Neuse River Council of Governments

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Telephone 919-638-3185

October 19, 1987

MEMO

TO: Bill Elston
Office of Commanding General

FROM: Glenn Forrest GF

SUBJECT: Solid Waste Feasibility Study

Enclosed is one copy of the draft report and executive summary completed by Malcolm-Pirnie.

I am asking you to please review this report and on October 28, 1987, at 10:30 a.m. meet at our office with representatives from Malcolm-Pirnie to discuss any changes you feel need to be made.

If you should have any questions concerning this study, please do not hesitate to call.

Please indicate your plans on the enclosed card and return it to us. I look forward to seeing you on October 28, 1987, at 10:30 a.m. here in our office.

Thank you.

NEUSE RIVER SOLID WASTE FEASIBILITY STUDY

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INTRODUCTION

Future legislation, with respect to landfills, is expected to require considerable upgrading, or replacement of the existing landfills. Much of the study area is coastal in nature, and characterized by sandy sediments and high water tables. This combination of increasingly stringent regulations coupled with unfavorable hydrogeologic conditions has lead to an increased interest in alternatives to landfills. Landfills, in the future, will be difficult to permit and costly to construct and operate. It is probable that the States groundwater policy and the new EPA guidelines will lead to the requirement for double liner, double leachate collection systems.

This study was designed to examine waste-to-energy projects as alternatives to landfills. Regional, subregional, and local project scenarios were developed, and their economic, technical and environmental feasibility was examined.

PROPOSED PROJECT DESCRIPTION

The proposed project consists of three waste-to-energy facilities, for the supply of steam to National Spinning Co., MCAS Cherry Point and MCB Camp Lejeune. Figure 1 shows the location of these facilities, and the approximate waste shed area required to support each facility.

The waste-to-energy facility, envisioned for National Spinning Co., will provide all of the steam required for heating and process use at this plant.

The waste-to-energy facility, envisioned for MCAS Cherry Point, will provide a steam baseload, of 50,000 lb per hour, to supplement the existing steam plant at this air station.

The waste-to-energy facility, envisioned for MCB Camp Lejeune will provide a major portion of the steam required to replace two of the base's steam plants (AS-4151 and G-650). The existing steam plant, G-650, will be used during the winter months, as a peaking boiler. The proposed facility will also be equipped with turbine-generators to generate electrical power during the summer months, when steam use is low.

Project Costs

Table 1 shows the estimated, project and facility, capital costs, annual costs, and revenues, with a resultant break-even tipping fee. These tipping fees are not intended to be an actual tipping fee, but are used here for comparison purposes only.

As an alternative to these waste-to-energy facilities, individual (county) or regional landfills could be utilized. The future costs of landfills ($ per ton) have been calculated on a county-wide basis, and are compared to the break-even tipping fee, for each facility, as follows:

Waste-To-Energy VS Landfill Costs

Waste-to-Energy Facility		Future Cost of Landfill	
Facility	Break-even Tipping Fee* ($ Per Ton)	Future Cost** ($ Per Ton)	County
National Spinning	53.78	85.10	Hertford
		92.10	Bertie
		82.79	Martin
		58.29	Beaufort
MCAS Cherry Point	37.84	49.61	Craven
		128.53	Pamlico
		56.44	Carteret
MCB Camp Lejeune	48.70	44.75	Onslow

* Includes system transportation costs.

** Exclusive of waste transportation costs.

These estimates indicate that waste-to-energy appears to be more economical than landfilling. The Camp Lejeune project appears marignally more expensive than the landfill alternative, however, the landfill cost does <u>not</u> include transportation costs. Waste transportation costs for Onslow County were previously estimated to be $5.07 per ton. This would revise the total landfill cost to $49.82 per ton slightly higher than the waste-to-energy alternative.

TABLE 1

PROPOSED PROJECT - ECONOMICS

($ MILLIONS)

Capital Cost	NATIONAL SPINNING	MCAS CHERRY POINT	MCB CAMP LEJEUNE	PROJECT TOTALS
Construction Cost	18.9	15.4	26.9	61.2
Start-up Costs	0.9	0.8	1.3	3.0
Turnkey Design and Construction Admin.	1.9	1.5	2.7	6.1
Capital Subtotal	$21.7	$17.7	$30.9	$70.3
Debt Coverage	4.3	3.5	6.2	14.0
TOTAL BOND ISSUE	$26.0	$21.2	$37.1	$84.3
Annual Costs				
O & M (@ $22/ton)	2.2	1.7	2.2	6.1
Residue Disposal (@ $35/ton)	0.9	0.8	0.9	2.6
Debt Service (8%, 20 yrs)	2.6	2.2	3.8	8.6
TOTAL ANNUAL COST	$5.7	$4.7	$6.9	$17.3
Annual Energy Revenues				
Steam	1.3	2.6	1.8	5.7
Electric	0.0	0.0	0.8	0.8
Total Energy Revenues	$1.3	$2.6	$2.6	$6.5
NET DISPOSAL COST	$4.4	$2.1	$4.3	$10.8
Break-even Tipping Fee ($/ton)	$44.65	$27.40	$43.63	$39.45

NOTE: ALL COSTS ARE STATED IN 1987 DOLLARS

CONCLUSIONS

Waste-to-energy projects present a alternative to the expected future costs of landfilling all of the regions solid waste, and would extend the life of existing and/or future landfills. Major conclusions derived from the study include:

- o The recommended project represents the most cost effective disposal alternative for this area.
- o Mass burn facilities have been identified as the preferred technology, based on reliability, and economic considerations.

RECOMMENDATIONS

Based on the solid waste feasibility study, it is recommended that:

- o The affected County governments Governments pursue the project to supply steam to National Spinning Co., MCAS Cherry Point and MCB Camp Lejeune.
- o All waste generated within the study area be committed to the project.
- o Siting studies, and studies required for the marine bases be initiated.

PROJECT IMPLEMENTATION

It is recommended that a full service approach with public ownership be pursued and that financing for this project be undertaken by the issuance of conventional revenue bonds. Table 3 is the project implementation schedule which has been developed for the proposed project.

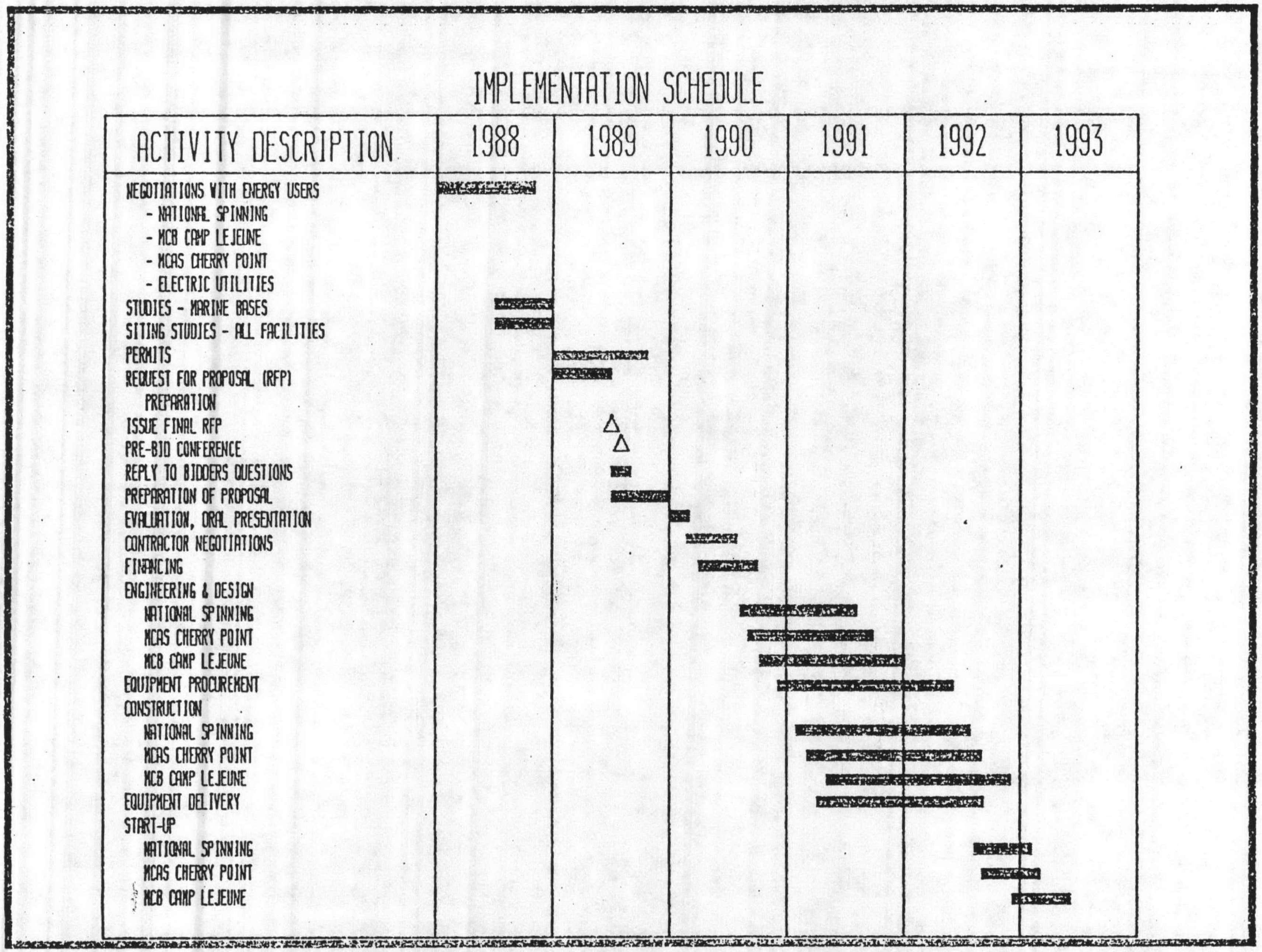
IMPLEMENTATION SCHEDULE
ACTIVITY DESCRIPTION
1988
1989
1990
1991
1992
1993
NEGOTIATIONS WITH ENERGY USERS
- NATIONAL SPINNING
- MCB CAMP LEJEUNE
- MCAS CHERRY POINT
- ELECTRIC UTILITIES
STUDIES - MARINE BASES
SITING STUDIES - ALL FACILITIES
PERMITS
REQUEST FOR PROPOSAL (RFP)
PREPARATION
ISSUE FINAL RFP
PRE-BID CONFERENCE
REPLY TO BIDDERS QUESTIONS
PREPARATION OF PROPOSAL
EVALUATION, ORAL PRESENTATION
CONTRACTOR NEGOTIATIONS
FINANCING
ENGINEERING & DESIGN
NATIONAL SPINNING
MCAS CHERRY POINT
MCB CAMP LEJEUNE
EQUIPMENT PROCUREMENT
CONSTRUCTION
NATIONAL SPINNING
MCAS CHERRY POINT
MCB CAMP LEJEUNE
EQUIPMENT DELIVERY
START-UP
NATIONAL SPINNING
MCAS CHERRY POINT
MCB CAMP LEJEUNE

FIGURE 2

MALCOLM PIRNIE

ENVIRONMENTAL ENGINEERS, SCIENTISTS & PLANNERS

NEUSE RIVER WASTE TO ENERGY FEASIBILITY STUDY

Neuse River and Mideast Council of Goverment Communities

Draft Report

October 1987

NEUSE RIVER SOLID WASTE DISPOSAL FEASIBILITY STUDY

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1.0 INTRODUCTION

1.1 PROJECT OVERVIEW

This solid waste feasibility study has been prepared for the Neuse River and Mid-East Councils of Governments, a group of counties and government agencies. Included within the study area are:

- Beaufort County
- Bertie County
- Carteret County
- Craven County
- Hertford County
- Martin County
- Onslow County
- Pamlico County
- MCAS Cherry Point
- MCB Camp Lejeune

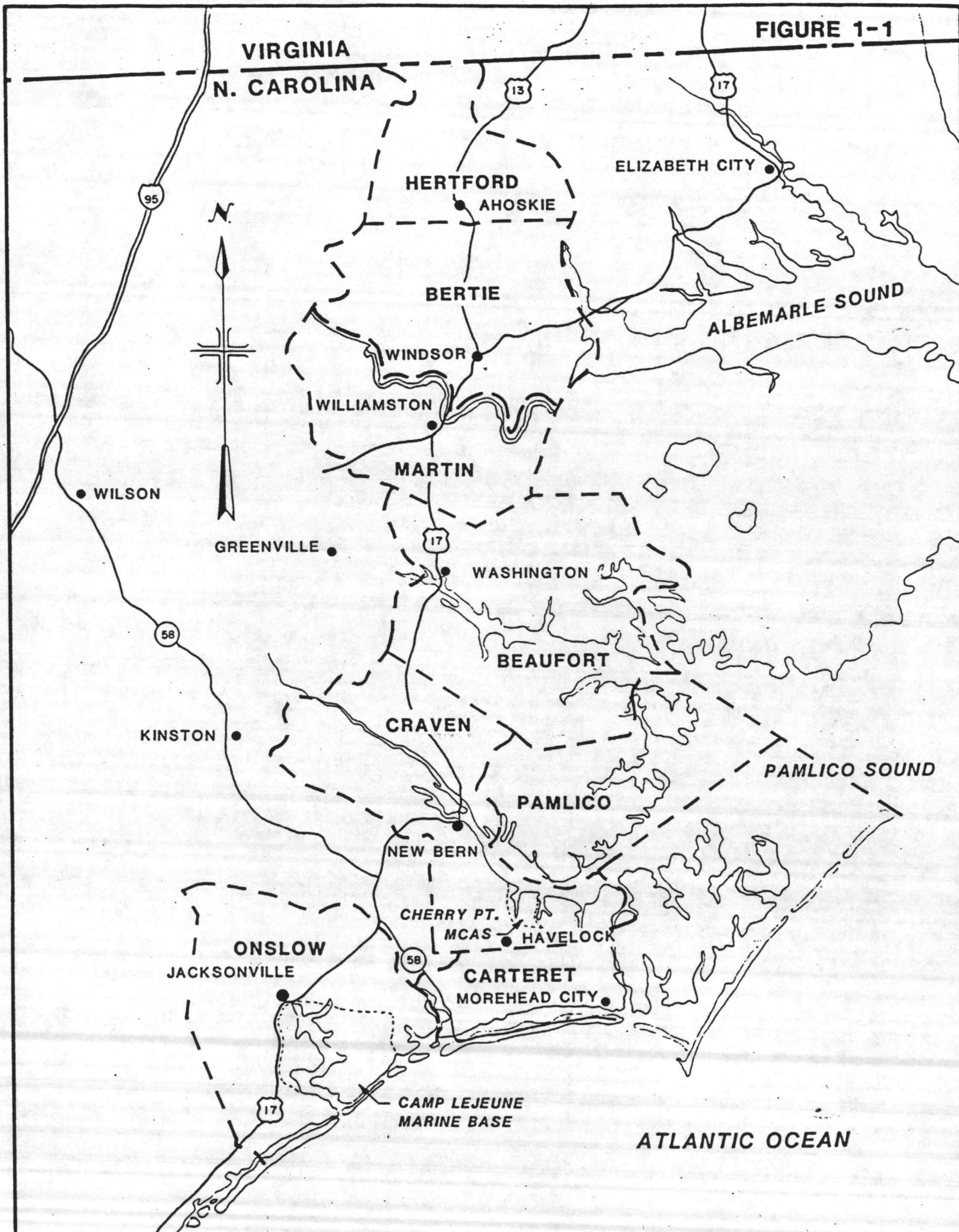
For simplicity this area will be referred to as Neuse River for the remainder of the report. Figure 1-1 shows the area encompassed by this study.

Future legislation, particularly with respect to landfills, is expected to require considerable upgrading, or replacement of existing landfills. Much of the study area is coastal in nature and characterized by sandy sediments and high water tables. This combination of increasing stringent regulations coupled with unfavorable hydrogeologic conditions has lead to an increased interest in alternatives to landfills. Landfills, in the future, will be difficult to permit and costly to construct and operate.

This study examines waste-to-energy projects as alternatives to landfills. Regional, subregional and local project scenarios are developed and their economic, technical and environmental feasibility examined.

1.2 DOCUMENT PURPOSE

This report is intended to serve as a guide to feasible energy recovery technologies. It provides a description of available



MALCOLM PIRNIE

NEUSE RIVER COUNCIL OF GOVERNMENTS

SOLID WASTE FEASIBILITY STUDY

STUDY AREA

MALCOLM PIRNIE, INC.

SEPT 1987

technologies and assesses their abilities to meet the needs of the study area. Included in this document is a description of the existing solid waste management system, solid waste quantity projections and solid waste composition estimates.

The output of this report is a group of energy recovery scenarios. Also included are recommendations for each jurisdiction for options other than waste-to-energy, and a series of recommendations for proceeding beyond this study is given.

2.0 REGULATORY ASPECTS

2.1 SOLID WASTE DISPOSAL

2.1.1 Federal Regulatory Background

All solid waste regulations in the United States are based upon RCRA Subtitle D (Sections 4001-4010), amended to the Solid Waste Disposal Act in 1976. This federal statute was intended to:

- o Promote environmentally sound disposal methods
- o Maximize reuse of recoverable resources
- o Encourage resource conservation

It accomplished these goals by setting forth mandatory minimum standards or criteria for states. These criteria cover eight general areas:

1) Floodplains
2) Endangered Species
3) Surface Water
4) Ground Water
5) Waste Application Limits for Land Used in Production of Food Chain Crops
6) Disease Transmission
7) Air
8) Safety

The Hazardous and Solid Waste Management Act (HSWMA) was added to RCRA in 1984 because of Congressional concern over Subtitle D facilities receiving small quantities of hazardous wastes from households or small quantity generators. HSWMA directed the EPA to review Subtitle D and report back to Congress by November 8, 1987. Specifically the EPA was to revise existing groundwater contamination criteria by March 31, 1988 to ensure human health and environmental protection. The Act also required that EPA investigate the need for additional authorities to enforce the RCRA criteria. As a result of its review, EPA is expected to require groundwater monitoring, establish facility siting criteria and require that correction actions be taken in the event of contamination. Also, EPA is expected to require a double liner and leachate

collection system for those facilities, such as sanitary landfills, that receive small quantities of hazardous waste.

HSWMA also requires the EPA to establish a permit program or system of prior approval for facilities receiving small quantities of hazardous waste by November 8, 1987. By use of a permit program, EPA will ensure that facilities are in compliance with the revised Criteria. HSWMA also gives EPA authority to enforce the Criteria at facilities not in compliance within 18 months of the revisions (by September 31, 1989).

2.1.2 North Carolina Regulations

The primary solid waste regulations used in North Carolina are the Solid Waste Management Rules prepared by the Solid and Hazardous Waste Management Branch of the North Carolina Department of Human Resources. These rules last amended July 1, 1985, apply to all solid waste disposal facilities. They are expected to remain valid until the EPA develops new criteria in March of 1988.

In addition to establishing specific criteria for the storage, handling and disposal of solid wastes, the Rules also specify other state standards that solid waste handlers must meet. Of those standards, one has become controversial. A standard promulgated by the Groundwater Management Branch requires that zero leakage or zero groundwater contamination occur. This standard has raised protests from disposal facility owners that it is not possible to meet a zero leakage standard. It has also caused new permit applications for single liner/-leachate collection system landfills to be denied. The only landfill permit application that has been accepted featured a double liner/-leachate collection system design similar to what EPA is expected to propose. This handling of landfill permit applications and the standard itself have raised a resolution from the North Carolina Association of County Commissioners calling for a relaxation of the standard. The resolution, adopted December 10, 1986, includes the following:

> "WHEREAS, the need for newly revised groundwater regulations have completely frustrated the permitting of solid waste disposal facilities, including the imposition of exorbitant costs for contamination prevention measures, in a manner inconsistent with

the spirit and intent of such laws as passed by the North Carolina General Assembly, and

WHEREAS, the need for new and expanded county solid waste disposal facility sites has reached a critical point.

NOW, THEREFORE BE IT RESOLVED that the North Carolina Association of County Commissioners calls on the appropriate regulatory agencies and the North Carolina General Assembly to recognize the impractical nature of groundwater regulations as they apply to landfills and to take the necessary corrective measures to allow counties to adequately dispose of solid waste while also providing a reasonable amount of environmental protection."

Even though its zero leakage standard has drawn protests, North Carolina is heading in the most likely direction of landfill design. If the state were to modify its groundwater protection standards to a less controversial wording, it would probably continue to permit only the double liner and leachate collection system design because of anticipated EPA standards.

2.2 AIR QUALITY REGULATIONS

The passage of the Federal Clean Air Act and subsequent regulations led to the closing of many old solid waste incinerators. These volume reduction units had poor combustion control and no emission control equipment. Combustion of solid waste produces various air emissions which must be controlled in any modern facility.

Various air quality and emission regulations are applicable to waste-to-energy projects. These include regulations promulgated by both the U.S. Environmental Protection Agency (EPA) and the North Carolina State Department of Natural Resources and Community Development. More specifically, solid waste combustors in North Carolina are labeled as "Class IV-C" sources of air pollution and are subject to the Subchapter 2D Air Pollution Control Regulations of the North Carolina Administrative Code. Federal regulations applicable to new waste combustors have been promulgated under the Clean Air Act. Major aspects of these regulations are summarized as follows:

National Ambient Air Quality Standards (NAAQS) - Pollutants for which a NAAQS exists are termed "criteria" pollutants. For such "criteria" pollutants, evidence indicates the possibility of widespread

adverse health impacts. These pollutants are total suspended particulates (TSP), lead, nitrogen dioxide, sulfur dioxide, carbon monoxide and ozone. NAAQSs are designated as primary or secondary. Primary standards are related to the protection of public health while secondary standards are related to impacts on wildlife, vegetation, materials and visibility.

Existing ambient air quality shows that all counties within the study area are attainment areas (NAAQS standards are being met) for TSP, nitrogen dioxide, sulfur dioxide, carbon monoxide and ozone. NAAQS are shown in Table 2-1. The State of North Carolina has adopted most of these standards.

National Emission Standards for Hazardous Air Pollutants (NESHAP) - Many "non-criteria" air pollutants exist which may pose significant health risks but for which no NAAQS exist. In order to deal with such pollutants, NESHAPs have to date been promulgated as process-specific emission limitations for 7 pollutants. Such emission thresholds often are based upon occupational exposure standards. Best Available Control Technology (BACT) may be required to control the emission of such "non-criteria" pollutants. The only NESHAP which applies to waste combustors is for beryllium which is emitted from resource recovery facilities in trace amounts (see Table 2-2). However, it is possible that a new NESHAP for dioxins will be promulgated as early as 1989 based upon risk assessments.

State Toxic Air Pollutant Control Program - Currently, North Carolina is in the economic assessment stage of developing a Toxic Air Pollutant Control Program. Regulations could be in effect in as soon as a year. Such regulations will deal with incinerator-derived "non-criteria" pollutants not regulated by NESHAPs. The program will define ambient air quality guidelines. For carcinogens, these guidelines will be based upon health risk assessments, while for non-carcinogens, guidelines will be derived from threshold limit values which in turn are based upon occupational exposures.

New Source Performance Standards (NSPS) - USEPA NSPS regulate particulate matter emissions from municipal incinerators and resource recovery facilities having a design capacity exceeding 50 tons/day and

Table 2-1

Ambient Air Quality Standards Applicable to New Waste Combustors Located within North Carolina

National Ambient Air Quality Standards

Pollutant	Averaging Time	Primary	Secondary
Ozone	1 hr	235 ug/m^3	235 ug/m^3
Carbon Monoxide	8 hr	10 mg/m^3	10 mg/m^3
	1 hr	40 mg/m^3	40 mg/m^3
Nitrogen Dioxide	Annual Average	100 ug/m^3	100 ug/m^3
Sulfur Dioxide	Annual Average	80 ug/m^3	--
	24 hr	365 ug/m^3	--
	3 hr	--	1300 ug/m^3
Suspended Particulate Matter (TSP)	Annual Geometric Mean	75 ug/m^3	60 ug/m^3**
	24 hr	260 ug/m^3**	150 ug/m^3
Lead	Calendar Quarter	1.5 ug/m^3	1.5 ug/m^3

** Note: North Carolina has not adopted this standard.

Table 2-2

Emission Standards Applicable to New Waste Combustors Located within North Carolina

National Emission Standard for Hazardous Air Pollutants (NESHAPs)

Pollutant	Standard or Rule
Beryllium	Cannot discharge more than 10 grams in any 24-hour period or emit at a rate exceeding 0.01 ug/m^3 averaged over a 30-day period.

New Source Performance Standard (NSPS)

Pollutant	Standard or Rule
TSP	0.08 gr/dscf adjusted to 12% CO_2 or 0.01 lbs/million BTU (approximately = 0.03 gr/dscf) if facility processes roughly 200 TPD or more.

North Carolina Emissions Standards

Pollutant	Standard or Rule
Visible Emissions (opacity)	Visible emissions shall not be greater than 40% opacity for an aggregate of more than 5 minutes in any one hour or more than 20 minutes in any 24 hour period.
TSP	4.0 lb/hr (only applies if this standard is less stringent than applicable NSPS).
Mercury	2300 grams/day*

*Standard may not apply if mercury is only incidentally found in the municipal waste.

burning more than 50% solid waste. According to USEPA guidelines, emissions cannot contain particulate matter in excess of 0.08 grains/-standard ft³ of dry exhaust gas (0.08 gr/scfd) adjusted to 12% CO_2. The State of North Carolina has adopted this NSPS for particulate matter. In 1986, EPA promulgated another particulate matter standard for new, large industrial boilers of 0.1 pounds particulate matter per million BTU (approximately equivalent to 0.03 gr/dscf). Since heat recovery facilities are equipped with boilers, new resource recovery combustion facilities that process roughly 200 tons per day or more of municipal waste are subject to this NSPS. No other incinerator emissions are currently regulated by NSPS. However, additional NSPS for criteria pollutants emitted from resource recovery facilities and well as for acid gas emissions such as hydrogen chloride may be promulgated in the future. Performance tests are required to demonstrate compliance with the NSPS for particulates.

State Emission Standards - North Carolina has promulgated various emission standards which would apply to new waste combustion units within the jurisdiction of the Neuse River Council of Governments. Table 2-2 provides a summary of these emission standards.

New Source Review (NSR) - If a municipal incinerator is designed to charge more than 250 tons/day of refuse, and if after addition of pollution control equipment the facility may emit more than 100 tons/-year of any pollutant regulated under the Clean Air Act, then the new source is classified as a "major source" and is subject to the New Source Review process.

New Source in Non-Attainment Area (NSINA) - If a new "major source" is located in a non-attainment area for a "criteria" pollutant, then emissions from such a facility must not contribute to further air quality degradation. NSR requirements call for use of Lowest Achievable Emission Rate (LAER) which is the best existing technology that can be applied to the NSINA regardless of cost or lack of a proven operating record. A combustion facility proposing to emit a nonattainment pollutant over a specified threshold will be required to obtain an equal or larger offset in

emissions of that pollutant from an existing source. Currently there are no non-attainment areas within the study area, thus requirements for offsets and use of LAER should not apply.

Prevention of Significant Deterioration (PSD) - If a new "major source" is to be located within an attainment area for a pollutant, then under the NSR process, PSD review will be required for that pollutant if it will be emitted at a rate greater than its "significant emission rate" as shown in Table 2-3. PSD requirements include the use of Best Available Control Technology (BACT) as determined on a case-by-case basis by the reviewing agency. Computer modeling and ambient air quality data acquisition are also required in order to demonstrate that neither NAAQS nor allowable PSD increments will be exceeded as a result of facility emissions. PSD increments are maximum allowable source impact concentration increases over background air quality. Such increments have been promulgated for sulfur dioxide and particulates. Pre-construction air quality monitoring is often a requirement of PSD review but may be waived if predicted source impacts are below certain threshold levels or if adequate monitoring data already exists. A final PSD requirement is that impacts on visibility, vegetation and soils be investigated. In addition, non-criteria pollutants for which there are no national health-based standards are considered under PSD regulations. Such non-criteria pollutants so regulated include: asbestos, beryllium, mercury, vinyl chloride, fluorides, sulfuric acid mist, hydrogen sulfide, total reduced sulfur and reduced sulfur compounds.

Table 2-3

Significant Emission Rates for Determining the Need for PSD Review

Pollutant	Threshold Level, tons/yr
CO	100
NOx	40
SO_2	40
TSP	25
Ozone (total volatile organic compounds)	40
Pb	0.6
Asbestos	0.007
Be	0.0004
Hg	0.1
Vinyl Chloride	1.0
Fluorides	3.0
H_2SO_4 mist	7.0
H_2S	10.0
Total Reduced Sulfur (including H_2S)	10.0
Reduced sulfur compounds (including H_2S)	10.0

3.0 WASTE STREAM ANALYSIS

3.1 INTRODUCTION

Municipal solid waste management programs can become very complex. They often involve a combination of collection, resource recovery, and disposal techniques. Fortunately, all programs begin with the same basic issues:

- o How is refuse collected? Refuse must be transported from its generation point to a disposal or processing facility. Existing refuse collection systems should be identified as they impact the feasibility of new management programs.
- o Where and how is solid waste disposed? Existing disposal facilities and their life expectancies must be considered when planning solid waste management programs. They dictate when and what new disposal facilities will be required.
- o How much solid waste is generated? Solid waste generation varies seasonally, and over time. Both present and future waste quantities should be estimated for use in long range planning.
- o What is the solid waste composition? Municipal solid waste consists of a variety of components. Its composition varies from locale to locale and seasonally. It also varies with respect to its generator. Residential solid waste composition differs from commercial solid waste composition. Successful waste management programs are based upon realistic composition estimates.
- o How is solid waste controlled? Control or ownership of the waste stream must be established to ensure adequate supply for management facilities. This is particularly true when planning facility financing.

Because of the number of municipalities and military bases involved in the Neuse River project, these issues may seem complex. They are considered for individual areas and for the region as a whole in the following text.

3.2 MUNICIPAL SOLID WASTE COLLECTION

Existing solid waste collection practices are a major component of the present waste management system. If that system is modified through new waste management facilities, collection mechanics and economics may

change. Beyond changing with system modifications, waste collection is also important because it affects waste stream control or ownership.

Most counties within the study area maintain control of their waste streams by taking responsibility for collection. As Table 3-1 indicates, these counties either use publicly-owned vehicles or contract with private haulers for collection. Because of the rural nature of the area, most counties collect a portion of the waste from convenience stations rather than individual waste generators. Only one locality owns and operates a transfer station. Hertford County uses this facility to compact a portion of the County's waste prior to transporting it to the County landfill.

Private haulers collect waste from the military bases within the study area. Camp Lejeune and Cherry Point do not have formal agreements with these haulers nor do they own transfer or convenience stations. MSW is collected from individual generators and transported directly to either the Craven County or Camp Lejeune landfills.

3.3 SOLID WASTE DISPOSAL

3.3.1 Existing Disposal Methods

Waste disposal is a major factor in solid waste management systems. Modification of solid waste management program, is usually the result of decreased disposal capacity. New disposal facilities are constructed to extend existing disposal facility life or to replace depleted facilities. Disposal facilities also play a role in waste stream control. As is the case with the Neuse River Counties, a locality often has only one disposal facility. As a result,the majority of its waste will be disposed of at the solitary facility. This disposal pattern affords operators ultimate control of the waste. When multiple facilities are available in a locality, the facility with large capacity that can accept solid waste economically often receives and thus controls a large portion of the waste stream.

Currently, Neuse River localities provide disposal capacity in the form of sanitary landfills. As shown in Figure 3-1, each County in the study area owns and operates its own landfill. In addition to these

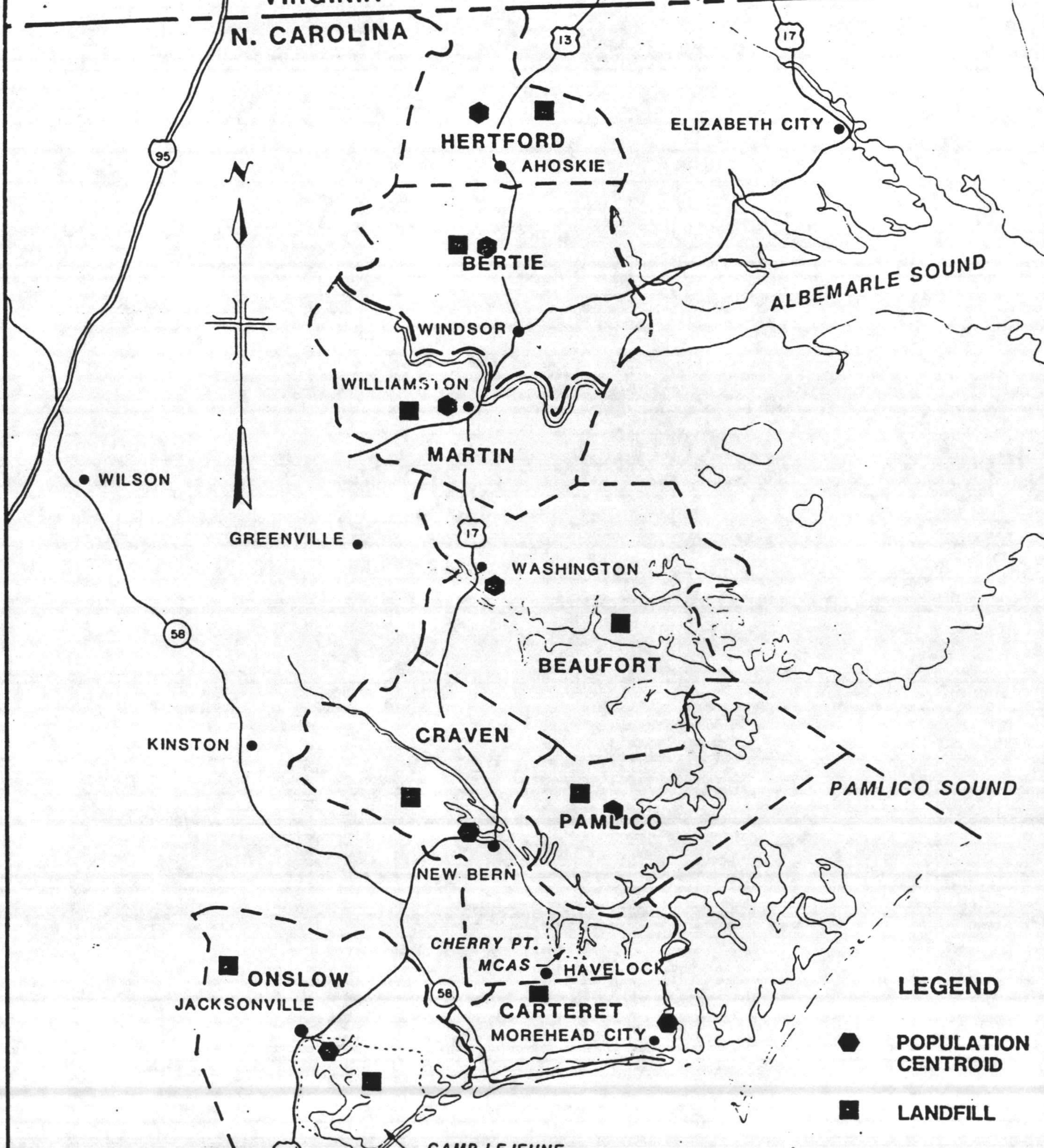
Table 3-1

Neuse River Solid Waste Feasibility Study
MSW* Collection and Transportation

MSW Source	MSW Primarily Collected By:	Convenience Stations	Transfer Stations
Beaufort County	Public Collectors	70% Waste is collected from nine convenience stations with storage capacities of 80 CY to 280 CY	None
Bertie County	Public Collectors	100% Waste collected from 8 CY to 14 CY convenience stations	None
Carteret County	Either Public Collectors or County-Contracted Private Collector	5% Waste is collected from either 40 CY Compactor Box or Open Top Box	None
Craven County	25%-30% MSW Privately Collected 70%-75% Publicly Collected	11% Collected from three stations. Each station has mini compactor and 42 CY storage	14% MSW taken to one transfer station. Station has compactor with 42 CY box and 80 CY additional storage
Hertford County	Either Public Collectors or County-Contracted Private Collectors	80% MSW collected from more than 70 sites containing between 80 CY to 160 CY storage capacity	None
Martin County	Public Collectors	25% MSW collected from 160 sites with 4 CY storage capacity	None
Onslow County	Private Collectors	None	None
Pamlico County	Private Collectors	None	None

*MSW - Municipal Solid Waste

FIGURE 3-1



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public sanitary landfills, Camp Lejeune operates its own sanitary landfill. Public sanitary landfills range in life expectancies from 1½ to 15 years. As Table 3-2 indicates, budgeted operations and maintenance costs at the Neuse River public sanitary landfills ranged from $70,000/year to $519,700/year in Fiscal Year 1987. Facility operators do not charge tipping fees based on weight, and only the Craven County landfill is equipped with scales. Craven County uses its scales periodically to check daily landfill tonnage estimates. Landfills in the study area are constructed and operated in accordance with the regulations in effect when they were permitted. Most have no formal liner; relying on natural soil properties to limit leachate migration. None of the sites has an active leachate collection or management system. All sites can be categorized as simple "cut and cover" operations where waste is placed in an excavation and covered with soil. Craven County controls groundwater levels through a perimeter ditch which lowers groundwater in the fill area.

The general sandy native coastal sediments, high groundwater table and lack of liner and leachate control systems lead to a potential for groundwater degradation.Because of North Carolina's concern for groundwater protection, the Branch of Solid and Hazardous Waste is expected to continue to require upgraded landfill designs. This trend is likely to cause Neuse River counties to upgrade existing landfills or construct new facilities with more stringent designs. As of March 1987, the Department had issued one permit under the State zero leakage/zero ground water contamination rule. That permit was for a landfill designed with a double liner and double leachate collection system. Given the State's groundwater protection stance. it is anticipated that any future Neuse River landfill permitted by the Department will be of a double liner/leachate collection design.

3.3.2 Landfill Costs

The cost of landfilling is controlled by the regulations which govern solid waste management. Present operations in the region are governed by the regulations which were in effect at the time of their

Table 3-2
Neuse River Solid Waste Feasibility Study
Existing Landfills

Landfill Owner:	Operated By:	Used By:	Landfill Life: Permit Life:	Actual Life:	Problems:	Current Budgeted Operational Costs:
Beaufort County	Beaufort County	Beaufort County	2 years	1½ years	None Reported	None Given
Bertie County	Bertie County	Bertie County	Not Reported	5 years	None Reported	$350,000/yr
Carteret[1] County	Carteret County	Carteret County	8 years[2]	8 years[2]	No Major Problems: Have had problems controlling blowing paper	$236,000/yr
Craven County	Craven County	Craven County Cherry Point MCAS (9% Total Landfilled Wastes from Cherry Point)	Until facility is closed	13 years	High Water table, flat terrain	$215,408/yr
Hertford County	Hertford County	Hertford County	2 years	2 years	Contamination discovered in 2 out of 3 on site groundwater monitoring wells. Corrective actions being taken.	$236,167/yr
Martin County	Martin County	Martin County	Until facility is closed	3 years at most	None Reported	$162,000/yr
Onslow County	Onslow County	Onslow County	7 years	15 years	None Reported	$519,700/yr
Pamlico County	Pamlico County	Pamlico County/ Richlands Township in Beaufort County	Not Given	18 months to 12-15 years	Permit Problems. According to County, North Carolina Department of Solid Waste Management believes site is unsuitable for conventional design & use because of groundwater contamination potential	$70,000/yr
Camp Lejeune	Base Maint.	Camp Lejeune/ Government Contractors working on base	Not Given	7 years	None Reported	$572,380/yr

(1) County leases land from the U.S. Forest Service
(2) Dependant upon approval of new landfill plan by State of North Carolina.

permitting. Since that time, State solid waste regulations have been much more stringent and new EPA guidelines will be published in March 1988. (See Section 2.1). The effect of these new regulations is going to be a radical departure from the way landfills are presently constructed and operated in the region.

In order to estimate the future cost of landfilling solid waste in coastal North Carolina certain assumptions must be made. The following key assumptions were made as part of this analysis:

- design life of twenty years
- double liners
- leachate collection and treatment
- synthetic membrane final cover

Assuming that each of these eight Counties in the area would implement their own landfill, total unit cost estimates incorporating construction, closure and operating costs were developed. These costs are presented in Table 3-3. The unit costs calculated exhibit that there is a significant economy of scale in landfill development. Small landfills are much more expensive than large landfills on a unit cost (dollars per ton) basis. This is clearly illustrated by Pamlico County (23 tpd @ $129 per ton) and Onslow County (285 tpd @ $45 per ton). In general, jurisdictions managing less than 100 tpd have estimated costs ranging from $58/ton to $129/ton while jurisdictions landfilling greater than 100 tpd exhibit costs of $45/ton to $56/ton. This economy of scale indicates that smaller jurisdictions should strongly consider pooling their resources in regional landfills. While transportation costs will be higher for regional systems, actually landfilling costs will be lower.

3.4 SOLID WASTE QUANTITIES

3.4.1 Waste Quantity Calculation and Methodology

Solid waste quantities can be projected by using historical quantity data, population projections, and anticipated changes in socioeconomic conditions. The projection is a multi-step process as follows:

TABLE 3-3

LANDFILL ECONOMICS, $MILLIONS

COSTS	COUNTY TPD	BEAUFORT 96	BERTIE 38	CARTERET 134	CRAVEN 195	HERTFORD 44	MARTIN 46	ONSLOW 285	PAMLICO 23
CAPITAL COSTS									
DEVELOPMENT		$9.64	$5.27	$12.41	$16.77	$5.73	$5.89	$23.13	$4.07
CLOSURE		2.07	0.85	2.87	4.14	0.98	1.02	6.01	0.53
SUBTOTAL		11.71	6.12	15.28	20.91	6.71	6.91	29.14	4.60
ENGINEERING PERMITTING, CONTINGENCIES, 15%		1.76	0.92	2.29	3.14	1.01	1.04	4.37	0.69
TOTAL		$13.47	$7.04	$17.57	$24.05	$7.72	$7.95	$33.51	$5.29
ANNUAL COSTS									
OPERATIONS AND MAINTENANCE		$0.67	$0.57	$0.97	$1.08	$0.58	$0.58	$1.24	$0.54
DEBT SERVICE		1.37	0.72	1.79	2.45	0.79	0.81	3.41	0.54
TOTAL		$2.04	$1.29	$2.76	$3.53	$1.37	$1.39	$4.65	$1.08
UNIT COST, $/TON		$58.29	$92.82	$56.44	$49.61	$85.10	$82.79	$44.75	$128.53

NOTES: -SOLID WASTE QUANTITIES ARE FOR THE YEAR 1992.
-ECONOMICS ARE BASED UPON A 20 YEAR DESIGN LIFE.

1. Tipping weight records from County solid waste disposal facilities are analyzed. Yearly quantities are divided by population estimates to calculate historical per capita generation rates (in pounds of solid waste per capita - day).

2. Historical generation rates are analyzed to determine a projected generation rate. This rate is typically a constant, for per capita generation usually does not change significantly from year to year.

3. Future population projections are multiplied by the generation rate to determine future municipal solid waste quantities.

Population estimates for the Neuse River area were obtained from the North Carolina Department of Planning. Each landfill operator was asked to provide current waste quantities disposed of at their facility. Because no area landfill operator keeps daily weight records, all quantities given were estimates. These estimates were divided by current service area populations to determine waste generation factors, shown in Table 3-4. As Table 3-4 indicates, waste generation factors obtained using landfill weight or volume estimates vary greatly. Only one generation factor, the Craven County figure, is based upon confirmable solid waste estimates. The County periodically double checks its weight estimates by using its landfill scales to weigh collection vehicles. All other factors are based upon waste quantity estimates that may or may not be accurate. None of the other counties are equipped with scales or use other methods capable of measuring actual waste volumes. Because Craven County is similar to the other localities in the study area, and because its waste estimates are confirmable, its generation factor of 3.5 pounds of waste per capita per day was appropriate for the study area. This includes residential and commercial waste. The Neuse River region is basically rural in nature, with a few scattered suburban areas about the City of Jacksonville and the military bases of Camp Lejeune and Cherry Point. The study area has a small quantity of industry that includes facilities owned by Perdue, Inc. and National Spinning Company, Inc. Therefore, while the study area is primarily rural in nature, it does contain a few commercial/industrial generators of solid waste that justify a factor slightly higher than a typical 3.3 pounds per capita per day for rural

Table 3-4

Landfill Waste Estimates, 1987

Landfill	Waste Estimate, TPD (tons per day)	Service Area Population	Estimated Waste Generation Factor, (pounds per capita-day
Beaufort County	175	45,226	7.7
Bertie County	30*	21,539	2.8
Carteret County	171*	11,279	30.3
Craven County	146	84,032	3.5
Hertford County	110*	24,393	9.0
Martin County	35*	26,309	2.7
Onslow County & Camp Lejeune	693*	129,615	10.7
Pamlico County	30	11,417	5.3

*TPD estimated from cubic yard estimates using an assumed 400 pounds per cubic yard compaction factor.

areas and significantly lower than the 4.6 pounds per capita per day typical of more industrialized areas.

After the generation factor was determined for the Neuse River study area, it was multiplied by population projections to obtain projected solid waste quantities. These quantities are shown for each county in Figure 3-2. Table 3-5 shows waste quantity by individual county and total MSW projections for the years 1987, 1992, 1997, and 2007. Solid waste projections for Cherry Point are included in Craven County estimates, and Camp Lejeune projections are included in the Onslow County projections.

As Table 3-5 and Figure 3-2 indicate, Cherry Point MCAS waste estimates are included in Craven county Projections, and Camp Lejeune estimates are included in Onslow County projections. This is because the most reliable available population information, North Carolina population estimates, do not differentiate between military and civilian population. However, waste quantities for both Camp Lejeune and Cherry Point were estimated in the 1977 Solid Waste Management Master Plans: MCAS Cherry Point and MCB Camp Lejeune, prepared by SCS Engineers. shown in Table 3-6, the projections were estimated from weight data gathered over a two week sampling period. While the methodology used appears sound, the sampling period was not long enough to determine seasonal waste quantity information. Also, projections have not been updated since 1977. As a result, these projections will not be used in the study. Waste quantities shown in Table 3-5 are based on North Carolina population estimates and the 3.5 pounds per capita-day generation factor.

Seasonal variations in waste were not developed for Neuse River. It appears that the coastal areas experience an increase in solid waste quantities during their April to September tourist seasons. However, seasonal variations in waste are heavily dependent on many socioeconomic conditions,and cannot be accurately determined without year-long weight records. It is difficult to determine whether the Neuse River area's waste increases with the end of crop season or when Marine base tours of duty begin, as well as with tourist seasons.

NEUSE RIVER SOLID WASTE FEASIBILITY STUDY
PROJECTED SOLID WASTE PRODUCTION OVER TIME

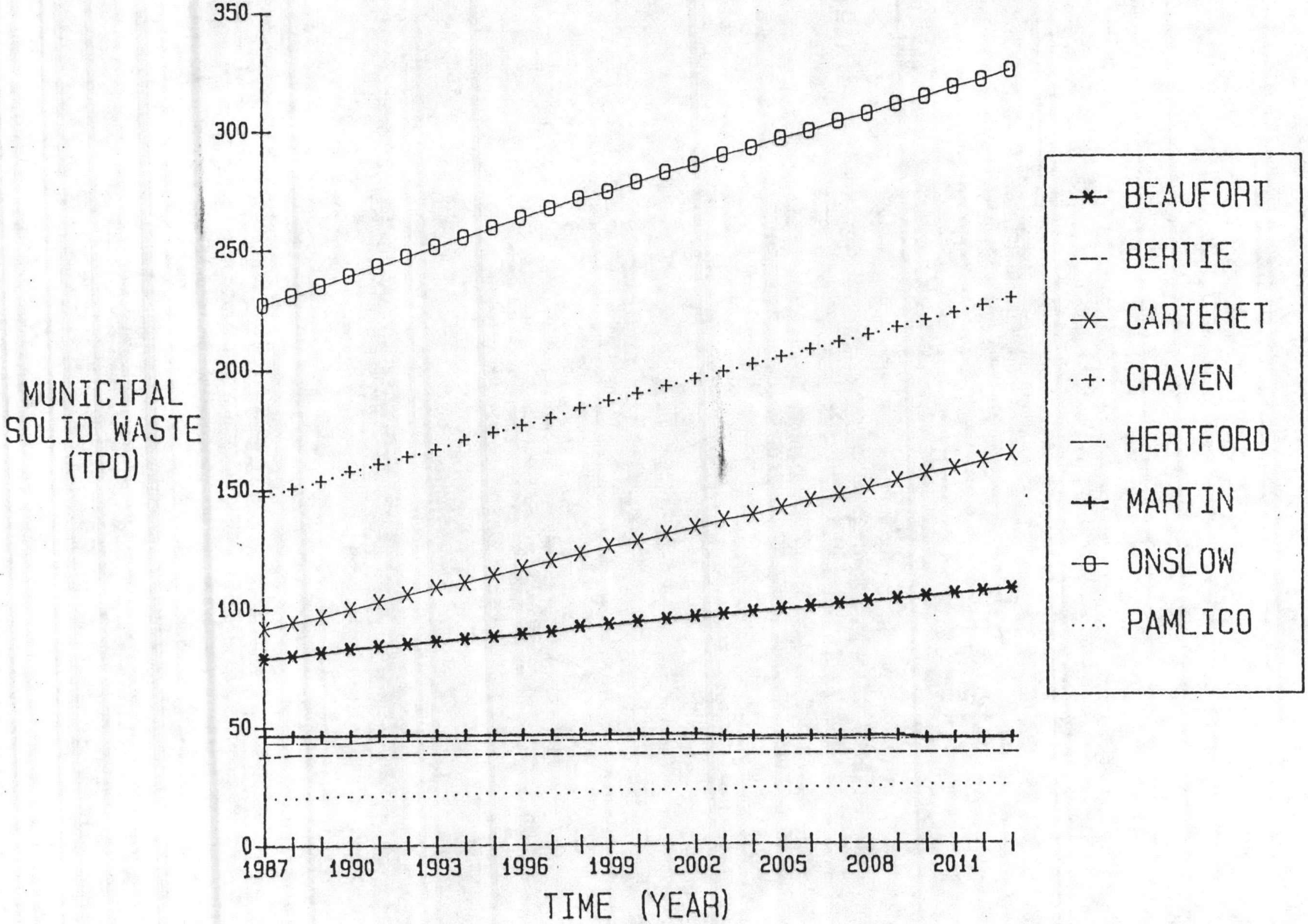


FIGURE 3-2

Table 3-5

Waste Quantity Estimates

	Tons Per Day					
County	1987	1992	1997	2002	2007	2012
Beaufort	79	85	90	96	101	106
Bertie	38	38	38	38	38	38
Carteret	92	106	120	134	147	161
Craven	147	163	179	195	210	225
Hertford	43	44	44	44	44	44
Martin	46	46	46	46	45	44
Onslow	227	247	267	285	310	320
Pamlico	20	21	22	23	25	25
TOTALS	692	750	806	861	920	963

Table 3-6

MCAS Cherry Point and MCB Camp Lejeune
Solid Waste Estimates, 1977

Year	Solid Waste Estimates MCAS Cherry Point	(tons per day)[2] MCB Camp Lejeune
1976	43	95
1985	55	122
2000	69	137

[1]From SCS Engineers, Solid Waste Management Master Plans: MCAS Cherry Point and MCB Camp Lejeune, 1977

[2]Report published weekly tonnages. Quantities were converted to tons per day (based on 365 days per year) for comparison with Table 3-4

Data that would have been gathered would likely have been inaccurate due to limited study time and insufficient waste weighing equipment. The methodology involving evaluation of existing waste composition was also not feasible because of lack of sufficient data. Most existing composition data generally recognized as accurate is from studies performed for urbanized communities. These communities differ from the Neuse River area in many socioeconomic factors, including population density and percentages of commercial and industrial business. A solid waste composition study was recently performed in North Carolina for the Land-of-Sky region. This estimate is shown in Table 3-7. The region, while less populated than the areas usually considered in composition estimates, differs in that it is primarily a mountainous region. It also lacks the institutional waste component provided by the Neuse River region's military bases.

Due to insufficient data, the year 2000 national municipal solid waste (MSW) composition estimate shown in Figure 3-3 and found in Characterization of Municipal Solid Waste in the United States, 1960 to 2000 by Franklin Associates, Ltd. was used. The estimate is a national average prepared for the Environmental Protection Agency using the materials flow approach. It was calculated by gathering data from previous composition studies and from materials consumption studies. The data were then manipulated to determine historical and projected MSW quantities and compositions. In addition to a national average composition, a national average higher heats value was used in this study. Typically, MSW higher heating values range from 4,000 to 5,500 BTU/lb, with an average value of 4500 BTU/lb.

In addition to municipal solid waste composition, it is often necessary to estimate residential solid waste composition. Residential waste differs from commercial waste in the types and quantities of waste components. For example, a paper copying business would produce more paper and less yard wastes than a single family residence. Residential solid waste is less difficult to control than commercial waste. Many localities only provide collection for the residential waste stream. Because of this, residential recycling programs are often used to reduce

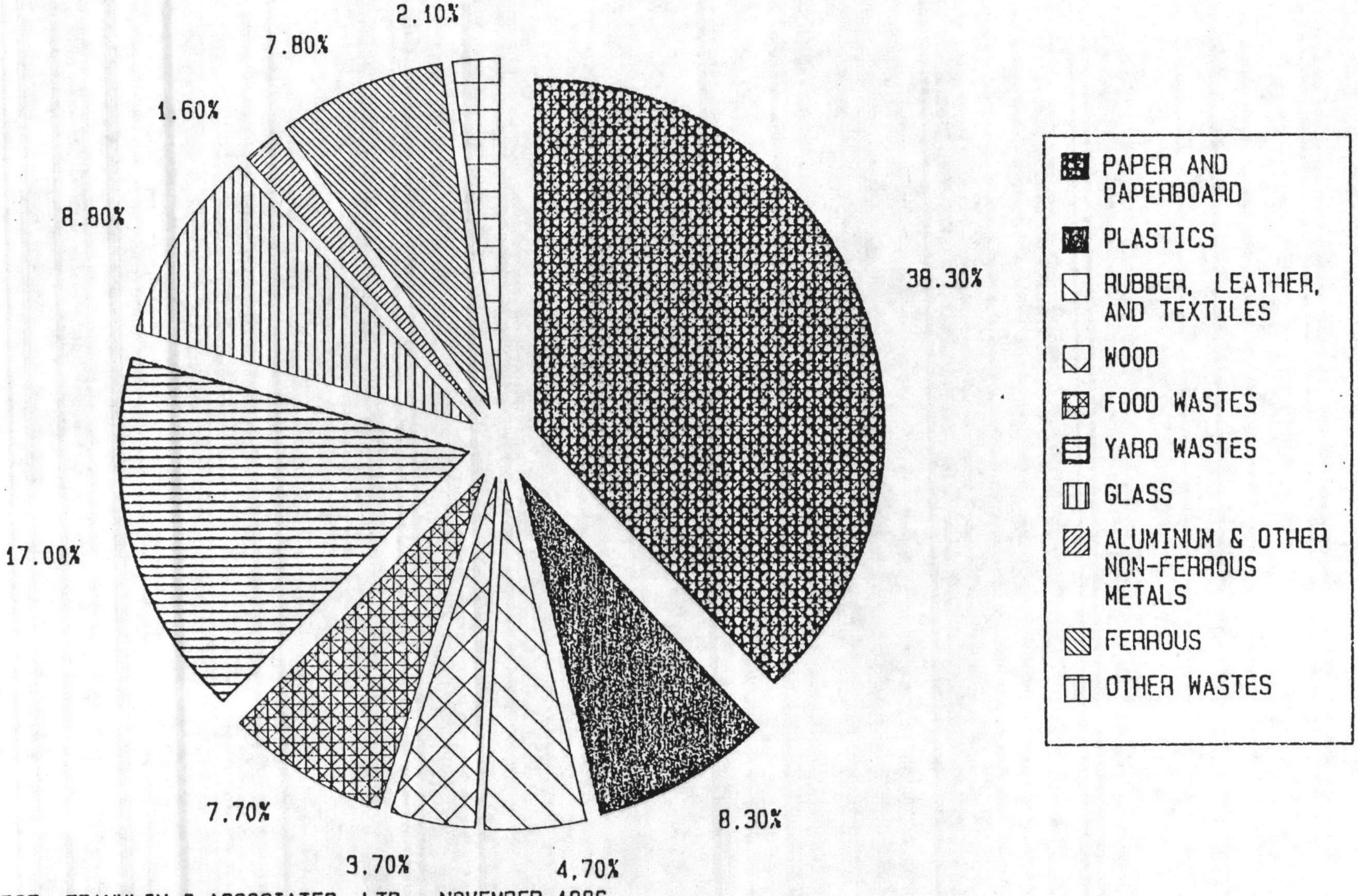
TABLE 3-7
BUNCOMBE, MADISON, AND TRANSYLVANIA COUNTIES, NORTH CAROLINA
MUNICIPAL SOLID WASTE COMPOSTITION

% BY WEIGHT

COMPONENT	MADISON CO. COMMERCIAL/INDUSTRIAL	BUNCOMBE CO. COMMERCIAL	BUNCOMBE CO. INDUSTRIAL	BUNCOMBE CO. RESIDENTIAL	TRANSYLVANIA CO. RESIDENTIAL	TRANSYLVANIA CO. COMMERCIAL/INDUSTRIAL
PAPER	22.9	30.1	13.2	24.5	21.1	19.7
CARDBOARD	22.7	22.3	36.4	6.9	8.7	30.9
ORGANICS	14.8	13.8	0.3	19.4	17.2	14.8
PLASTIC	14.0	7.7	15.8	10.0	11.5	11.1
METALS:						
FERROUS	9.0	9.7	12.1	9.6	8.4	5.3
ALUMINUM	0.8	0.5	0.2	0.9	1.4	1.1
OTHER NON-FERROUS	2.6	0.0	0.2	0.3	0.3	0.4
TEXTILES/RUBBER	6.5	3.8	6.7	9.4	5.8	2.2
WOOD AND CONSTRUCTION WASTE	3.9	9.2	14.2	7.9	17.8	8.6
GLASS	2.8	2.8	0.8	11.0	7.8	5.9
TOTAL	100.0	99.9	99.9	99.9	100.0	100.0

(1) COMMERCIAL & INDUSTRIAL SOLID WASTES ONLY

MUNICIPAL SOLID WASTE COMPOSITION 1990 NATIONAL AVERAGE



SOURCE: FRANKLIN & ASSOCIATES, LTD., NOVEMBER 1986.

FIGURE 3-3

the waste stream. In order to determine the amount of waste stream reduction, the residential waste stream composition must be known. Should the Neuse River region implement a comprehensive recycling program, it should estimate its residential composition to determine recovery rates. Residential composition estimates for Transylvania and Buncombe Counties, as obtained in the Land-of-Sky study, is shown in Table 3-8.

Another interesting aspect of the Neuse River area waste is the presence of military waste. Like residential or industrial waste, military waste has a unique composition. As part of a 1977 waste management plan, SCS Engineers sampled military waste for a two week period and used gathered data to estimate military waste composition. Results of their study are shown in Table 3-9. As shown in Table 3-9, the military waste estimate varies in higher "other paper" components and decreased in "Newsprint" components.

It is of import, however, that estimates are based on a two week sampling period. Data gathering over a much longer sampling period should be pursued prior to using military waste composition estimates. Otherwise, seasonal component variations and the effects of unusual discards will not be appropriately reflected in the estimate.

Information supplied by the localities indicates that approximately 70% of the solid waste disposed of in public landfills is residential, 25% is commercial, and 3% is industrial. The base maintenance estimates that approximately 50% of wastes received at the Camp Lejeune landfill is a result of military activity, 20% is residential, 25% commercial, and 5% industrial. This information is often used in determining how to control solid waste. For example, industrial solid waste is more difficult to control because it is often collected and disposed of by private companies. If an area's industrial waste represents only a small portion of the total waste stream, a locality may opt to forgo the expense and difficulty involved in capturing that portion.

3.6 WASTE STREAM CONTROL

A general rule applies to solid waste control: Whoever possesses the waste, controls the waste. Thus, the waste belongs to the generator

TABLE 3-8
RESIDENTIAL SOLID WASTE COMPOSITIONS
(% by Weight)

COMPONENT	TRANSYLVANIA COUNTY, N.C.	BUNCOMBE COUNTY, N.C.
PAPER	21.1	24.5
WOOD/CONSTRUCTION WASTE	17.8	7.9
ORGANICS	17.2	19.4
PLASTIC	11.5	10
CARDBOARD	8.7	6.9
FERROUS METAL	8.4	9.6
GLASS	7.8	11
TEXTILES/RUBBER	5.8	9.4
ALUMINUM	1.4	0.9
OTHER NON-FERROUS METALS	0.3	0.3
TOTAL	100	99.9

SOURCE: SANDI MAURER AND CAM METCALF, _SOLID WASTE STREAM QUANTITY QUANTITY AND COMPOSTITION STUDY FOR BUNCOMBE, MADISON AND TRANSYLVANIA COUNTIES, NORTH CAROLINA_, JANUARY 15, 1987.

TABLE 3-9
MILITARY SOLID WASTE COMPOSITIONS
SEPTEMBER 1977

ITEM	SUPPLY		OFFICES		BARRACKS		MESS HALL	
	CHERRY POINT	CAMP LEJEUNE	CHERRY POINT	CAMP LEJEUNE	CHERRY POINT	CAMP LEJEUNE	CHERRY POINT	CAMP LEJEUNE
NEWSPRINT	-	-	-	-	10	24	-	-
CORRUGATED	38	55	17	35	15	37	30	20
OTHER PAPER	30	27	63	42	-	13	10	35
ALUMINUM	-	-	-	-	-	-	-	-
OTHER NON-FERROUS	-	-	-	-	-	-	-	-
FERROUS	-	2	-	5	-	1	20	20
BEVERAGE CONTAINERS	5	5	8	5	5	11	5	-
TIN CANS	-	-	-	-	-	-	15	-
OTHER METALS	-	-	-	-	-	-	-	-
GLASS	6	3	-	-	15	4	5	-
PLASTICS	1	3	-	3	5	4	-	10
GARBAGE	11	-	6	-	40	1	15	15
TEXTILES	-	2	4	-	5	3	-	-
WOOD	7	3	2	10	5	2	-	-
YARD WASTES	-	-	-	-	-	-	-	-
INERTS	-	-	-	-	-	-	-	-
OTHER	3	-	-	-	-	-	-	-
TOTAL	101	100	100	100	100	100	100	100

SOURCE: SCS ENGINEERS, SOLID WASTE MANAGEMENT MASTER PLANS:MCAS CHERRY POINT AND MCB CAMP LEJEUNE, SEPTEMBER 1977

until collected, the collector until disposal, and the disposal site owner upon receipt.

In the case of the Neuse River area, solid waste is currently controlled by many groups. Control of solid waste collection is splintered between the Counties, local municipalities, Federal government, private contractors and individuals.

Each county has control over municipal solid waste disposal, for it owns and operates its landfill. The counties may choose to approach any management program from the disposal control viewpoint Because a portion of the solid waste is collected by private companies or hand delivered to landfills by generators, few counties currently can dictate how often and by what method all refuse in their area is collected. They can, however, dictate how and what refuse will be accepted at their disposal facilities. There is no guarantee that this present control over disposal can be maintained.

3.6.1 Reasons for Waste Stream Control

The issue of waste control may be confusing to those who do not deal with municipal solid waste. After all, refuse is just that - materials that individuals find useless and wish to be rid of. However, there is value in what people throw away. Solid waste contains recyclable materials and energy value, both of which can be translated into revenues.

Regardless of the value of solid waste, control of the waste stream is needed. The primary reason for control is the protection of public health. Solid waste must be disposed of properly to ensure that food, water and air supplies are not contaminated. Homes, workplaces and recreational areas must be free of harmful debris. Also dependant on proper disposal methods is the environment, where animal and plant life must be protected from contamination.

In addition to preserving human, animal and plant life, solid waste stream control is necessary to ensure the financial success of resource recovery projects. Successful projects depend upon a guaranteed waste stream so that they can meet energy capacity or material requirements.

A committed waste stream help project developers assure their financial backers that a resource recovery facility can produce material and energy revenue streams necessary to offset operating and capital costs.

3.6.2 Waste Stream Control Methods

Waste stream may be controlled by any of the following methods:

- Through the Free Market: A disposal facility may capture an areas waste stream by offering tipping fees lower than those of neighboring disposal facilities. A recycling facility may control the recyclables flow by paying source separators for their materials.

- Through Contracts: A locality might control its waste stream contractually. This would involve negotiating contracts with collectors in the counties (municipalities, private collectors, and the Federal Government). These contracts would assure collectors of acceptable tipping fees and reliable disposal. The disposal facility owner would promise not to turn away the collectors' wastes. The contracts would guarantee counties a certain waste flow, or allow them to penalize collectors by levying a fee intended to help meet facility costs.

- Through Legislation: Legislation can give a municipality the legal authority to control the waste stream. Legislation is traditionally enacted as a way to protect the public health. Less traditional reasons for legislation are also being used with increasing frequency. These reasons include the production of energy, the protection of public investments, or as a method to support economic development.

Of the three methods used to control municipal solid waste streams, the freemarket method is usually the most popular with collectors and the general public. No freedom is lost to government control, and users of the facility generally spend less disposing of their refuse. Unfortunately, it is not always a viable option for resource recovery projects. The operating and capital costs of these disposal facilities must be met. The energy and material revenues received rarely are sufficient to meet these expenses. This is especially true in an area similar to the Neuse River region, where counties that may not opt for a resource recovery facility or may have a longer life on their conventionally designed landfill offering landfill tipping fees below those of adjacent county facilities.

Contractual control of the waste stream may or may not be a viable option for the Neuse River Counties. It guarantees the availability of a waste stream without asserting legislative control. Unfortunately, the widespread nature of the area and the large number of participants in the Neuse River waste collection system may make contractual control of the waste stream impractical. It may not be feasible to negotiate the number of municipal and private contracts required to control the waste stream. Also, it may be difficult for sponsors to provide the low tipping fees necessary to make disposal at a facility cost-effective for long distance haulers. The waste collection system may be too splintered with its municipal collectors and private collectors to utilize individual contracts with each carrier.

Legislative control is much simpler than contractual control. One ordinance may be sufficient to mandate that all carriers use a certain facility. The Neuse River Counties may use legislative control to divert waste to specific facilities on either the County or State level as follows:

- County level: Each county performs two primary solid waste functions: disposal and planning. Counties may pass ordinances restricting municipal solid waste disposal to certain facilities. They might also use their planning function to divide areas into several waste streams, each with a designated disposal facility.

- State level: The counties may also enlist the State of North Carolina's help in obtaining control of the waste stream. The State legislature may direct that resource recovery facilities be built in the counties, or dictate that waste flow be controlled by the area. The State might also create a regional authority.

While the County has several options in gaining legislative control of the waste stream, it may meet with opposition in doing so. Not all counties and individual town and city governments in the Neuse River area may welcome legislative control. Private collectors have, in the past, challenged waste control ordinances in other locations on the grounds that antitrust laws have been violated, or the ordinances infringe on collectors' property rights.

Given the possible opposition to legislative waste stream control, Participating counties must consider any local ordinances or State resolutions very carefully. Limiting a collector's disposal options may be interpreted as limiting the collector's rights. Any legislation enacted must be justified from a public welfare standpoint and must be reasonable to abide by. Legislation should be enforced so that minimal violations occur, and minimal public confusion exists as to what the legislation requires.

3.6.3 Methodology for Gaining Solid Waste Stream Control

Because legislative control offers a good possibility of controlling a large portion of the waste stream, the Neuse River counties should begin a plan for instituting new County ordinances or for passing a resolution through the State legislature. It is essential that waste stream control be gained prior to the development of new disposal facilities. Gaining waste stream control can be a long process, often taking several years to complete.

If a local ordinance method is used, the counties should immediately begin to take the following steps in establishing waste stream control:

- o Meet with county, city and town administrators or planners to discuss the establishment of waste control ordinances.
- o Prepare a formal solid waste management plan, approved by participants, that outlines control measures.
- o Create local ordinances requiring the outlined control measures be followed by all permitted collection vehicles. This ordinance must be carefully reviewed for discrepancies or points that might be challenged prior to passage.
- o Modify or establish a collection vehicle permitting process so that each vehicle is assigned a tipping location based upon its collection area.
- o Upon implementation of resource recovery systems, limit waste acceptance at landfills to wastes from County solid waste facilities.

If the State is to be involved, the counties should immediately begin to take the following steps in establishing waste stream control:

- Form a task force with town and city administrators, County officials and State Representatives to develop the basis for a State Resolution and to determine whether regional authorities are needed.

- Meet with the Representatives or Senators and their staff who will author the Resolution to ensure it meeting the task force's requirements.

- Provide a lobbying effort throughout the Resolution's consideration by the State legislature.

- Develop a plan for implementing the Resolution. This may be similar to the local ordinance plan in terms of wasteshed formation and disposal control.

4.0 ENERGY RECOVERY ANALYSIS

4.1 INTRODUCTION

The recovery of energy from solid waste has been attempted in a variety of ways over the years. Each of these methods has had varying degrees of success and each has been offered by numerous vendors whose systems were all slightly different.

- o Biological
- o Chemical
- o Biochemical
- o Combustion

The selection of the appropriate technology will be based upon technical, regulatory/environmental and economic aspects. Any technology selected must be:

- o Reliable
- o Economical
- o Environmentally Sound

Energy recovery is a key component to any comprehensive waste management program. The technology selected will undoubtedly be capital intensive but has the ability to produce significant revenue streams to offset these costs. As an integral part of the overall solid waste management system, it must function with a high degree of reliability.

4.2 TECHNOLOGY OVERVIEW

4.2.1 Pyrolysis

The pyrolysis process is the destructive distillation of solid wastes in an absence or near absence of oxygen. This oxygen deficient environment promotes the decomposition of solid waste into various products including gas consisting mainly of combustible hydrocarbons, a carbon rich residue, and a pyrolytic oil that resembles number 6 fuel oil.

The refuse pyrolytic process has been developed in various manners since the late 1960's. These processes vary in the production of methane, pyrolytic oil, and residual charcoal but not in principal.

Even though the pyrolytic process has been used commercially for many years to produce methanol, acetic acids, turpentine from wood, and the gasification of coal, it has only recently been applied to refuse.

The pyrolysis process in general has the following typical processes involved with it;

- Refuse Storage - The as-received refuse is mixed which provides for a greater homogeneity and removal of grossly objectionable items.

- Material Processing and Separation - The removal of unwanted heavies (inerts), ferrous and non-ferrous metals are carried out during this phase. This process is sometimes called the refuse-derived fuel (RDF) or front-end system.

- Pyrolytic Reactor - The carbon rich refuse enters the reactor where an endothermic,pyrolytic reaction occurs. The reaction produces a hydrocarbon fuel comparable to natural gas which is essentially methane with some carbon dioxide. The process can also produce liquid fuel oil similar to number 6 fuel oil. The solid fuel product, or char, can be used to fuel the reactor. The remaining residue must be landfilled.

- Collection Storage and/or Upgrading System for Fuel Byproduct - The fuel byproduct is separated, cleaned, and treated to remove any objectionable impurities. The waste products from this process will be disposed of in a landfill or vent to atmosphere.

These steps are shown in Figure 4-1.

Four major manufacturers have developed refuse pyrolysis systems and constructed pilot or full scale systems. These systems, for different reasons, have all been shut down, terminated or abandoned. The failures were the result of economic as well as technical problems in operation.

The marketability of the recovered materials (i.e., ferrous, glass, aluminum, etc.) derived from the preprocessing depends on product quality and availability of markets.

The alternative fuels produced by pyrolysis vary in market value. The methane gas must be cleaned of any objectionable impurities and can be either sold to local natural gas companies, used as a medium Btu fuel (350 Btu/SCF) or used in the process. The pyrolytic oil produced by the process can be sold as a commercial fuel oil. The fuel oil is similar

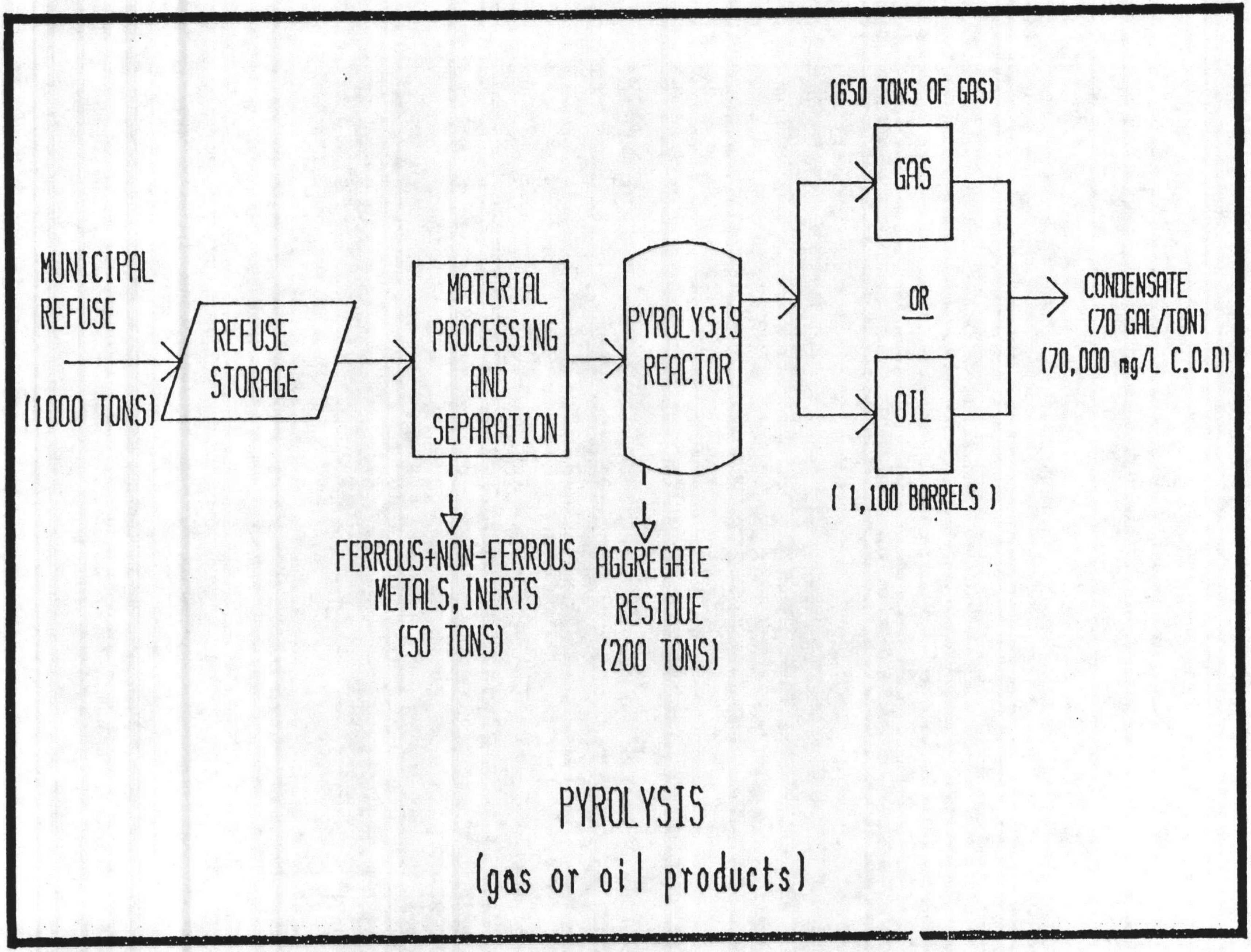

MUNICIPAL REFUSE
(1000 TONS)
REFUSE STORAGE
MATERIAL PROCESSING AND SEPARATION
FERROUS+NON-FERROUS METALS, INERTS
(50 TONS)
PYROLYSIS REACTOR
AGGREGATE RESIDUE
(200 TONS)
(650 TONS OF GAS)
GAS
OR
OIL
(1,100 BARRELS)
CONDENSATE
(70 GAL/TON)
(70,000 mg/L C.O.D)
PYROLYSIS
(gas or oil products)

FIGURE 4-1

to No. 6 fuel oil, most oil burning equipment can use this grade fuel oil with some minor modifications. Some problems have been experienced with corrosion resulting from the use of pyrolytic oils.

The claimed weight reduction of refuse, excluding recovery of ferrous and non-ferrous metals, is approximately 60 to 80 percent. The aggregate residue remaining from the Municipal Solid Waste (MSW) input is approximately 20 percent of the refuse stream by weight. In addition, the inert rejects from the front-end system consist of approximate 10-15% of the incoming waste stream. Because the pyrolysis process is still experimental the net volume reduction is uncertain but would probably be in the range of 75 to 85 percent, if the process are performing properly. Pyrolysis is inherently less efficient than direct waste combustion.

Pyrolysis is not considered to have a record of successful operation at a scale appropriate for the Neuse River project. To our knowledge, no major vendors exist with successful experience with this system.

4.2.2 Fermentation

Subsequent to the 1978 energy crisis, a great deal of attention has been given to the production of ethanol, as an alternative fuel, from cellulose waste. The portion of cellulose waste that is separated from municipal solid waste (MSW), can be used in a refuse-to-ethanol process which is called enzyme hydrolysis. The enzyme hydrolysis process uses fermentation to enzymatically control anaerobic breakdown of the energy rich combustible fraction of MSW with its high cellulose content.

The typical refuse-to-ethanol process would involve the following eight processes:

- <u>Refuse Storage/Preprocessing</u>:
  The untreated MSW enters the enzyme hydrolysis process plant and is deposited for preprocessing. The preprocessing will remove inorganic materials such as ferrous and nonferrous metals, glass, and inert heavies as well as organic refractories such as plastics. This is essential to the success of the fermentation process.

- Refuse Derived Fuel (RDF) Feedstock Storage and Preparation:
  The preprocessed product stream is the fraction of MSW which is highly biodegradable. The cellulolytic RDF will be the feedstock and is conveyed to a storage bin. The feedstock will be prepared in a wet hydrapulping process such as the Black Clawson System. The prepared RDF will be pumped to the enzyme production process.

- Enzyme Production:
  The prepared feedstock RDF enters an enzyme fermenter. The enzyme fermenter will anaerobically convert the refuse. Also entering the fermenter is seed culture, purge water, and pH control with anti-foam agent. The enzyme mixture will be pumped to the (SSF) Simultaneous Saccharification and Fermentation process.

- Simultaneous Saccharification and Fermentation (SSF):
  The SSF process takes the enzyme process product and injects it into the SSF fermenter. There it will be further converted to a sugar mixture then to ethanol and finally pumped to the solids separation process.

- Solids Separation:
  This process removes the solids from the liquid stream and allows the liquid to enter the distillation process, while the solids go to the evaporation process for disposal.

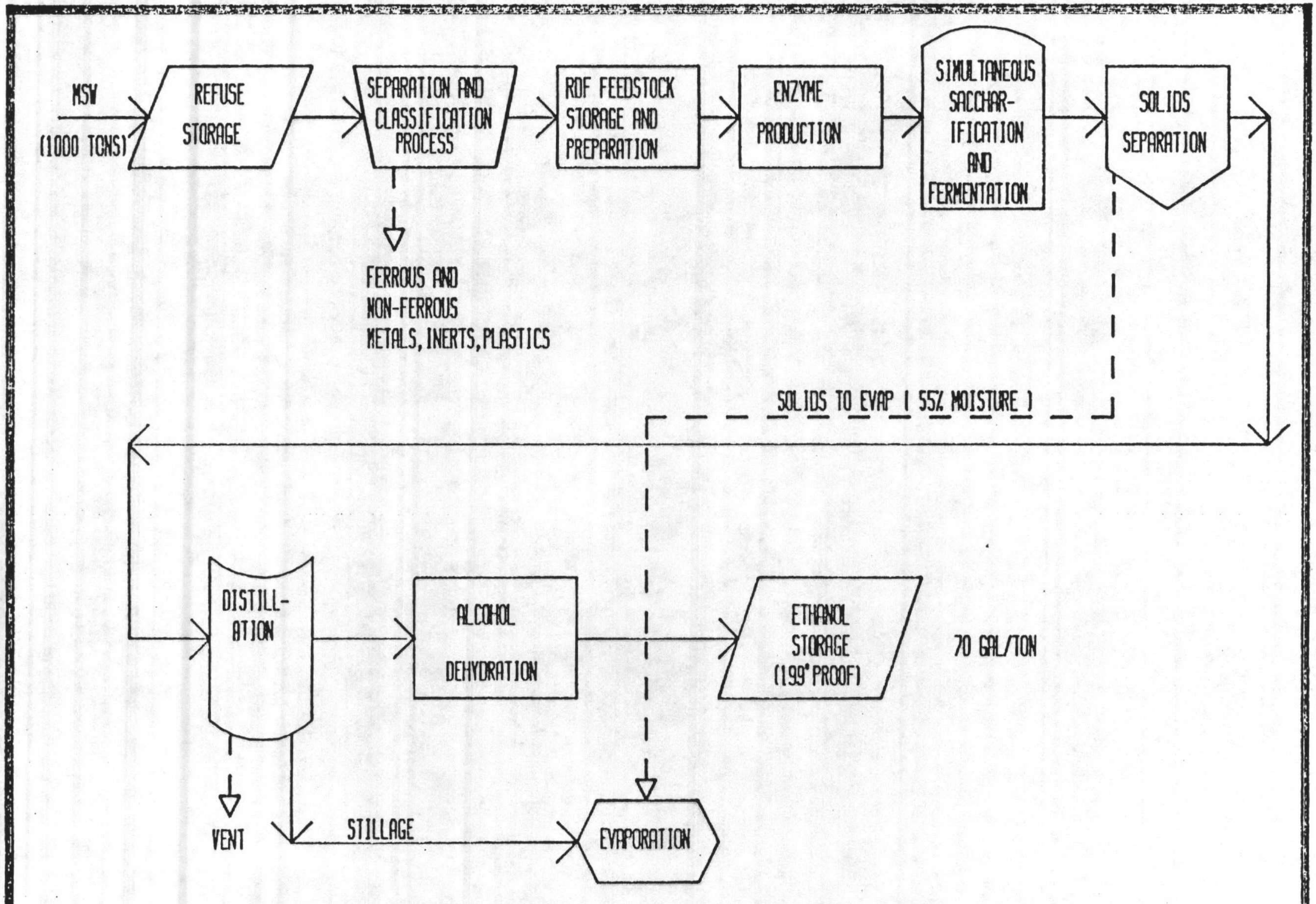
- Distillation:
  The distillation process will purify the alcohol with the aid of a steam operated stiffer and rectifier. The gas from the dual process is condensed and added to the ethanol stream leaving the rectifier. The ethanol is pumped to the dehydration process. The spillage from the stiffer is pumped to the evaporation process.

- Alcohol Dehydration:
  The dehydration process will purify the ethanol that is approximately 190° proof to approximately 199° proof. The purification is accomplished by a molecular sieve dryer. The 199° proof ethanol will be pumped to storage and the water from the dryer is pumped back to the hydrapulping process.

- Evaporation:
  The evaporation process consists of a vapor recompression evaporator, a solids mixer and pneumatic dryer. The pneumatic dryer's solids are recycled into the system as fuel for the boiler plant. The condensate will return to the processes as feed and make up water.

The fermentation process is shown in Figure 4-2.

Production of alcohol has some special regulatory constraints at both the Federal and State levels. Due to the limited data available and no present facilities operating, the environmental and regulatory aspects of this process cannot be fully evaluated.



FERMENTATION FOR ETHANOL PRODUCTION

FIGURE 4-2

The demonstrated reliability of the enzyme hydrolysis process has yet to be proven at any scale above experimental. The process is obviously a complex one that requires much equipment and sensitive biological reactions. The largest plant constructed was a one ton per day pilot plant built by Gulf Oil in 1973. The plant is shut down and Gulf Oil has pulled out of the field.

Based on the fermentation process development to date, this technology is not considered to have a record of satisfactory operation for the Neuse River Project and is not viable for further consideration.

4.2.3 Anaerobic Digestion with Methane Recovery

The anaerobic digestion process biologically converts municipal refuse into methane. The process involves the biological gasification of MSW by anaerobic microorganisms in an oxygen deficient liquid medium. The resultant product is methane rich gas which can be used to fire a boiler in its original state or further refined and upgraded to pipeline quality for commercial usage.

The typical anaerobic digestion process involves the following processes:

- o Refuse Storage - The untreated municipal waste enters the plant by packer trucks. The trucks dump the refuse into the storage pit. This allows the refuse to be mixed, which provides for greater homogeneity. The refuse is then processed in the material recovery section of the plant.

- o Preprocessing - Material Recovery - The stored refuse will undergo preprocessing consisting of primary shredding to reduce its size. The shredded refuse will then have the ferrous metals extracted, trommeled, and then secondary shredding. Finally the refuse will be air classified to remove and separate the nondigestible materials.

- o Premix Tank Process - The digestible organic fraction of the refuse will become the feedstock for the process, which is called refuse derived fuel (RDF). The RDF will be mixed with primary sewage sludge and recycled filtrate water from the vacuum filter. This slurry also has certain nutrients added to it that promote the digestion process.

- o Digestion - The refuse slurry mixture is then introduced into a reactor (digester). The mixture is heated to the desired temperature that enables the anaerobic digestion to take place. The

contents of the digester are constantly mixed and the byproduct methane gas is continuously extracted. The digestion process is designed to convert approximately one half of the organic solids into the product gas (50% methane, 50% carbon dioxide). The digested slurry is removed from the anaerobic digesters after a designated period of time.

- Solids Separation - The digested slurry that leaves the anaerobic digesters will go to the solids separation process. This process will separate the solids from the spent effluent which are then transported to a landfill or used in an incinerator. The vacuum filter will reclaim liquid and recycle it back into the premix process.

- Methane Gas Clean-up - The digester byproduct gas, methane, if required will enter the clean-up process. The gas, as produced by the digester can be used on-site, but requires extensive cleanup (cost approximately $2.00/million Btu (1980)) to achieve pipeline quality.

The anaerobic digester process is shown in Figure 4-3.

Environmental concerns from this process include air emissions from both the process and the solids incinerator as well as the odor potential.

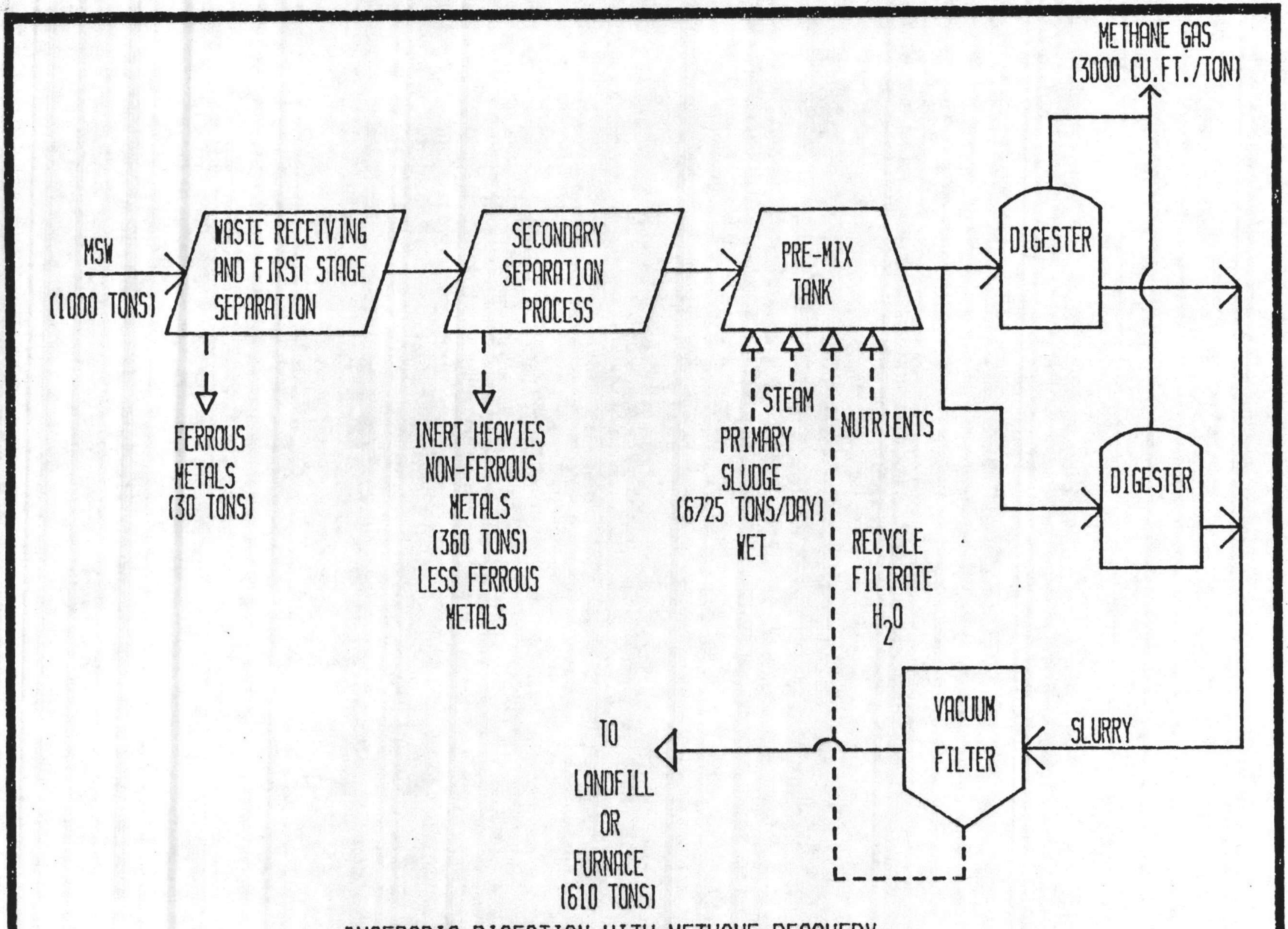
The demonstrated reliability of anaerobic digestion with methane recovery from municipal refuse is unknown. The Department of Energy and Waste Management, Inc. have constructed a 50-100 ton per day demonstration project in Pompano Beach, Florida. The plant commenced operation in November, 1978 in an experimental mode. This mode of operation is unsuitable to evaluate long-term, full-scale reliability.

The marketability of the methane gas that is recovered from the anaerobic digestion process varies with the demand for natural gas.

This technology is still being developed and must be regarded as experimental. Because the process of anaerobic digestion of MSW is experimental this technology will not be considered further in this analysis.

4.2.4 Refuse Derived Fuel (RDF) Combustion

RDF firing systems involve the combustion of mechanically processed MSW. Mechanical processing allows the preparation of a higher quality fuel and the recovery of recyclable materials. Higher quality is



ANAEROBIC DIGESTION WITH METHANE RECOVERY

FIGURE 4-3

obtained because the material is more homogenous, contains less inert or incombustible materials, and permits even feed to the combustion process.

A number of strategies can be utilized for energy recovery from solid fuel RDF. The RDF can be fired in either a boiler specifically dedicated to RDF combustion or co-fired with another fuel. This will affect the firing technology used and the extent of the RDF processing required. The fuel may be sold to outside parties or burned inhouse. Fuel may be shredded into a fluff, ground into a powder, or densified (pelletized).

Byproducts such as ferrous metals, aluminum, and glass may be recovered, but the primary intent of the preprocessing is to improve fuel quality. Another benefit is less overall ash production.

The type of preprocessing equipment used in RDF facilities varies considerably according to the purpose of the process equipment. See Table 4-1 for list of various process equipment. If the intent is for improving fuel quality then a particular process train will be used. If the intent is for materials recovery, a multitude of options are available depending on what product is being recovered. However, some similarities exist in all RDF process trains.

The first stage usually involves size reduction, shredding and/or homogenizing equipment. The second stage usually includes product separation equipment. If metals are to be removed, a magnetic separator can be used. Glass and aluminum are typically removed by trommels, which are large rotary cylinders with specially sized holes to remove the intended product. Screening devices such as disc screens are often used. Air classifiers are used to separate large noncombustibles by an air separation process. The final stage typically includes fine shredding, drying, and/or densification.

A generalized description of RDF processing and dedicated combustion follows. Figures 4-4 and 4-5 show schematics of this system.

Waste is received in an enclosed area and discharged to a tipping floor where grossly objectionable items are removed. The floor also serves as waste storage for periods of equipment maintenance and other times as needed.

Table 4-1

Mechanical Processing Equipment used in Materials Recovery Systems

1. Size Reduction/Shredding
   a. Hammermills - vertical & horizontal shaft
   b. Shear shredder
   c. Rotary, guillotine and scissors-type shears
   d. Grinders - roller, disc-mill, ball mill
   e. Flail mill
   f. Wet pulper
   g. Knife mill

2. Air Classifiers (Separation of large non-combustibles)
   a. Straight
   b. Zigzag
   c. Vibrating
   d. Drum
   e. Concentric

3. Screens (Materials separation by size)
   a. Trommel
   b. Vibrating - reciprocating and gyrating
   c. Disc

4. Magnetic Separators
   a. Belt-type
   b. Drum-type

5. Glass and Aluminum Separators
   a. Heavy Media Separation
   b. Aluminum Magnets (Eddy Current Separation)
   c. Froth Flotation units
   d. Optical Sorting
   e. Hand Sorting

6. Dryers
   a. Drum-type
   b. Fluid-bed

7. Densifiers
   a. Pelletizers
   b. Briquetters
   c. Cubers
   d. Extruders
   e. Compactors

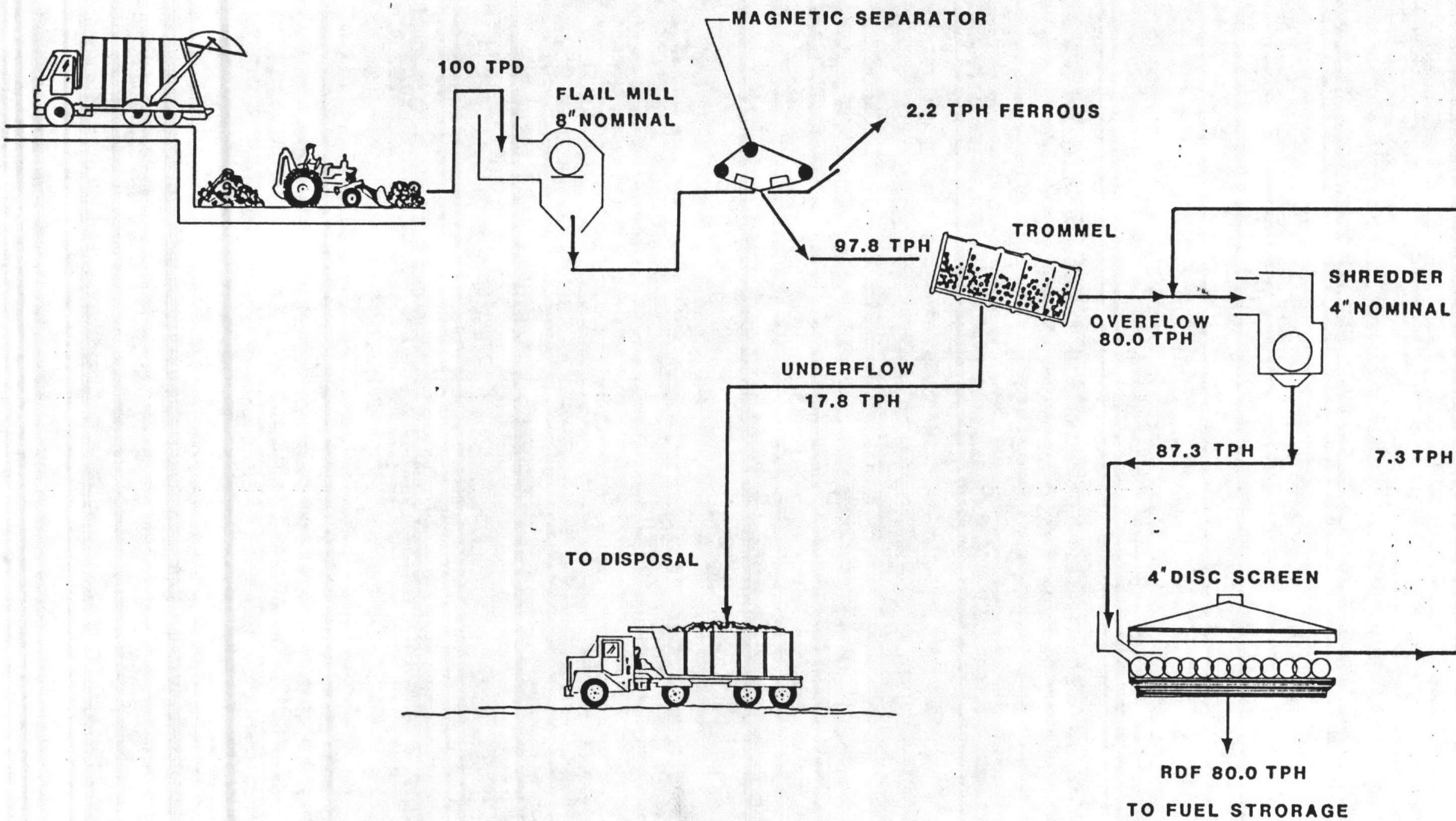


FIGURE 4-4

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SOLID WASTE FEASIBILITY STUDY
RDF PROCESSING FLOWSHEET

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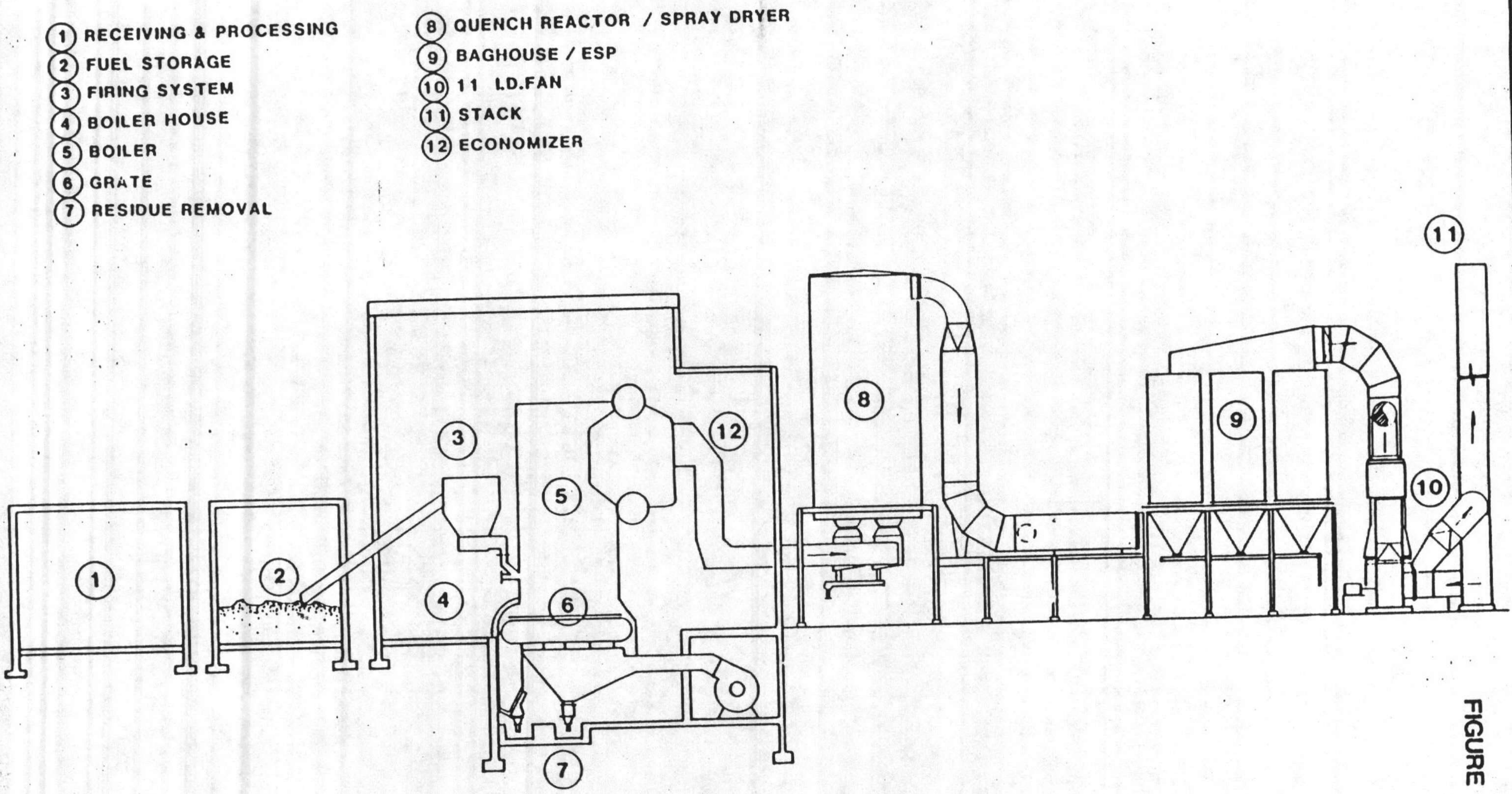

ELEVATION

FIGURE 4-5

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SOLID WASTE FEASIBILITY STUDY
RDF COMBUSTION SCHEMATIC

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Waste is fed to the processing system via front-end loaders and conveyors. As shown in Figure 4-4, the first step in most processes is homogenization and gross size reduction. This is accomplished here with a flail mill. Following this step, ferrous recovery using magnetic separation is common. A trommel, which is a size separation device follows. Table 4-1 lists other processing equipment available for size reduction/shredding. Small inert particles are removed and sent to disposal. The larger combustible fraction is sent to a shredder whose sole function is size reduction. The last processing step is a disc screen, which is a size separation device intended to remove large objects from the fuel stream. These large objects are returned to the shredder.

The RDF produced in this system represents approximately 80 percent, by weight, of the incoming MSW. RDF produced is either burned directly or put into storage.

RDF systems have suffered serious reliability problems. These problems have occurred in three basic areas - processing, fuel storage and retrieval and combustion.

The types of problems in each area are as follows:

Processing

- o Shredders have been prone to jamming, high maintenance expenses and explosions.
- o Conveyors have experienced problems in overloading, stalling and mechanical failure.
- o Secondary processing systems (i.e., glass jigs, eddy-current separators, etc.) designed to recovery recyclables have had reliability problems as well as producing recyclables with high contamination levels.
- o System performance regarding production of a consistent fuel from a particle size, moisture and ash content and heating value standpoint has been poor.

Fuel Storage and Retrieval

- o Fuel storage systems have been unreliable due to bridging, spontaneous combustion and dust control.

- o Fuel retrieval systems have experienced serious problems in achieving constant flow rates as well as clogging and jamming.

Combustion

- o Inconsistent boiler feed rates and boiler feed spout clogging are common.
- o Difficulties in combustion control have been experienced related to variable fuel feed rates and properties.
- o Wide surges in uncontrolled air emissions and energy production rates have resulted from combustion control and fuel feed difficulties.
- o Ash handling systems become overloaded due to poor combustion and/or variable fuel quality

These problems range from manageable operations items to serious defects resulting in facility shut-down. Table 4-2 lists representative RDF systems in the United States and their status. Of the 21 facilities listed in this table, 7 have been closed, 7 are operating after substantial modifications and 7 are operational. Several major RDF systems are currently in planning or construction including facilities in Detroit and Honolulu.

RDF processing systems have the capability to recover a variety of materials including ferrous metals, aluminum and glass. The ferrous metal recovered can be sold for scrap. Aluminum and glass are recoverable. The aluminum is a very desirable material due to its relatively high value. Glass is not as desired because of scrap paper and other contaminants in the glass and the requirement for color sorting. RDF can be sold but, historically, most co-firing facilities have had operating difficulties so the present preference is for dedicated boilers. Steam and electricity sales are comparable to those of mass burn.

Although RDF boilers are slightly smaller than mass burn units, the preprocessing equipment requires greater area.

The overall reduction, by weight, from the process ranges from 60 to 85 percent.

4.2.4.1 Spreader Stoker Boilers

A spreader stoker boiler utilizes a semi-suspension burning concept

Table 4-2

Representative RDF Projects in United States

Location	Start-up Date (year)	Capacity (tons/day)	Status
Akron, OH	1979	1000	Operating after Modif.
Albany, NY	1981	700	Operating
Ames, IA	1975/76	200	Operating after Modif.
Baltimore Co., MD	1976	1200	Operating
Bridgeport, CT	1979	2400	Closed
Chicago, IL	1976	1000	Closed
Columbus, OH	1983	2000	Operating, Reduced Cap.
Dade Co., FL	1982	3000	Operating, Retro. Underway
Duluth, MN	1980/85	400	Operating after Modif.
Haverhill, MA	1984	1300	Operating, Retro. Underway
Hempstead, NY	1978	2000	Closed
Lakeland, FL	1983	300	Operating
Lane County, OR	1978	500	Closed
Madison, WI	1979	400	Closed
Milwaukee, WI	1977	1600	Closed
Monroe Co., NY	1979	2000	Closed
Niagara Falls, NY	1980	2000	Operating after Modif.
Reno, NV	1987 (Phase II)	250 (Phase I)	Phase I operating
		1000 (Phase II)	Phase II constr. expected to begin in 1987
Richmond, VA	1983	250	Operating
Tacoma, WA	1983	250	Operating
Wilmington, DE	1984	1000	Operating

where the fuel ignites and burns partially in suspension prior to falling to a traveling grate where combustion is completed. This technology was originally developed for coal combustion and has been utilized for both dedicated RDF combustion and RDF co-firing with coal in utility boilers.

Approximately 7 facilities in the U.S. utilize dedicated spreader stoker boilers. While these facilities have generally been operational, most have experienced serious RDF handling and production problems including frequent shut downs, destructive explosions, excessive equipment wear and high maintenance costs. An explosion at one plant (Akron, Ohio) resulted in the death of three workers. Most facilities have also required major retrofitting or equipment modification.

The spreader-stoker boiler technology has been successfully utilized for the combustion of many fuels over the years and has been shown to be adaptable to RDF firing. In fact, five or more new facilities are currently in some stage of planning or construction.

4.2.4.2 Fluidized Bed Incineration

Fluidized bed incineration involves the combustion of RDF within a turbulent mixture of suspended hot sand or other materials. There are no successfully operated U.S. facilities using this technology. A facility constructed in Duluth, Minnesota (400 TPD) which was designed to co-fire sewage sludge and refuse has been shut down due to operational problems and is being retrofitted for sludge firing only. Three plants in Japan are being successfully operated at capacities ranging from 40 to 150 TPD.

Based on the lack of successful operations in the U.S. or in the world, the fluidized bed technology is not considered to have a record of satisfactory operation appropriate for this project.

4.2.4.3 RDF Co-firing in Utility Suspension Boiler

Unlike a spreader stoker boiler, the combustion of RDF in a suspension boiler is intended to take place in full suspension together with a co-fired fuel. Typically, pulverized coal or fuel oil would be

fired with the RDF. Firing in full suspension generally requires a higher degree of mechanical processing than most other RDF technologies. Fine shredding and screening to remove non-combustibles in addition to coarse shredding and ferrous removal are required.

Currently, there are five operational facilities in the U.S. producing RDF for firing in utility boilers supplying a range of 90 to 500 TPD of RDF. Baltimore County is presently producing and marketing RDF to Baltimore Gas & Electric for cofiring with coal. Over recent years, at least 10 facilities producing RDF for sale to utilities have failed and are not currently operating because of problems associated with co-firing of the RDF. Many utilities have been dissatisfied with the RDF and regard it as an unreliable fuel source. Problems have included excessive slagging, boiler tube corrosion, and overloading of air pollution control and ash handling equipment.

Due to the poor reliability of this system, RDF is not recommended for this project.

4.2.5 Mass Combustion

The combustion of solid waste with little or no preprocessing is known as mass burning and, when combined with energy recovery, is currently a well developed and widely practiced resource recovery technique. Table 4-3 lists some of the mass burn facilities currently in operation in the U.S.

The general types of mass burn technologies that have commonly been utilized are as follows:

- Refractory Lined Furnaces with Convection Boilers
- Rotary Kiln with Convection Boiler
- Waterwall Boilers
- Rotary Waterwall
- Modular Controlled Air Incinerators

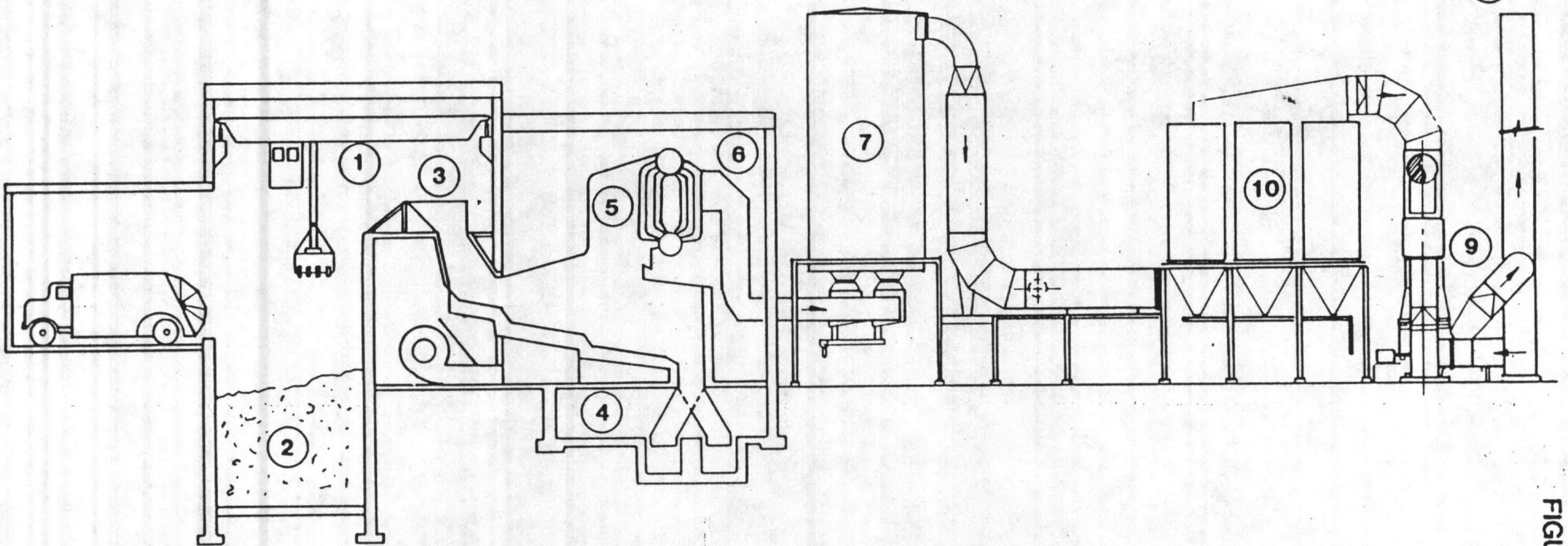
The basic process is described in the following paragraphs and is shown schematically in Figure 4-6. Waste is received in an enclosed area and discharged to a pit that serves as waste storage. Generally, the pit is designed for a one to five day storage volume. Waste is moved from the pit into the boiler charging hoppers via an overhead

Table 4-3

MASS BURN RESOURCE RECOVERY FACILITIES IN THE U.S.

Location	Start-up Date (year)	Capacity (Tons/day)	Status
Hillsborough Co., FL	4/87	1200	Operational
Key West, FL	1/87	150	Operational
Pinellas Co., FL	5/85	3150	Operational
Tampa, FL	9/85	1000	Operational
Chicago, IL	9/70	1600	Operational
Baltimore, MD	5/85	1950	Operational
North Andover, MA	9/85	1500	Operational
Saugus, MA	11/75	1500	Operational
Glen Cove, NY	3/83	250	Operational
Peekskill, NY	10/84	2250	Operational
Tulsa, OK	5/86	1125	Operational
Harrisburg, PA	10/72	720	Operational
Gallatin, TN	12/81	200	Operational
Nashville, TN	2/74	1120	Operational
Hampton, VA	9/80	200	Operational
Norfolk, VA	1967	360	Operational
Portsmouth, VA	6/76	160	Operational
Waukesha, WI	6/79	175	Operational
New Hanover Co., NC	6/84	200	Operational
Marion CO, OR	3/86	550	Operational

1. OVERHEAD CRANE
2. DUMPING PIT
3. CHARGING HOPPER
4. ASH SYSTEM
5. BOILER
6. ECONOMIZER
7. QUENCH REACTOR / SPRAY DRYER
8. STACK
9. I.D. FAN
10. BAGHOUSE / ESP



ELEVATION

FIGURE 4-6

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SOLID WASTE FEASIBILITY STUDY
MASS BURN SYSTEM SCHEMATIC

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crane. Hydraulic rams are generally utilized to move waste from the charging hoppers into the boiler.

Once in the boiler, there are a variety of systems which are utilized for fuel bed transfer. Most of these systems consist of cast grates which serve to mix the burning waste as it passes through the unit. As the waste nears burn-out, the fuel bed leaves the grates and is transferred via gravity or rams to the ash handling system.

Combustion air into the system is supplied as both overfire and underfire relative to the fuel bed. The amount of excess air varies from system to system and at a given facility as fuel quality varies. Combustion gases exit the boiler via the economizer and pass into the air pollution control train.

Various air pollution control systems are available. The schematic shows a lime injection spray dryer for acid gas control followed by either a baghouse or a high efficiency electrostatic precipitation for particulate removal.

Fly ash is removed in the air pollution control system and is combined with bottom ash from the boiler prior to disposal.

There are numerous waterwall furnace-boiler mass burn system operating in the U.S. and abroad. There are approximately 11 facilities operating in the U.S. with capacities ranging from 150 TPD to 3150 TPD. There are approximately 36 plants under advanced planning and 14 plants are under construction.

The mass burn process has exhibited a high degree of reliability at a variety of plant scales. Units in Europe have operated at 75 to 85 percent availability over 20 to 30 year periods. Overall facility availabilities, where some redundancy is present, is often in the range of 85-95 percent.

Saturated or superheated steam can be produced depending upon the energy market requirements. Some corrosion, particularly in superheaters, has been noted in superheated applications. This has left most boiler manufacturers hesitant to exceed 900°F, 900 psig steam conditions.

The mass burn waterwall furnace-boiler system has an average waste volume reduction value of 90-95 percent and a reduction by weight of 75-80 percent.

Considering boiler efficiencies only, a modern waterwall boiler is between 65 and 70 efficient in recovering the fuel heat input into steam.

The mass burn technology of waterwall furnace boiler systems is considered to have a record of satisfactory operation appropriate for this project.

Descriptions of these processes are presented below.

4.2.5.1 Refractory Lined Furnaces with Convective Boilers

This system consists of a stoker-fired, fixed wall refractory furnace, where unprocessed refuse is incinerated on a grate system, with a follow-on convection-type waste heat boiler which is added to extract heat from the products of combustion.

This energy recovery technology has been in existence in Europe and the United States for some time, with wide application and proven reliability. However, this technology has the following shortcomings:

- o Convection is not the most efficient manner for heat transfer. Because the system uses only the convection portion of heat transfer and does not utilize radiant heat, the surface area of the boiler is increased to achieve desired steam generation rates and efficiencies.
- o High maintenance costs and efficiency losses are incurred due to the lack of control over furnace temperatures. The lack of control causes excessive slagging of the boiler tubes which inhibits efficient heat transfer and increases maintenance costs as well as downtime.
- o Higher capital and operational costs due to excessive air pollution equipment needed to treat the high levels of excess combustion air. The excess air is used to control furnace temperatures as a primary control method.
- o High maintenance costs due to replacement of refractory.

Although this technology has some disadvantages, there are also some advantages to the technology which include:

- o Inherent design flexibility which accommodates a wide spectrum of individual unit sizes.
- o Ability to prefabricate and shop assemble major equipment components, thereby reducing field labor expense.
- o Ability to accept a wide variety of fuel qualities.

These advantages are also followed by some positive operating aspects that should be mentioned. In comparison with a waterwall system, the refractory-lined convection system is more resilient to wear. They are less affected by explosions in the combustion area. The damage to refractory walls are more easily repaired than the damages to a water tube section. The refractory tend to stabilize the combustion process with varying fuel quality as a direct result of heat stored in the refractory material walls.

4.2.5.2 Rotary Kiln with Convection Boiler

The rotary kiln can also be used as the primary combustion chamber. The refuse is fed into the rotary kiln where the combustion of the refuse occurs. The discharge end of the kiln has an ash removal system. The hot gasses pass into a convection boiler to generate steam. This type of application is generally a modular construction design and hence small scale (500 TPD or less).

Another approach is a refractory-lined furnace followed by a rotary kiln. This system is similar to the fixed wall system in that a downstream waste heat boiler is utilized to recover energy from the combustion process. However, with a rotary kiln system, residue from the last combustion grate passes into a refractory-lined cylindrical kiln. Here, the rotation of the kiln agitates the residue and allows for the combustion of any remaining unburned refuse. This process reportedly provides for an exceptionally high degree of residue burn-out and reduction. This system is known as the Volund technology.

Rotary kiln technology has been utilized at over 47 facilities throughout the world and has shown the ability to provide on-line operating availabilities in excess of 80 percent.

4.2.5.3 Waterwall Furnace-Boiler

Field-erected, waterwall boiler system technology was developed in Europe by applying power plant design criteria to refuse incineration. A waterwall boiler system recovers radiant heat from the combustion process through the use of waterwall lined furnaces and tube banks. Most of these technologies were developed in Europe. Several successfully demonstrated proprietary designs are currently being marketed in the United States as follows:

- o Joseph Martin (Munich, West Germany)
- o Vareinigte Kesselwerke, Division of Deutche Babcock (Dusseldorf, West Germany), known as VKW
- o Von Roll (Zurich, Switzerland)
- o Seghers (Belgium)
- o Widmer & Ernst (Switzerland)

The proprietary nature of these designs rests primarily in the grate system design although boiler designs vary from system to system.

While the above mentioned European proprietary designs are being marketed in the United States, there are several generic (non-proprietary) domestic wastewall furnace/boiler designs existing in the United States. This technology has been successfully demonstrated throughout the U.S. Some of the reported advantages of this technology include:

- o Relatively high unit on-line reliability (approximately 75 percent).
- o High overall thermal efficiency (67 to 75 percent).
- o Available in proprietary and non-proprietary systems designs.
- o 90 percent waste volume reduction with only 10 percent waste volume to be landfilled.
- o Adaptable to sewage sludge disposal.

The technology has some inherent disadvantages which include:

- Slagging and sintering of ash and clinker may occur on boiler wall surfaces.

- Tube wear may occur in the luminous flame zone.

- Field-erected systems have inherently higher capital costs.

- Procurement of proprietary systems may include payments of royalties (license fees) to a European system vendor.

A general arrangement of a typical waterwall boiler system is presented in Figure 4-7. There are approximately 11 operating facilities in the U.S. with operating capacities ranging from 150 tons per day to 2250 tons per day. These facilities have demonstrated an ability to meet performance guarantees, applicable air emission standards, and provide high on-line operating availabilities. Based on this experience, this technology is considered to have a record of satisfactory operation at a scale appropriate for this project and will be evaluated as part of a more detailed investigation.

4.2.5.4 Rotary Waterwall

The rotary waterwall system was formerly known as the O'Connor system and is currently marketed by Westinghouse. They are the only manufacturer of this system (see Figure 4-8).

The system consists of a perforated, water-cooled, rotary, combustion drum. Waste is fed to the rotary drum via a crane-fed charging hopper and ram. The rotating drum is inclined and causes the fuel bed to tumble through the unit as it burns. Ash falls out of the drum into the ash handling system. Excess combustion air of approximately 45 to 50 percent is added. A convective boiler follows the rotary drum.

The rotary water-cooled combustor has impressive claimed operating statistics. Westinghouse claims the waste-to-energy system has thermal efficiencies of up to 80 percent. The burnout of combustible waste is claimed to be 90-95 percent. These claimed values are generalized by the manufacturer and actual data presented by Westinghouse indicates actual average thermal efficiency at the Gallatin, Tennessee facility of 70 percent.

While there are several facilities utilizing this technology with long operating records in Japan, there is only one facility in the U.S. with a significant history. This facility, in Gallatin, Tennessee, has been operational since 1982. Several more facilities in the U.S. are in planning, construction, or start-up.

The single largest unit with a significant operational record is sized at 165 TPD and is in Japan. The Bay County, Florida project will employ units sized at 255 TPD each. The largest unit currently offered by the system vendor has a capacity of approximately 500 TPD.

4.2.5.5 Modular Controlled Air Incinerators

4.2.5.5.1 Modular Starved Air

Modular starved-air incineration systems are relatively recent technologies. These system are produced in shop-assembled modules which are connected in the field. The system consists of a two-stage combustion process. Waste entering the facility is discharged on to a tipping floor. Wheeled front-end loaders feed raw wastes to charging hoppers. The charging hoppers are equipped with guillotine fire doors which sequential open and close with the charging hopper ram stroke to maintain a gas seal. Waste is conveyed through the refractory-lined primary chamber by a series of hydraulic rams. Ash leaving the unit falls into an ash quench tank. Drag chain conveyors remove the ash from the quench and discharge it to containers.

In starved-air systems, waste is fed into the first stage, or primary chamber, and burned in an oxygen deficient atmosphere. The resultant volatiles and products of combustion pass to a second stage, or secondary chamber, where additional air is injected to complete the combustion process. Supplementary fossil fuel fired burners are utilized to stabilize and complete combustion. As the hot gases exit the secondary chamber, they pass through a waste heat boiler where gas temperatures are reduced, heat recovered, and steam is generated. A schematic cross-section of this technology is shown in Figure 4-9.

It is important to understand that the second stage supplemental burners are an integral part of the air pollution control concept of

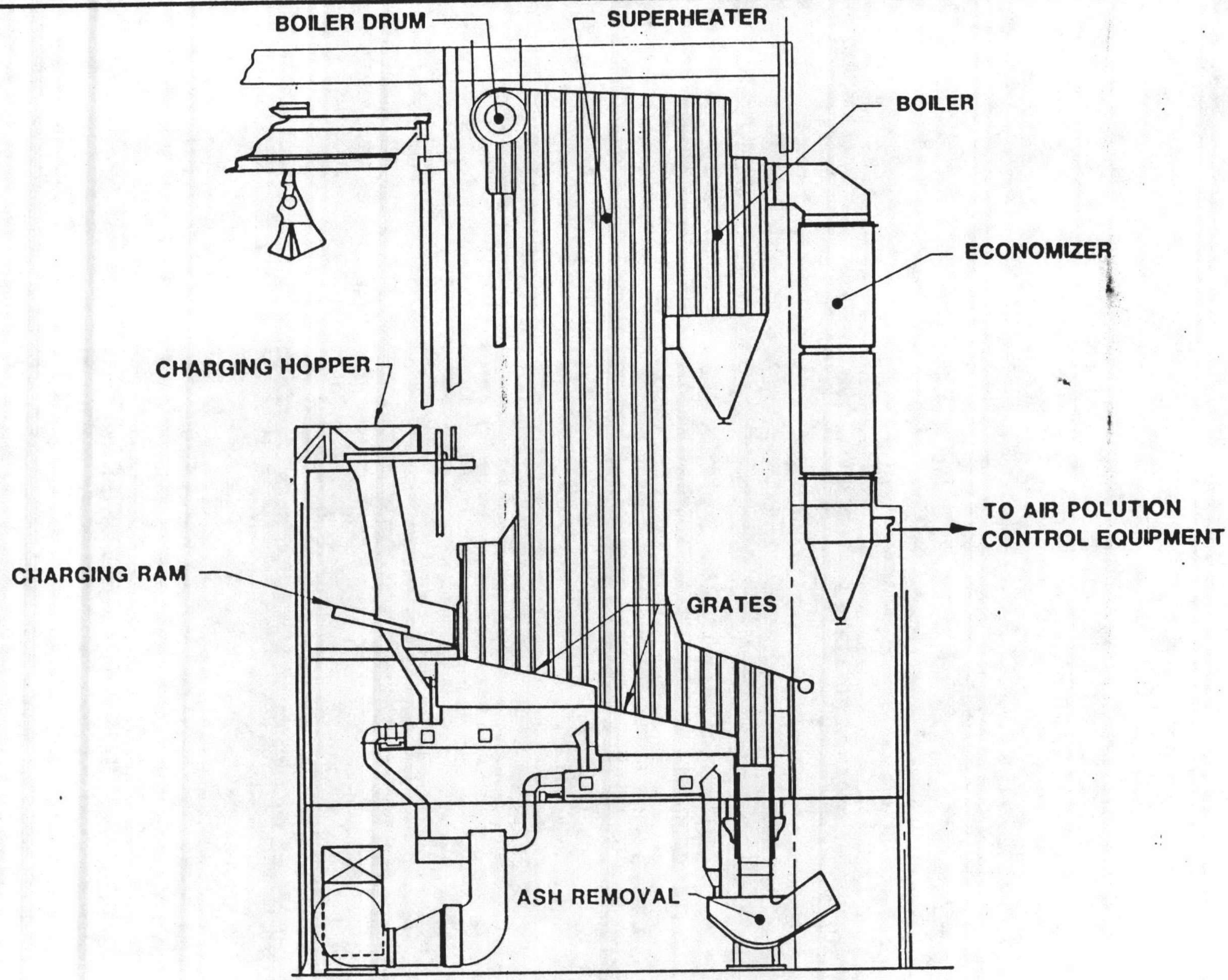

FIGURE 4-7

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SOLID WASTE FEASIBILITY STUDY
MASS-BURN WATERWALL BOILER

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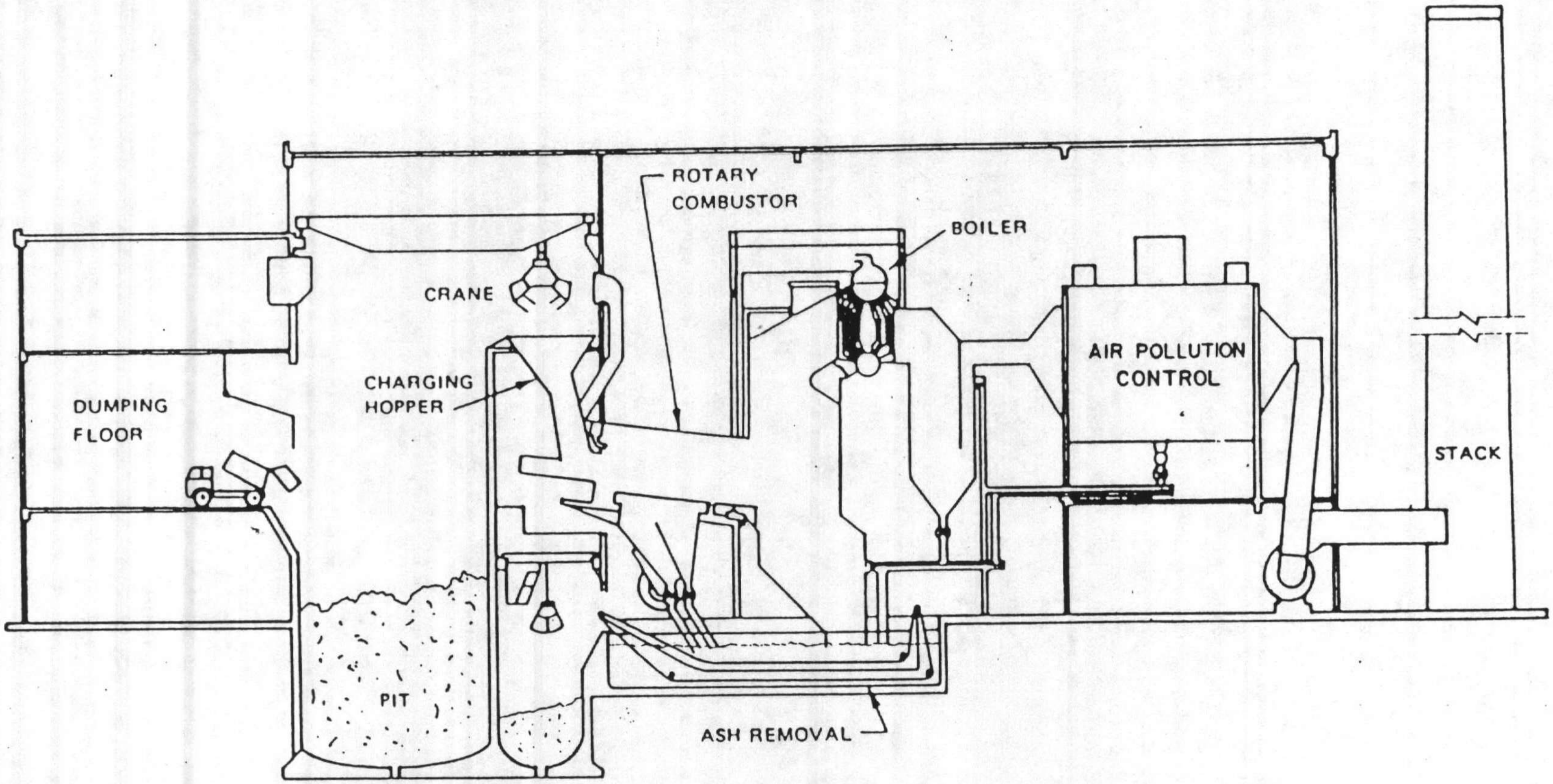

FIGURE 4-8

MALCOLM PIRNIE

NEUSE RIVER COUNCIL OF GOVERNMENTS
SOLID WASTE FEASIBILITY STUDY
ROTARY WATERWALL COMBUSTION

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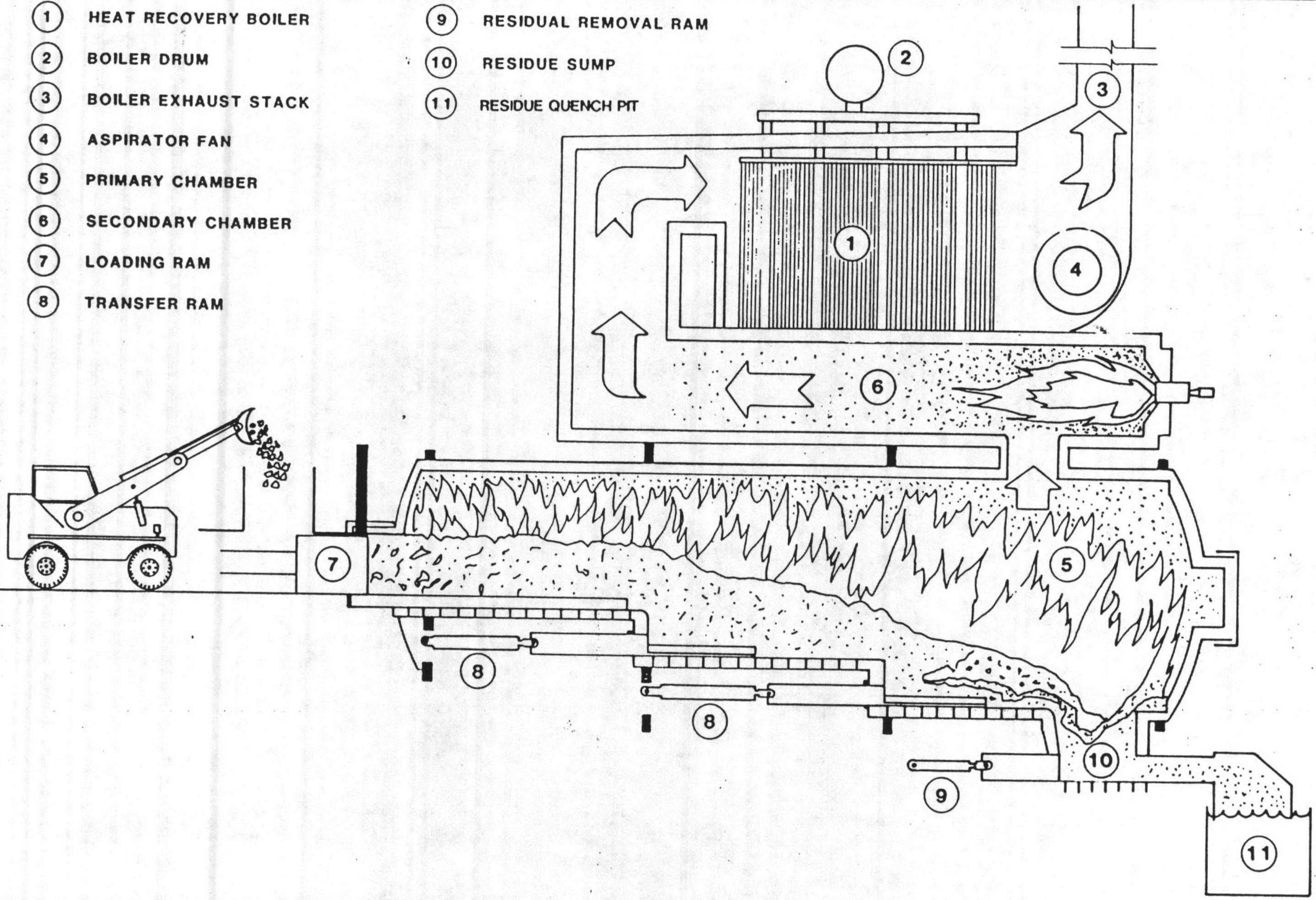

FIGURE 4-9

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NEUSE RIVER COUNCIL OF GOVERNMENTS
SOLID WASTE FEASIBILITY STUDY
MODULAR STARVED AIR INCINERATION WITH HEAT RECOVERY BOILER

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these units. They are used intermittently (thermostatically controlled by flue gas temperature) to insure complete combustion of the effluent gas.

The thermal efficiency of this process is 55 to 65 percent. Due to the intentional incomplete combustion of the refuse, the residue produced by a starved air modular system has a relatively high putrescible content and is not as biologically stable as that produced by the excess air or stoker-fired systems. Combustion residue represents 30-40 percent by weight of the incoming waste stream.

4.2.5.5.2 Modular Excess Air

Excess air modular systems are similar to and have most of the attributes of starved-air equipment. However, first stage combustion takes place in a full oxidation mode as with other mass burn systems. This results in higher levels of "burn-out" relative to starved air systems, stable residue and emissions requiring full scale air pollution equipment.

Modular systems have several advantages including:

- o low capital costs
- o shorter construction times
- o simple operations

These systems have provided relatively good service in small-scale applications with low flow, saturated steam markets on interruptible service.

Modular systems are not without their problems however. In a recent survey, we contacted 19 modular system owners to determine the status of these projects. Nearly 80 percent of these facilities were either experiencing major operational problems or had undergone a major plant overhaul to correct serious operational deficiencies. The problems included boiler failures, refractory failures, hydraulic problems and ash handling problems. Of the 37 facilities currently in the U.S., a total of six have been completely shut down.

Disadvantages of modular systems include:

- o low thermal efficiencies;
- o high ash putrescible content and production;
- o low availabilities;
- o high maintenance costs;
- o limited to saturated steam production making electrical production infeasible;
- o limited unit size (approximately 200 TPD).

4.2.6 Technology Overview-Recommendations

Due to the proven design, versatility, and reliability, Mass Burn Boilers, with the options of waterwall, rotary waterwall, refractory and modular, are recommended as the technology suitable for resource recovery facilities in this area.

A specific choice of waterwall, rotary waterwall, refractory or modular will depend on specific project requirements. Waterwall or rotary waterwall boilers are suitable for electric and/or steam-producing facilities. Modular boilers are only suitable for steam producing facilities, and where space and/or stack height restrictions exist.

4.3 ENVIRONMENTAL ASPECTS OF ENERGY RECOVERY

4.3.1 Overview

Waste combustion for the purpose of volume reduction has a considerable history dating back fifty years or more. For many years, there was little concern for the potential environmental impacts from this process. As long ago as 1950 in Europe, the waste combustion process was used not solely for volume reduction of waste but also for the recovery of useful energy. This transition from volume reduction to energy recovery was important because, as energy recovery grew more important over the years, the quality and degree of control of combustion increased. This has had a very positive impact on both air emissions and ash residue disposal.

Over this same period, public awareness and concern grew for aesthetic or community impacts such as noise, odor and visual access. Again, the facilities evolved to respond to these changes. The following sections will deal with areas of environmental concern related to energy recovery from waste combustion. The areas addressed apply to mass-burn as well as RDF combustion systems. Key differences between technologies will be highlighted, where appropriate.

4.3.2 Aesthetic Concerns

Noise

Waste-to-energy facilities have the potential for generation of noise from several sources. These include associated vehicular traffic (collection vehicles primarily), processing equipment, fans, cooling towers, boilers and other equipment. The noise generated by a given facility will be dependent upon the geometric and architectural design as well as the particular equipment selected. In general, facility associated vehicular traffic (i.e., collection vehicle, etc.) can generate significant noise on an intermittent basis. This can be mitigated by proper siting which provides vegetative or topographic buffering. In addition, collection vehicle traffic generally only occurs during daylight hours when ambient noise levels tend to be higher.

Processing equipment tends to emit high noise levels but is enclosed within a building. Noise measurements taken outside several RDF facilities indicate little or no discernible difference over background ambient noise levels at properly designed facilities.

Other facility equipment such as cooling towers, which are located outside, must be physically located on the site in a manner which minimizes impacts on adjacent properties. On-site buffering with vegetation and/or topographic features such as berms can be highly successful in mitigation.

In summary, while there are several sources of noise from energy recovery facilities, readily available mitigation techniques can be applied to minimize noise impacts on surrounding properties.

Odor

Any solid waste management facility has the potential to generate odor from the decomposition of the refuse. Key concerns in this area revolve around how waste is received, stored and processed.

In energy recovery facilities, incoming refuse is received in a tipping area which is totally enclosed except for the vehicle entrance doors. Collection vehicles discharge their loads to either a tipping floor or pit. RDF system generally utilize a floor while mass-burn systems use pits. Waste is usually received on a five or six day per week, eight to ten hours a day, schedule. The entire receiving area is often placed under a slight negative pressure so that the net air flow is into the building, not out, thus minimizing the potential for escape of any odors.

The waste combustion process operates on a seven day per week, twenty-four hour per day basis. Because of the waste receiving schedule mentioned above, this obviously means that some short-term storage of refuse is required within the facility. Most modern combustion facilities draw air for combustion from the area of waste storage (floor or pit). Any odors which are generated are drawn into the furnace where they are destroyed by contact with temperatures in excess of 1800°F.

Visual Access

Visual access, in simple terms, is a measure of how much of a given facility can be seen from various viewing locations. Energy recovery facilities, in their basic state, tend to have an "industrial" look. As the public has grown to be more concerned over the visual quality of their environment, energy recovery facilities have paid increasing amounts of attention to the architectural treatment of structures. Modern waste-to-energy facilities are attractive in almost any setting. It is quite common in Europe and Japan, for instance, to have waste-to-energy facilities in downtown residential districts.

Even with attractive architecture, public sentiment generally dictates that these facilities not be in full view. Visual access concerns can be mitigated through the same techniques as were mentioned for noise - vegetative and topographic buffering. The exception to this

is the stack which is generally 200 to 300 feet in height. It is an unavoidable consequence that the stack will be viewable due to its height. This can be mitigated through architectural treatment.

4.3.3 Air Emissions

Priority Pollutants

Much data have been collected from various operating waste-to-energy facilities regarding air emissions. Controlled emissions are a function of both the air pollution control equipment utilized and, to a lesser extent, design of the combustion systems. For the purpose of this section, modern combustion system design with acid-gas scrubbing and high-efficiency particulate control will be assumed. The specific air pollution control train would consist of a lime injection, spray drier followed by a baghouse or high efficiency electrostatic precipitator (ESP).

For a facility(ies) of the size contemplated here this air pollution control train would probably be required under PSD review and is currently being defined as "Best Available Control Technology" (BACT) in a number of states throughout the country. The acid gas scrubber neutralizes SO_x, HCl and HF gases through the injection of an alkali slurry into the flue gas stream. In a "dry" scrubber, the injected slurry drys to a powder due to the heat in the flue gas. This powder, which consists primarily of calcium salts such as $CaSO_4$ and $CaCl_2$ if lime is used, is subsequently removed by the particulate control device.

In the past, most waste combustion systems utilized electrostatic precipitators (ESP) for particulate control. An ESP removes particulates from the gas stream via an electrical charge. Recently, more attention has been focused on fabric filters or baghouses. They remove particulate matter from the gas stream via physical filtration. The gas stream passes through a series of high temperature resistant fabric tubes or bags. Particles are trapped by the fabric. Baghouses generally have higher efficiencies in the removal of smaller particulate matter than ESPs.

Table 4-4 gives the projected emissions for a 750 TPD mass burn facility. Mass burn rather than RDF technology was chosen to base

estimates upon only because more emission data is available for such facilities. The data presented in Table 4-4 are preliminary estimates only and are not the result of a detailed analysis. Considerable work, which is well beyond the scope of this study, is necessary to produce more definite estimates.

Trace Pollutants

Waste combustion systems have been known to emit trace quantities of heavy metals and organics that are of environmental and public health concerns. The heavy metals emitted are present in the raw waste stream in every day consumer items such as paper, plastics packaging, cans, etc. Trace organics have been found to form as both a byproduct of combustion and have some presence in the raw waste stream.

Heavy Metals

Various heavy metals are emitted from waste combustion processes. Among those of concern are arsenic, beryllium, cadmium, chromium, lead, mercury, nickel and zinc. As previously stated, these metals are present in various forms in the raw waste. Many metals volatilize in the combustion zone and recondense on suspended particulate matter in the boiler sections as the gas temperature falls. Thus, the overwhelming majority of metal emissions are associated with the suspended particulates and may be controlled through the use of typical particulate control devices. High efficiency devices that are effective on small particulates are necessary because the condensation tends to favor smaller (10 micron and less) particles.

The New York State Department of Environmental Conservation (NYDEC) performed source stack testing at the Westchester RESCO (Peekskill, NY) 2250 TPD facility. Part of this testing consisted of metals measurements and subsequent air dispersion modeling to predict maximum ground level impacts. Table 4-5 presents these data. A comparison of the modeled maximum ambient concentration to the acceptable (i.e., no adverse effects) ambient levels indicates that facility impacts were a small fraction of acceptable levels for most metals tested. These

Table 4-4

ESTIMATED FACILITY EMISSIONS - 750 TPD

Pollutant		Uncontrolled*** Emissions lb/day	Control Efficiency, %**	Estimated Facility Emissions lb/day
TSP	Range:	9,750-38,250	99.4-99.6	39-230
	Average:	28,500	99.5	143
SO_2	Range:	150-1,800	59.6-99.7	0.5-727
	Average:	1,275	75.7	310
NO_x	Range:	1,650-1,875	0	1,650-1,875
	Average:	1,763	0	1,763
CO	Range:	450-3,825	0	450-3,825
	Average:	1,800	0	1,800
HC	Range:	23-180	0	23-180
	Average:	90	0	90
HCl	Range:	1,950-9,675	91.2-97.6	47-851
	Average:	5,925	93.8	367
Pb	Range:	15-203	99.3-99.9	0.02-1.4
	Average:	135	99.7	0.4
Hg	Range:	0.13-9	30-94.6	0.007-6.3
	Average:	2.7	73.1	0.7
Be	Range:	3.6×10^{-4}-0.23	99.3	2.5×10^{-6}-1.6×10^{-3}
	Average:	0.09	99.3	6.3×10^{-4}
Total TCDD				*7.7×10^{-6}
Total TCDF				*1.2×10^{-6}

TCDD - Tetrachlorodibenzodioxin
TCDF - Tetrachlorodibenzofuran

* - Based upon the controlled emission factor for the 550 TPD Marion County, Oregon mass burn facility which uses a spray dryer followed by a baghouse for air pollution control.

** - These data are based upon US EPA data for mass burn facilities which utilize a spray dryer followed either by an ESP or baghouse to control pollutant emissions.

*** - These data are based upon US EPA data for mass burn facilities.

Table 4-5

WESTCHESTER RESCO**
EMISSION SOURCE TESTING RESULTS
INORGANICS

Contaminant	g/m^3 Acceptable Ambient Level	g/m^3 Modeled Maximum Ambient Concentrations	Percentage of Ambient Guidline
Hydrogen Chloride	23.3×10^{-6}	0.89×10^{-6}	3.8
Arsenic	667×10^{-9}	$<27.8 \times 10^{-12}$	0.0042
Beryllium	10×10^{-9}	0.15×10^{-12}	0.0015
Mercury	167×10^{-9}	22.5×10^{-9}	13.5
Cadmium	2000×10^{-9}	0.28×10^{-9}	0.014
Chromium	167×10^{-9}	$<1.69 \times 10^{-9}$	1.0
Lead	1500×10^{-9}	1.74×10^{-9}	0.12
Manganese	--*	0.26×10^{-9}	--
Nickel	3333×10^{-9}	0.89×10^{-9}	0.027
Vanadium	--*	87.9×10^{-12}	--
Zinc	30×10^{-9}	10.9×10^{-9}	36.3
Sulfur Dioxide	80×10^{-6}	4.36×10^{-6}	5.5
Nitrogen Oxides	100×10^{-6}	5.46×10^{-6}	5.5

Source: New York State Department of Environmental Conservation

*New York State has not identified acceptable ambient levels for these substances.

**Air pollution control consists of an ESP, but does not include any acid gas controls.

results suggest that the real impact of metals emissions from waste combustion facilities is very minor.

Trace Organics

Trace organic emissions from waste combustion systems are very much a function of combustion control. Modern designs which maximize the efficiency of energy recovery tend to have high combustion efficiencies with stable temperature regimes through the boiler. With good combustion control, emissions of trace organics tend to be very low.

The trace organics of most concern are the dioxin and furan compounds. These two families of compounds exhibit both toxic and carcinogenic properties. The most toxic dioxin isomer is 2,3,7,8 TCDD which gained much notoriety as a suspected constituent of Agent Orange.

While these compounds are dangerous at relatively low levels, they are emitted at extremely minute rates. For instance, stack testing performed by NYDEC at the 2250 TPD Westchester County RESCO facility found the following emission rates:

Contaminant	Average Emission Rate, nanogram/sec
Total TCDD	92.6
Total TCDF	976.2

TCDD - Tetrachlorodibenzodioxin
TCDF - Tetrachlorodibenzofuran

A nanogram is 10^{-9} grams. These emission rates are extremely small numbers which are difficult to put into context. Available data suggest that trace organic emissions from waste combustion are never a concern with respect to acute toxicity. The concentrations are just too low. In addition, numerous credible health risk assessments have concluded that the cancer risk from trace organics is very small under even conservative assumptions. These include those done for North Hempstead, New York; Montgomery County, Maryland; York County, Pennsylvania and Fairfax County, Virginia.

For instance, in the NYDEC stack testing at the Westchester RESCO facility, air modeling was performed to predict the maximum ground level concentration of trace organics. This modeling is EPA approved and is

conservative in its assessment of maximum concentrations. For this facility, the modeling showed that the ground level concentrations at the point of maximum impact were 36.76 x 10^{-15} gm/m^3 for total TCDD and 386 x 10^{-15} gm/m^3 for total TCDF. A total of twenty-one different compounds were considered. Using available data and accepted health risk assessment procedures, the following were the estimated excess lifetime cancer risks:

New York State Method	EPA Method
1.7	0.7

stated in cases per million exposed. That means that, under very conservative assumptions, if one million people spent their entire 70 year lifespan within the area of maximum impact between 0.7 and 1.7 excess cases of cancer might develop which were attributable to the facility. Because the maximum impact area is much smaller than necessary for a million people to inhabit and because people do not stay in one limited location twenty-four hours a day, the actual risk is much lower. Health risk assessments for the 1800 tpd mass burn project in Montgomery County, Maryland and 3000 tpd mass burn project in Fairfax County, Virginia estimated excess cancer cases to be 2.9 and 2.7 per million, respectively. For reference, other common cancer risks are shown in Table 4-6.

In 1985, the Swedish government declared a moratorium on the construction of new waste burning facilities in order that an evaluation of dioxin emissions and subsequent risk could be conducted. Sweden currently burns 50 percent of their waste. What followed was an intensive effort to define emissions, effectiveness of controls and risks to public health. In 1986, the moratorium on new construction was lifted. Existing plants are required to retrofit emission controls or meet prescribed guidelines. New facilities will be required to meet emission guidelines. In short, the Swedes concluded that, with appropriate emission controls, environmental and health risks from waste combustion are manageable. The U.S. is also making this realization and so far eight states (Illinois, Kentucky, Michigan, Nevada, Oklahoma, Rhode

Table 3-1

Neuse River Solid Waste Feasibility Study
MSW* Collection and Transportation

(Continued)

MSW Source	MSW Primarily Collected By:	Convenience Stations	Transfer Stations
Camp Lejeune	Private Collectors	None	None
Cherry Point MCAS	Private Collectors	None	None

TABLE 4-6

COMMON CANCER RISKS

Risk	Excess Cases per Million
Naturally Occuring Radiation	20
Drinking One Beer a Day	10
Sharing a Room with a Smoker	10
Drinking 40 Diet Sodas	1
Smoking Two Cigarettes	8
Smoking	60,000

Source: Risk/Benefit Analysis, E. Crouch and R. Wilson, 1982.

Island, Virginia, and Wisconsin) have specific regulations for limiting dioxin emissions from incineration.

4.3.4 Combustion Residue

Residue or ash is produced by the combustion process. It consists largely of inorganic compounds with trace amounts of organics. Figure 4-10 gives a graphic representation of ash composition.

There are two categories of ash - bottom and fly. Bottom ash is what is left on the combustion grate within the boiler. For mass burn systems, bottom ash is produced at a rate of 20 to 25 percent by weight of incoming waste. RDF combustion systems typically generate bottom ash at a rate of 10 to 15 percent by weight of input fuel.

Fly ash is particulate matter which is entrained in the combustion gases and carried out of the boiler. Due to stringent air emission regulations, in excess of 99 percent of this fly ash is removed from the gas stream by the air pollution control devices prior to discharge. While bottom ash tends to be granular, with particle sizes in the range of 0.1 to 100 mm, fly ash is powdery in texture with particle sizes ranging from 0.001 to 1.0 mm.

Most existing waste-to-energy facilities landfill all of their ash. Usually, bottom and fly ash streams are combined prior to disposal. As Figure 4-10 indicates there is some heavy metal content in ash. This has lead to some concern over its disposal.

The testing of ash in the past has been conducted using the EPA procedure known as the EP Toxicity Test. In this test, an organic acid (acetic) is added to the sample to lower the pH to approximately 5. After twenty-four hours, the liquid is analyzed for certain chemical constituents. If the levels of these constituents exceed prescribed limits than the waste is deemed hazardous. Past testing of waste-to-energy combined ash has yielded mixed results. Some ash has passed while others have failed. The usual constituents that sometimes exceed the limits are chromium and lead. Cadmium also occasionally exceeds the limits. The metals which are contained in the ash were present in the raw waste. They are not created by the combustion process. The combustion process, by destroying the vast majority of organics in the waste

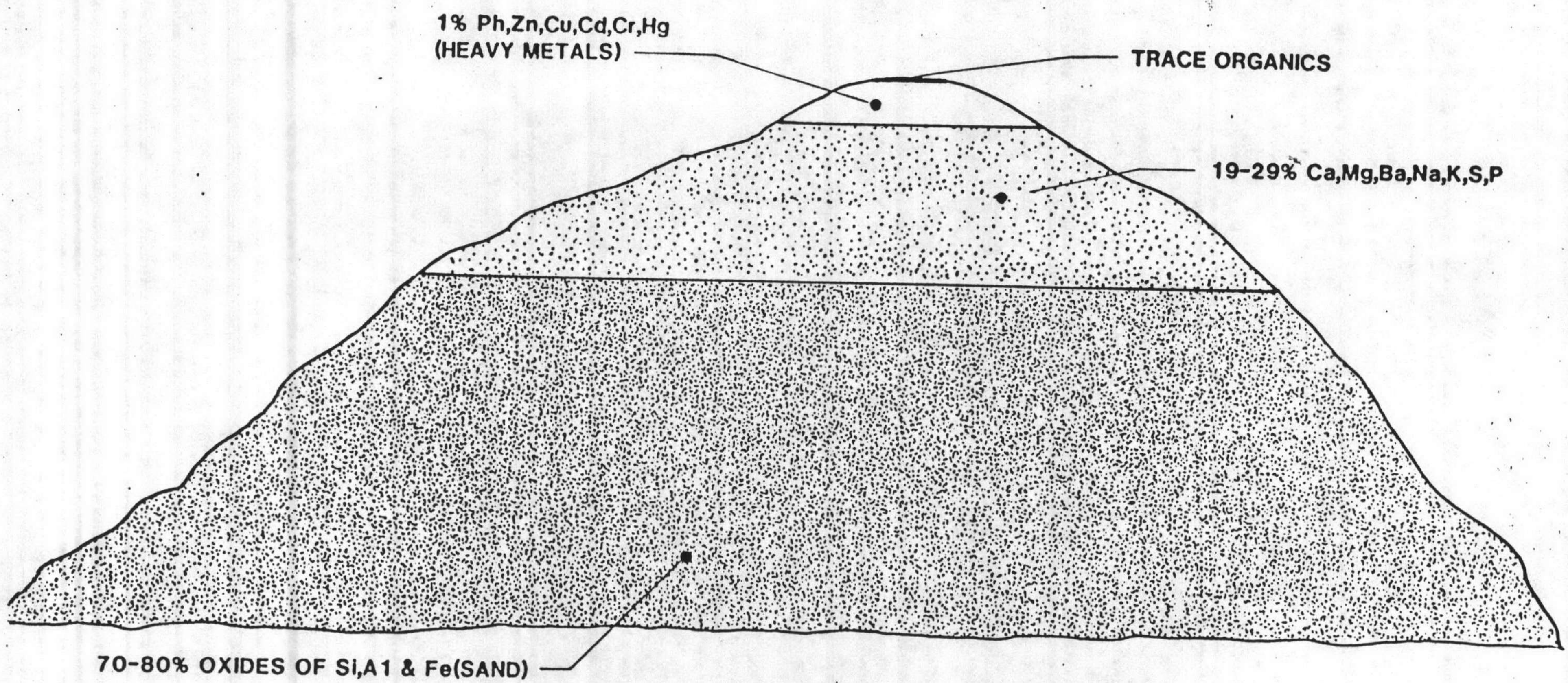

FIGURE 4-10

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SOLID WASTE FEASIBILITY STUDY

TYPICAL RESOURCE RECOVERY ASH COMPOSITION

MALCOLM PIRNIE, INC

AUGUST 1987

thereby reducing the overall mass, tends to concentrate these constituents.

There has been much technical debate surrounding the appropriateness of the EP toxicity test for testing of ash from municipal waste. The raw waste is categorically exempt from the testing by law. Some parties, including New York State, have claimed that this exclusion extends to ash from municipal waste. Further, the test is intended to simulate disposal conditions by using a low pH solution of an organic acid. In a municipal landfill, raw waste decomposes under anaerobic conditions causing the formation of significant amounts of organic acids as a byproduct of the microbial activity. Ash has very low levels of putrescible matter and hence has extremely limited potential for acid formation. In addition, ash is very alkaline with significant buffering capacity. Metals are most soluble at low pH. If the ash is highly alkaline and will not form acids then it stands to reason that the metals present will have very limited mobility. Put simply, the EP Toxicity test is not representative of actual disposal conditions.

Pirnie has performed significant research in this area on ash from the Westchester RESCO facility. In this work, combined ash from this 2250 TPD mass burn facility was subjected to a long-term (twenty-five years) disposal simulation with the objective of defining actual leachate characteristics. In this test, the ash was exposed to pH 4.2 simulated acid rain for a period that was equivalent to 25 years. This period was composed of a 15 year active fill and a 10 year closed fill.

Table 4-7 presents the results of this testing. As can be seen, the pilot test leachate does not exceed any of the EP Toxicity limit values. In fact, it meets many of the EPA Drinking Water Criteria. These data support the contention that the EP Toxicity test procedure is not appropriate for ash and that it can be disposed of in a properly designed landfill. EPA is in the process of reviewing the regulatory status of ash and will be reporting to Congress in the next several months.

TABLE 4-7

PILOT TEST ASH LEACHATE RESULTS

Parameter	Pilot Test Range	EP Toxicity Criteria	EPA Drinking Water Criteria
pH	10.2 - 10.6	<2 or >12.5	6.5 - 8.5
Aluminum	0.4 - 1.5	--	--
Arsenic	<0.005	5.0	0.05
Barium	<0.2	100.0	1.0
Cadmium	0.01 - 0.05	1.0	0.01
Chromium, Total	<0.01 - 0.12	5.0	0.05
Lead	<0.05 - 0.13	5.0	0.05
Mercury	<0.0005	0.2	0.002
Selenium	<0.0005 - 0.009	1.0	0.01
Silver	<0.02	5.0	0.05
Zinc	0.006 - 0.031	--	5.0

Source: "The Laboratory Evaluation of Expected Leachate Quality from a Resource Recovery Ashfill", Cundari and Lauria, 1986.

5.0 ENERGY MARKETS ANALYSIS

5.1 STEAM MARKETS

The sale of steam from refuse-to-energy projects is quite common. Potential steam markets include industry, government facilities and institutions. Table 5-1 lists the steam markets identified within the area encompassed by this study. Figure 5-1 shows the location of these steam markets.

The characteristics of the user affect the viability of the market, including daily and seasonal fluctuations as well as temperature and pressure conditions affect the viability of the market.

The identified steam markets are described as follows:

A. National Spinning Co.

National Spinning Co. utilizes steam for space heating and process use, and presently generates its own steam to meet all steam requirements. The National Spinning steam plant presently has three boilers ranging in age from 17 years old to 21 years old. All of these boilers are nearing the end of their economic lives. The cost of maintaining and repairing these boilers is almost certain to outweigh the long term cost of replacing the boilers. National Spinning Co. is considering the replacement of these boilers.

These boilers use either natural gas or No. 6 Fuel Oil, dependent on the availability of natural gas. The boilers presently supply steam to the plant at an average flow rate of 42,000 lb/hr, at 110 psig and 340^{o} F. The plant experiences an occasional peak load of as much as 60,000 lb/hr.

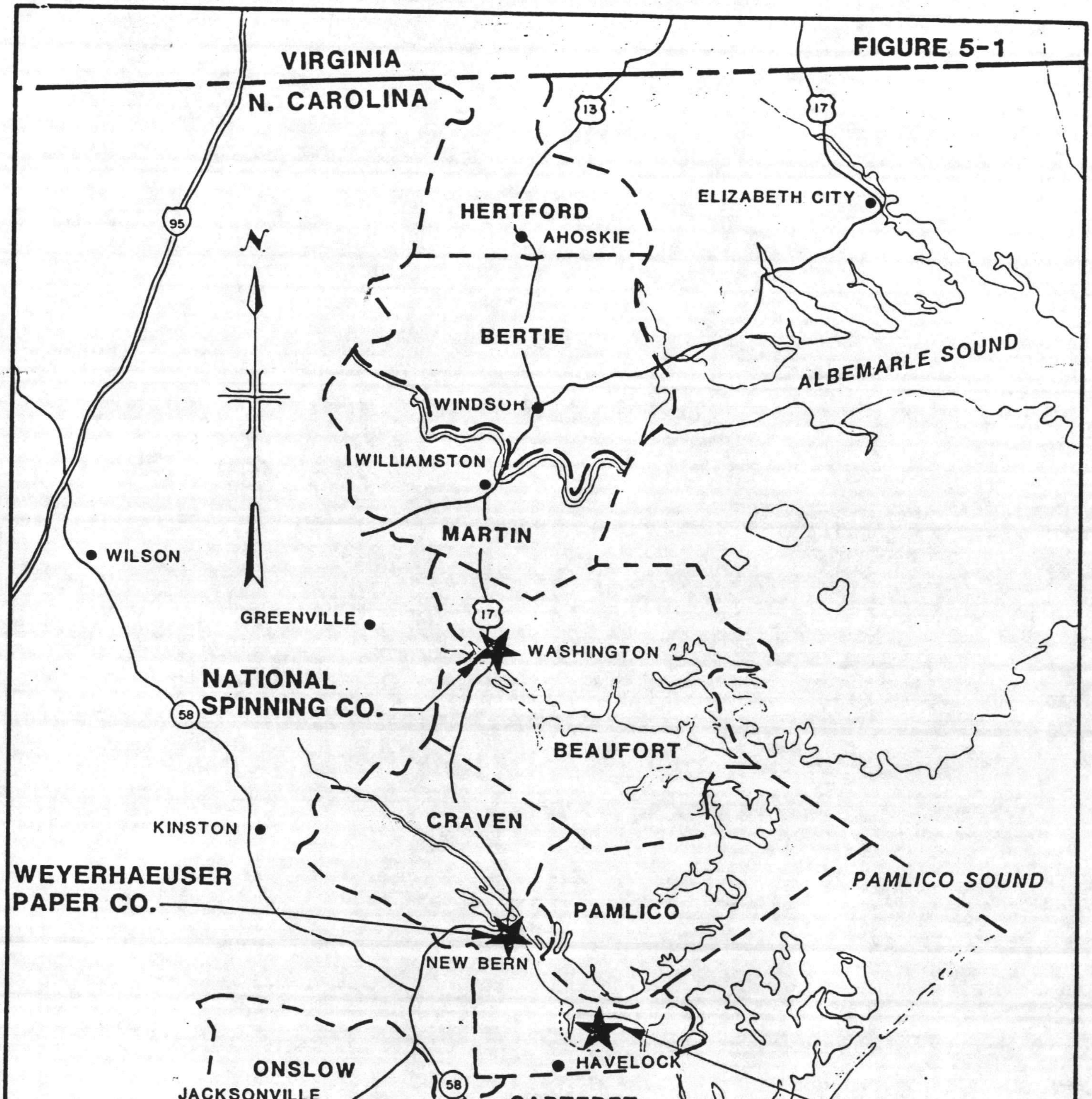
The condensate return is approximately 10% of the steam supplied. This low condensate return is the result of heat exchanger failures. It is estimated that repair/replacement of the heat exchangers could result in a condensate return of approximately 80%. Low condensate returns result in higher operating costs, due to the cost of make-up water, chemicals,

TABLE 5-1

STEAM MARKETS

Market	Location
National Spinning Co.	Washington City Beaufort County
MCB Camp LeJeune	Onslow County
MCAS Cherry Point	Craven County
Weyerhaeuser Paper Co.	New Bern City Craven County

FIGURE 5-1



MALCOLM PIRNIE	NEUSE RIVER COUNCIL OF GOVERNMENTS SOLID WASTE FEASIBILITY STUDY	MALCOLM PIRNIE, INC.

and the heating required to raise the temperature of the make-up water to the condensate return temperature.

National Spinning Co. has a relatively constant steam requirement, and is ideally suited for an energy recovery facility. Property adjacent to the plant has been identified as a possible site location for such a facility. Specific siting investigations are beyond the scope of this study.

Preliminary discussions with National Spinning personnel indicates an interest in a waste-to-energy facility. Such a facility would relieve National Spinning Co. of the cost of purchase, installation, operation and maintenance of new boilers and/or the operation and maintenance of the present boilers.

B. <u>MCB Camp Lejeune</u>

MCB Camp Lejeune has ten steam plants dispersed throughout the base. Upon review of the facility sizes and locations, seven of the ten plants are deemed unsuitable for replacement, with a waste-to-energy facility, due to the small sizes of the plants, and their relative locations to other steam plants.

The three remaining steam plants are designated 1700, G-650, and AS-4151, by base officials. Figure 5-2 shows the approximate location of these facilities on the base. Plants G-650 and AS-4151 are considered close enough together to consider replacing or supplementing these plants with a single waste-to-energy facility.

1) <u>Steam Plant, 1700</u>

Steam from this plant is used primarily for heating, with some process use. The steam plant consists of five boilers, four of which are approximately forty-five years old and one which is approximately eleven years old. The plant uses both coal and No. 6 fuel oil.

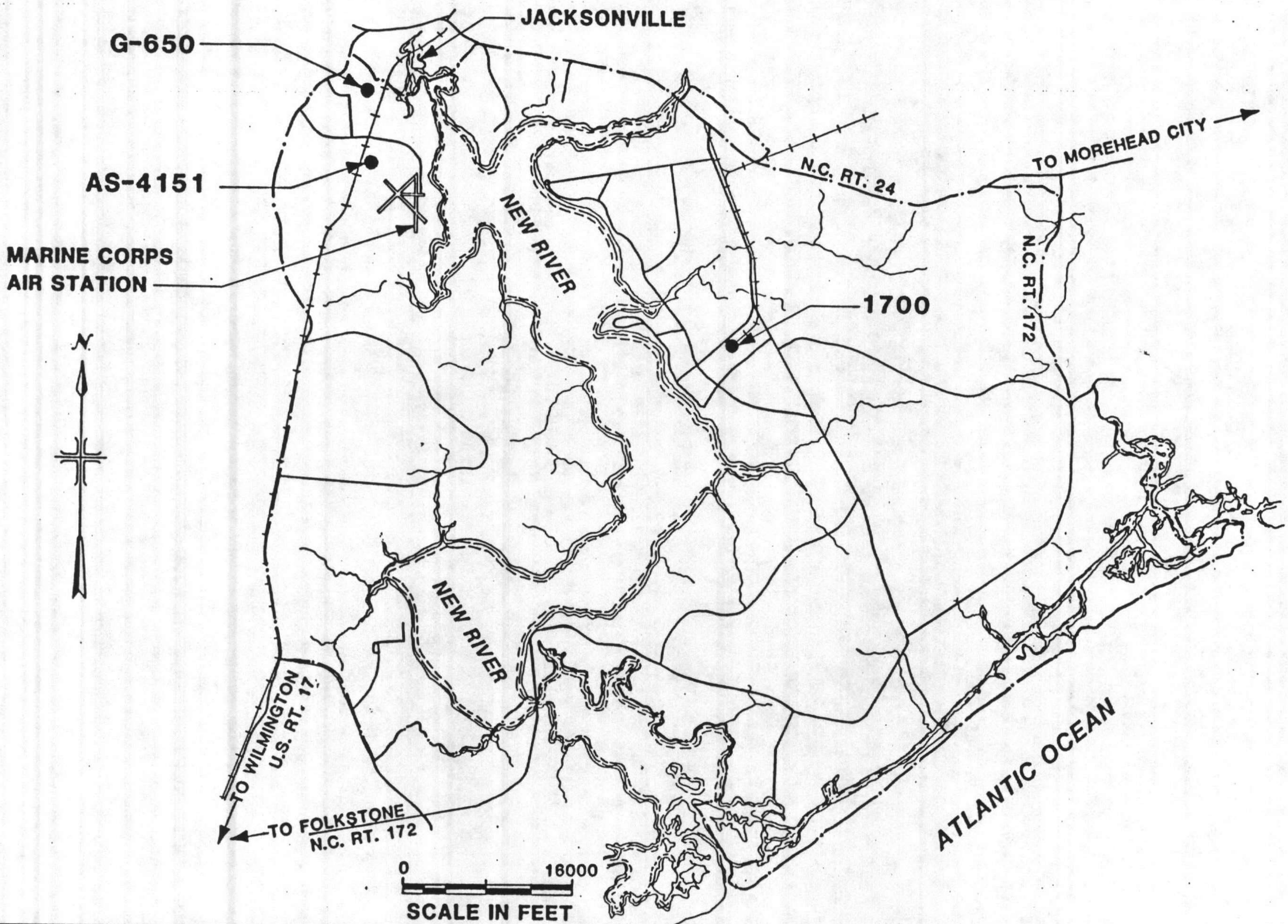


FIGURE 5-2

NEUSE RIVER COUNCIL OF GOVERNMENTS
SOLID WASTE FEASIBILITY STUDY
MCB CAMP LEJEUNE

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SEPT 1987

The boilers at this steam plant provide users with steam at 150 psig and a temperature of 366^{o} F. Condensate return, to this plant, is approximately 25%. The low condensate return is due to system leaks and lack of, or insufficient systems at points of use.

Steam use for this plant exhibits an annual cycle, with a winter peak, and a summer low. Figure 5-3 shows this cycle for the period beginning May 1986 and ending May 1987.

The high summer to winter variance makes this steam plant suitable for replacement with a cogenerating or baseload facility. A cogenerating facility utilizes excess steam, during times of low steam demand, to produce electricity. A baseload facility provides a constant year-round steam supply, with the existing boilers providing winter and peak loading.

Officials at MCB Camp Lejeune have indicated that siting for a resource recovery facility near this steam plant would be very difficult, due to the heavy development and security problems. Preliminary discussions, with base officials do not indicate an interest in replacing/supplementing this steam plant with a resource recovery facility, due to siting and security problems.

2) Steam Plants, G-650 and AS-4151

Steam from both plants is used primarily for heating, with some process use. Steam Plant G-650 consists of three boilers, two of which are approximately eighteen years old and one which is approximately sixteen years old. Base officials are presently involved in the design to replace the aging boilers at this facility with new

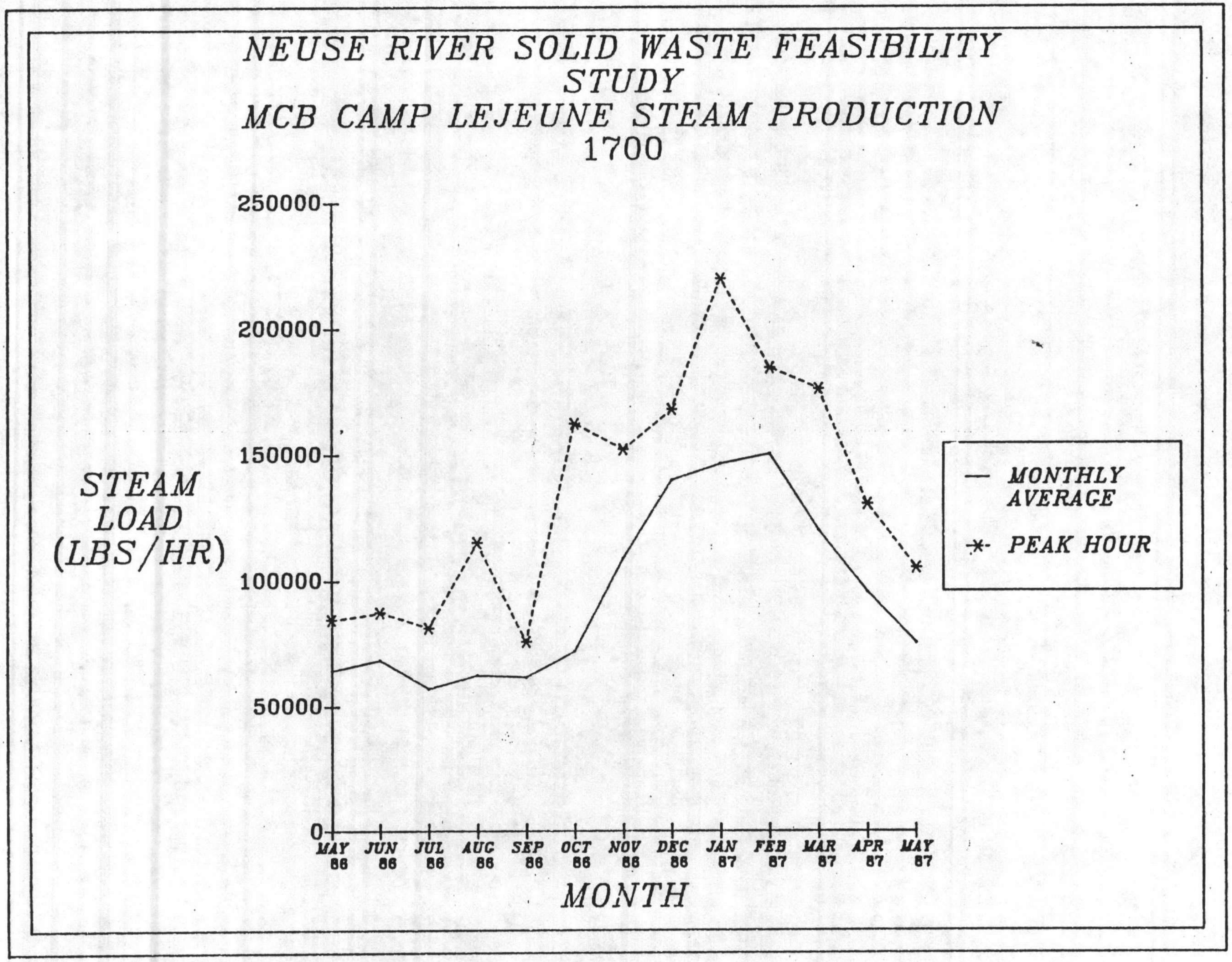

NEUSE RIVER SOLID WASTE FEASIBILITY STUDY
MCB CAMP LEJEUNE STEAM PRODUCTION
1700
250000
200000
150000
100000
50000
0
STEAM LOAD (LBS/HR)
MAY 86
JUN 86
JUL 86
AUG 86
SEP 86
OCT 86
NOV 86
DEC 86
JAN 87
FEB 87
MAR 87
APR 87
MAY 87
MONTH
MONTHLY AVERAGE
PEAK HOUR

FIGURE 5-3

boilers. Steam plant AS-4151 consists of three boilers approximately eleven years old. Both plants use No. 6 Fuel Oil.

The following table shows steam pressure, temperature and condensate return rates for both steam plants.

Steam Plant	Steam Pressure (PSIG)	Steam Temperature (°F)	Condensate Return
G-650	100	325	45%
AS-4151	150	360	40%

Similar to steam plant 1700, the relatively low condensate return is due to system leaks and lack of, or insufficient, systems at points of use.

Again, similar to steam plant 1700, steam plants G-650 and AS-4151 exhibit annual cycles, with a winter peak and a summer low. Figure 5-4 shows this cycle for the period beginning May 1986 and ending May 1987. Figure 5-4 shows the steam use for both plants, together. The high summer to winter variance makes these plants suitable for replacement with a cogenerating or baseload facility. A cogenerating facility utilizes excess steam during times of low steam demand, to produce electricity. A baseload facility provides a constant year-round steam supply, with the existing boilers providing winter and peak loading.

Siting for such a facility may be somewhat difficult due to some development in the area, and the nearby base airfield, which may have some affect on location due to the facility stack height.

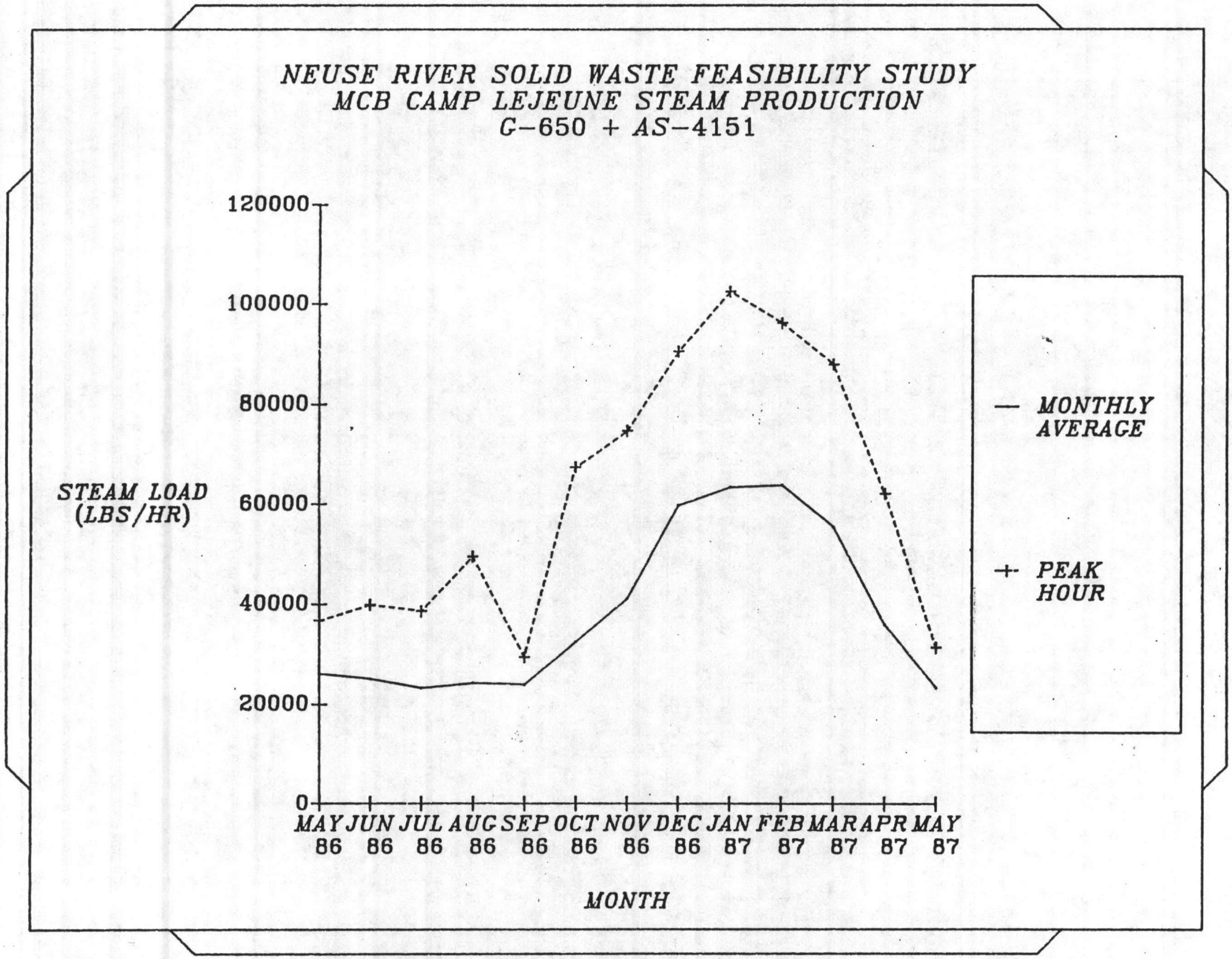

NEUSE RIVER SOLID WASTE FEASIBILITY STUDY
MCB CAMP LEJEUNE STEAM PRODUCTION
G-650 + AS-4151
STEAM LOAD (LBS/HR)
120000
100000
80000
60000
40000
20000
0
MAY 86
JUN 86
JUL 86
AUG 86
SEP 86
OCT 86
NOV 86
DEC 86
JAN 87
FEB 87
MAR 87
APR 87
MAY 87
MONTH
MONTHLY AVERAGE
PEAK HOUR

FIGURE 5-4

Preliminary discussions, with base officials, indicate an interest in replacing/supplementing these steam plants with a resource recovery facility.

Base officials have also expressed concern over possible security problems due to increase in traffic to the base by refuse vehicles. Officials have suggested that this traffic could be limited by the use of a transfer station which would handle the small refuse vehicles, and coordinate refuse delivery to the base, or alternately by siting the facility off base.

C. MCAS Cherry Point

MCAS Cherry Point utilizes steam for space heating, process use, and mechanical drives. The base plant presently has five boilers, one of which is approximately forty-four years old, two of which are approximately forty-two years old and two of which are approximately ten years old. The plant uses both coal and No. 6 Fuel Oil. Replacement of these boilers is presently underway, with the project in the design phase.

The boilers at this facility provide users with steam at 100 psig and 337^{o} F. Condensate return is approximately 30% of the steam supplied to users.

Similar to MCB Camp Lejeune, steam use at this plant exhibits an annual cycle, with a winter peak and a summer low. Figure 5-5 shows this cycle for both 1985 and 1986. Some peak hourly loads higher than shown on Figure 5-5 are expected. The high summer to winter variance makes this steam plant suitable for replacement with a cogenerating or base load facility. A cogenerating facility utilizes excess steam during times of low steam demand, to produce electricity. A baseload facility provides a constant year-round steam supply, with the existing boilers providing winter and peak loading. Officials at MCAS

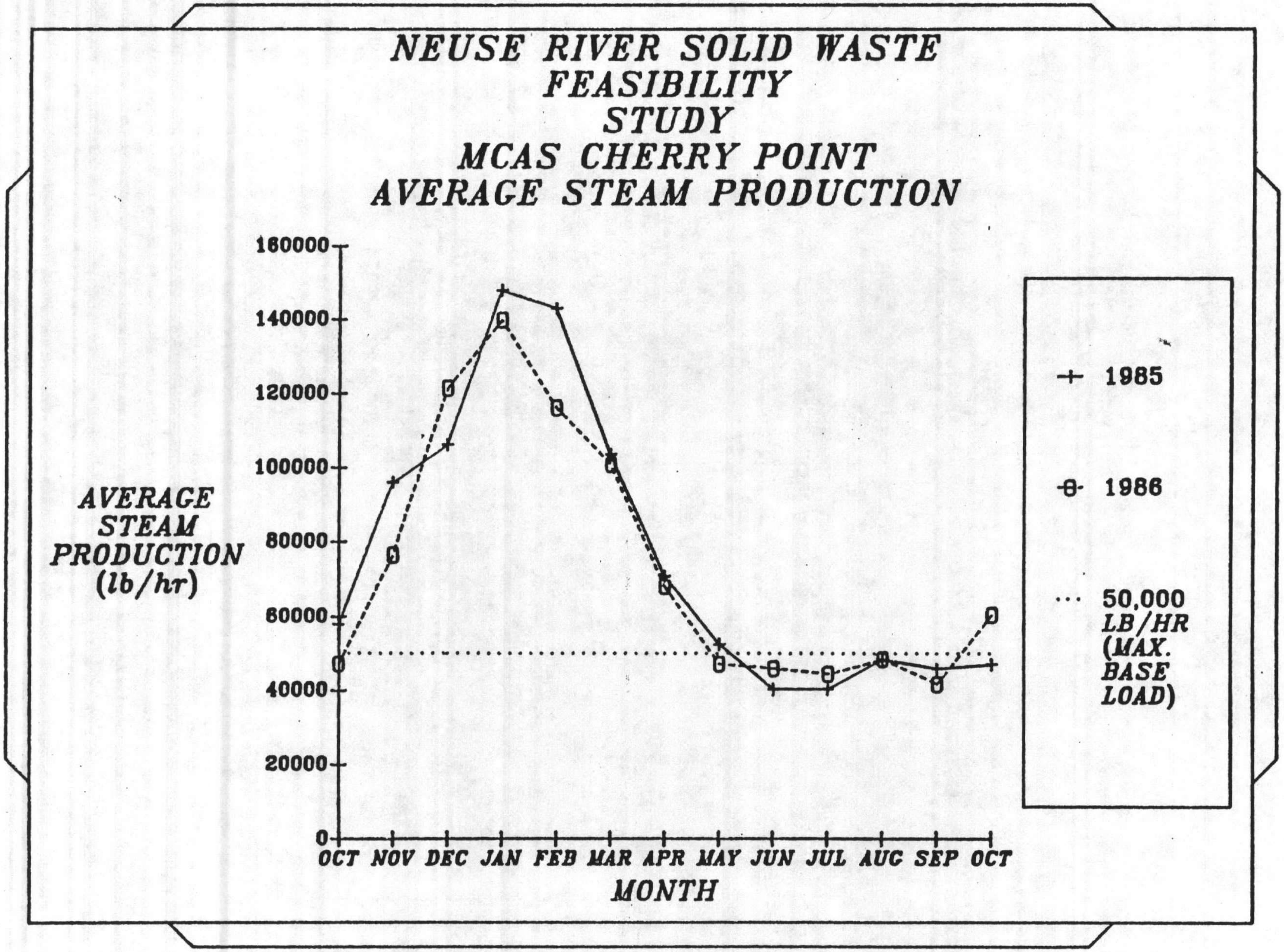

NEUSE RIVER SOLID WASTE
FEASIBILITY
STUDY
MCAS CHERRY POINT
AVERAGE STEAM PRODUCTION
AVERAGE
STEAM
PRODUCTION
(lb/hr)
160000
140000
120000
100000
80000
60000
40000
20000
0
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT
MONTH
1985
1986
50,000
LB/HR
(MAX.
BASE
LOAD)

FIGURE 5-5

Cherry Point have indicated that the maximum acceptable baseload facility would be one that supplied 50,000 lb/hr of steam to present system.

Preliminary discussions with base officials indicate that siting for a resource recovery facility will be very difficult due to the small size of the base, heavy development, and the close proximity to the air strip. A suitable site, for a resource recovery facility, on base has been identified. This site is approximately 2.2 miles from a tie-in point at the main steam line. Generally, steam lines are kept to less than two miles in length, due to construction costs and pressure loss. Off base sites are a possibility, but would increase the steam line length by approximately ½ mile. Resource Recovery Facility stack heights limit how close a facility can be located to the base air strip.

D. Weyerhaeuser Paper Co.

Preliminary discussions with Weyerhaeuser Paper Co. have indicated that all steam and system information at this facility is confidential. Weyerhaeuser Paper Co. has indicated that it is not interested in a waste-to-energy project, at this time.

5.2 ELECTRICAL ENERGY MARKET

The revenue gained by the sale of electricity to an utility can be important to the success of a resource recovery facility. This sale of energy is governed by Federal and State legislation. The Federal legislation that provides for the sale of electrical energy to power producers is entitled the Public Utility Regulatory Policies Act of 1978 (PURPA). The Act requires utilities to purchase power that is generated by a qualifying small power producer at full avoided costs.

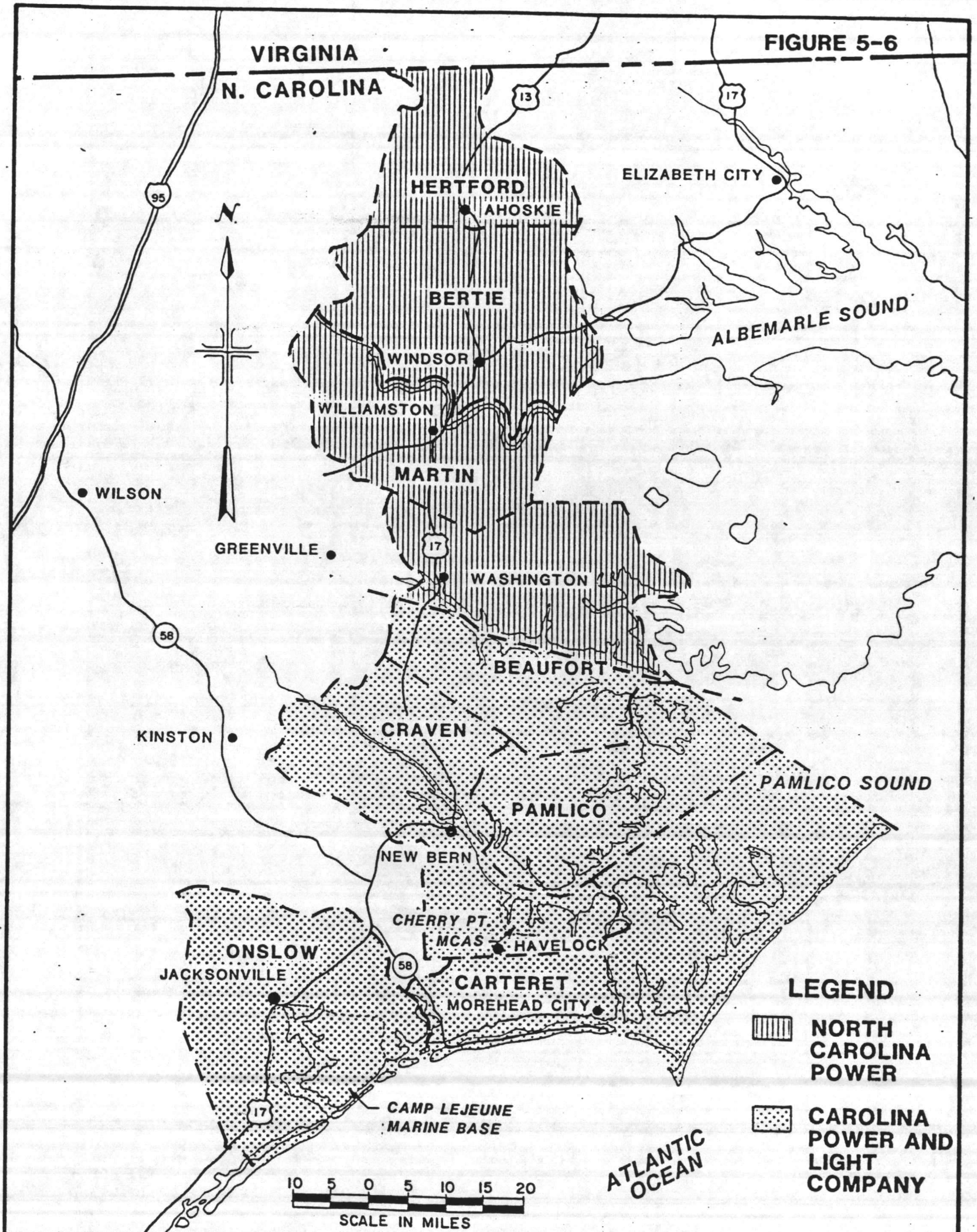
While PURPA provides the basic framework for negotiations between qualifying facilities (QF) and the utilities, two agencies are responsible for implementing these procedures. The first agency is entitled the Federal Energy Regulatory Commission (FERC). FERC is involved through the promulgation of rules under PURPA to encourage cogenerators and small power producers. The rates that are offered must be equitable; neither burdening rate payers or discriminating against QF's. In addition, FERC rules specifically exempt QF's from regulations that govern public utilities.

Each state is required, through their appropriate utility regulatory body, to implement these rules. In North Carolina the North Carolina Utilities Commission (NCUC) is the agency charged with that responsibility. The NCUC reviews and approves general rate tariffs and specific negotiated agreements between QF's and public utilities. There are two types of energy utilities in North Carolina that serve the public. The first are investor owned utilities such as North Carolina Power (NCP) and Carolina Power and Light (CP&L). The second type of electric utility is the consumer owned utility such as ElectriCities of North Carolina, Inc. and the North Carolina Association of Electrical Cooperatives. Both types of utilities serve the Neuse River area. The appropriate utilities are further discussed below.

5.2.1 INVESTOR OWNED ELECTRIC UTILITIES

North Carolina Power (NCP)

North Carolina Power is the Southern Division of Virginia Power which services approximately half of the Neuse River area. The service area of NCP can be seen on Figure 5-6. North Carolina Power owns and operates power facilities in the state and also receives energy from the parent company, Virginia Power. NCP is traditionally a summer peaking utility whose net summer capacity is approximately 11,740 MW for its entire service area. North Carolina Power is not restricted to the counties shown on Figure 5-6.



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NCP has a tariff schedule filed with the NCUC governing the purchase of power from co-generators and small power producers. The tariff schedule 19H, "Power Purchases at Levelized Rates from Cogeneration and Small Power Production Qualifying Facilities" is applicable to qualifying generators or small power producers that contract less than or equal to a total of 5 MW of capacity. Depending upon the scenario, see Section 6.1, the electrical producing facilities envisioned for this area, may or may not be capable of producing more than 5 MW. A separate negotiated schedule must be arranged between the resource recovery facility and North Carolina Power, if the facility produces more than 5 MW of electrical power.

Schedule 19H indicates that NCP will compensate a qualifying facility for both energy and capacity payments if the facility meets their requirements.

Energy Payments

The energy payment will represent the avoided cost of generating power and will vary with the time of day and duration of contract. The schedule 19H tariff rates are the following:

Contract Length in years	Payment Period, ¢/kwh On Peak	Off Peak
5	3.356	2.660
10	4.062	3.138
15	4.763	3.606

This schedule indicates that the on-peak payment is the most valuable to North Carolina Power and therefore the highest rate. The on-peak hours are between 7:00 a.m. to 10:00 p.m., Monday through Friday. The off-peak hours are all the remaining hours other than those listed as on-peak hours.

Capacity Payments

The payments for capacity represents the value of capacity to the system or the amount of new capacity the utility does not have to

provide itself. The rate paid by NCP for capacity varies with the length of the purchase contract as follows:

Contract Term, Years	Monthly Capacity Rate $/kw
5	6.85
10	7.58
15	8.27

The capacity payments are adjusted according to the length of contract and are monthly levelized purchase prices.

Energy revenue projections were based upon the published schedule 19H tariff. Table 5-2 displays these projections based upon a facility power output of 5 MW and a 5, 10, 15 year contract term. The facility has an availability factor of 90 percent and operates all year, around the clock. These estimates resulted in annual energy payments of $1.2 million for a 5 year contract, $1.4 million for a 10 year contract, and $1.6 million for a 15 year contract. The annual capacity payments were $370,000, $409,000, and $446,000 respectively. By summing the energy and the capacity payments the total yearly payments were $1.5 million for a 5 year contract, $1.8 million for the 10 year contract, and $2.1 million for the 15 year contract. By using these total payments, an effective rate covering both energy and capacity was calculated at $0.0352/kwh, $0.0413/kwh, and $0.0473/kwh respectively.

These calculated values are used for planing purposes only due to the facility size limitations of schedule 19H. Any new agreements involving more than 5 MW, would be the subject of involved negotiations.

Carolina Power and Light (CP&L)

Carolina Power and Light is the other investor-owned utility that serves the Neuse River area. CP&L serves approximately half the area involved in this study. The CP&L service area can be seen on Figure 5-6. CP&L provides electricity to approximately 864,000 customers through out the state, and is not restricted to the counties shown in Figure 5-6.

TABLE 5-2
NEUSE RIVER SOLID WASTE FEASIBILITY STUDY
NORTH CAROLINA POWER ENERGY REVENUE PROJECTIONS
SCHEDULE 19H

CONTRACT LENGTH (YRS)	5	10	15
GENERATING CAPACITY (KW)	5000	5000	5000
ON-PEAK HRS.	3915	3915	3915
AVAILABILITY FACTOR	0.9	0.9	0.9
ON-PEAK-RATE (CENTS/KWHR)	3.356	4.062	4.763
ON-PEAK-ENERGY PAYMENTS ($)	591,243	715,623	839,122
OFF-PEAK-HRS	4845	4845	4845
AVAILABILITY FACTOR	0.9	0.9	0.9
OFF-PEAK-RATE (CENTS/KWHR)	2.66	3.138	3.606
OFF-PEAK-ENERGY PAYMENTS ($)	579,947	684,162	786,198
TOTAL ENERGY PAYMENT	1,171,190	1,399,785	1,625,320
AVAILABILITY FACTOR	0.9	0.9	0.9
MONTHLY CAPACITY ($/KW)	6.85	7.58	8.27
CAPACITY PAYMENT ($)	369,900	409,320	446,580
TOTAL PAYMENTS ($)	1,541,090	1,809,105	2,071,900
EFFECTIVE RATE ($/KWH)	$0.0352	$0.0413	$0.0473

NOTES:

TOTAL PAYMENTS ($) = TOTAL ENERGY PAYMENTS + CAPACITY PAYMENTS
EFFECTIVE RATE = TOTAL PAYMENTS ($) / DELIVERED KWH *
* DELIVERED KWH=5000*TOTAL HRS/YR

CP&L, like NCP, is a summer peaking utility that has a summer peaking generation capacity of approximately 9,654 MW.

CP&L has an approved rate tariff designated schedule CSP-10. This schedule governs Cogeneration and Small Power Producers. The tariff includes both energy payments and capacity payments and is based on projections of avoided cost. The tariff schedule has a requirement that the qualifying faculty generate a capacity of 5 MW or less. Large facility output would require that a new schedule be negotiated.

Energy Payments

The energy payments of schedule CSP-10 vary with the time of day and by the month.

Contract Length in years	Payment Period, ¢/kwh On Peak	Off Peak
5	2.845	2.567
10	3.252	2.810
15	3.667	3.072

The on-peak period are the hours between 10:00 a.m. and 10:00 p.m., Monday through Friday for the calendar months of April through September. The months of October through March have on-peak hours between 6:00 a.m. and 1:00 p.m. and between the hours of 4:00 p.m. and 9:00 p.m., Monday through Friday.

The off-peak hours in any billing month are all hours that have not been listed as on-peak hours.

Capacity Payments

Payments for capacity represent the value of avoided capacity, and varies with the contract term and month of the year. The schedule is based on the on-peak kwh supplied by the seller.

Contract Length in years	Payment Period, ¢/kwh On Peak Summer	Off Peak Non-Summer
5	1.407	1.209
10	1.516	1.303
15	1.644	1.413

The summer months are the months of June through September, while the non-summer months are all the other months of the year.

This schedule CSP-10 has a provision titled "Seller Charge." This charge is defined as a fee the seller shall pay to CP&L. The seller's charge rate is the following:

	Contract Capacity 1000 kw and above
Monthly Sellers Charge	$193

The results of calculations of revenue, from the rate schedule CSP-10, can be seen on Table 5-3. The calculations were based on an output of 5,000 kw with contract lengths of 5, 10, and 15 years. The facility has a availability factor of 90 percent with continuous around the clock operation. These estimates resulted in annual energy payments of $1.05 million for a 5 year contract, $1.2 million for a 10 year contract, and $1.3 million for a 15 year contract. The associated capacity payments were $179,800, $215,300, and $233,470, respectively. The total payment was derived by summing the energy payment and capacity payment and subtracting the sellers charge for one year. The results for a 5 year contract was $1.2 million, 10 year contract was $1.4 million, and a 15 year contract was $1.5 million. The effective rates were $0.0280, $0.0316, and $0.0348 respectively.

5.2.2 CONSUMER OWNED UTILITIES

There are two types of consumer-owned utilities in North Carolina. These are Electrical Membership Corporation (EMC) and Municipal Power Agencies (MPA). Both of these utilities are further discussed below:

TABLE 5-3
NEUSE RIVER SOLID WASTE FEASIBILITY STUDY
C P & L ENERGY REVENUE PROJECTIONS
SCHEDULE CSP-10

CONTRACT LENGTH (YRS)	5	10	15
GENERATING CAPACITY (KW)	5000	5000	5000
ON-PEAK HRS.	3132	3132	3132
AVAILABILITY FACTOR	0.9	0.9	0.9
ON-PEAK-RATE (CENTS/KWHR)	2.845	3.252	3.667
ON-PEAK-ENERGY PAYMENTS ($)	400,974	458,337	516,827
OFF-PEAK-HRS	5628	5628	5628
AVAILABILITY FACTOR	0.9	0.9	0.9
OFF-PEAK-RATE (CENTS/KWHR)	2.567	2.81	3.072
OFF-PEAK-ENERGY PAYMENTS ($)	650,118	711,661	778,015
TOTAL ENERGY PAYMENT	1,051,093	1,169,997	1,294,842
AVAILABILITY FACTOR	0.9	0.9	0.9
ON-PEAK SUMMER HRS/YR	1056	1056	1056
ON-PEAK NON-SUMMER HRS/YR	2076	2076	2076
ON-PEAK (CENTS/KWHR) SUMMER	1.407	1.516	1.644
ON-PEAK (CENTS/KWHR) NON-SUMMER	1.209	1.303	1.413
TOTAL CAPACITY PAYMENTS ($)	179,805	215,296	233,473
TOTAL PAYMENTS ($)	1,228,582	1,382,978	1,525,998
EFFECTIVE RATE ($/KWH)	$0.0280	$0.0316	$0.0348

NOTES:
TOTAL PAYMENTS ($) = TOTAL ENERGY PAYMENT+TOTAL CAPACITY PAYMENT-(MONTHLY SELLER CHG.)*
EFFECTIVE RATE = TOTAL PAYMENTS ($) / (DELIVERED KWH) **
* MONTHLY SELLER CHARGE = $193 * 12 MONTHS
** DELIVERED KWH=5000*TOTAL HRS/YR

Electrical Membership Corporation (EMC)

The Electrical Membership Corporations of North Carolina operate throughout the State, although individual EMC's serve rather limited areas. The Neuse River area has seven operating EMC's, as follows:

ELECTRIC MEMBERSHIP CORPORATIONS

- Roanoke EMC
- Edgecombe - Martin EMC
- Halifax EMC
- Tideland EMC
- Jones - Onslow EMC
- Carteret - Craven EMC
- Harkers Island EMC

North Carolina EMC's may be interested in co-ownership in a resource recovery project. The rural electric membership corporations operate as an electric utility, therefore, they are required by PURPA to purchase energy from small power producers and cogenerators.

The power purchased would be at full avoided cost for a qualifying facility as established by FERC regulations. The energy rate tariff that the EMC's use for purchase of electricity, is similar to that of CP&L and is structured to interface with CP&L power generating facilities.

The EMC's that are located within the Neuse River area are historically summer peaking utilities. The system peak was 1,624 MW with an estimated system average for 1986 of 1,300 MW. The peak demands for the local EMC's that are within the study area are as follows:

EMC	1986 Peak
Roanoke	24,660 KW
Edgecombe-Martin Co.	26,600 KW
Halifax	15,300 KW
Tideland	41,650 KW
Jones-Onslow	122,980 KW
Carteret-Craven	79,100 KW
Harkers Island	3,500 KW

These energy peaks reflect the total energy requirement of the EMC, and are not necessarily restricted to the counties involved in this study. This list demonstrates that the Jones-Onslow EMC has the highest energy peak of 122,980 KW and Carteret-Craven is the next highest at 79,100 KW. The EMC's listed have average energy demands that vary from 75% to 80% of the peak demand.

<u>ElectriCities of North Carolina, Inc.</u>

North Carolina Eastern Municipal Power Agency (NCEMPA) became a municipal corporation in December 1976. There are now 32 cities and towns that are acting members. The members own and operate their own electrical distribution system as well as being co-owners of investor-owned power generating facilities. NCEMPA supplies approximately 175,000 electric power customers with yearly energy use of approximately 359 million kilowatt-hours (1985). The estimated 1985 peak resource demand was 971.2 MW. This capacity was purchased from CP&L. As with the EMC's, NCEMPA co-owns some of its generating capacity with CP&L.

The NCEMPA transmits its power over NCP and CP&L transmission lines. NCEMPA has a transmission rate schedule that has been filed with FERC. This rate is the same for all locations, with a uniform delivery-point charge on all of the agencies participants, as well as a uniform leased-facilities charge on all members that receive energy below the transmission voltages.

The rates that NCEMPA charges its members are set forth by the NCEMPA Board of Commissioners. The rate for all-requirement service is designed to cover the costs of operation, ownership, maintenance, financing, administration, supplemental power costs, etc. The current energy charges from CP&L to ElectriCities are the following:

Supplemental Capacity	16.66 $/KW
Energy Capacity Rate	16.94 MILLS/KWH
Transmission Rate	1.54 $/KW

Each member then sets its rates to their customers. Because each member is a municipality they have authority over themselves, and are not required to pass their rate changes through the North Carolina Utilities Commission.

The NCEMPA has four members in the Neuse River area:

Member City	County
New Bern	Craven
Belhaven	Beaufort
Robertsonville	Martin
Washington	Beaufort

The NCEMPA is regulated by Federal legislation such as FERC. The legislation of PURPA also requires NCEMPA to purchase power from a QF. These municipalities are also potential customers but because of the small amount of members in the Neuse River area, they may or may not be viable markets dependent on the location of a resource recovery facility. Any rate schedules would have to be negotiated with them for the purchase of power.

Also located within this study area is a self-operated utility, that is not a member of NCEMPA. This municipal utility is the City of Windsor.

Figure 5-7 shows the locations of the NCEMPA members, and the city of Windsor.

5.3 SUMMARY

An analysis of available energy markets within the study area has indicated the presence of strong, viable steam and electrical markets. Potential steam markets includes:

National Spinning
MCAS Cherry Point
MCB Camp Lejeune

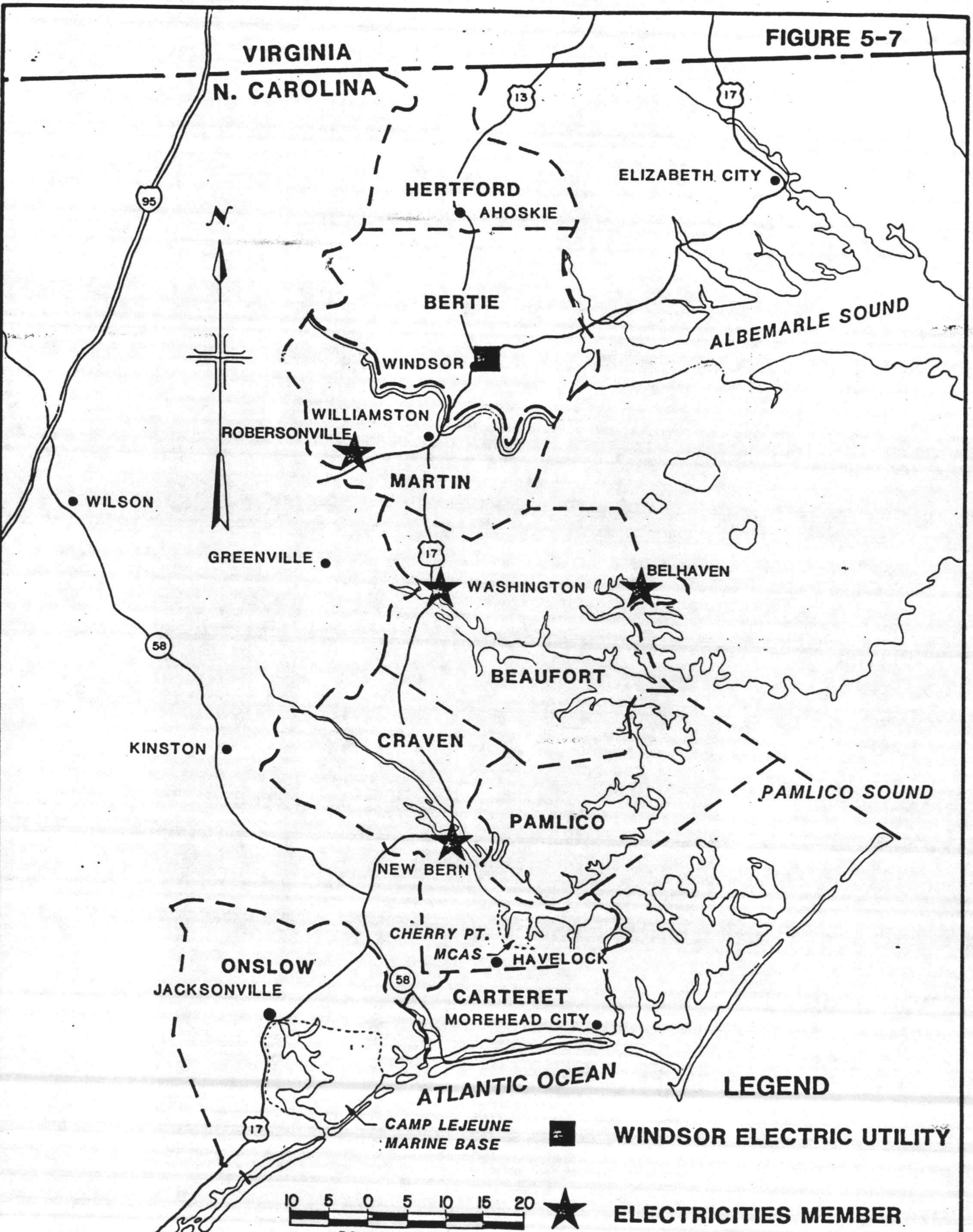

FIGURE 5-7

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Potential electrical markets include:

North Carolina Power
Carolina Power and Light
North Carolina EMC
North Carolina Eastern Municipal Power Agency

The following section will examine specific project scenarios which utilize these markets.

6.0 PROJECT SCENARIOS

6.1 Scenario Overviews

An investigation of the following waste-to-energy scenarios has been undertaken for this project:

A. One Electrical Generating Facility - Encompassing all eight counties involved in this study.

B. Two Electrical Generating Facilities - One servicing the four most northerly counties and the other servicing the four most southerly counties.

C. Steam generating facilities, with some cogeneration - Encompassing the three most promising steam markets.

The third scenario has several variables which are, to a great extent, dependent on economics and successful negotiations with steam markets.

6.1.1 Scenario A

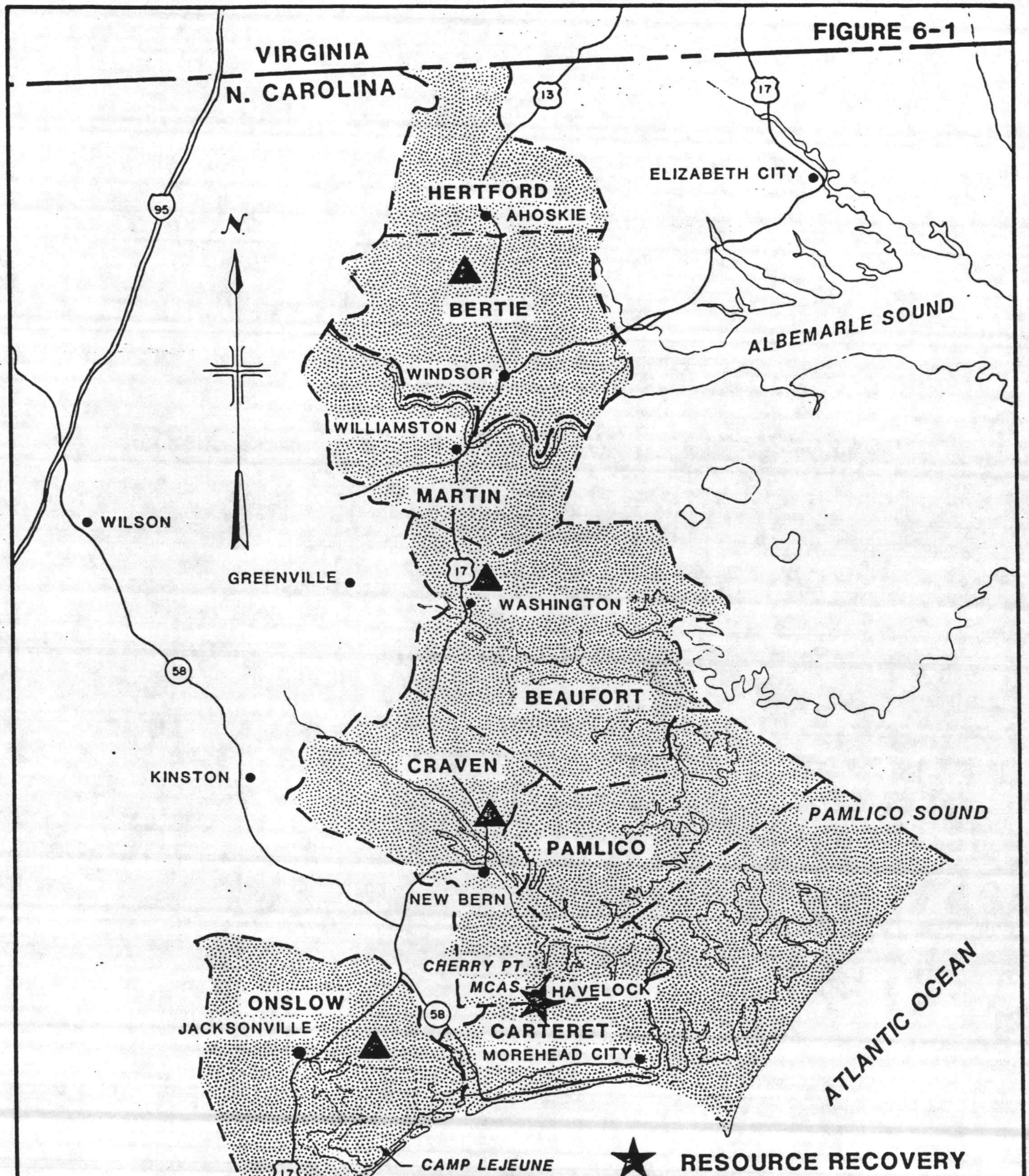
Scenario A consists of a single electrical generating facility, to process all municipal solid waste (MSW) produced in the eight county area, including the two military bases. Economically, the facility should be located near the centroid of solid waste production (See Figure 6-1). Of the eight counties, Onslow and Carteret are the largest producers of MSW resulting in the waste generation centroid location to be near the City of Havelock. In addition, several transfer stations will help reduce the cost of transportation. Figure 6-1 also shows several, general locations for these transfer stations.

A single electric generating facility would be capable of producing approximately 15.75 MW of electricity, from the 750 TPD of waste available in the year 1992. Actual electrical production depends on the efficiency and operating characteristics of the installed equipment, as well as the composition and quantity of waste burned. The actual facility would be sized with a total installed capacity of 940 TPD.

6.1.2 Scenario B

This scenario splits the eight counties into the four most northerly and the four most southerly counties. For convenience, the

FIGURE 6-1



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Beaufort, Craven, Pamlico county line has been used as a dividing line for the two facilities. Actual locations of facilities , and distances to facilities will determine this dividing line.

NORTHERN FACILITY

The northern facility would be located at or slightly north of the City of Washington, near the centroid of MSW production, with a transfer station located north of the City of Windsor (See Figure 6-2). The location of the facility, as well as being near the centroid of waste production, is situated such that only one transfer station is necessary. This project would serve the counties of Hertford, Bertie, Martin and Beaufort. The following projections show estimated waste quantities for this project, assuming a 1992 start-up and a twenty year life:

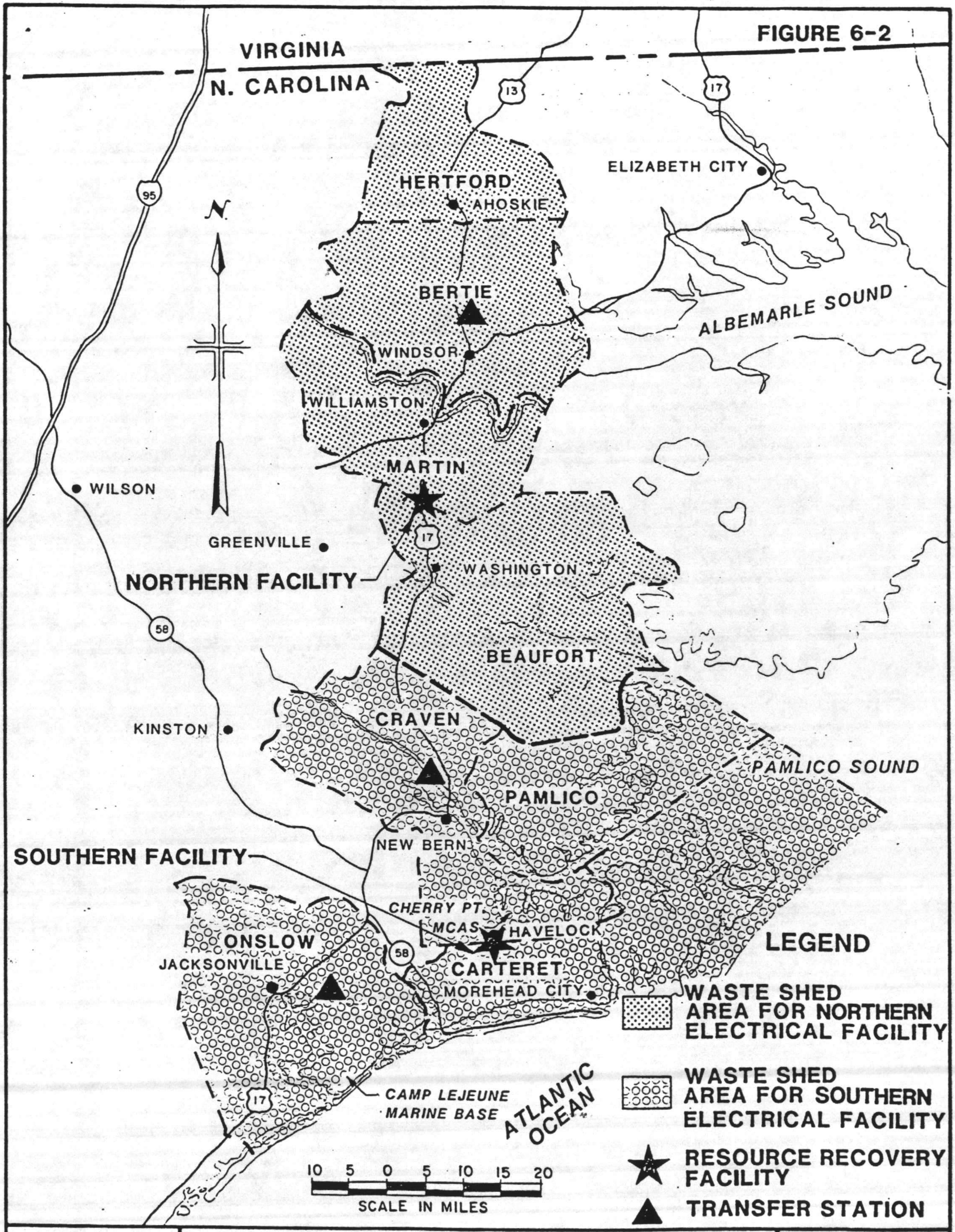
	YEAR (TPD)		
County	1992	2002	2012
Hertford	44	44	44
Bertie	38	38	38
Martin	46	46	44
Beaufort	85	96	106
Totals (TPD)	213	224	232
Estimated Electrical Output (MW)	4.5	4.7	4.9

The associated electrical output of the facility, of 4.5 MW in 1992 is based on steam temperature and pressure of 600^{o} F and 600 psig, respectively, and on the expected efficiency of system components. The actual installed capacity of this facility is sized at 270 TPD.

SOUTHERN FACILITY

The southern facility would be located south of the City of Havelock, with transfer stations located north of the City of New Bern

FIGURE 6-2



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and near the City of Jacksonville (See Figure 6-2). This project would serve the counties of Craven, Pamlico, Carteret and Onslow. The following projections show the estimated waste quantities for this project, assuming a 1992 start-up, and a twenty year facility life:

	YEAR (TPD)		
County	1992	2002	2012
Craven	163	95	225
Bertie	21	23	25
Pamlico	106	134	161
Onslow	247	285	320
Totals (TPD)	537	637	731
Estimated Electrical Output (MW)	11.3	13.4	15.3

The facilities electrical output of 11.3 MW in 1992 is based on steam temperature and pressure of 600^{o} F and 600 psig, respectively, and on the expected efficiency of system components, as well as waste composition and quantity. The population of these four counties is expected to rise dramatically compared to the northern counties in the period of 1992 through 2012, resulting in an estimated electrical output of 15.3 MW, in the year 2012. The actual installed capacity is sized at 670 TPD.

6.1.3 Scenario C

Scenario C entails the supply of steam to industry and military bases, and consists of two options as follows:

Scenario	Steam Markets Served
C1	National Spinning MCAS Cherry Point MCB Camp Lejeune
C2	National Spinning MCB Camp Lejeune

The area supplying waste to each facility, commonly referred to as waste shed, was determined based upon geographical features affecting transportation and economics. The amount of waste required to serve a given market was determined based upon its energy usage characteristics.

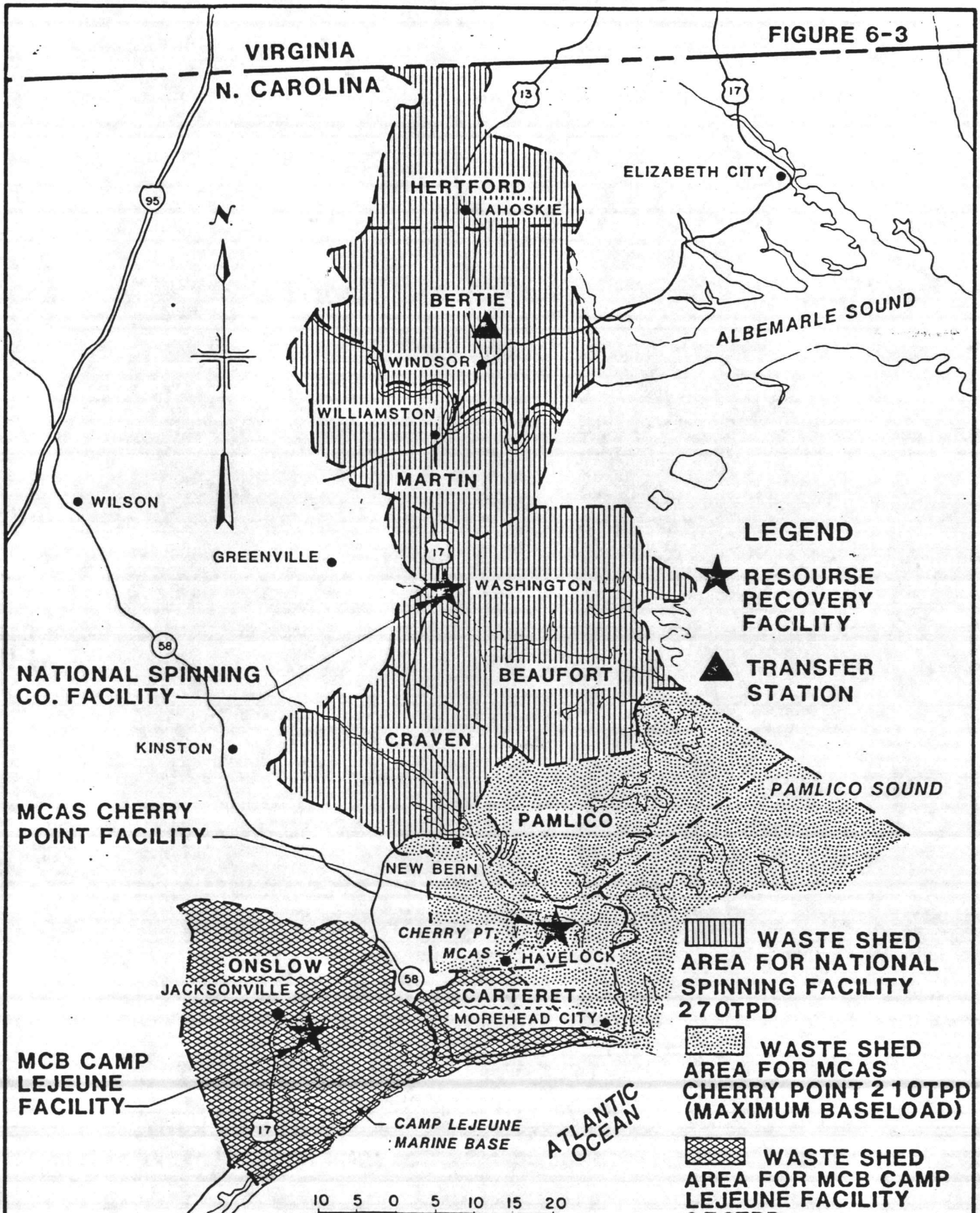
Scenario C1

Scenario C1 consists of three separate projects serving National Spinning, MCAS Cherry Point and MCB Camp Lejeune. The location and approximate waste sheds for these projects are shown in Figure 6-3.

National Spinning has a relatively consistent steam demand and operates continuously. The consistent demand, with a maximum hourly demand of 60,000 lb/hr and an average demand of 42,000 lb/hr makes them a logical market for full replacement. A waste-to-energy facility, sized at approximately 270 tpd nominal capacity, could replace all of the steam currently supplied by fossil fuel boilers. This could be accomplished with three combustion trains sized at 110 tpd each for a total plant capacity of 330 tpd. Due to occasional almost instantaneous loading and in order to increase overall availability, this facility will require a small dual fuel peaking boiler, to ensure continuous steam supply to the plant.

MCAS Cherry Point has a highly variable steam demand (See Figure 6-4). Based upon discussions with base personnel, it was determined that the most favorable approach would be the supply of a base load of approximately 50,000 lb/hr (maximum), which is equivalent to approximately 210 tpd. Given the fact that this is a base load situation, the total plant capacity should be sized at 270 tpd consisting of three combustion trains sized at 90 tpd each.

The remaining tonnage, i.e., the amount of solid waste not going to National Spinning Co. or MCAS Cherry Point, is available for a facility at MCB Camp Lejeune. This is approximately 270 tpd., in the year 1992. MCB Camp Lejuene has a highly variable steam demand. As shown in Figure 6-5, 270 tpd will not meet all of the winter steam demand, but does meet a sufficiently large portion of the demand to warrant a waste-to-energy facility. The deficit can be made up with one of the existing boiler plants. A peaking boiler (fossil fuel) would be used to supplement the



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SCENARIO C-1

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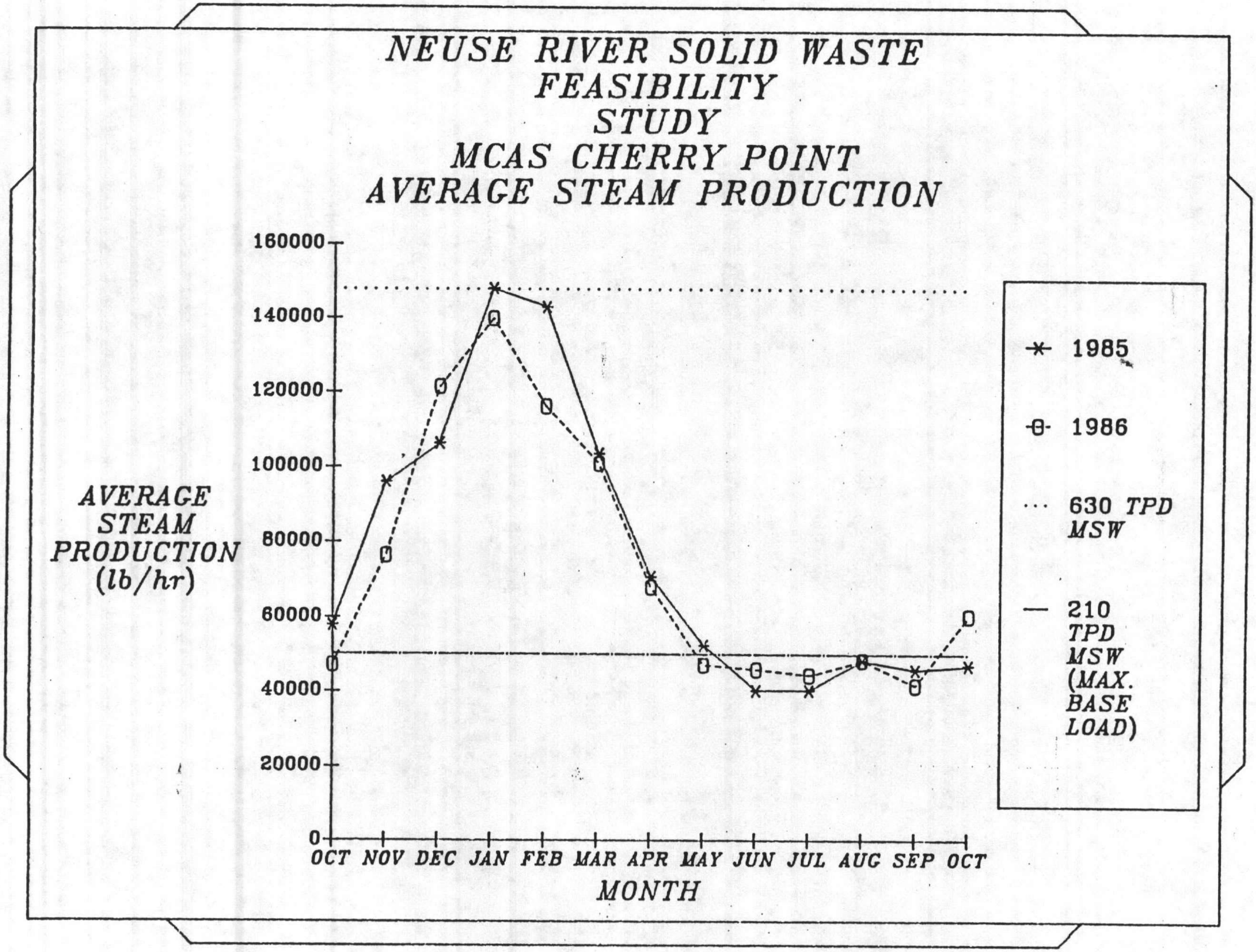
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STUDY
MCAS CHERRY POINT
AVERAGE STEAM PRODUCTION
AVERAGE
STEAM
PRODUCTION
(lb/hr)
160000
140000
120000
100000
80000
60000
40000
20000
0
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT
MONTH
1985
1986
630 TPD MSW
210 TPD MSW (MAX. BASE LOAD)

FIGURE 6-4

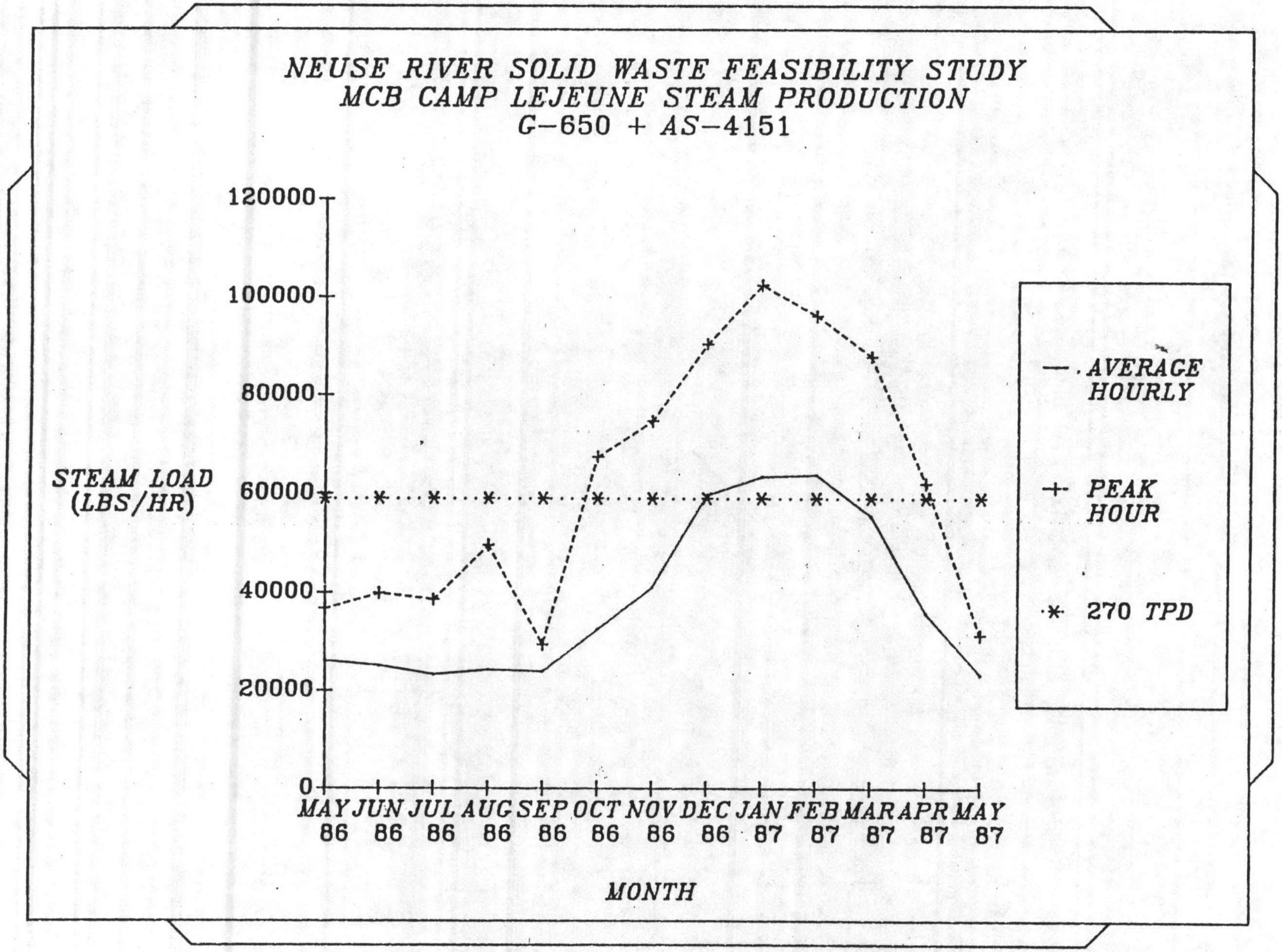

NEUSE RIVER SOLID WASTE FEASIBILITY STUDY
MCB CAMP LEJEUNE STEAM PRODUCTION
G-650 + AS-4151
STEAM LOAD (LBS/HR)
120000
100000
80000
60000
40000
20000
0
MAY 86
JUN 86
JUL 86
AUG 86
SEP 86
OCT 86
NOV 86
DEC 86
JAN 87
FEB 87
MAR 87
APR 87
MAY 87
MONTH
AVERAGE HOURLY
PEAK HOUR
270 TPD

FIGURE 6-5

waste-to-energy facility when steam loads are excessive, or where sudden peaks are experienced which cannot be handled by the waste-to-energy facility.

One of the existing steam plants, G-650 or AS-4151 should be utilized for this service. Steam Plant G-650 would be ideal as plant officials are presently involved in the design to replace the aging boilers at this facility. The size of this project, coupled with a relatively low pressure for steam use indicates co-generation potential. An estimated 2.6 MW of electrical production ban be generated by the waste-to-energy facility.

Scenario C2

Scenario C2 consists of two separate projects serving National Spinning and MCB Camp Lejeune. The location and approximate waste sheds for these projects are shown in Figure 6-6. As with scenario C1, the National Spinning waste-to-energy facility, is sized at approximately 330 tpd (nominal 270 tpd), with a small peaking boiler.

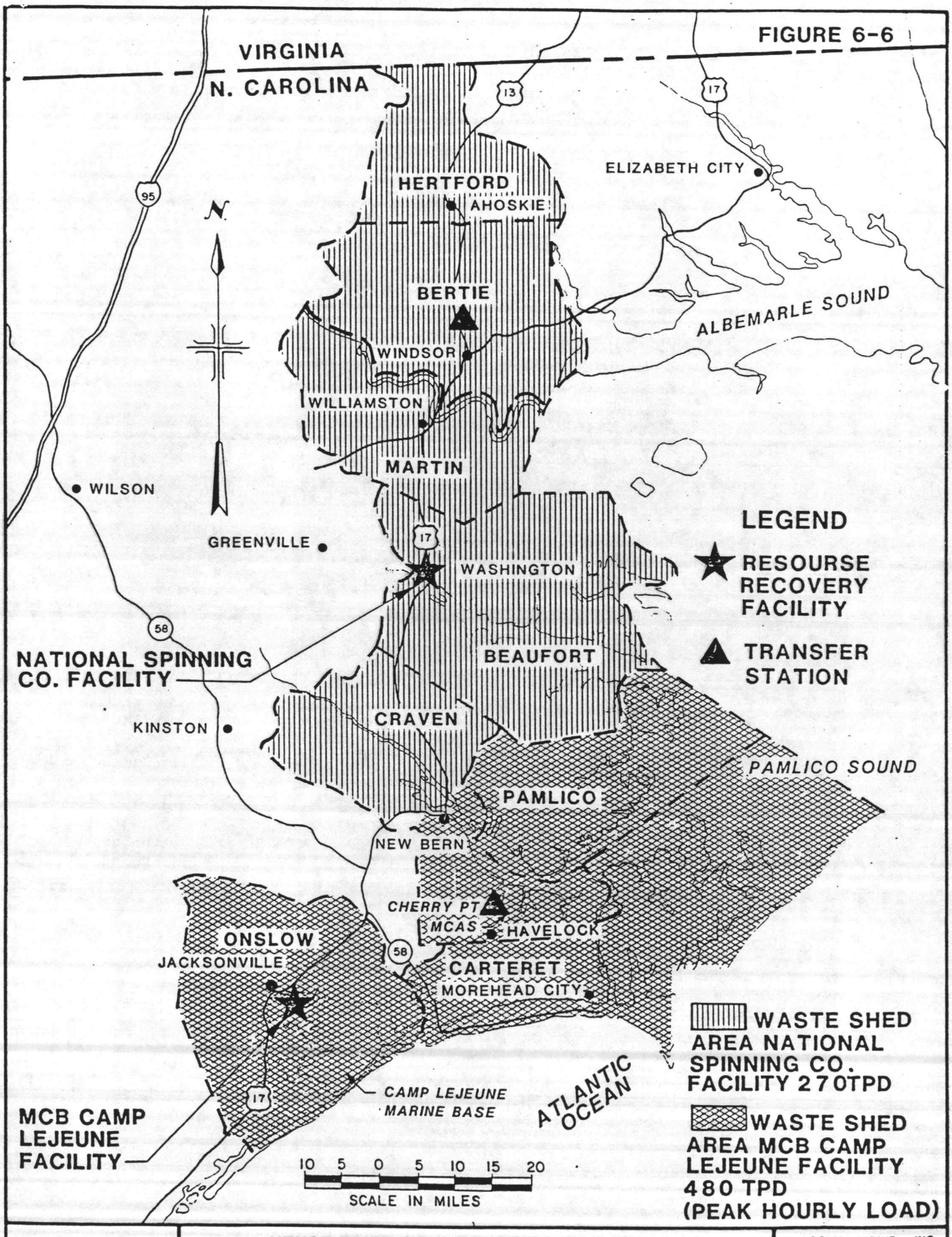
The remaining waste not going to National Spinning Co., is available for a facility at MCB Camp Lejeune, and is approximately 480 tpd. The actual facility would be sized with a total installed capacity of 600 tpd. As shown in Figure 6-7, 480 tpd exceeds all of the steam demands of steam plants G-650 and AS-4151.

The combination of the steam demand and the available waste makes this facility ideal for cogeneration, where excess steam is used to generate electrical power. It is estimated that this facility would produce an average of 6.8 MW, in the year 1992.

6.2 TRANSPORTATION ANALYSIS

A major impact on the feasibility of any waste-to-energy project scenario is the cost of transportation of MSW to a resource recovery facility. A transportation analysis was prepared to determine the mileage expected for each of the scenarios outlined in Section 6.1. The mileages were estimated using the following variables:

FIGURE 6-6

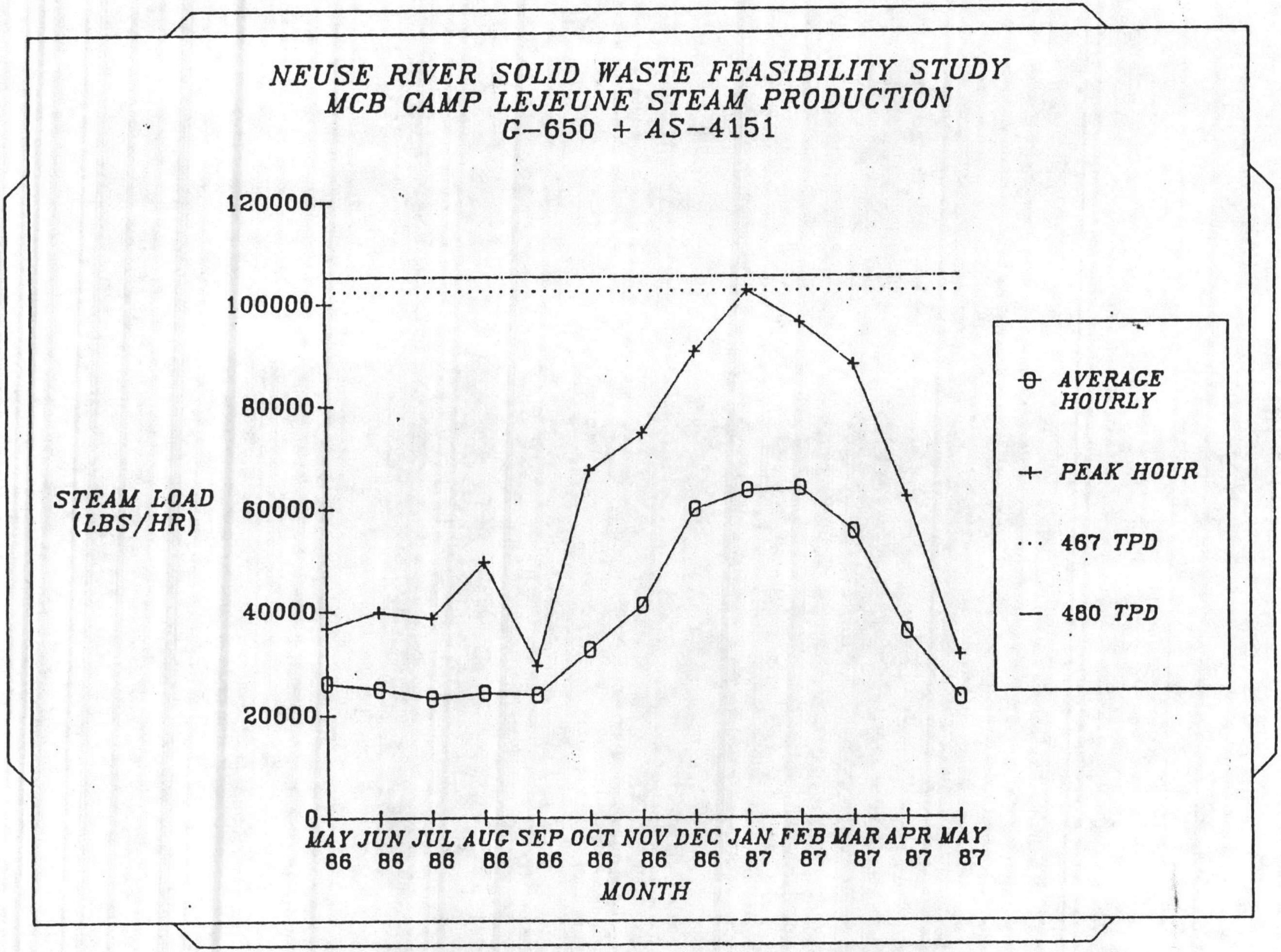


MALCOLM PIRNIE

NEUSE RIVER COUNCIL OF GOVERNMENTS
SOLID WASTE FEASIBILITY STUDY
SCENARIO C2

MALCOLM PIRNIE, INC.

SEPT 1987



NEUSE RIVER SOLID WASTE FEASIBILITY STUDY
MCB CAMP LEJEUNE STEAM PRODUCTION
G-650 + AS-4151
STEAM LOAD (LBS/HR)
120000
100000
80000
60000
40000
20000
0
MAY 86
JUN 86
JUL 86
AUG 86
SEP 86
OCT 86
NOV 86
DEC 86
JAN 87
FEB 87
MAR 87
APR 87
MAY 87
MONTH
AVERAGE HOURLY
PEAK HOUR
467 TPD
480 TPD

FIGURE 6-7

- County waste quantities

- Distance between population centroid and transfer station, or resource recovery facility

- Distance between transfer station(s) and resource recovery facility

- Waste collection vehicles have a capacity of 6 tons

- Transfer trucks have a capacity of 18 tons

Estimated transportation mileages were then multiplied by $1.25/mile, to obtain transportation costs. The results are shown in Table 6-1. The figure $1.25/mile is an average cost which includes vehicle capital costs, fuel costs, vehicle maintenance and labor.

Barging costs are not included in the transportation analysis as the relatively small quantities of MSW produced would not justify the cost of constructing marine transfer stations at both points of crossing. Barging MSW is only cost effective with large quantities of MSW over a relatively long distance.

6.3 SITE REQUIREMENTS

Some major considerations when locating a specific site for a resource recovery facility are:

- Distance from Energy Market

  Generally, for project economics, a resource recovery facility must be located within one to two miles of an energy market. In the case of a steam market, an excessive length of steam piping will affect system pressure losses, heat losses and the construction cost of the facility. In the case of an electric market, the distance to transmission lines or substations, will affect line losses and the construction cost of the facility.

- Water Availability

  Resource recovery facilities can use large amounts of water for cooling. This water should be obtainable within a reasonable distance from the site. If suitable water is not available, air cooled equipment can be used as an alternative.

Table 6-1

TRANSPORTATION ANALYSIS

	Annual Transportation Distance (miles)	Annual Transportation Cost $\$ x10^6$/year
Scenario A	2,645,909	3.31
Scenario B		
213 TPD Facility	636,563	0.80
537 TPD Facility	1,743,998	2.18
Total Scenario B	2,380,561	$2.98
Scenario C1		
National Spinning	599,913	0.75
MCAS Cherry Point	639,133	0.80
MCB Camp Lejeune	420,734	0.53
Total Scenario C1	1,659,780	$2.08
Scenario C2		
National Spinning	599,913	0.75
MCB Camp Lejeune	1,512,129	1.89
Total Scenario C2	2,112,042	$2.64

- Sewer Availability

  Wastewater, mostly from cooling water, housekeeping and sanitary uses and leachate requires sewage processing. A suitable sewerage system should be located within a reasonable distance from any resource recovery facility site.

- Electric Power

  All resource recovery facilities require electricity to run equipment. Even electric generating facilities (resource recovery) require electric power upon start-up, and in the event of an unforeseen generator shutdown.

- Residential Impact

  The public usually opposes siting resource recovery facilities near residential areas. Concerns include property value, traffic, noise, odors, aesthetics and air quality. Resource recovery facilities are more easily sited in industrial areas.

- Stack Height

  In the locality of air strips, the facility stack height is restricted due to low flying aircraft. Resource recovery facilities for both MCAS Cherry Point and MCB Camp Lejeune would be located near air strips. Stack height limitations are likely to affect the location of both of these facilities.

6.4 Supplementary Fuel

Scenario C1 includes a resource recovery facility that requires the use of a supplementary boiler (see Section 6.1). This is the MCB Camp Lejeune Facility. As suggested in Section 6.1, retaining steam plant G-650 as a supplementary boiler is an option which would reduce the construction and maintenance costs of installing a new supplementary boiler. Figure 6-5 shows the available MSW tonnage, in 1992, with relation to the quantity of steam required to fulfill the steam requirements of G-650 and AS-4151. Assuming G-650 is maintained as a supplementary boiler, Figure 6-5 shows that this supplementary boiler would be required almost continuously from December through February, and intermittently from October to December and March through April.

It is expected that, since MCB Camp Lejeune would probably operate and maintain steam plant G-650, revenues from the sale of steam would be reduced due to the cost of operating and maintaining this steam plant.

This reduction in steam revenues is reflected in the economic comparison, see Section 6.5.

6.5 ECONOMIC ANALYSIS

Tables 6-2, 6-3, 6-4 and 6-5, show the expected construction costs for each of the four scenarios outlined in section 6.1. Construction costs are based on historical data from other waste-to-energy facilities of similar sizes, and types. These costs are conservative and not site specific.

Tables 6-6, 6-7, 6-8 and 6-9 show the economics of all four scenarios. The capital costs of each scenario includes construction costs (from Tables 6-2, 6-3, 6-4 and 6-5), costs associated with the facility startup, design and construction administration, and debt coverage. Start-up costs have been estimated to be approximately 5% of the total construction costs while design and construction administration costs are estimated to be approximately 10% of the total construction costs.

In addition the following assumptions were made:

- Turbine is of the condensing type
- Turbine/Generator sets were sized at 100% of the system design value, with two turbine/generator sets per facility.
- Energy value of waste was assumed to be 4,500 btu/lb.
- The resource recovery facility is of the Mass Burn Type.

Annual Costs include operation & maintenance, residue disposal and debt service. Operation and maintenance and residue disposal costs are based on data from other waste-to-energy facilities. Residue disposal costs are the costs incurred to dispose of ash from the facility. Generally, this includes transportation and landfill of the residue.

Annual energy revenues include revenues from the sale of steam and electricity to the various users. The following values were used to calculate steam revenues for each steam facility:

TABLE 6-2

CONSTRUCTION COSTS
SCENARIO A
($ MILLIONS)

	ELECTRIC (750 TPD)
Boiler/Furnace (3 each) Feed pumps, blowers, stack rams, etc.	21.5
Turbine/Generators (2 each)	5.7
Condenser/Cooling Tower & Pumps	1.4
Air Pollution Equipment (3 each) Dust and Odor Control	8.4
Other Equipment Cranes, Scales, Ash handling	7.0
Site & Sitework	2.5
Facility Buildings, HVAC, Architecture	19.0
Piping, Valving, etc.	3.8
Electrical and Controls	4.7
Total Construction Costs	$74.00

NOTE: ALL COSTS ARE STATED IN 1987 DOLLARS

TABLE 6-3

CONSTRUCTION COSTS
SCENARIO B
($ MILLIONS)

	ELECTRIC (540 TPD)	ELECTRIC (210 TPD)
Boiler/Furnace (3 each) Feed pumps, blowers, stack rams, etc.	15.7	6.7
Turbine/Generators (2 each)	4.1	1.7
Condenser/Cooling Tower & Pumps	1.0	0.4
Air Pollution Equipment (3 each) Dust and Odor Control	6.1	2.6
Other Equipment Cranes, Scales, Ash handling	5.1	2.2
Site & Sitework	1.8	0.8
Facility Buildings, HVAC, Architecture	13.9	5.9
Piping, Valving, etc.	2.8	1.2
Electrical and Controls	3.4	1.5
Total Construction Costs	$53.90	$23.00

NOTE: ALL COSTS ARE STATED IN 1987 DOLLARS.

TABLE 6-4

CONSTRUCTION COSTS
SCENARIO C1
($ MILLIONS)

	NATIONAL SPINNING (270 TPD)	MCAS CHERRY POINT (210 TPD)	MCB CAMP LEJEUNE (270 TPD)
Boiler/Furnace (3 each) Feed pumps, blowers, stack rams, etc.	5.9	4.3	7.4
Turbine/Generators (2 each)	0.0	0.0	1.9
Condenser/Cooling Tower & Pumps	0.0	0.0	0.5
Air Pollution Equipment (3 each) Dust and Odor Control	2.3	1.7	2.9
Other Equipment Cranes, Scales, Ash handling	1.9	1.3	2.4
Site & Sitework	0.7	0.4	0.8
Facility Buildings, HVAC, Architecture	5.3	3.6	6.6
Piping, Valving, etc.	1.0	0.8	1.3
Electrical and Controls	1.3	0.9	1.6
Steam Pipe	0.5	2.4	1.5
Total Construction Costs	$18.90	$15.40	$26.90

NOTE: ALL COSTS ARE STATED IN 1987 DOLLARS

TABLE 6-5

CONSTRUCTION COSTS
SCENARIO C2
($ MILLIONS)

	NATIONAL SPINNING (270 TPD)	MCB CAMP LEJEUNE (480 TPD)
Boiler/Furnace (3 each) Feed pumps, blowers, stack rams, etc.	5.9	12.2
Turbine/Generators (2 each)	0.0	3.2
Condenser/Cooling Tower & Pumps	0.0	0.8
Air Pollution Equipment (3 each) Dust and Odor Control	2.3	4.8
Other Equipment Cranes, Scales, Ash handling	1.9	4.0
Site & Sitework	0.7	1.4
Facility Buildings, HVAC, Architecture	5.3	10.8
Piping, Valving, etc.	1.0	2.2
Electrical and Controls	1.3	2.6
Steam Pipe	0.5	2.1
Total Construction Costs	$18.90	$44.10

NOTE: ALL COSTS ARE STATED IN 1987 DOLLARS

TABLE 6-6

SCENARIO A - ECONOMICS

($ MILLIONS)

Capital Cost	
Construction Cost	74.0
Start-up Costs	3.7
Turnkey Design and Construction Admin.	7.4
Capital Subtotal	$85.1
Debt Coverage	17.0
TOTAL BOND ISSUE	$102.1
Annual Costs	
O & M (@ $22/TON)	6.0
Residue Disposal (@ $35/ton)	2.4
Debt Service (8%, 20 yrs)	10.4
TOTAL ANNUAL COST	$18.8
Annual Energy Revenues	
Steam	0.0
Electric	4.8
TOTAL ENERGY REVENUES	$4.8
NET DISPOSAL COST	$14.0
Break-even Tipping Fee ($/ton)	$51.14

NOTE: ALL COSTS/REVENUES ARE STATED IN 1987 DOLLARS

TABLE 6-7

SCENARIO B ECONOMICS

($ MILLIONS)

Capital Cost	SOUTHERN FACILITY	NORTHERN FACILITY	TOTALS
Construction Cost	53.9	23.0	76.9
Start-up Costs	2.7	1.1	3.8
Turnkey Design and Construction Admin.	5.4	2.3	7.7
Capital Subtotal	$62.0	$26.4	$88.4
Debt Coverage	12.4	5.3	17.7
TOTAL BOND ISSUE	$74.4	$31.7	$106.1
Annual Costs			
O & M (@ $22/ton)	4.3	1.7	6.0
Residue Disposal (@ $35/ton)	1.7	0.7	2.4
Debt Service (8%, 20 yrs)	7.6	3.2	10.8
TOTAL ANNUAL COST	$13.6	$5.6	$19.2
Annual Energy Revenues			
Steam	0.0	0.0	0.0
Electric	3.4	1.8	5.2
TOTAL ENERGY REVENUES	$3.4	$1.8	$5.2
NET DISPOSAL COST	$10.2	$3.8	$14.0
Break-even Tipping Fee ($/ton)	$51.75	$49.58	$51.14

NOTE: ALL COSTS/REVENUES ARE STATED IN 1987 DOLLARS

TABLE 6-8

SCENARION C1 - ECONOMICS

($ MILLIONS)

Capital Cost	NATIONAL SPINNING	MCAS CHERRY POINT	MCB CAMP LEJEUNE	TOTALS
Construction Cost	18.9	15.4	26.9	61.2
Start-up Costs	0.9	0.8	1.3	3.0
Turnkey Design and Construction Admin.	1.9	1.5	2.7	6.1
Capital Subtotal	$21.7	$17.7	$30.9	$70.3
Debt Coverage	4.3	3.5	6.2	14.0
TOTAL BOND ISSUE	$26.0	$21.2	$37.1	$84.3
Annual Costs				
O & M (@ $22/ton)	2.2	1.7	2.2	6.1
Residue Disposal (@ $35/ton)	0.9	0.8	0.9	2.6
Debt Service (8%, 20 yrs)	2.6	2.2	3.8	8.6
TOTAL ANNUAL COST	$5.7	$4.7	$6.9	$17.3
Annual Energy Revenues				
Steam	1.3	2.6	1.8	5.7
Electric	0.0	0.0	0.8	0.8
Total Energy Revenues	$1.3	$2.6	$2.6	$6.5
NET DISPOSAL COST	$4.4	$2.1	$4.3	$10.8
Break-even Tipping Fee ($/ton)	$44.65	$27.40	$43.63	$39.45

NOTE: ALL COSTS/REVENUES ARE STATED IN 1987 DOLLARS

TABLE 6-9

SCENARIO C2 - ECONOMICS

($ MILLIONS)

Capital Cost	NATIONAL SPINNING	MCB CAMP LEJEUNE	TOTAL
Construction Cost	18.9	44.1	63.0
Start-up Costs	0.9	2.2	3.1
Turnkey Design and Construction Admin.	1.9	4.4	6.3
Capital Subtotal	$21.7	$50.7	$72.4
Debt Coverage	4.3	10.1	14.4
TOTAL BOND ISSUE	$26.0	$60.8	$86.8
Annual Costs			
O & M (@ $22/ton)	2.2	3.8	6.0
Residue Disposal (@ $35/ton)	0.9	1.5	2.4
Debt Service (8%, 20 yrs)	2.6	6.2	8.8
TOTAL ANNUAL COST	$5.7	$11.5	$17.2
Annual Energy Revenues			
Steam	1.3	2.8	4.1
Electric	0.0	2.1	2.1
TOTAL ENERGY REVENUES	$1.3	$4.9	$6.2
NET DISPOSAL COST	$4.4	$6.6	$11.0
Break-even Tipping Fee ($/ton)	$44.65	$37.67	$40.18

NOTE: ALL COSTS/REVENUES ARE STATED IN 1987 DOLLARS

Facility	Production Cost ($/1000 lb steam)
National Spinning	3.63
MCAS Cherry Point	6.62
MCB Camp Lejeune	
G-650	8.19
AS-4151	8.11

The above data were supplied by the steam users. Preliminary calculations show that the production cost of $3.63/1000 lb steam reported, for National Spinning may not include equipment depreciation, labor, or major maintenance on the existing boilers. It is expected that full replacement of the National Spinning boilers may be worth more than the figure shown in the above table.

Electrical revenues were based on the steam, or excess steam produced by the facility, expected turbine performance, and the 15 year rate schedule of CP & L or NCP (Dependent on facility location). (See section 5.0) Negotiations with the Electric Membership Corporations of North Carolina, or the Municipal Power Agencies could yield a more profitable rate schedule. Electrical production greater than 5MW was assumed to have the same rate schedule as those less than 5MW (See Section 5.0).

The resultant break-even tipping fees represent the required disposal charge for a project with a zero net cost (break-even). They are not intended to be an actual tipping fee, but are used here for comparison purposes only.

Tables 6-10, 6-11, 6-12, and 6-13, are a breakdown of the transportation costs, including transfer stations. Again, a break-even tipping fee has been calculated for transportation.

Table 6-14 is a comparison of tipping fees calculated in tables 6-6 through 6-13.

Table 6-6 though 6-13 are based on a series of assumptions. The figures shown in these table are estimates, and may be subject to modification under any of the following factors:

- Delays in project completion with consequent delays in the contemplated revenue flow and exposure to inflation.

TABLE 6-10

SCENARIO A - TRANSPORTATION

($ MILLIONS)

CAPITAL COSTS (Transfer Stations)	
Construction Cost	5.3
Design and Construction Admin.	0.5
Capital Subtotal	$5.8
Debt Coverage	1.2
TOTAL BOND ISSUE	$7.0
Annual Costs	
Transportation Costs (O&M)	3.3
Debt Service (8%, 20 yrs)	0.7
TOTAL ANNUAL COST	$4.0
Break-even Tipping Fee ($/ton)	$14.61

NOTE: ALL COSTS ARE STATED IN 1987 DOLLARS

TABLE 6-11

SCENARIO B - TRANSPORTATION

($ MILLIONS)

CAPITAL COSTS (Transfer Stations)	SOUTHERN FACILITY	NORTHERN FACILITY	TOTALS
Construction Cost	2.2	0.5	2.7
Design and Construction Admin.	0.2	0.1	0.3
Capital Subtotal	$2.4	$0.6	$3.0
Debt Coverage	0.5	0.1	0.6
TOTAL BOND ISSUE	$2.9	$0.7	$3.6
Annual Costs			
Transportation Costs (O&M)	2.2	0.8	3.0
Debt Service (8%, 20 yrs)	0.3	0.1	0.4
TOTAL ANNUAL COST	$2.5	$0.9	$3.4
Break-even Tipping Fee ($/ton)	$12.68	$11.74	$12.42

NOTE: ALL COSTS ARE STATED IN 1987 DOLLARS

TABLE 6-12

SCENARION C1 - TRANSPORTATION

($ MILLIONS)

CAPITAL COSTS (Transfer Stations)	NATIONAL SPINNING	MCAS CHERRY POINT	MCB CAMP LEJEUNE	TOTALS
Construction Cost	0.5	0.0	0.0	0.5
Design and Construction Admin.	0.1	0.0	0.0	0.1
Capital Subtotal	$0.6	$0.0	$0.0	$0.6
Debt Coverage	0.1	0.0	0.0	0.1
TOTAL BOND ISSUE	$0.7	$0.0	$0.0	$0.7
Annual Costs				
Transportation Costs (O&M)	0.8	0.8	0.5	2.1
Debt Service (8%, 20 yrs)	0.1	0.0	0.0	0.1
TOTAL ANNUAL COST	$0.9	$0.8	$0.5	$2.2
Break-even Tipping Fee ($/ton)	$9.13	$10.44	$5.07	$8.04

NOTE: ALL COSTS ARE STATED IN 1987 DOLLARS

TABLE 6-13

SCENARIO C2 - TRANSPORTATION

($ MILLIONS)

CAPITAL COSTS (Transfer Stations)	NATIONAL SPINNING	MCB CAMP LEJEUNE	TOTAL
Construction Cost	0.5	1.3	1.8
Design and Construction Admin.	0.1	0.1	0.2
Capital Subtotal	$0.6	$1.4	$2.0
Debt Coverage	0.1	0.1	0.2
TOTAL BOND ISSUE	$0.7	$1.5	$2.2
Annual Costs			
Transportation Costs (O&M)	0.8	1.9	2.7
Debt Service (8%, 20 yrs)	0.1	0.1	0.2
TOTAL ANNUAL COST	$0.9	$2.0	$2.9
Break-even Tipping Fee ($/ton)	$9.13	$11.41	$10.59

NOTE: ALL COSTS ARE STATED IN 1987 DOLLARS

TABLE 6-14

ECONOMIC COMPARISON
($ PER TON)

	FACILITY COST	TRANSPORTATION COST	TOTAL COST
SCENARIO A	$51.14	$14.61	$65.75
SCENARIO B			
SOUTHERN FACILITY	$51.75	$12.68	$64.43
NORTHERN FACILITY	$49.58	$11.74	$61.32
SCENARIO C1			
NATIONAL SPINNING	$44.65	$9.13	$53.78
MCAS CHERRY POINT	$27.40	$10.44	$37.84
MCB CAMP LEJEUNE	$43.63	$5.07	$48.70
SCENARIO C2			
NATIONAL SPINNING	$44.65	$9.13	$53.78
MCB CAMP LEJEUNE	$37.67	$11.41	$49.08

NOTE: ALL COSTS ARE STATED IN 1987 DOLLARS.

- Capital cost overruns.
- New legislation affecting any aspect of facility operation, especially pollution control requirements.
- Changes in waste composition and heating value.
- Fluctuations in the price of energy.
- Adverse changes in the energy purchaser's financial condition.
- Adverse cost of connection to electrical grid, for electric generating facilities.

6.6 SCENARIO RECOMMENDATIONS

Due to the favorable Economic Comparison, shown in Table 6-14, Scenario C1 is the recommended Scenario. As outlined in Section 6.1, this scenario includes the following facilities:

- National Spinning Co. - full load
- MCAS Cherry Point - Maximum base load
- MCB Camp Lejeune - cogeneration facility.

The principal reasons for Scenario C1's favorable economics are waste transport and energy values. Because Scenario C1 contains three projects overall waste transport distances and hence costs are reduced. Revenues derived from steam sales generally exceed electrical revenues for most situations.

7.0 PROJECT IMPLEMENTATION STRUCTURES AND METHODS

7.1 Overview

For any given resource recovery project, there are a number of ways which it may be implemented. Some implementation structures are quite complex involving multiple participants with varying roles and multiple pathways for monies. At the heart of any project however, there are only four basic questions that must be addressed as follows:

- Ownership
- Procurement (Design and/or Construction)
- Operations
- Financing

All of these elements are intertwined and no single element can be analyzed in complete isolation from the others. Each decision represented above will be made by the jurisdiction(s) in light of their situation, capabilities and desires. Each decision places the risk for that element on one party or another. As no one usually accepts risks without compensation, there is almost always a price associated with each assignment of risk.

7.2 Ownership

Decisions regarding ownership of resource recovery facilities have, in the past, been driven by tax laws. Because of the previous tax law structure, significant advantages could accrue to private entrepreneurs who placed equity into projects. The advantage to the jurisdiction was that this private equity resulted in lower project costs. The disadvantage was that the jurisdiction relinquished control of the facility.

With the recent tax law revisions, there is little incentive towards private ownership. This is particularly true for jurisdictions with significant resources and experience in complex public projects. For smaller jurisdictions with little experience and limited resources, private ownership may make sense in certain instances.

7.3 Procurement

Procurement, as used here, denotes the method by which the facilities are designed and constructed. There are various ways to assign these responsibilities depending on the jurisdictions capabilities and desires. Three basic approaches exist as follows:

Conventional (A/E) Approach

The conventional or Architectural/Engineering approach is the traditional and most widely used approach for procuring public works projects. A professional engineering firm is retained by the procuring agency to participate in the planning and design of a project. The engineer, acting as agent for the agency, prepares equipment and system specifications to be let out for public bidding. Following bid evaluation, the engineer is retained construction management administration and/or inspection of the project in order to ensure the use of proper materials, supplies, equipment, etc. Upon completion of construction, the engineer assists in plant startup and testing and may be required to prepare operating manuals for the facility. Once the facility has passed acceptance testing, operational responsibility becomes that of the procuring agency who might either operate the facility itself or contract out its operation to a private firm.

Turnkey

In a turnkey approach, a single entity is awarded a contract to design, construct, and start-up the facility. The turnkey contractor selects the equipment and supplies to be used and may either design and construct the facility itself or subcontract portions of the work. In either case, the contractor assumes sole responsibility for the project. Upon completion of construction and start-up and successful testing, the project is accepted by the procuring agency.

Full Service

An extension of the turnkey approach is to assign total responsibility for facility design, construction, startup, testing,

operation, and possibly ownership, to a single entity or full service developer. Under this approach, the procuring agency is provided with a total service rather than an operable facility.

The assignment of risks for these approaches is shown in the following table:

RISK SHARING UNDER ALTERNATIVE PROCUREMENT APPROACHES

		A&E	Turnkey	Full Service
1.	Completion of project construction within specified time frame	PA	C	C
2.	Construction cost overruns	PA	C	C
3.	Satisfaction of acceptance test	E	C	C
4.	Changes in laws and regulations requiring additional capital investment	PA	PA	PA
5.	Operating and maintenance costs	PA	PA	C
6.	System performance during operation	PA	PA	C
7.	Solid waste supply, composition and characteristics	PA	PA	C/PA
7.	Recovered product marketing	PA	PA	C

E Engineer
C Contractor
PA Public agency

7.4 Operations

Regardless of other facility decisions, resource recovery facilities may be either publicly or privately (i.e., through contracts) operated. This decision hinges on the ability of the public agency to operate an energy producing facility. These facilities require specialized labor and a commitment to on-going maintenance which are sometimes not part of public agency operating procedures. A number of (particularly smaller) facility failures have been attributable to inadequate operation and maintenance. If this commitment to properly

skilled operations and quality maintenance is made, public agency operations can be effective.

7.5 Financing

The question of financing is closely related to ownership and procurement. As previously stated, these aspects must be examined in concert in order to reach a comprehensive decision.

Financing of projects of this magnitude requires considerable resources. Two general approaches have been taken:

- general obligation (G.O.) bonds
- revenue bonds.

General obligation (G.O.) bonds have the full faith and credit of the issuing entity (jurisdiction) behind them. Put simply, if the facility does not perform to expectations the issuing agency will make up the difference through its general revenues. Hence, G.O. bonds are usually secured through the taxing authority of the issuing agency.

Revenue bonds, conversely, are secured only by the project revenue stream. This, of course, leads to greater project scrutiny by the financial community of project soundness. The only revenues pledged to bond payments are waste disposal fees and energy revenues.

A key consideration in revenue bond financing is the ability of the project to control the waste stream. If the waste stream is not controlled via legislation or local ordinance, insufficient security exists to issue the bonds. If the waste were to be displaced to another project as a result of lower tipping fees, insufficient revenues, both waste disposal and energy, would be generated to make the bond payments.

Industrial development bonds differ from other types of municipal securities in that they are backed solely by a taxable entity such as an industrial corporation and not by any governmental unit. The proceeds of the bonds are used to finance facilities constructed for the business operations of these taxable entities. These bonds are typically issued

by an agency or other political subdivision for the purpose of financing a facility which will benefit the local area.

The source of payments of IDBs is tipping fees and revenues from energy sales. They are secured by liens, guarantees or other arrangements, and may be used in connection with leveraged leases or project financing. With the advent of the 1986 Tax Reform Act, bond volume allocations granted to each state is limited to $75.00 per capita. It is expected that the state will issue these bonds on a jurisdictional basis.

For example: In the year 1992, the population of the area included in this study will be approximately 428,805. The maximum bond allocation, for this area, will then be approximately 32.2 million dollars, for <u>all</u> intended eligible tax exempt projects. As shown in Table 6-7, the total bond issue requirement, for Scenario C1, is 80.4 million dollars, 48.2 million more than the bond allocation. It is unlikely that the state would divert bond allocations from other jurisdictions.

Since the basic IRS rule states that the project will be exempt up to the point where the refuse has been converted into a marketable product have value, the only equipment not qualifying would be turbine generators and condensers, as well as the steam line to the turbine. The non-qualifying equipment does not exceed 5 percent of the cost of the project (an "insubstantial portion") so this is not a potential problem.

North Carolina Energy Development Authority (NCEDA)

The North Carolina Energy Development Authority was created to assist in the planning, financing and development of energy facilities. NCEDA may issue revenue bonds to support its facilities. The NCEDA was created, in part, to assist in financing resource recovery projects.

Various possibilities exist for NCEDA participation in a project. They have the authority necessary to fully participate including acquiring land, executing contracts, compelling adoption of solid waste ordinance and similar acts. NCEDA may own the facility, either outright or in a joint venture arrangement with jurisdictions (County/ies).

They may also enter into third party arrangements incorporating private ownership although significant logistical and legal questions exist for this arrangement.

To date the NCEDA has not been involved in any resource recovery projects which have been implemented. Their capabilities offer significant potential for future project development.

7.6 Recommended Scenario Implementation Structure

The recommended scenario (C1) consists of three discrete projects. Two of these projects involve federal (military) energy markets and the third involves a private industry. From a waste supply perspective, all projects involve multiple jurisdictions, including towns, cities, counties and military bases. Because each project within this scenario is different, each will be analyzed separately.

National Spinning

This project involves waste generated by the counties of Hertford, Bertie, Martin, Beaufort and Craven. Only part of Craven County's waste is necessary for this project, whereas the total county-wide waste is assumed to be devoted from the other jurisdictions.

The sole energy market for this project is a private industry , National Spinning, located in the town of Washington in Beaufort County.

This project could be implemented either publicly or privately. If public implementation is selected either a multi-County waste authority consisting of Hertford, Bertie, Martin, Beaufort and Craven Counties could be pursued or a single county could take the lead. In this case, because Beaufort County is the largest waste contributor to the project and is host to the energy market, they are the most logical entity. It would then be necessary for Beaufort to execute waste supply contracts with other participating jurisdictions. In addition, an energy contract with National Spinning would be necessary.

Participation of NCEDA also looks promising and should be pursued. Because none of the jurisdictions involved in this project are presently producing steam for an industrial client, nor have any of the

jurisdictions operated facilities of similar complexity, it is recommended that a private contractor be hired to design, construct and operate this facility.

Because the complete impact of the new tax laws have not yet been realized, the marketplace for private ownership of projects has not yet been fully tested. It is recommended that the procurement for this project be flexible and consider a full-service approach with both public and private ownership. If private ownership offers a significant financial advantage, the Counties may wish to select this option. The disadvantage is that at the end of the service agreement (20 years) the plant will belong to the full-service contractor and the jurisdictions will have to negotiate for their solid waste disposal needs.

MCAS Cherry Point and MCB Camp Lejeune

These projects both involve supply of steam to military installations and waste supply from multiple jurisdictions. Craven, Pamlico and Carteret Counties would supply waste for Cherry Point and Onslow and Carteret would supply waste for Camp Lejeune.

The involvement of the military in both these projects somewhat complicates the implementation structure. On the one hand, Federal partnership brings financial resources and stability while on the other, Federal financial participation could mean significant project delays and complications. Because these projects are provision of a service to a military installation, it is instructive to examine trends in this area. In recent years, there has been a considerable emphasis on third party privatization of services at military bases. In fact, supply of steam as well as other services at Cherry Point is currently undergoing a competitive process which will compare existing civilian employees with third party private ventures. If these ventures are more cost-effective, the services will be privatized.

Because of this significant trend in provision of military services it is recommended that these projects be pursued as full service procurements. Craven County should take the lead in developing the Cherry Point Project and Onslow should take the lead in the Camp Lejeune

Project. Participation of NCEDA is also a possibility which should be further explored.

7.7 Implementation Schedule

A general implementation schedule for the recommended Scenario C1 is shown Figure 7-1. This schedule assumes that project implementation begins in 1988. Based upon an orderly implementation without significant delays, project start-ups could begin in mid-1992. Full-scale operation is expected in early 1993.

This schedule is preliminary in nature and depends on the ultimate project structure and capability and resolve of project participants.

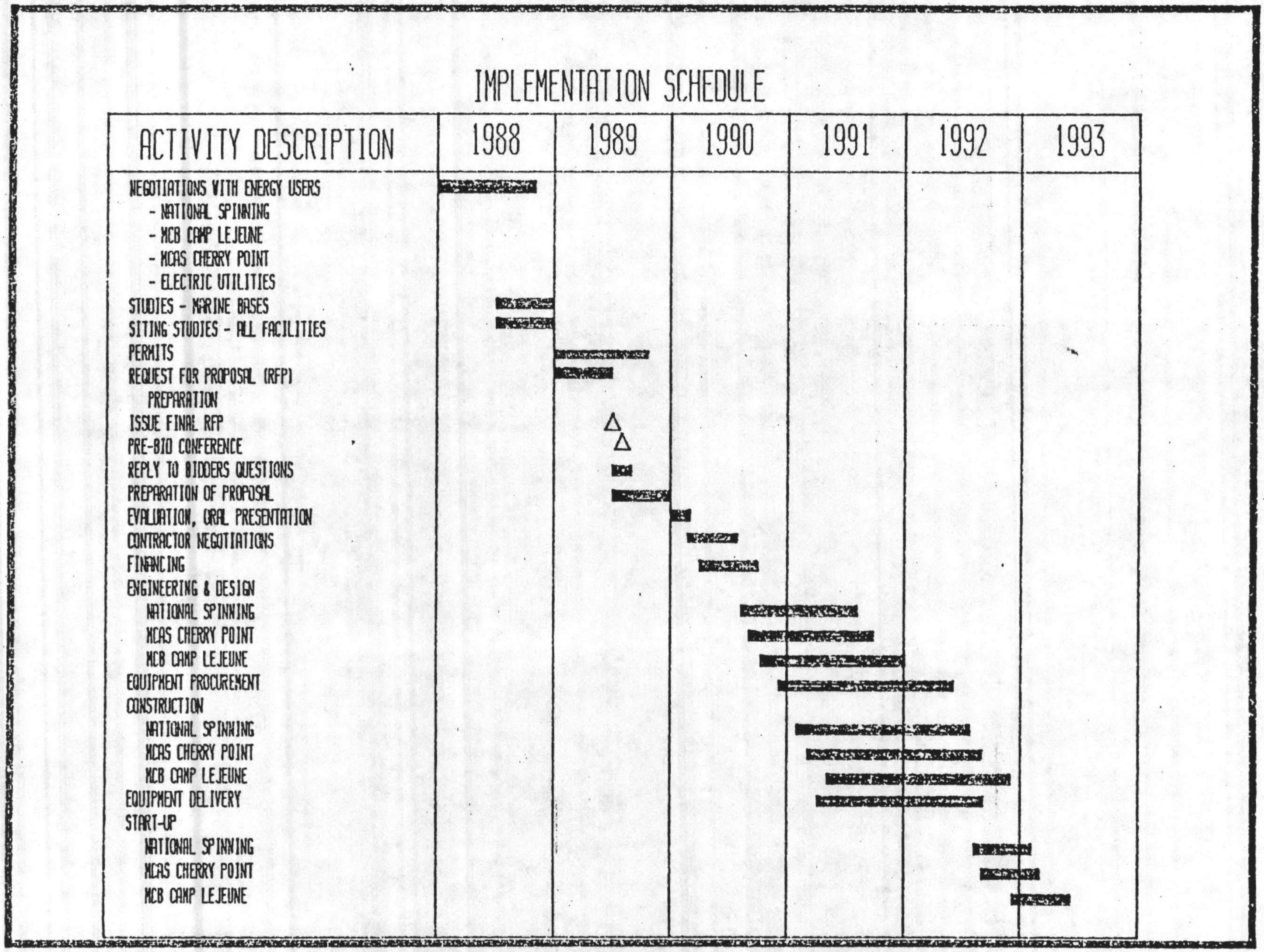

IMPLEMENTATION SCHEDULE
ACTIVITY DESCRIPTION
1988
1989
1990
1991
1992
1993
NEGOTIATIONS WITH ENERGY USERS
- NATIONAL SPINNING
- MCB CAMP LEJEUNE
- MCAS CHERRY POINT
- ELECTRIC UTILITIES
STUDIES - MARINE BASES
SITING STUDIES - ALL FACILITIES
PERMITS
REQUEST FOR PROPOSAL (RFP) PREPARATION
ISSUE FINAL RFP
PRE-BID CONFERENCE
REPLY TO BIDDERS QUESTIONS
PREPARATION OF PROPOSAL
EVALUATION, ORAL PRESENTATION
CONTRACTOR NEGOTIATIONS
FINANCING
ENGINEERING & DESIGN
NATIONAL SPINNING
MCAS CHERRY POINT
MCB CAMP LEJEUNE
EQUIPMENT PROCUREMENT
CONSTRUCTION
NATIONAL SPINNING
MCAS CHERRY POINT
MCB CAMP LEJEUNE
EQUIPMENT DELIVERY
START-UP
NATIONAL SPINNING
MCAS CHERRY POINT
MCB CAMP LEJEUNE

FIGURE 7-1

8.0 RECOMMENDATIONS

8.1 Technology

A review of available energy recovery technology has been performed and the following mass burn options were deemed appropriate.

- waterwall
- rotary waterwall
- modular

The final selection can be determined during procurement. For the recommended projects which incorporate electrical production, modular units are not appropriate technology.

8.2 Waste Stream

Conduct a weighing program in each County to verify waste quantities. These programs should consist of at least two weeks of weighing at the landfills on a quantity basis.

8.3 Energy Markets

Steam

A review of steam markets identified the following:

- National Spinning
- MCAS Cherry Point
- MCB Camp Lejeune

All of these expressed interest in project participations and appear to be strong markets. Both military bases represent extremely stable, long-term markets. National Spinning, being a private industry, is much less stable as a long-term market. The energy sales contract must reflect this concern.

Electricity

For the cogeneration projects, viable electrical markets, North Carolina Power and Carolina Power and Light, exist which have approved

cogeneration tariffs. The rates offered by these markets will be the subject of negotiations.

Implementation

Discussions should commence between project participants regarding project structure. Included should be discussions with North Carolina Energy Development Authority.

Tentative agreements regarding commitments of interest should be drafted which include project roles. These agreement will later be superseded as waste supply and energy market contracts are formally drafted and approved.