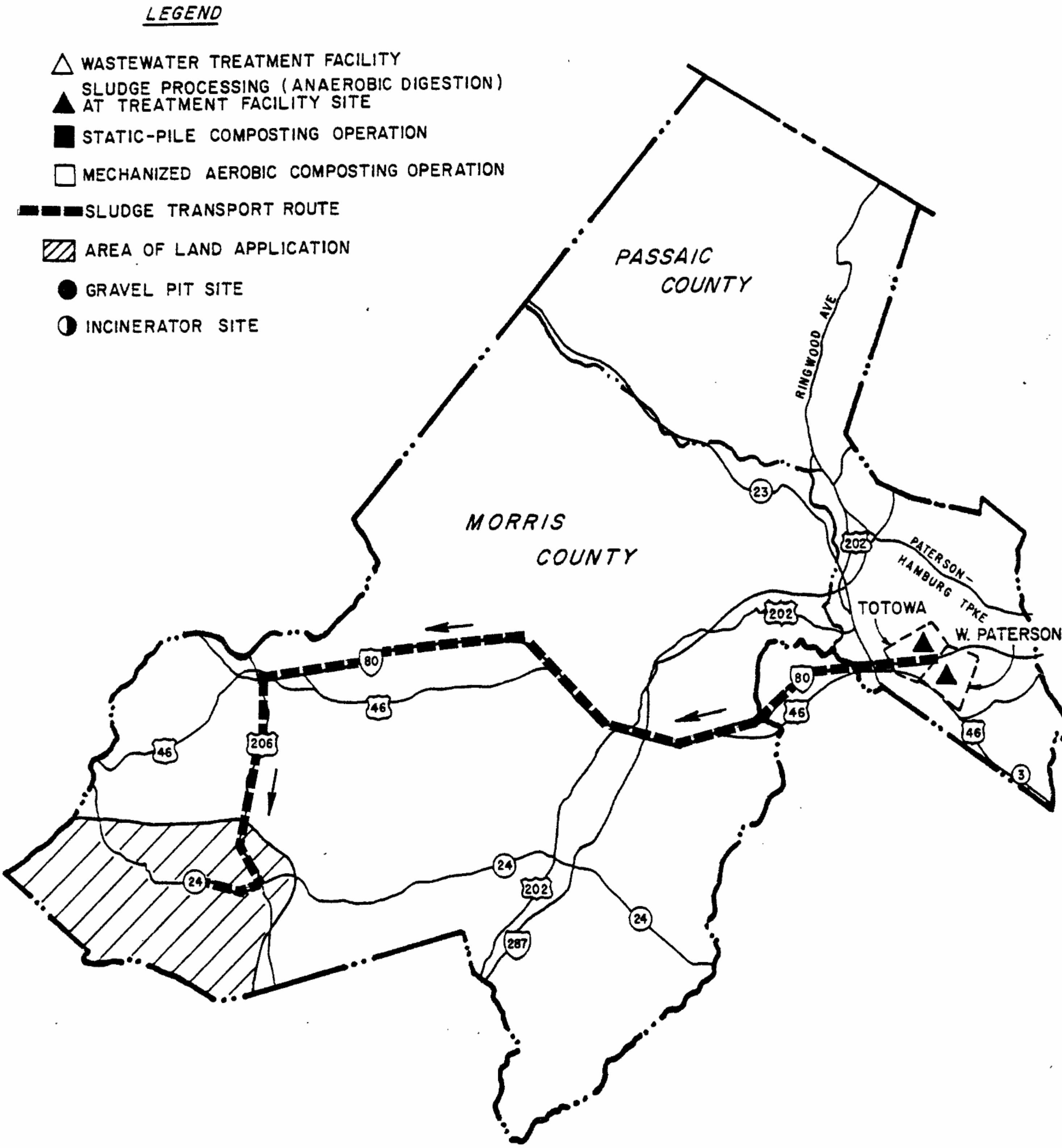
August, 1978



SLUDGE MANAGEMENT ALTERNATIVE 4 & 5
TWPSA SLUDGE MANAGEMENT PLAN

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TOTOWA - WEST PATERSON SEWERAGE AUTHORITY

Pandullo Quirk Associates

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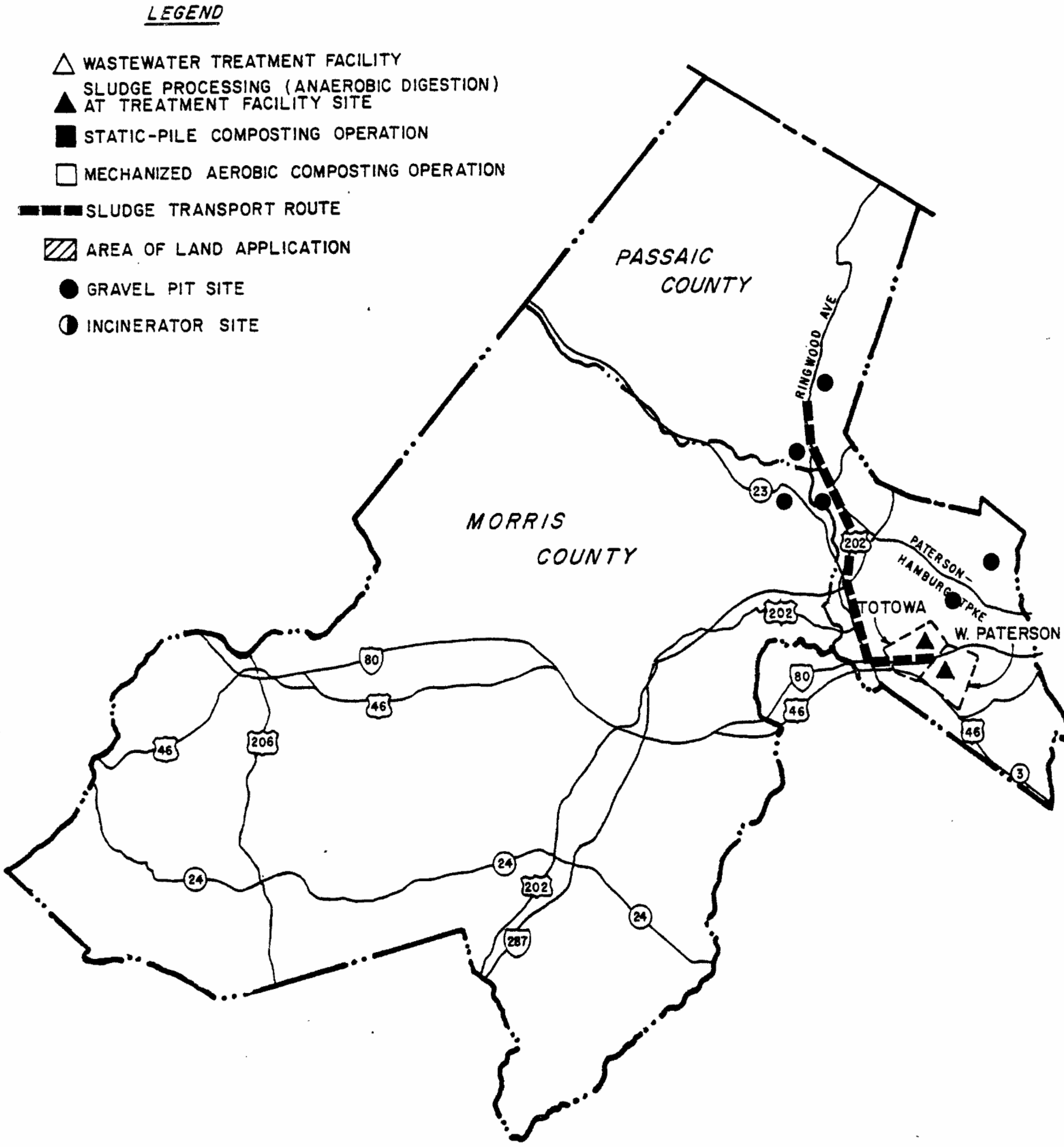
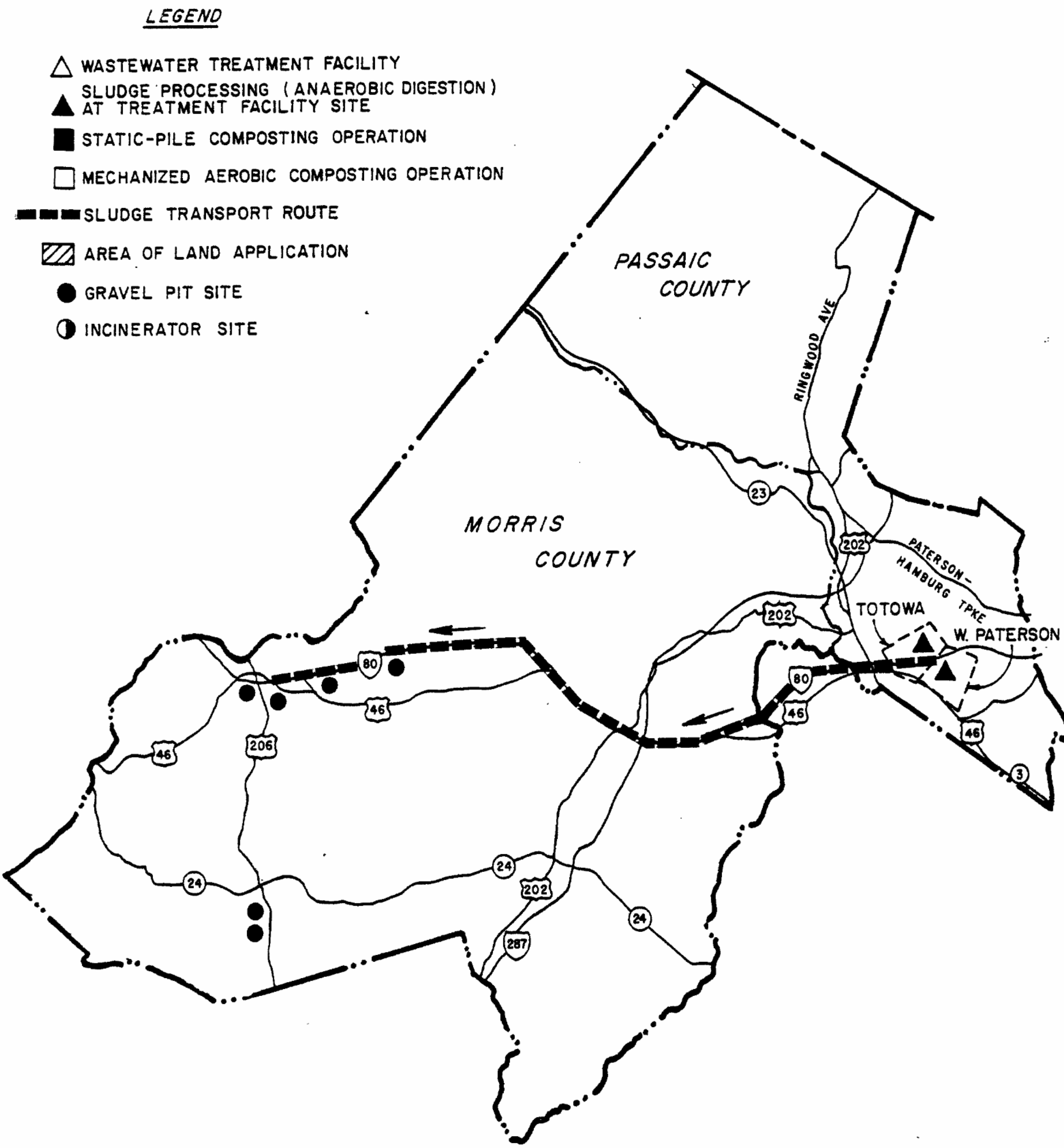


SLUDGE MANAGEMENT ALTERNATIVE 6
TWPSA SLUDGE MANAGEMENT PLAN

TOTOWA - WEST PATERSON SEWERAGE AUTHORITY

Pandullo Quirk Associates



SLUDGE MANAGEMENT ALTERNATIVE 6A
TWPSA SLUDGE MANAGEMENT PLAN

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TOTOWA–WEST PATERSON SEWERAGE AUTHORITY

Pandullo Quirk Associates

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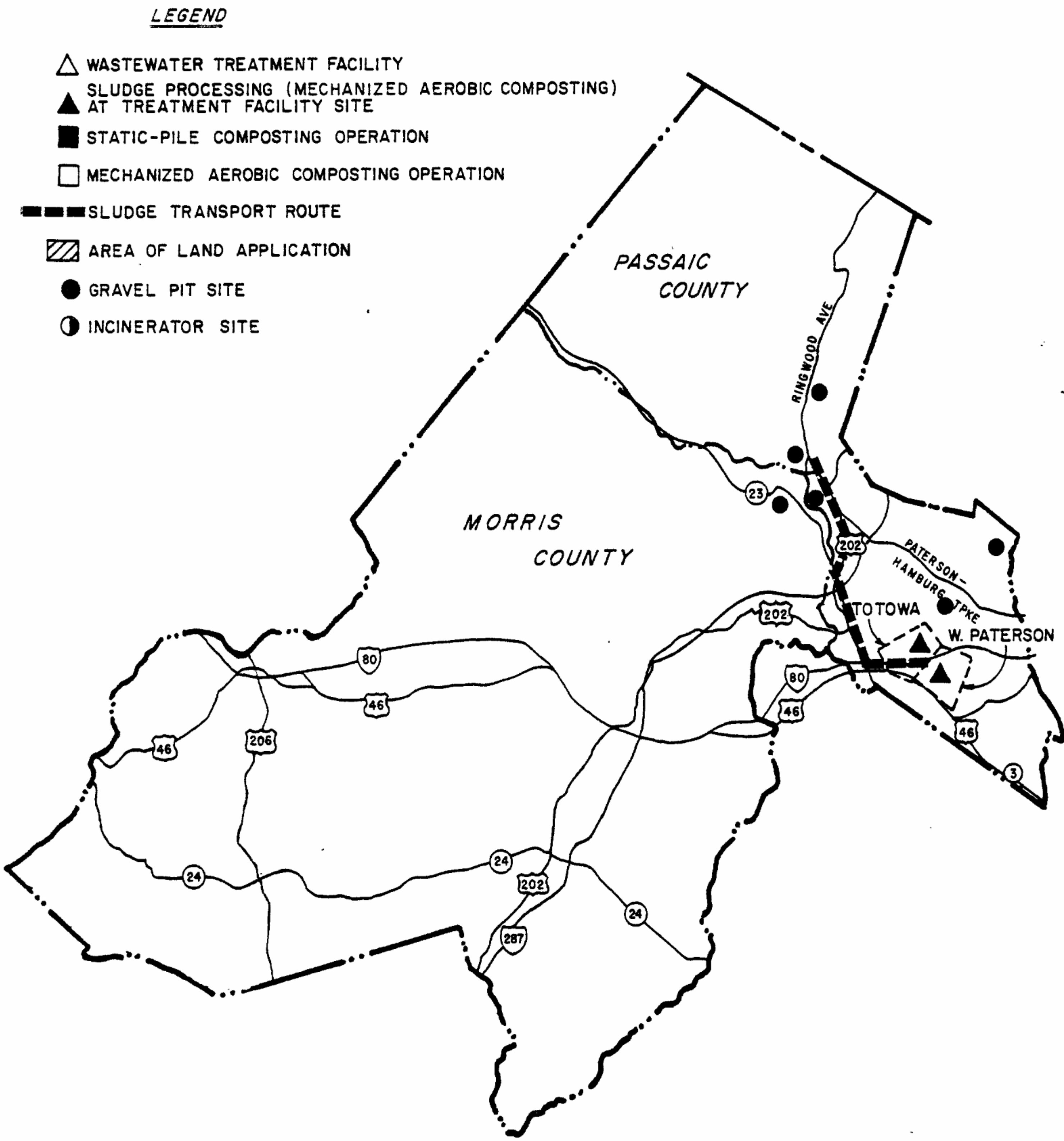
August 1978



SLUDGE MANAGEMENT ALTERNATIVE 7
TWPSA SLUDGE MANAGEMENT PLAN

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TOTOWA-WEST PATERSON SEWERAGE AUTHORITY

Pandullo Quirk Associates

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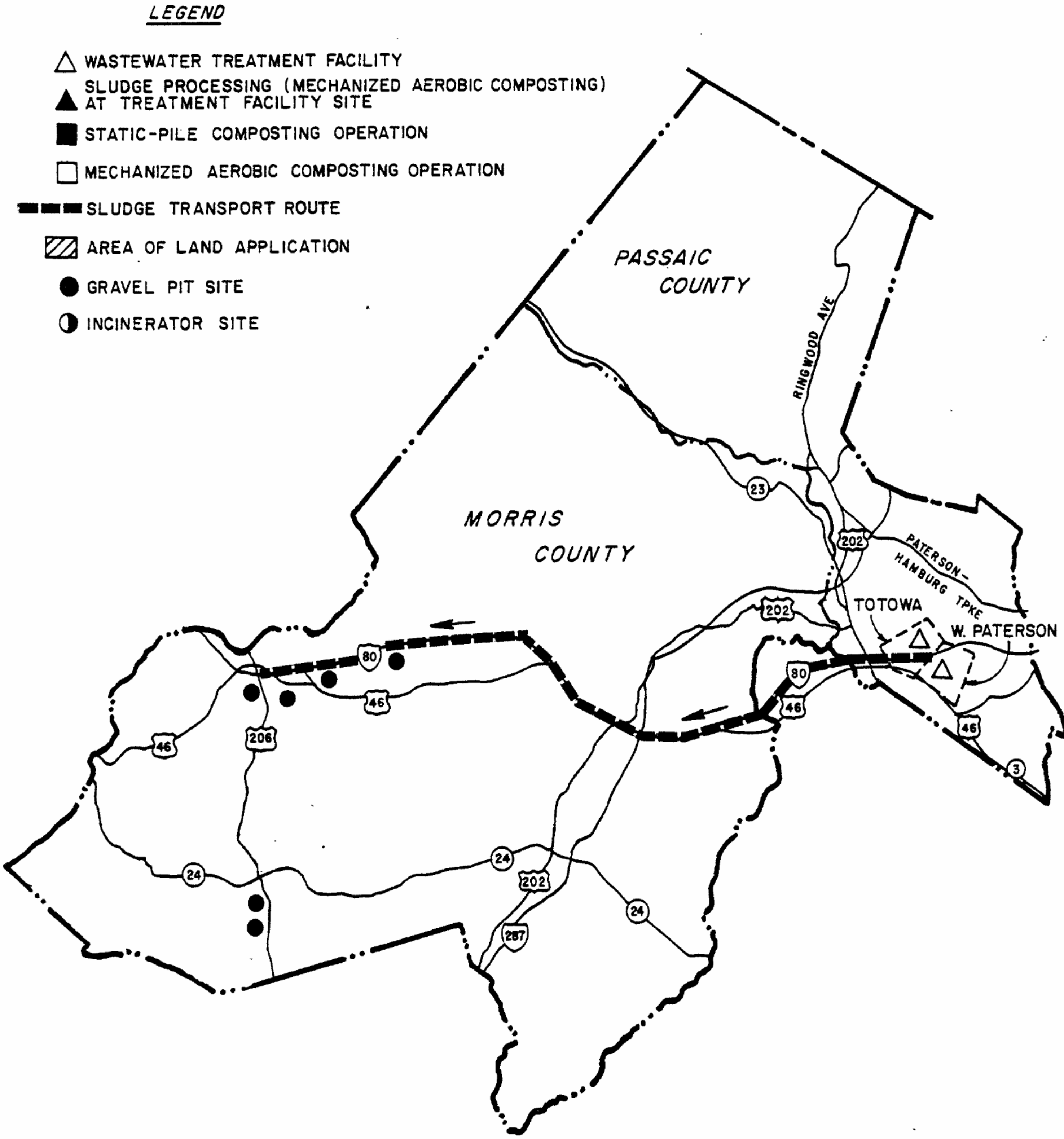

SLUDGE MANAGEMENT ALTERNATIVE 7A
TWPSA SLUDGE MANAGEMENT PLAN

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Pandullo Quirk Associates

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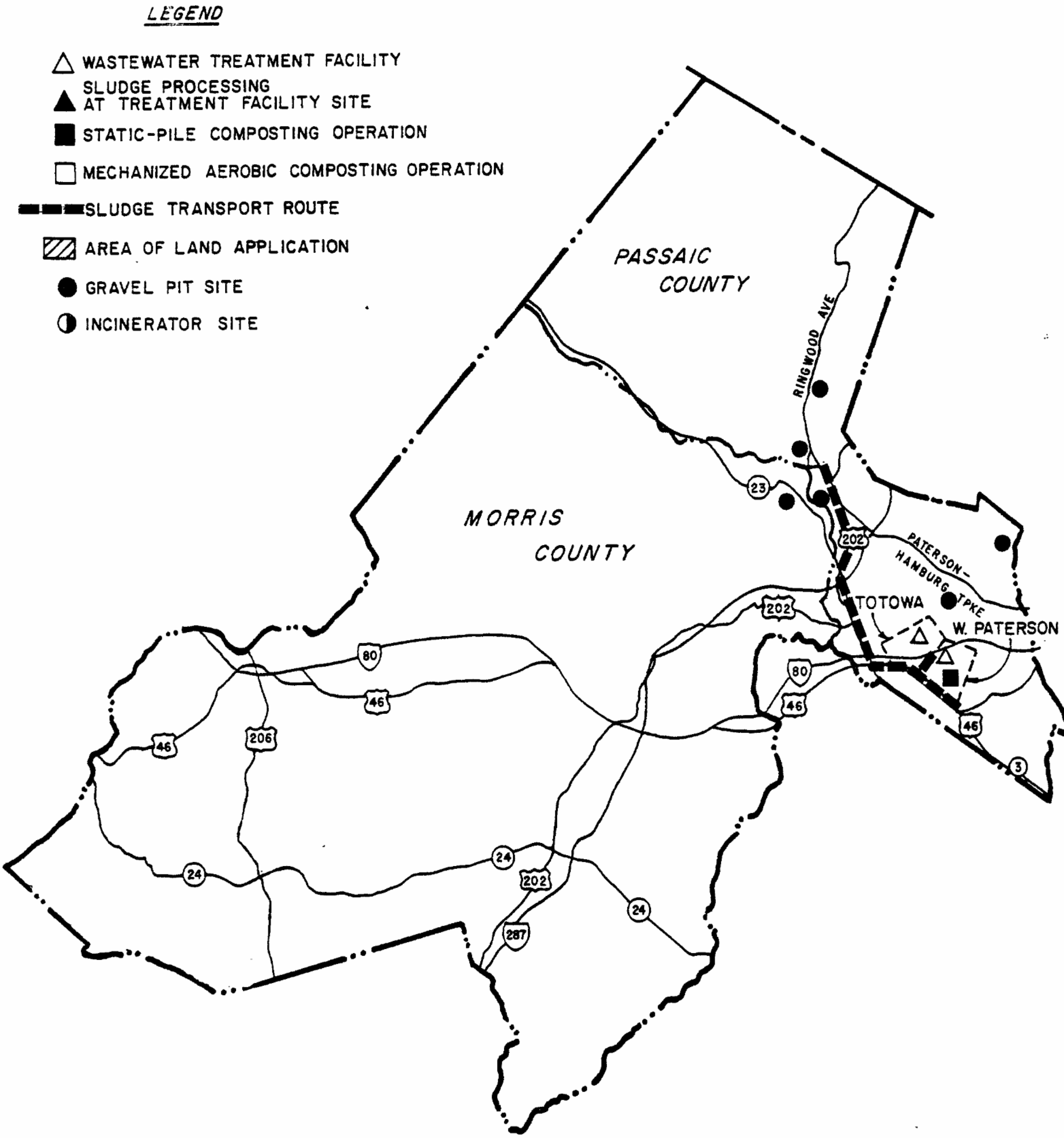

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SLUDGE MANAGEMENT ALTERNATIVE 8
TWPSA SLUDGE MANAGEMENT PLAN

TOTOWA- WEST PATERSON SEWERAGE AUTHORITY

Pandullo Quirk Associates

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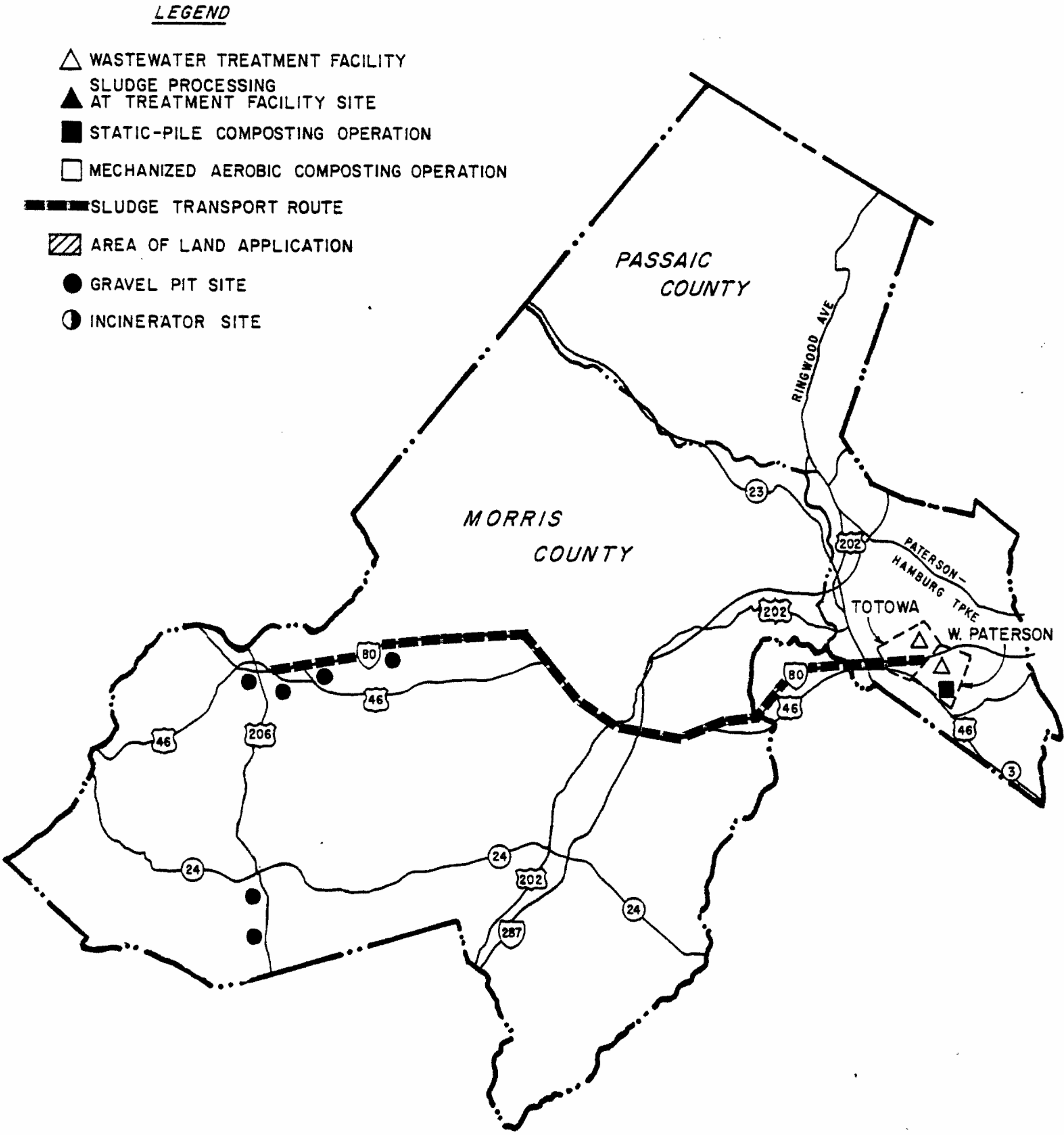
August, 1978



SLUDGE MANAGEMENT ALTERNATIVE 8A
TWPSA SLUDGE MANAGEMENT PLAN

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TOTOWA-WEST PATERSON SEWERAGE AUTHORITY

Pandullo Quirk Associates

August, 1978

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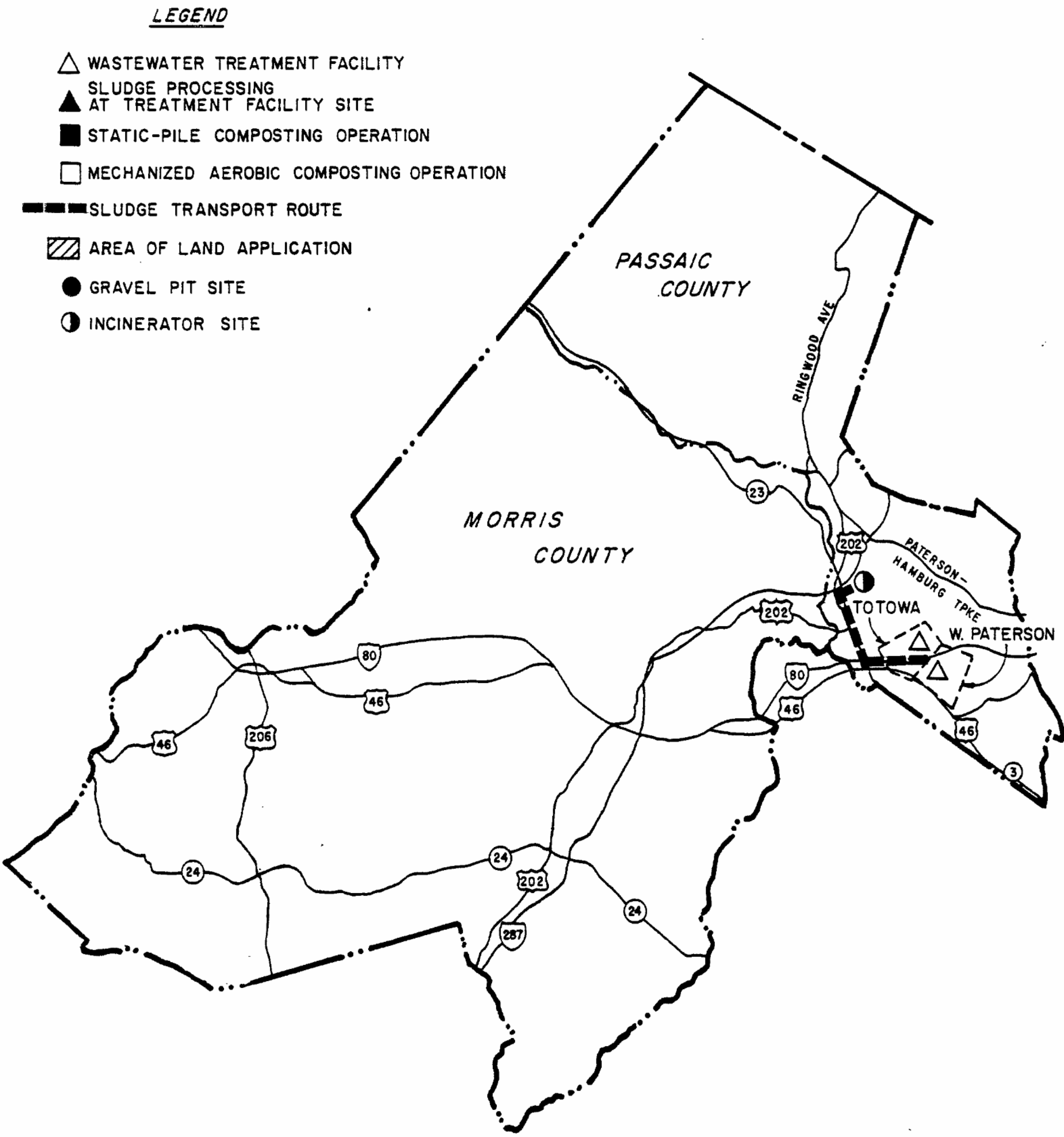
FIGURE



SLUDGE MANAGEMENT ALTERNATIVE 10 & 10A
TWPSA SLUDGE MANAGEMENT PLAN

TOTOWA-WEST PATERSON SEWERAGE AUTHORITY

Pandullo Quirk Associates

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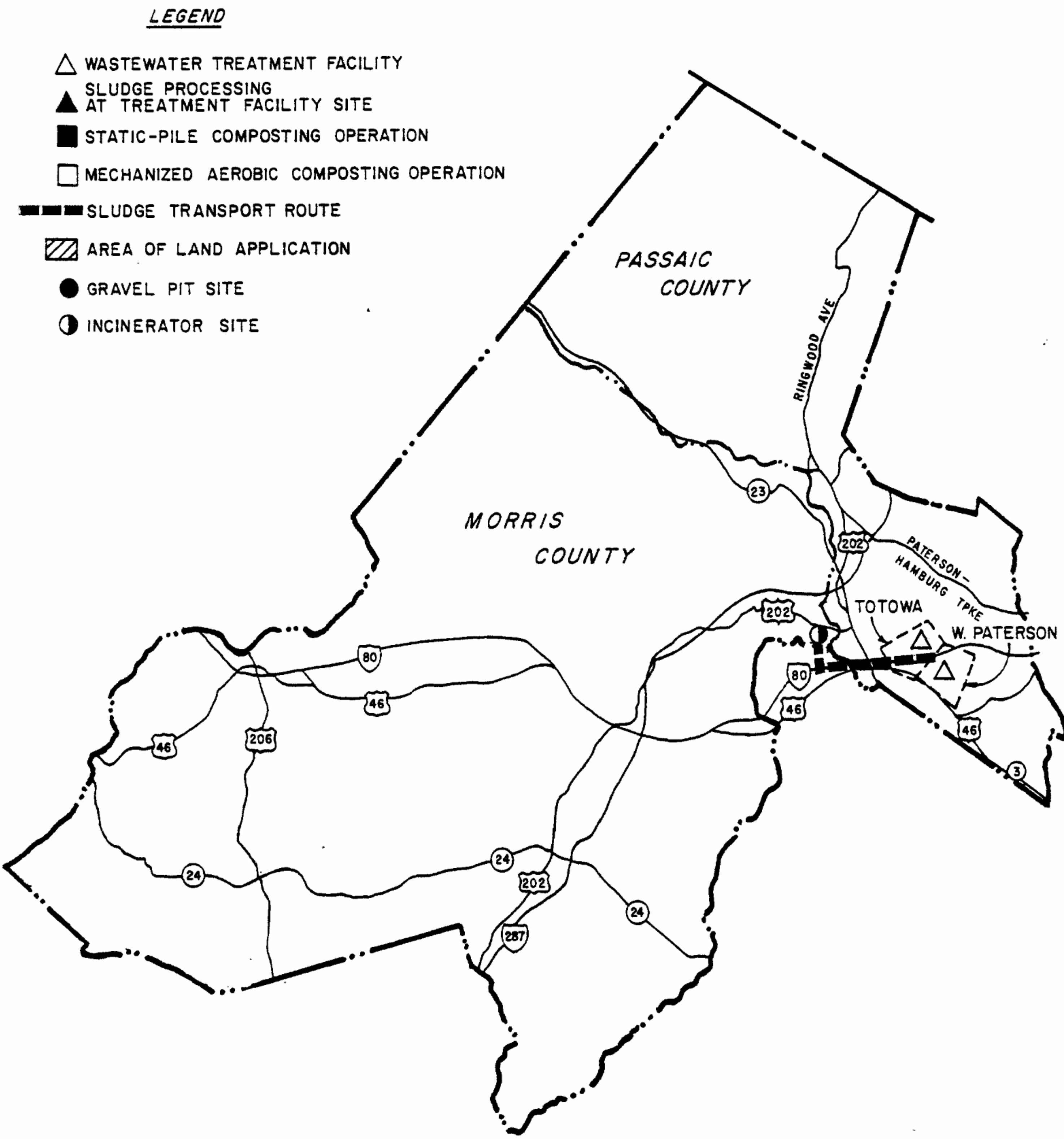
August, 1978

FIGURE 23



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SLUDGE MANAGEMENT ALTERNATIVE 11 & 11A
TWPSA SLUDGE MANAGEMENT PLAN

TOTOWA–WEST PATERSON SEWERAGE AUTHORITY

Pandullo Quirk Associates

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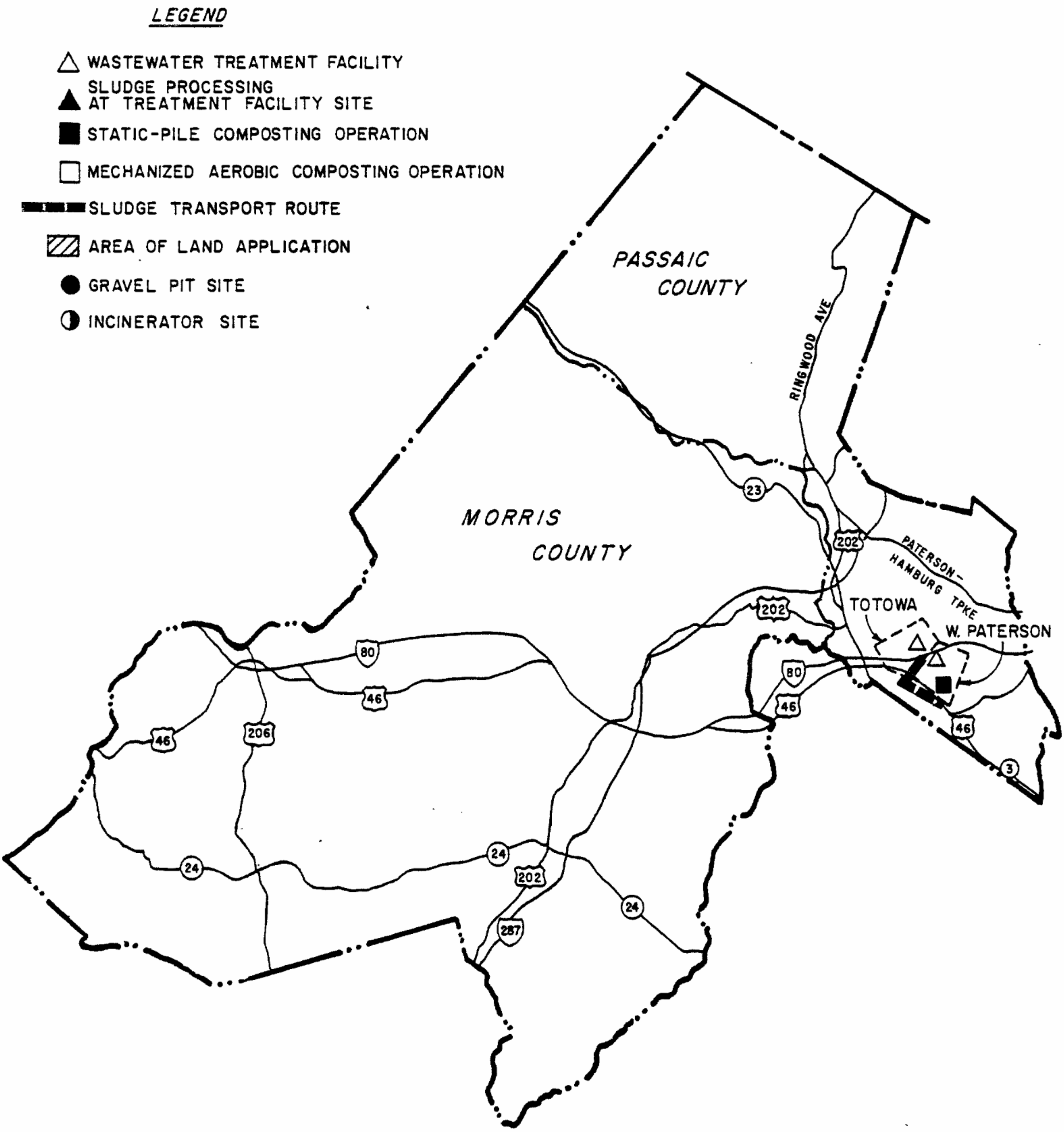
August, 1978

FIGURE



SLUDGE MANAGEMENT ALTERNATIVE 12
TWPSA SLUDGE MANAGEMENT PLAN

N

TOTOWA- WEST PATERSON SEWERAGE AUTHORITY

Pandullo Quirk Associates

0 2.5 5 MI.

August, 1978

are not graphically presented since they involve only the sites of the TWPSA wastewater treatment facilities. A brief description of each alternative sludge management system is presented in the following discussions.

Alternative 1: Vacuum filtrated sludge from each TWPSA wastewater treatment facility would be transported along Routes 80, 206 and 24 to the land application area in southwestern Morris County. Prior to land application, dewatered sludges would undergo static pile composting (Figure 12).

Alternative 1A: Similar to Alternative 1 with the exception that dewatered sludges would be stabilized by the mechanical aerobic composting operation (Figure 13).

Alternative 2: Sludges would undergo mechanized aerobic composting at each TWPSA treatment plant site prior to dewatering and transportation to the land application site for subsequent disposal (Figure 14).

Alternative 3: Sludge wastes from the wastewater treatment facilities would be transported to a static-pile composting operation located within the TWPSA region. Composted sludge would then be trucked to the land application site in Morris County (Figure 15).

Alternatives 4 and 5: Sludge wastes would be anaerobically digested at the treatment plant and transported to the land application site. Alternative 4 requires the transport of a dewatered sludge, whereas Alternative 5 deals with the transportation of a liquid sludge (Figure 16).

<u>Alternative 6</u>: Anaerobic digestion of sludge with the landfilling of a dewatered sludge within 10 miles of the TWPSA region (Figure 17).

<u>Alternative 6A</u>: Similar to Alternative 6 except that the location of landfill sites is within 25 miles of TWPSA region (Figure 18).

<u>Alternative 7</u>: Similar to Alternative 6, however, sludges are treated by the mechanized aerobic composting operation (Figure 19).

<u>Alternative 7A</u>: Similar to Alternative 6A, however, sludges are treated by the mechanized aerobic composting operation (Figure 20).

<u>Alternative 8</u>: Similar to Alternative 6 with exception that sludges would be treated by the static-pile composting operation located within the TWPSA region (Figure 21).

<u>Alternative 8A</u>: Similar to Alternative 6A with the exception that sludges would be treated by the static-pile composting operation located within the TWPSA region (Figure 22).

Alternative 9: Incineration of sludge wastes at the TWPSA wastewater treatment facilities.

Alternatives 10 and 10A: Transportation of sludges to Wayne incinerator. Dewatered sludges are transported in Alternative 10, liquid sludges in Alternative 10A (Figure 23).

Alternatives 11 and 11A: Transportation of sludges to TBSA incinerator. Dewatered sludges are transported in Alternative 11, liquid sludges in Alternative 11A (Figure 24).

Alternative 12: Dewatered sludges are transported to external site for static-pile composting. Compost products would then be distributed to markets (Figure 25).

Alternative 13: Similar to Alternative 12, however, sludges would undergo stabilization by the mechanized aerobic composting operation at the wastewter treatment facilities.

5.0 ASSESSMENT OF ALTERNATIVE SYSTEMS

5.1 Methodology

All alternative sludge management systems identified in Section 4.3 for the TWPSA sludge management plan were assessed as to their cost-effectiveness, environmental soundness, socio-economic advantages and implementability. By initially assessing the cost-effectiveness of these alternative sludge management systems as required by the EPA regulations reported in Appendix A of 40 CFR Part 35, a preliminary ranking of the least cost alternatives was developed. These alternatives were further assessed using developed environmental and socio-economic criteria. The results of the environmental, socio-economic, and implementability assessments are cost-effective sludge management systems that afford the least, if any, adverse environmental constraints, while simultaneously providing a beneficial contribution to the social and economic structure within the TWPSA region.

The criteria of the evaluation matrix were basically categorized under four major areas of analysis: cost, environment, socio-economic and implementation. Descriptions of these four areas as they related to evaluation of the alternate systems are found in Sections 5.2 through 5.4.

Tables 8, 9 and 10 in Section 5.2 present cost data and ranking of the alternatives. Tables 11 and 12 present the results of the environmental matrix analysis and the ranking of alternatives, respectively. These tables are presented in Section 5.5.

5.2 Cost

The cost-effective analysis of the identifiable alternative sludge management systems was accomplished through comparison of total present worth values of each system. Total present worth values are the summation of total present worth construction costs and the total present work operation and maintenance (O&M) costs of each management system's components. A discussion of the development of the construction (or capital) costs and O&M costs follows.

5.2.1 Capital and O&M Costs

Capital costs and Operation and Maintenance (O&M) costs were developed or obtained for the processes and operations described in Section 4.1.7, Process Alternatives section. All capital costs were updated to reflect March 1978 dollars and are referenced to the Engineering News Record (ENR) Construction Cost Index of 3138. O&M costs were also updated to reflect March 1978 dollars for the New York-New Jersey area, and are referenced to the Wholesale Price Index of 203.8 and the Consumer Price Index of 192.2. Labor costs were in part reflective of the current Bureau of Labor Statistics figures. Capital and O&M costs from manufacturers and operating facilities were utilized subsequent to confirmation.

Capital costs were generally established for normal conditions and included such costs as basic manufacturing and installation costs, contractor's profit, contingencies (25%), and equipment costs. All non-land related capital costs were multiplied by a 1.32 factor to establish project costs. Land related capital costs were multiplied by a 1.20 factor.

O&M costs included costs for operating labor for equipment startup, sampling, monitoring, control, and shutdown of equipment. Maintenance labor is essential for cleaning and repair of equipment. Materials costs included those costs for chemicals, power for pumps, blowers and machinery and include electricity, diesel fuel, and gasoline, lubricants, and woodchips. A more detailed description of the costs included for the aforementioned alternatives is presented in the following discussions.

Static Pile Composting: Capital costs for the static pile composting operation include the construction cost for a 1.5 acre asphalt composting pad, including a 12" stone base and 4" asphalt layer ($12.10/sq. yd.), nearly one-fifth acre of roads ($7.50/sq. yd.), approximately 170 linear feet of sewer ($37/linear ft.), and 0.15 acre runoff retention pond ($2.50/cu. yd. for excavation and $0.75/sq. ft. for lining). Other capital costs included one office trailer ($5,7000), storage facility for equipment ($1,150), two front end loaders (@ $60,400 a piece), one mechanical screen ($17,100), one tractor and pickup (each @ $5,400) and approximately 30 air blowers ($300 a piece). Additional capital cost for land was considered for a 5 acre site including a 200' buffer zone. Land cost in West Paterson and Totowa was estimated at $14,000/acre on the average.

O&M costs included those costs for acquiring woodchips at $3.50/cubic yard, plastic perforated 4 inch pipe at 40¢/l.f., gasoline costs at 60-3/10¢/gallon, diesel fuel at 43-2/10¢/gallon and electricity for 5¢kw-hr. Labor costs for the labor force of one supervisor and three operators were estimated to be respectively $7.50/hr and $6.00/hr. Approximately 8% of the total O&M cost was added for such expenses as equipment maintenance, equipment insurance, pad and road maintenance and water and sewer costs. The operation of the 4 ton/day composting operation was based on a seven day per week operation, 8 hours per day.

No additional costs were determined for treatment of leachate at compost site. Collection of leachate, transportation to a point of treatment and treatment of leachate are additional considerations.

<u>Mechanized Aerobic Composting</u>: The mechanized aerobic composting operation is based on a 4-ton per day, 5 day per week, 4 hours per day operation. Capital investment included $500,000 for 2 composting units. This cost includes costs for the structure, air equipment, mixing unit and sludge and sawdust storage. Land requirements at approximately 6,000

sq. ft. are considered as existing at the present treatment plant sites.

Annual operating labor costs include one part-time employee at $7.50/hr. Total operation and maintenance costs amount to $22,000 based on a $15.00/dry ton cost reported by the manufacturer. This cost includes all costs associated with the carbon carrier, labor, electricity, sawdust, maintenance and repair.

Incineration: Costs and installation costs for the multiple hearth incinerator including appropriate air pollution control devices (wet scrubber) amount to $853,000 dollars. The operating period for this facility is 5 hours per day, 7 days per week.

Operation and maintenance labor requirements are 1.2 manhours/dry ton at an average rate of $6.00/hr. labor rate, or $7.80/dry ton. Materials and supplies costs were estimated at $2/dry ton, while fuel and electricity were estimated, respectively, to amount to $19.40/dry ton and $4.80/dry ton.

Total O&M costs for the incinerator operation approximated $34/dry ton.

Anaerobic Digesters: Capital costs include those costs for the digesters, floating covers, gas collecting equipment, heat exchanges, control building, piping to an on site location and associated mechanical and electrical equipment.

The design of the digesters was based upon an assumed solids loading of 0.2 lb/cu. ft./day.

O&M costs for the unit processes have been related to the average daily weight of dry solids processed and include such labor costs for equipment startup, control and monitoring of process. Included in the costs are credit for the indirect internal energy reuse such as recovery of heat from digester off-gas systems. Labor costs were based on an average hourly wage rate of $6.00.

<u>Dewatering</u>: Capital costs used for the dewatering alternatives was based on the vacuum filtration unit including a continuous belt vacuum filter, housing, pumps, equipment for chemical conditioning and biological treatment of the effluent.

O&M costs included costs for the chemicals and power for pump and blowers, and labor costs for the operation and maintenance of equipment.

<u>Sludge Holding Tanks</u>: Capital costs for sludge holding tanks include the tanks and piping within the limits of the structure constructed. Additional capital and O&M costs were for mechanical aerators to maintain a thoroughly mixed and odor free sludge mixture.

<u>Trucking</u>: Transportation costs for dewatered sludges were developed based on a 25 cu. yd. capacity during truck transportation of sludges for one way distances in miles.

Costs reflect fees paid to private sludge hauling contractors in the New York-New Jersey area. Tank truck costs were based on a tank truck capacity of 6,000 gallons and transportation of liquid sludges with a solids concentration of 5%.

Land Application Costs: Capital Costs for land application of sludge include the cost for purchasing land of approximately 260 acres at each site (at $445/acre in Morris County), site preparation ($2,000) and installation of four groundwater monitoring wells ($530 per well). Additional capital costs included equipment cost for a truck, and a plow and injector unit ($30,000) operated in the contour-furrow mode. Operation and maintenance costs included the costs for the operation and maintenance of the monitoring wells ($90/well/year) and for the daily application of the sludge onto the land (approximately $24,000/year for an application rate of 10 tons/day on 260 acres of land). Groundwater and soil sample analysis are assumed to be analzed by treatment plant personnel. No costs for growing or harvesting crops have been considered. Planting, growing, and harvesting costs for a crop such as alfalfa seed may amount to as much as $170/acre/year.

Landfilling Costs: Capital costs for landfilling include the purchase of land for each site (at $14,000/acre or $1,500/acre in areas of 10 and 25 miles, respectivly, from the treatment plant site), construction cost of the landfill including one bulldozer equipped for landfill operation.

Operations and maintenance costs include equipment operating labor and maintenance labor. Included in the O&M costs is the cost for installation of an impermeable liner (at $.75/ sq. ft.). An ample supply of daily earth cover material was assumed to be available at each site, negating the need to transport cover material from outside sources. No costs have been assigned to the value of any reclaimed gravel pits or other previously unproductive lands.

Market Costs: All transportation costs from any sludge treatment site to a potential market is presumed to be borne by the market. As such, no marketing costs are incurred by the TWPSA. In addition, no income has been realized by this present worth analysis as a result of marketing the sludge. The lack of income for the marketing of sludge is assumed to balance out the lack of transportation costs for transporting sludges to the market.

5.2.2 Present Worth Analysis

The present worth analsis was performed on all alternatives so that the cost-effectiveness of each alternative may be compared to the other alternatives. The current USEPA authorized interest rate of 6-5/8% was used for a planning period of twenty years. Salvage values as defined in EPA cost-effectiveness analysis guidelines, Appendix A of 40 CFR, Part 35, were applied to equipment and constructed units deemed salvageable at the end of the 20 year planning period.

The results of the present worth analysis of the alternative sludge management systems is presented in Tables 8 and 9. Table 10 presents the rank of least cost alternative sludge management system.

Cost information presented in Tables 8 and 9 indicate that composting of sludge either at the site of the TWPSA wastewater tratment facilities with a market for the compost product to be the most cost effective sludge management alternative. The highest ranked alternative utilizing an outside sludge management plan is Alternative 11A. This alternative involves the transportation of a liquid sludge to the TBSA incinerator.

Generally, those alternatives involving landfill as the disposal component ranks near the end of the list on Table 10. This may be attributable in part to the costs for providing a secured (lined) landfill. Alternatives involving land application rank in the middle to the upper third third of the list, while those alternatives in which the disposal mode was to a market or an outside sludge management operation ranked in the upper third.

5.2.3 Additional Cost Considerations

The cost-effectiveness analysis has shown that composting along with a market of the compost product affords the most cost-effective treatment and disposal of sludge wastes generated by the TWPSA wastewater treatment facilities.

TABLE 8

TOTAL PRESENT WORTH (March 1978 $1000)
ALTERNATIVE SLUDGE MANAGEMENT SYSTEMS
TWPSA SLUDGE MANAGEMENT PLAN

	Sludge System Components	Alternative Sludge Management Systems																			
		1	1A	2	3	4	5	6	6A	7	7A	8	8A	9	10	10A	11	11A	12	13
TREATMENT	Sludge Storage	135	135	135	135	-	-	-	-	135	135	135	135	135	135	135	135	135	135	135
	Vacuum Filtration	344	344	344	344	344	-	344	344	344	344	344	344	344	344	-	344	-	344	344
	Anaerobic Digestion	-	-	-	-	769	769	769	769	-	-	-	-	-	-	-	-	-	-	-
	Transportation(1)	-	-	-	81	-	-	-	-	-	-	81	81	-	-	-	-	-	81	-
	Transportation(2)	220	220	220	228	220	550	111	166	111	166	111	166	-	95	125	95	125	-	-
	Static Pile Composting	1435	-	-	1519	-	-	-	-	-	-	1519	1519	-	-	-	-	-	1519	-
	Mechanized Aerobic Composting	-	887	887	-	-	-	-	-	887	887	-	-	-	-	-	-	-	-	887
	Incineration	-	-	-	-	-	-	-	-	-	-	-	-	1648	4124	4124	2401	2401	-	-
DISPOSAL	Landfill	-	-	-	-	-	-	1952	1652	1952	1652	1952	1652	-	-	-	-	-	-	-
	Land Application	630	630	630	630	630	630	-	-	-	-	-	-	-	-	-	-	-	-	-
	Market	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
	Total	2764	2216	2216	2937	1963	1949	3176	2931	3429	3184	4142	3897	2127	4698	4384	2975	2661	2079	1366

(1) Transportation to external site in TWPSA region
(2) Transportation to disposal site

TABLE 9

BREAKDOWN OF TOTAL PRESENT WORTH (March 1978 $1000)
ALTERNATIVE SLUDGE MANAGEMENT SYSTEMS
TWPSA SLUDGE MANAGEMENT PLAN

	Sludge System Components	Alternative Sludge Management Systems																		
		1	1A	2	3	4	5	6	6A	7	7A	8	8A	9	10	10A	11	11A	12	13
TREATMENT	Construction Costs	387	707	707	457	684	535	684	684	707	707	457	457	1060	207	58	207	58	457	707
	Project Costs	511	933	933	595	903	707	903	903	933	933	595	595	1399	272	76	271	75	594	932
	Replacement Costs	64	18	18	64	18	18	32	32	32	32	78	78	0	0	0	0	0	46	0
	O&M Costs	1362	451	451	1443	222	74	222	222	451	451	1443	1443	746	211	63	211	63	1443	451
	Salvage Value	4	17	17	4	11	11	11	11	17	17	4	4	18	4	4	4	4	4	17
	Sub-Total	1933	1385	1385	2098	1132	788	1146	1146	1399	1399	2112	2112	2127	479	135	478	134	2079	1366
DISPOSAL	Construction Costs	251	251	251	251	251	251	849	599	849	599	849	599	-	-	-	-	-	-	-
	Project Costs	317	317	317	317	317	317	1087	787	1087	787	1087	787	-	-	-	-	-	-	-
	O&M Costs	514	514	514	522	514	844	943	998	943	998	943	998	-	4219	4249	2497	2527	-	-
	Sub-Total	831	831	831	839	831	1161	2030	1785	2030	1785	2030	1785	-	4219	4249	2497	2527	-	-
	Total	2764	2216	2216	2937	1963	1949	3176	2931	3429	3184	4142	3897	2127	4698	4384	2975	2661	2079	1366

TABLE 10

RANK OF LEAST COST
ALTERNATIVE SLUDGE MANAGEMENT SYSTEMS
TWPSA SLUDGE MANAGEMENT PLAN

Rank	Sludge Management Alternative	Alternative Description	Total Present Worth (March 1978 $1000)
1	13	Mechanized Compost - Market	1366
2	5	An. Digestion - Land Application	1949
3	4	An. Digestion - Land Application	1963
4	12	Static Pile Compost - Market	2079
5	9	Incineration - TWPSA	2127
6	1A	M. Compost - L. Application	2216
7	2	M. Compost - L. Application	2216
8	11A	Incineration - TBSA	2661
9	1	S.P. Compost - L. Application	2764
10	6A	An. Digestion - Landfill (25 mi.)	2931
11	3	S.P. Compost - L. Application	2937
12	11	Incineration - TBSA	2975
13	6	An. Digestion - Landfill (10 mi.)	3176
14	7A	M. Compost - Landfill (25 mi.)	3184
15	7	M. Compost - Landfill (10 mi.)	3429
16	8A	S.P. Compost - Landfill (10 mi.)	3897
17	8	S.P. Compost - Landfill (10 mi.)	4142
18	10A	Incineration - Wayne	4384
19	10	Incineration - Wayne	4698

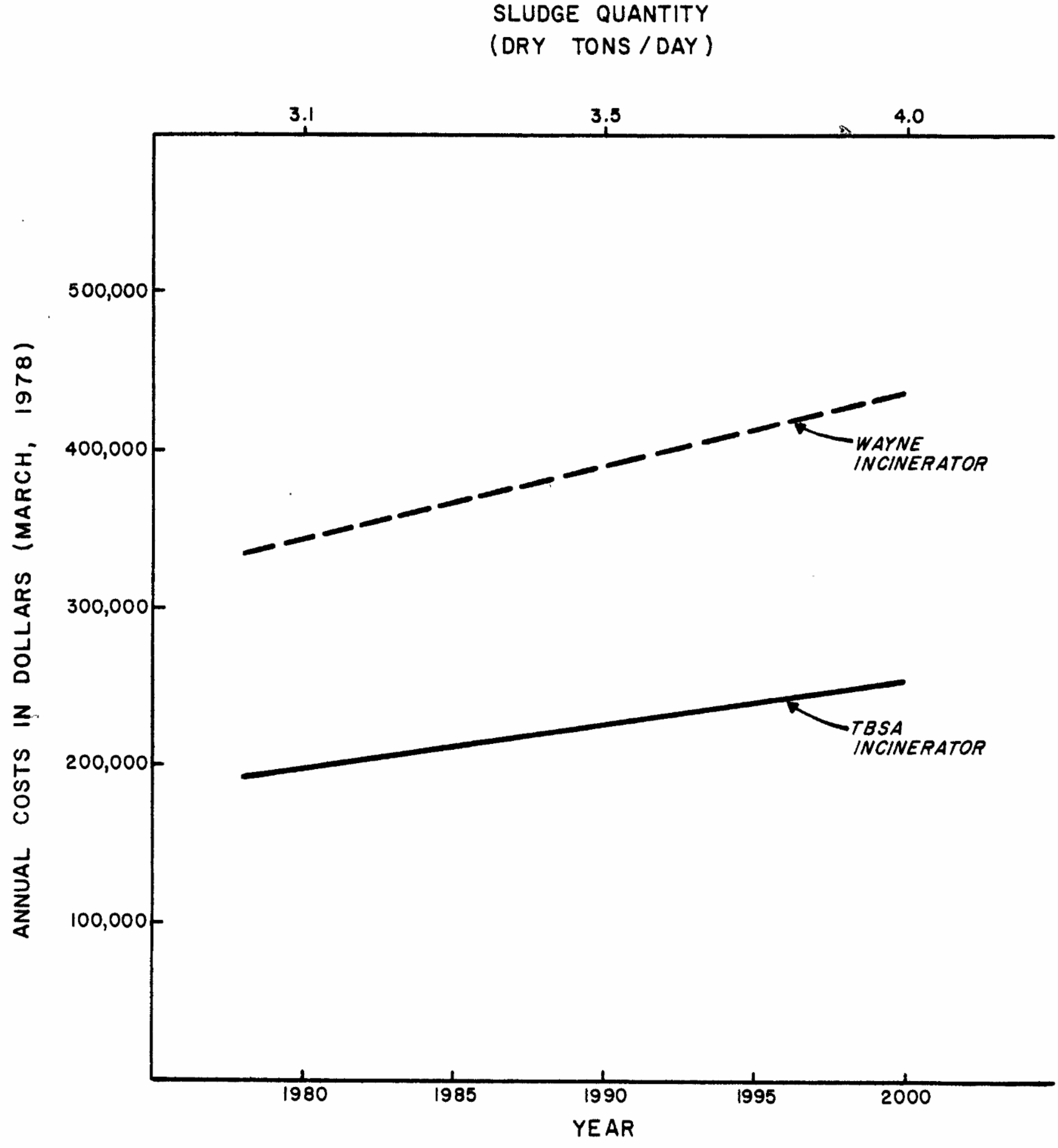
The bulking material used for the mechanized aerobic composting operation is sawdust. The substitution of the sawdust by light municipal refuse as a bulking agent has been shown to be feasible. This raises the possible consideration of co-disposal of two waste streams, municipal sludges and municipal solid wastes. An approximate savings of nearly 20% to 30% of the total O&M cost could result.

The costs presented for the alternative system proposing the disposal of sludges to the TBSA incinerator include a cost for sludge storage. This cost would be eliminated if the existing anaerobic digesters were utilized for sludge storage. Thus making the use of the TBSA incinerator more attractive.

Figure 26 presents the estimated annual costs for use of the incinerators at the TBSA and Wayne facilities. These costs were based on the reported costs $300/dry ton and $175/dry ton for the Wayne and TBSA facilities, respectively.

5.3 Environmental Analysis

Enironmental analysis of sludge management activities is undertaken to determine the actual impacts of using a particular site. Natural environmental criteria were developed for use in the matrix, which were pertinent to soils, surface waters, wetlands, ground waters, vegetation and wildlife.



ESTIMATED ANNUAL INCINERATION COSTS
TWPSA SLUDGE MANAGEMENT PLAN

TOTOWA-WEST PATERSON SEWERAGE AUTHORITY

Pandullo Quirk Associates

Soils, surface waters, wetlands and groundwaters were dealt with in the initial screening of disposal areas (Section 3.2) to arrive at environmentally sound selections. Therefore, only vegetation and wildlife criteria were developed and utilized in the matrix.

With regards to potential landfill sites, assumptions were made on the impacts to vegetation and wildlife based on the proximity of the sites to the TWPSA region. It was generally believed that impacts would be greater in landfill sites furthest away (25 miles) from the TWPSA area since these areas are more rural and thus may be conducive for habitation of wildlife and exotic vegetation. Those landfill sites nearer in proximity to the TWPSA area are situated in more populated areas and the impacts would be less. By nature of their use, agricultural lands were not deemed susceptible to severe impacts if used for land application of sludge products.

5.4 Socio-Economic Analysis

Socio-economic criteria utilized for the evaluation matrix consisted of real property acquisition costs, surrounding land use, and the potential for adverse impacts on future land use, real property values and social infrastructure and implmenetation feasibility.

Existing land uses and proposed future land uses of Passaic and Morris Counties were generally discussed as summaries of the information presented in Section 3.1.

Ranges of real property values were reported for the areas containing the potential landfill sites and land application area. Real property values for areas closest in vicinity to the TWPSA area ranged from $5,000 to nearly $35,000 per acre. Whereas the real property values for areas furthest away from the TWPSA area ranged from three hundred dollars to five thousand dollars.

Sludge management alternatives which could be carried out in its entirety within the jurisdictions of the TWPSA were deemed the most implementable. Those alternatives which involved other jurisdictional areas, such as those involving potential landfill or land application sites were deemed less or not implementable, and those alternatives that utilized an existing sludge management operation such as the TBSA or the Township of Wayne's incinerator were deemed implementable since contact had been made with the respective authorities and interests were expressed.

Although not included in the matrix evaluation, consideration was given to historical sites and the impacts on these sites. Generally, none of the potential landfill sites or land application sites were actually historical sites. Much of Washington Township, however, consists of historical sites, some of which are within one mile of potential land application sites while others are well beyond the one mile distance.

5.5 Results of the Matrix Evaluation

Tables 11 and 12 present the results of the matrix evaluation of the alternative sludge management systems developed for the TWPSA sludge management plan. Table 11 lists the average values of potential impacts as determined by the four participants. Total scores are indicated at the bottom of the matrix.

The alternative sludge management systems were ranked from 1 to 19 on Table 12, commencing with the alternative exhibiting the lowest total score. Those alternative sludge management systems involving a market for ultimate disposal of sludge product or utilizing an incineration ranked highest. Those alternative systems that rely on landfilling or land application were ranked at the bottom of the list.

The process employed in developing the quantitative alternative system evaluation was to assess the systems by using a matrix approach. The various criteria by which each alternative system is to be evaluated are tabulated vertically and the various alternate systems listed horizontally. Based on a pre-determined methodology, each system is evaluated quantitatively by assigning appropriate numbers for each parameter; the magnitude of the number indicating the degree to which the system satisfies the criteria.

The numbers tabulated vertically for each system are totaled and the totals for each alternate system compared.

TABLE 11

EVALUATION MATRIX OF SLUDGE SYSTEM ALTERNATIVES
TWPSA SLUDGE MANAGEMENT PLAN*

Criteria

Process	1	1A	2	3	4	5	6	6A	7	7A	8	8A	9	10	10A	11	11A	12	13
Energy Consumption	1.3	1.0	1.3	2.0	1.3	1.0	0.8	0.8	0.5	0.5	0.8	0.5	3.8	1.8	1.3	1.0	1.3	1.3	0.8
Aesthetics & Odors	0.8	0.3	0.3	2.5	1.5	1.0	0.8	0.8	0.3	0.3	0.8	0.5	1.5	1.0	1.0	1.0	1.0	0.8	0.0
Land Consumption	0.3	0.3	0.3	1.0	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.0	0.0	0.0	0.0	0.3	0.3
Resource Recovery	1.8	1.8	1.8	1.8	1.8	2.5	2.3	2.3	2.0	2.0	2.0	2.0	2.3	4.0	4.0	4.0	4.0	1.0	1.3
Air Quality	0.5	0.5	0.5	0.8	0.8	0.5	0.3	0.3	0.3	0.3	0.5	0.3	1.8	1.0	1.0	1.0	1.0	0.5	0.5
Disposal Method																			
Land Consumption	3.0	3.0	3.0	3.3	3.0	3.0	1.5	1.5	1.5	1.5	1.5	1.5	0.5	0.0	0.0	0.0	0.0	0.8	0.5
Resource Recovery	3.0	3.0	3.0	3.0	3.0	3.0	4.0	4.0	3.8	3.8	3.8	3.8	3.0	3.0	3.0	3.0	3.0	2.8	2.8
Energy Consumption	2.3	2.0	2.3	2.3	2.3	3.5	1.3	2.5	1.0	1.8	1.3	2.0	1.0	1.3	2.3	1.5	2.5	1.0	0.8
Disposal Site																			
Vegetation and Wildlife	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0	1.0	1.8	1.0	2.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5
Real Property Acquisition Costs	1.0	1.0	1.0	1.0	1.0	1.0	2.0	1.0	2.0	1.0	2.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Potential for Adverse Impact:																			
- Future Land Use	0.5	0.5	0.5	0.5	0.5	1.0	1.3	1.0	1.3	1.0	1.3	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
- Real Property Values	1.0	1.0	1.0	1.3	1.0	1.0	1.5	1.5	1.5	1.5	1.5	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
- Social Infrastructure	0.8	0.8	0.8	0.8	0.8	0.8	1.3	1.5	1.3	1.5	1.3	1.5	0.3	0.3	0.3	0.3	0.3	0.8	0.8
Implementation Feasibility	2.3	2.3	2.3	2.3	2.3	2.8	2.3	2.8	2.8	2.8	2.3	2.8	1.3	1.3	1.0	1.0	1.0	3.0	3.0
Surrounding Land Use	1.3	1.3	1.3	1.3	1.3	1.3	2.0	2.3	2.0	2.3	2.0	2.3	0.3	0.3	0.3	0.3	0.3	1.0	0.8
TOTAL	20.9	19.8	20.4	24.9	21.9	23.7	22.7	24.6	21.6	22.4	22.4	23.0	16.1	14.0	14.2	13.1	14.4	13.8	12.1

*Best point score = 0.0 impact points
Worst point score = 4.0 impact points

TABLE 12

RANKING OF SLUDGE SYSTEM ALTERNATIVES
FROM EVALUATION MATRIX

TWPSA SLUDGE MANAGEMENT PLAN

Rank	Sludge Management Alternative	Alternative Description	Total Score
1	13	Mechanized Composting - Market	12.1
2	11	Incineration - TBSA	13.1
3	12	Static Pile Composting - Market	13.8
4	10	Incineration - Wayne	14.0
5	10A	Incineration - Wayne	14.2
6	11A	Incineration - TBSA	14.4
7	9	Incineration - TWPSA	16.1
8	1A	M. Composting - L. Application	19.8
9	2	M. Composting - L. Application	20.4
10	1	S.P. Composting - L. Application	20.9
11	7	M. Composting - Landfill (10 mi.)	21.6
12	4	An. Digestion - Land Application	21.9
13	7A	M. Composting - Landfill (25 mi.)	22.4
14	8	S.P. Composting - Landfill (10 mi.)	22.4
15	6	An. Digestion - Landfill (10 mi.)	22.7
16	8A	S.P. Composting - Landfill (10 mi.)	23.0
17	5	An. Digestion - Land Application	23.7
18	6A	An. Digestion - Landfill (25 mi.)	24.6
19	3	S.P. Composting - Land Application	24.9

The comparison reflects the relative preference for each of the systems under final consideration.

A conference of staff professionals, each with different technical backgrounds, was convened. The conference included an environmental scientist, a planner, and two engineers. Each of these individuals presented the pros and cons of the major components of the alternate systems as they related to the evaluation criteria within his field of expertise. Following the presentations, each individual independently rated each of the alternate systems.

The degree of satisfaction of the criteria for each alternate system was rated on a scale from 0 to 4; 0 indicating that the system component had no impact and 4 indicating that the system component had severe impact. All evaluations for each alternate system were totaled and averaged.

6.0 IMPLEMENTATION

Implementation of a sludge management plan for the TWPSA requires that the decision-making process include the non-technical inputs in conjunction with the technical inputs to arrive at the most suitable system. Alternatives that may appear to be the least costly may not satisfy criteria such as potential feasibility and public acceptability.

Once the technical data has been developed that systematically ranks the numerous alternatives, the non-technical factors associated with each alternative can be weighed. An overall evaluation can then be performed, resulting in the selection of a sludge management plan that best satisfies the multiplicity of factors being considered.

This section of the report deals with the non-technical inputs being considered and the potential for implementation of each alternative. Delays in satisfying political feasibility and public acceptability result in increased project costs which could more than offset differentials in costs between alternatives.

6.1 Non-Technical Factors

The selection of a sludge management system must be sensitive to the non-technical aspects of implementing the program as well as the technical input. Some factors that appear essential in the overall decision-making process are as follows:

- Acceptance by the public
- Effects on land use - present and proposed
- Effects on tax bases
- Effects on current income producing agricultural land
- Implementability
- Loss of potential funding if delay occurs in approvals
- Systems operation of the authority
- Acceptance by the regulatory agencies
- System flexibility
- Cost to the Authority taxpayers
- Marketing of product

Brief descriptions of each of the non-technical aspects are as follows:

1. <u>Acceptance by the Public</u>

   This factor relates to the public's reactions to the proposed facilities which would be influenced by size, appearance, consumption of prime lands, effects on tax bases, effects on land use, air pollution, noise, etc.

2. <u>Effects on Land Use - Present and Proposed</u>

   This factor relates to the impact that a proposed facility may have on current land use practices and on master planning on a local or county-wide basis for future land use that could be affected.

3. <u>Effects on Tax Bases</u>

   This factor relates to the impact that proposed change in land ownership or use may have on the tax base within municipalities in which facilities are planned.

4. Effects on Current Income Producing Agricultural Land

This factor relates to the impact on agricultural land use if a facility will necessitate a change in use of the land or its product and/or a change in ownership. Size requirements are major considerations.

5. Implementability

This factor is the overall heading under which many considerations are listed and is related to other political, socio-economic or environmental factors not specifically in this listing.

6. Loss of Potential Funding if Delays Occur in Approvals

This factor relates to delays in having a facility accepted by the Regulatory Agencies and/or the Public by virtue of time required for Public Hearings or objections from the Public and the risk of not having funding available at a future time for other portions of the Project.

7. Systems Operation of the Authority

This factor relates to the functions performed by the Authority's staff to operate facilities for wastewater management. Of primary concern is the types and numbers of personnel and equipment to operate a facility. Land application, land farming, and product and by-product disposal are samples of particular types of operating personnel capabilities that are unusual to needs for wastewater collection, treatment and disposal.

8. Acceptance by the Regulatory Agencies

   This factor relates to the amenability of a proposed system with current agency policies regarding methods of treatment and disposal.

9. System Flexibility

   This factor relates to the ability of the Authority to modify a system or its use during its operation or in the future when technology or needs may change. It also relates to the associated costs.

10. Cost to the Taxpayers

    This factor relates to the costs for facilities that will be borne by the local taxpayers for various cost-effective systems that have varying proportions of capital and operation and maintenance cost components.

11. Marketing of Product

    This factor relates to the ability to market for ultimate disposal by-products of the wastewater management system components.

Many of the factors are closely interrelated and, as a result, can be consolidated into basic groupings in some cases to facilitate analyses of the alternative systems.

6.2 Evaluation of Alternatives

With consideration to the technical and non-technical inputs, the four basic disposal alternatives (land application, landfill, market, incineration at TBSA or Wayne) and the three basic process alternatives (anaerobic digestion, composting, incineration) were reviewed in terms of satisfying the sludge management requirements for the TWPSA. A brief discussion of the eminent factors impacting each alternative is as follows.

Land Application

There are seven (7) implementation options open to the TWPSA to effect land application of composted sewage sludge to agricultural lands in Morris County.

1. DIRECT SALE (Marketing) of compost product to Farmers: There are a number of varied problems associated with the complex task of marketing which require factual information as a basis for sound evaluation. A detailed marketing research program is required to adequately assess the feasibility of this option. An analysis of this nature is beyond the scope of this report. However, even in the absence of a market analysis, several significant disadvantages may be associated with the direct sale option. First and foremost, the speculative nature of marketing mandates a contingency plan for the disposal or storage of accumulating quantities of

composted sludge. Here, the most logical of the two is a standby landfill site which would receive compost should product demand drop-off or cease altogether. Second, the TWPSA would have no control over the actual application process or monitoring, surveilance, and enforcement functions. Third, due to low nitrogen content, composted sludge could not profitably compete with commercial fertilizers. Although composted sludge could be used as a soil conditioner, the associated cost may not produce any significant demand among farmers. Lastly, due to the small amount of agricultural activity in Morris County, it may be doubtful that a market even exists. The extension of marketing beyond Morris County to increase the size of the market area may be warranted.

2. INCENTIVE PAYMENTS to Farmers for taking the compost product: This option, also a marketing function, attempts to persuade farmers to use the compost product through incentive payments. These incentive payments may take the form of a "free" product, assumption of transportation costs in delivering the product to the farmer, or outright cash payments for using the product. Here again, the speculative nature of this option requires a contingency plan in the form of a standby landfill site. Also, the TWPSA would still have no control over the applica-

tion process, or monitoring, surveilance, and enforcement functions. This option may make the use of the compost product more attractive to the farmer by eliminating his risk in terms of invested cash. However, since risk-bearing is an inescapable marketing function, the farmer's risk must be borne by someone. In this case the risk is passed to the TWPSA in terms of increased costs resulting from the incentive payments. This option is more costly than the Direct Sale option and still provides no guaranteed stable outlet for the product.

3. LEASE OF FARMLAND with no crop production by the Authority: Under this option, the TWPSA enters into a lease agreement with the farmer for the purpose of applying the compost product to agricultural lands. The Authority would assume the cost and responsibility for hauling, application, and monitoring. The farmer could continue to grow and market a crop. There are several advantages to this option. First, the Authority could maintain control of the application and monitoring process. Second, a greater degree of assurance is provided over the previous marketing options that land will be available (with the exception of lease-breaking) for application of the product. Third, the Authority need not bear the cost and risk of marketing the compost product. Fourth, the land being used for

application need not be withdrawn from the municipal tax base since the farmer maintains ownership. Although this option may be desirable to the Authority in terms of control, it may be among the least desirable among farmers since they would be "locked-in" to producing crops not destined for human consumption. This inability to diversify crops within a current demand/price market may prove extremely unattractive to farmers. Also, the lack of control over natural forces, such as crop quality and quantity, would force farmers into a "lease-breaking" situation. In this regard, a contingency plan, such as a "stand-by" landfill site may also be required. With the addition of land application costs, monitoring costs plus the cost of the lease, it is clear that this option will be more expensive than the previous two options discussed.

4. <u>LEASE OF FARMLAND with crop production by the Authority</u>: Under this option, the Authority would have full responsibility for both land application and crop production. The farmer would maintain property ownership, thereby maintaining the municipal tax base. The major difference between this option and option 3 is the Authority's involvement in crop production and crop marketing. It is doubtful that the New Jerse Legislature, in providing the enabling legislation for the creation of

sewerage authorities, ever envisioned farming to be one of their functions. It is equally doubtful that municipalities, in establishing sewerage authorities, considered farming to be one of their functions. Aside from the apparent cost and risk involved, there are many complex legal, financial and political questions which must be resolved before a public sewerage authority enters into agricultural entrepreneurship--competing in the private market place, and quite possibly against each other. This type of analysis is beyond the scope of this report. It is clear, however, that farming adds additional costs and risks to land application. It is also possible that a future attempt to break the lease could be made by the farmer. Here again, this option may require a "stand-by" landfill site.

5. <u>DIRECT PROPERTY ACQUISITION WITH LEASE BACK to the Farmer</u>: Under this option, the Authority would purchase the agricultural land from the farmer. It is assumed that the purchase method of acquisition is more feasible than condemnation, since it is doubtful that a sewerage authority could exercise the power of eminent domain outside of its jurisdictional territory and be successful. Should the acquisition of property under this option be financed in part by federal monies, such acquisition

is subject to the requirements of the "Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970" (USEPA 40 CFR Part 4). In addition to set procedures for real property acquisition, Section 4.205-3 of the Act provides for payment to farm operations a fixed amount equal to the average annual net earnings of the farm operation in cases of displacement. Due to tax and financial advantages, it is unlikely that the farmer would choose to remain in residence on the property. It is therefore conceivable that the farmer could claim eligibility under Section 4.205-3, even with a lease-back agreement. Property acquisition by a public sewerage authority would also remove the property from the municipal tax base--present and future. This option, involves property acquisition which offers the greatest degree of control to the Authority for land application. With ownership of agricultural land, the Authority is assured of a long-term future application area for the compost product. Consequently, no contingency plan may be required. In addition, this option would permit direct control by the Authority of the application process, monitoring and financial management. Although this option is among the most desirable for control of land application, it may be among the most difficult to implement due to political and institutional resistance.

6. DIRECT PROPERTY ACQUISITION with crop production by Authority: The major difference between this option and option 5 is that the Authority would have full responsibility for crop production and marketing in addition to land application. Here again, as in option 4, many complex legal, financial, and political questions arise with regard to a public sewerage authority entering into agricultural entrepeneurship. Analysis of these questions is beyond the scope of this report. Also, there is no question that this option is subject to the requirements of the "Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970"; especially Section 4.205-3 of the Act. This option is among the most expensive discussed so far since the Authority would also bear the capital, operation, maintenance, and marketing costs of crop production, including the risks associated therewith.

7. STATE COMMITMENT to accept compost product: Under this option, the State of New Jersey would agree to accept the composted sludge product from the Authority for application on State-owned lands and highway rights-of-way such as Routes 80, 46, and 23. This option would guarantee a uniform disposal

mechanism for the Authority's compost product and relieve the Authority of the costs and uncertainties associated with land application. Should composting prove to be the most desirable process alternative, this land application option may be the most acceptable to the Authority.

Table 13 presents a subjective tabulation of advantages and disadvantages associated with options for implementation and control of the land application process.

Landfilling

Landfilling of sludge has been a conventional means of disposal that recently has been found to be unfavorable in some areas due to the adverse environmental impacts that have occurred with leachate entering groundwater systems. These problems have arisen because existing landfills were not lined. Linings are now being utilized and can effectively control the problems associated with leachate.

The cost, however, for installation of a liner results in the unattractiveness of the landfill alternative. Furthermore, it appears that the NJDEP's policy on landfills tends to discourage the use of landfills while encouraging the consideration of other disposal options. Nevertheless, a lined landfill may be environmentally acceptable and necessary.

Identified landfill sites included abandoned gravel pits which can be reclaimed using landfilling techniques. Diffi-

TABLE 13

OPTIONS FOR IMPLEMENTATION AND CONTROL OF THE LAND APPLICATION PROCESS

TWPSA SLUDGE MANAGEMENT PLAN

IMPLEMENTATION ADVANTAGES (+) AND DISADVANTAGES (-)	OPTION 1 DIRECT SALE (MARKETING)	OPTION 2 INCENTIVE PAYMENTS	OPTION 3 LEASE-WITH NO CROP PRODUCTION	OPTION 4 LEASE-WITH CROP PRODUCTION	OPTION 5 PURCHASE WITH LEASE-BACK	OPTION 6 PURCHASE WITH CROP PRODUCTION	OPTION 7 STATE COMMITMENT
Control Application Process	-	-	+	+	+	+	+
Control of Monitoring	-	-	+	+	+	+	+
Land Application Process Expense	+	+	-	-	-	-	+
Land Acquisition Costs	+	+	+	+	-	-	+
Reimbursement for Farmer's Annual Profit	+	+	-	-	-	-	+
Cost for Farmer's Relocation	+	+	-	-	+	-	+
Cost for Crop Production	+	+	+	-	+	-	+
Cost for Monitoring	+	+	-	-	-	-	+
Cost for Marketing Compost Product	-	-	+	+	+	+	+
Reduction of Land From Municipal Tax Base	+	+	+	+	-	-	+
Assurance of Future Disposal Capacity	-	-	-	+	-	+	+
Costs of Leasing	+	+	-	-	+	+	+
Contingency Disposal Plan Required	-	-	-	-	+	+	+
Costs for Crop Marketing	+	+	+	-	+	-	+
Costs for Incentive Payments	+	-	+	+	+	+	+
Costs for Hauling	+	-	-	-	-	-	+
Hauling Energy Consumption	-	-	-	-	-	-	-
Land Application Energy Consumption	-	-	-	-	-	-	-
Reduction of Land from Future Uses	+	+	-	-	-	-	+
Compatability with Municipal Zoning	+	+	-	-	-	-	+
Potential for Some Financial Return	+	-	-	+	+	+	-
Time Required for Implementation	-	-	-	-	-	-	+
Employment Gain	-	-	+	+	+	+	-
Assurances Against Toxic Contamination	-	-	+	+	+	+	+
Local Political and Social Acceptability	+	+	-	-	-	-	+
Adaptable as a Non-Regional Alternative	-	-	-	-	-	-	+
Beneficial Use of a Recovered Resource	+	+	+	+	+	+	+
Long Term Commitment of Resources	+	+	-	-	-	-	+
TOTALS	17 (+) 11 (-)	14 (+) 14 (-)	11 (+) 17 (-)	11 (+) 17 (-)	13 (+) 15 (-)	11 (+) 17 (-)	24 (+) 4 (-)

culty in obtaining any of these pits may be encountered from either property owners, local residents or public officials on the local or state level. It appears that the implementation of a landfill disposal option could not be realized without the assistance of the state government.

The necessity for a landfill may become more apparent under the following potential conditions:

- Land application of sludge products approaches environmental limits
- Sludge processing is inoperable
- Need to dispose of scum, grit, screenings, etc., from the treatment processes
- Markets are not available
- Climatic conditions prevail relative to the use of land application techniques
- Land use changes.

System flexibility may be comprised without available access to a landfill facility.

<u>Marketing</u>

Marketing potentials are highly variable. Although marketing studies indicate positive responses, establishing and maitaining the markets are activities still to be undertaken and uncertainty as to their actualization must be considered.

<u>Incineration at TBSA, Wayne</u>

The desire and willingness of TBSA and Wayne to accept sludges from other municipalities and authorities is a strong indication of the potential for implementation of this alternative. This option, however, would remove all control of sludge disposal from the TWPSA. Contractural agreements for a specified period may insure a guaranteed disposal outlet for the TWPSA.

As indicated by the preliminary cost estimates reported by TBSA and Wayne, utilization of the TBSA incinerator appears to be less costly. Consideration of this alternative for the minimum period requested by TBSA, five years, would result in the compliance with the 1981 ocean disposal abatement schedule.

Use of the TBSA incinerator would further result in cost savings for the TWPSA by eliminating the necessity to operate existing digesting and dewatering processes and further eliminating labor requirements for these operations. Questions which may need to be resolved involve the grant eligibility of the incineration operation and are the federal portion of the grant monies obtained by TBSA or Wayne reflected in the user charges that may be appropriated to the TWPSA. Would the TWPSA be entitled to federal assistance if they are involved in another's sludge management system?

Anaerobic Digestion

In terms of costs to the Authority and the taxpayers, it ranks as one of the better alternatives due to the low operation and maintenance costs and to the funding of capital costs by USEPA at 75 percent. Marketing of a digested sludge has a lesser potential than compost. Energy consumption is lower for digestion than for composting. Sole reliance on landfilling of digested sludge will most likely be unacceptable by the State.

Static-Pile Composting

This alternative satisfies cost and environmental considerations and is the sludge management system which NJDEP favors most. This system, however, is somewhat higher in energy consumption than the mechanized aerobic composting operation. Energy costs will probably increase substantially in the future.

Static pile composting is performed in an open environment which could have an effect on adjacent land uses and corresponding land values. Land requirements for static-pile composting dictate that this operation be undertaken off site of the wastewater treatment facilities. Implementation could be a problem if sites within the TWPSA are unobtainable and if general public acceptance is not favorable.

A composting alternative requires substantial operating and maintenance personnel, so that the costs to the Authority may be high to operate the system. The product is readily disposable through land application, landfilling and marketing.

A composting alternative would most likely be approved by the regulatory agencies; however, public acceptance may cause delays due to the open nature of the process and the associated environmental problems.

Mechanized Aerobic Composting

This alternative offers the advantages of the more acceptable compost product and the conventional operation of tankage and equipment for processing operations. Slightly less energy is consumed than with static-pile composting and the potential environmental problems of static-pile composting are essentially eliminated in the enclosed environment.

Mechanized aerobic composting is cost effective. Furthermore, this composting may be classified as an innovative technology and thus may be eligible for 85 percent federal funding. Costs savings for operating may be achieved by utilizing light refuse instead of sawdust as the bulking agent.

Basically characterized as an aerobic digester, public acceptance of this composting operation may not be a cause for concern. Also, since the land requirements for this operation would allow the placement of this process at the wastewater treatment facility, the necessity to obtain additional private lands may be eliminated.

As is similar to the static-pile compost, the product from the mechanized aerobic composting operation is readily disposable through land application, marketing and landfilling. This alternative combines the benefits of an enclosed process, offering better quality control and reduced potential environmental impacts, with an acceptable product for disposal.

Incineration in the TWPSA Region

Of all the alternatives, incineration may consume the most energy, the cost of which is anticipated to increase substantially in the future. This alternative does not appear to be cost-effective over a 20 year period.

Process operations would not present unusual problems regarding land use, tax bases and land values. Environmental problems associated with land and water resources are not envisioned. Air pollution control devices are required for this process operation.

Acceptance by the regulatory agencies is questionable and may cause delays, since the process is energy intensive and potential resource recovery aspects of the sludge management plan would be reduced. This alternative should be implementable relative to public acceptance.

6.3 Selection of a Sludge Management Plan

In retrospect, a sludge management plan must be developed that is environmentally sound, socio-economically beneficial and implementable. The plan must also comply with the 1981 ocean disposal abatement schedule.

Land application, landfilling and marketing of a sludge product are potential disposal options available to the TWPSA. Land application sites are only available in southwestern Morris County, a distance of approximately 40 miles. Potential landfill sites are located within 10 miles and 25 miles of the TWPSA region and consist of reclaimable inactive gravel pits.

Direct contact with actual land owners and public officials of the communities in which these lands are situated is necessary to determine the availability and implementability of land-based disposal options. An extensive marketability analysis needs to be undertaken to determine the availability and depth of potential market outlets.

Use of an existing sludge management plan is feasible with the possible consideration of sludge incineration at the TBSA incinerator. This alternative may be the most implementable alternative and would result in the compliance with the 1981 abatement schedule.

Mechanized aerobic composting appears to be the most flexible sludge treatment component for long range planning objectives. This operation may be situated at the TWPSA wastewater treatment plant site and thus would appear to be the most implementable operation. The products from this composting operation could be disposed of in a variety of means including land application, marketing, landfilling and free distribution. Low energy and labor requirements make this option more attractive than other treatment processes considered in this report.

Since no one alternative can be implemented in its entirety at this time, the selection of a sludge management plan would involve the combination of alternatives studied. To comply with the 1981 ocean disposal abatement schedule, it is recommended that the TWPSA continue the dialogue with the TBSA for the purpose of utilizing their incinerator for the disposal of TWPSA sludges.

Consideration of the TBSA incinerator for a minimal period will provide sufficient time for the TWPSA to determine the availability of markets for a sludge product, and to determine the feasibility of utilizing agricultural lands in Morris County. Furthermore, consideration could be given to the proposed Wanaque Valley Regional Sewerage Authority's sludge management plan, soon to be developed. Participation of TWPSA in the WVRSA sludge management plan could involve, totally or partially, the treatment and disposal of sludges.

Recommended long-term sludge management plans would involve the use of a mechanized aerobic composting operation located on site of the TWPSA regional wastewater treatment facilities.