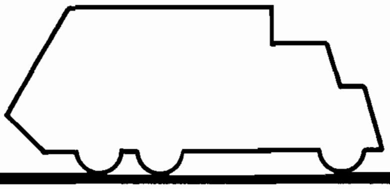
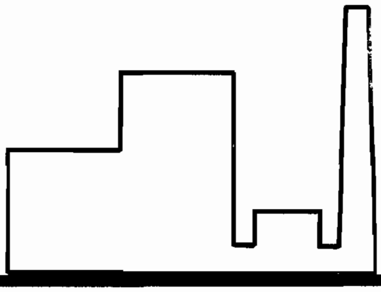
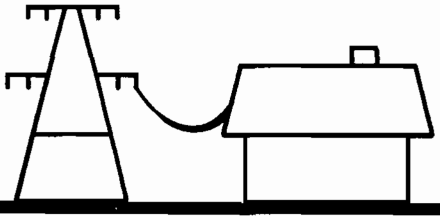
COLLIER COUNTY WASTE-TO-ENERGY PLANT

AIR QUALITY

Permitting Documents
Volume I







RESOURCE RECOVERY
RRC
OF COLLIER, INC.

DEPARTMENT OF ENVIRONMENTAL REGULATION
STATE OF FLORIDA

COLLIER COUNTY WASTE TO ENERGY PLANT

AIR QUALITY

PERMITTING DOCUMENTS

DER
MAY 1 1986
BAQM

Pending
*See 7/15/87
Correspondence
PSD-FL-111
0210051-NA-AC

SHAWMUT ENGINEERING, INC.
WESTINGHOUSE ELECTRIC CORPORATION
APRIL 30, 1986

COLLIER COUNTY WASTE-TO-ENERGY PLANT

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Prepared By:

KBN Engineering and Applied Sciences, Inc.
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Shawmut Engineering, Inc.
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National Ecology, Inc.
John Berry

APRIL 30, 1986

SHAWMUT ENGINEERING, INC.
Energy Project Developing and Consulting

5000 WABASH AVENUE • BALTIMORE, MARYLAND 21215 • TELEPHONE: (301) 542-8077

April 23, 1986

State of Florida
Department of Environmental Regulation
2600 Blair Stone Road
Tallahassee, FL 32301

Gentlemen:

Eric Ostergaard, Vice President of both Resource Recovery of Collier County, Inc. and Shawmut Engineering, Inc. is authorized to represent Resource Recovery of Collier County, Inc. in its application to operate/construct an air pollution source.

Sincerely,

SHAWMUT ENGINEERING, INC.

Charles S. Ezrine
President

RESOURCE RECOVERY OF COLLIER COUNTY, INC.

Charles S. Ezrine
President

BEST AVAILABLE COPY

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

AC 11-119614 (Unit 1)
AC 11-119615 (Unit 2)

DER
MAY 1 1986
BAQM

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

ALEX SENKEVICH
DISTRICT MANAGER

APPLICATION TO OPERATE/CONSTRUCT AIR POLLUTION SOURCES

SOURCE TYPE: Solid Waste Energy Recovery Facility [X] **New**[1] [ ] **Existing**[1]

APPLICATION TYPE: [X] **Construction** [ ] **Operation** [ ] **Modification**

COMPANY NAME: Resource Recovery of Collier, Inc. **COUNTY:** Collier

Identify the specific emission point source(s) addressed in this application (i.e. Lime Kiln No. 4 with Venturi Scrubber; Peaking Unit No. 2, Gas Fired) Solid Waste Energy Recovery Units 1 and 2 (CFB Boilers with fabric filters

SOURCE LOCATION: Street S.R. 84 at Naples Sanitary Landfill City Near Golden Gate

UTM: East Zone 17 434.4 North 2892.9

Latitude 26 ° 09 ' 30 "N Longitude 81 ° 39 ' 00 "W

APPLICANT NAME AND TITLE: Eric Ostergaard, V.P.

APPLICANT ADDRESS: 5000 Wabash Avenue, Baltimore, MD 21215

SECTION I: STATEMENTS BY APPLICANT AND ENGINEER

A. APPLICANT

I am the undersigned owner or authorized representative* of Resource Recovery of Collier, Inc.

I certify that the statements made in this application for a Construction permit are true, correct and complete to the best of my knowledge and belief. Furthe I agree to maintain and operate the pollution control source and pollution contr facilities in such a manner as to comply with the provision of Chapter 403, Flori Statutes, and all the rules and regulations of the department and revisions thereof. also understand that a permit, if granted by the department, will be non-transferab and I will promptly notify the department upon sale or legal transfer of the permitt establishment.

*Attach letter of authorization

Signed:

Eric Ostergaard, V.P.
Name and Title (Please Type)

Date: 30 April 1986 Telephone No. (301) 542-8077

B. PROFESSIONAL ENGINEER REGISTERED IN FLORIDA (where required by Chapter 471, F.S.)

This is to certify that the engineering features of this pollution control project ha been designed/examined by me and found to be in conformity with modern engineeri principles applicable to the treatment and disposal of pollutants characterized in t permit application. There is reasonable assurance, in my professional judgment, th

---

[1] See Florida Administrative Code Rule 17-2.100(57) and (104)

the pollution control facilities, when properly maintained and operated, will discharge an effluent that complies with all applicable statutes of the State of Florida and the rules and regulations of the department. It is also agreed that the undersigned will furnish, if authorized by the owner, the applicant a set of instructions for the proper maintenance and operation of the pollution control facilities and, if applicable, pollution sources.

DAVID A. BUFF
NO. 19011

Signed David A. Buff

David A. Buff
Name (Please Type)

KBN Engineering and Applied Sciences, Inc.
Company Name (Please Type)

P.O. Box 14288, Gainesville, Fla. 32604
Mailing Address (Please Type)

Florida Registration No. 19011 Date: 30 April 1986 Telephone No. 904/375-8000

SECTION II: GENERAL PROJECT INFORMATION

A. Describe the nature and extent of the project. Refer to pollution control equipment, and expected improvements in source performance as a result of installation. State whether the project will result in full compliance. Attach additional sheet if necessary.

See Appendices I and II

B. Schedule of project covered in this application (Construction Permit Application Only)

Start of Construction Feburary, 1987 Completion of Construction 1st Quarter 1989

C. Costs of pollution control system(s): (Note: Show breakdown of estimated costs only for individual components/units of the project serving pollution control purposes. Information on actual costs shall be furnished with the application for operation permit.)

P&ID Fans	$ 250,000	Limestone Injection	$200,000
Boiler Baghouse (2)	$1,150,000	Limestone	$100,000/yr.
Process Baghouse (6)	$ 600,000	Ash Handling	$300,000
Stack	$ 600,000		

D. Indicate any previous DER permits, orders and notices associated with the emission point, including permit issuance and expiration dates.

None

E. Requested permitted equipment operating time: hrs/day 24 ; days/wk 7 ; wks/yr 52 ; if power plant, hrs/yr 8,760; if seasonal, describe: Not seasonal

F. If this is a new source or major modification, answer the following questions. (Yes or No)

1. Is this source in a non-attainment area for a particular pollutant? No

   a. If yes, has "offset" been applied? -

   b. If yes, has "Lowest Achievable Emission Rate" been applied? -

   c. If yes, list non-attainment pollutants. -

2. Does best available control technology (BACT) apply to this source? If yes, see Section VI. Yes

3. Does the State "Prevention of Significant Deterioriation" (PSD) requirement apply to this source? If yes, see Sections VI and VII. Yes

4. Do "Standards of Performance for New Stationary Sources" (NSPS) apply to this source? Yes

5. Do "National Emission Standards for Hazardous Air Pollutants" (NESHAP) apply to this source? No

H. Do "Reasonably Available Control Technology" (RACT) requirements apply to this source? No

   a. If yes, for what pollutants? -

   b. If yes, in addition to the information required in this form, any information requested in Rule 17-2.650 must be submitted.

Attach all supportive information related to any answer of "Yes". Attach any justification for any answer of "No" that might be considered questionable.

SEE APPENDICES

SECTION III: AIR POLLUTION SOURCES & CONTROL DEVICES (Other than Incinerators)

A. Raw Materials and Chemicals Used in your Process, if applicable:

Description	Contaminants Type	Contaminants % Wt	Utilization Rate - lbs/hr	Relate to Flow Diagram
Limestone			1 ton/hr.	Part of Combustion Process

B. Process Rate, if applicable: (See Section V, Item 1)

1. Total Process Input Rate (lbs/hr): 72,320 lb/hr RDF (total two units)

2. Product Weight (lbs/hr): 220,000 lb/hr steam (total two units)

C. Airborne Contaminants Emitted: (Information in this table must be submitted for each emission point, use additional sheets as necessary)

SEE APPENDIX III

Name of Contaminant	Emission[1] Maximum lbs/hr	Emission[1] Actual T/yr	Allowed[2] Emission Rate per Rule 17-2	Allowable[3] Emission lbs/hr	Potential[4] Emission lbs/yr	Potential[4] Emission T/yr	Relate to Flow Diagram

[1] See Section V, Item 2.

[2] Reference applicable emission standards and units (e.g. Rule 17-2.600(5)(b)2. Table II, E. (1) - 0.1 pounds per million BTU heat input)

[illegible]culated from operating rate and applicable standard.

[4] Emission, if source operated without control (See Section V, Item 3).

D. Control Devices: (See Section V, Item 4)

Name and Type (Model & Serial No.)	Contaminant	Efficiency	Range of Particles Size Collected (in microns) (If applicable)	Basis for Efficiency (Section V Item 5)
Boiler Baghouse (2)	Particulate	99.89	0.01μ and larger	Based on
[illegible]ot yet selected)				13 gr/DSCF
				inlet loading
Process Baghouses (6)	Particulate	99%+	0.01μ and larger	Manufact.
				information

E. Fuels

Type (Be Specific)	Consumption*		Maximum Heat Input (MMBTU/hr)
	lb/hr avg/hr	max./hr	
RDF/Wood Waste/Tires	72,320	72,320	328
(total both Units)			

*Units: Natural Gas--MMCF/hr; Fuel Oils--gallons/hr; Coal, wood, refuse, other--lbs/hr.

Fuel Analysis: SEE APPENDIX III

Percent Sulfur: ______ Percent Ash: ______

Density: ______ lbs/gal Typical Percent Nitrogen: ______

Heat Capacity: ______ BTU/lb ______ BTU/gal

Other Fuel Contaminants (which may cause air pollution): ______

See emissions estimates for other contaminants

If applicable, indicate the percent of fuel used for space heating.

Annual Average NA Maximum ______

G. Indicate liquid or solid wastes generated and method of disposal.

Liquid wastes will include boiler blowdown, cooling tower blowdown, demineralizer regeneration effluent, and leachate from the boiler ash disposal cells. All liquid wastes will either be discharged to the sanitary sewer for treatment by the City of Naples, or discharged to a new package treatment plant located on-site or nearby. Solid wastes generated will consist of dust and boiler bottom ash and fly ash collected in the baghouses. This material will be placed in a lines cell in the Naples Sanitary Landfill.

H. Emission Stack Geometry and Flow Characteristics (Provide data for each stack):

S[illegible] Height: 260 ft. Stack Diameter: 4.0' (each flue) ft.

Gas Flow Rate: 71495' ACFM 42,038 DSCFM Gas Exit Temperature: 351 °F.
(each boiler)

Water Vapor Content: approx. 15 % Velocity: 94.8 FPS

See Appendices II and IV

SECTION IV: INCINERATOR INFORMATION

Note: Based on 100% RDF Firing

Type of Waste	Type O (Plastics)	Type I (Rubbish)	Type II (Refuse)	Type III (Garbage)	Type IV (Pathological)	Type V (Liq.& Gas By-prod.)	Type VI (Solid By-prod.)
Actual lb/hr Incinerated			SEE APPENDIX III				
Uncontrolled (lbs/hr)			SEE APPENDIX III				

Description of Waste Municipal solid waste supplemented by wood waste and tires

T[illegible] Weight Incinerated (lbs/hr) 72,320 Design Capacity (lbs/hr) 72,320

Approximate Number of Hours of Operation per day 24 day/wk 7 wks/yr. 52

Manufacturer Gotaverken

Date Constructed 1988 Model No. N/A

	Volume $(ft)^3$	Heat Release (BTU/hr)	Fuel		Temperature (°F)
			Type	BTU/hr	
[illegible]mary Chamber	SEE APPENDIX II				
Secondary Chamber					

Stack Height: 260 ft. Stack Diamter: 4.0 ft. (each flue) Stack Temp. 351°F

Gas Flow Rate: 71,495 ACFM 42,038 @ 12% CO_2 DSCFM* Velocity: 94.8 FPS
(each boiler)

*50 or more tons per day design capacity, submit the emissions rate in grains per standard cubic foot dry gas corrected to 50% excess air. 0.015 gr/dscf

Type of pollution control device: [X] Cyclone [ ] Wet Scrubber [ ] Afterburner

[X] Other (specify) Fabric Filter

Brief description of operating characteristics of control devices:

See BACT analysis for further information (Appendix VI)

Ultimate disposal of any effluent other than that emitted from the stack (scrubber water, ash, etc.):

See Section IIIG.

NOTE: Items 2, 3, 4, 6, 7, 8, and 10 in Section V must be included where applicable.

SECTION V: SUPPLEMENTAL REQUIREMENTS

Please provide the following supplements where required for this application.

1. Total process input rate and product weight -- show derivation [Rule 17-2.100(127)]

   SEE APPENDICES I AND II

2. To a construction application, attach basis of emission estimate (e.g., design calculations, design drawings, pertinent manufacturer's test data, etc.) and attach proposed methods (e.g., FR Part 60 Methods 1, 2, 3, 4, 5) to show proof of compliance with applicable standards. To an operation application, attach test results or methods used to show proof of compliance. Information provided when applying for an operation permit from a construction permit shall be indicative of the time at which the test was made.

   SEE APPENDICES I AND III

3. Attach basis of potential discharge (e.g., emission factor, that is, AP42 test).

   SEE APPENDIX III

4. With construction permit application, include design details for all air pollution control systems (e.g., for baghouse include cloth to air ratio; for scrubber include cross-section sketch, design pressure drop, etc.)

   NOT AVAILABLE AT THIS TIME

5. With construction permit application, attach derivation of control device(s) efficiency. Include test or design data. Items 2, 3 and 5 should be consistent: actual emissions = potential (1-efficiency).

   SEE APPENDIX III

6. An 8 1/2" x 11" flow diagram which will, without revealing trade secrets, identify the individual operations and/or processes. Indicate where raw materials enter, where solid and liquid waste exit, where gaseous emissions and/or airborne particles are evolved and where finished products are obtained.

   SEE APPENDIX VIII

7. An 8 1/2" x 11" plot plan showing the location of the establishment, and points of airborne emissions, in relation to the surrounding area, residences and other permanent structures and roadways (Example: Copy of relevant portion of USGS topographic map).

   SEE APPENDIX VIII

8. An 8 1/2" x 11" plot plan of facility showing the location of manufacturing processes and outlets for airborne emissions. Relate all flows to the flow diagram.

   SEE APPENDIX VIII

9. The appropriate application fee in accordance with Rule 17-4.05. The check should be made payable to the Department of Environmental Regulation.

10. With an application for operation permit, attach a Certificate of Completion of Construction indicating that the source was constructed as shown in the construction permit.

SECTION VI: BEST AVAILABLE CONTROL TECHNOLOGY

SEE APPENDIX VI

A. Are standards of performance for new stationary sources pursuant to 40 C.F.R. Part 60 applicable to the source?

☐ Yes ☐ No

Contaminant	Rate or Concentration

B. Has EPA declared the best available control technology for this class of sources (If yes, attach copy)

☐ Yes ☐ No

Contaminant	Rate or Concentration

C. What emission levels do you propose as best available control technology?

Contaminant	Rate or Concentration

D. Describe the existing control and treatment technology (if any).

1. Control Device/System:
2. Operating Principles:
3. Efficiency:*
4. Capital Costs:

*Explain method of determining

5. Useful Life:

6. Operating Costs:

7. Energy:

8. Maintenance Cost:

9. Emissions:

Contaminant	Rate or Concentration

10. Stack Parameters

a. Height: ft.

b. Diameter: ft.

c. Flow Rate: ACFM

d. Temperature: °F.

e. Velocity: FPS

E. Describe the control and treatment technology available (As many types as applicable, use additional pages if necessary).

1.

a. Control Device:

b. Operating Principles:

c. Efficiency:[1]

d. Capital Cost:

e. Useful Life:

f. Operating Cost:

g. Energy:[2]

h. Maintenance Cost:

i. Availability of construction materials and process chemicals:

j. Applicability to manufacturing processes:

k. Ability to construct with control device, install in available space, and operate within proposed levels:

2.

a. Control Device:

b. Operating Principles:

c. Efficiency:[1]

d. Capital Cost:

e. Useful Life:

f. Operating Cost:

g. Energy:[2]

h. Maintenance Cost:

i. Availability of construction materials and process chemicals:

[1] Explain method of determining efficiency.
[2] Energy to be reported in units of electrical power - KWH design rate.

j. Applicability to manufacturing processes:

k. Ability to construct with control device, install in available space, and operate within proposed levels:

3.

a. Control Device:

b. Operating Principles:

c. Efficiency:[1]

d. Capital Cost:

e. Useful Life:

f. Operating Cost:

g. Energy:[2]

h. Maintenance Cost:

[illegible]. Availability of construction materials and process chemicals:

j. Applicability to manufacturing processes:

k. Ability to construct with control device, install in available space, and operate within proposed levels:

4.

a. Control Device:

b. Operating Principles:

c. Efficiency:[1]

d. Capital Costs:

e. Useful Life:

f. Operating Cost:

g. Energy:[2]

h. Maintenance Cost:

i. Availability of construction materials and process chemicals:

j. Applicability to manufacturing processes:

k. Ability to construct with control device, install in available space, and operate within proposed levels:

F. Describe the control technology selected:

1. Control Device:

2. Efficiency:[1]

3. Capital Cost:

4. Useful Life:

5. Operating Cost:

6. Energy:[2]

7. Maintenance Cost:

8. Manufacturer:

9. Other locations where employed on similar processes:

a. (1) Company:

(2) Mailing Address:

(3) City:

(4) State:

---

[1] Explain method of determining efficiency.
[2] Energy to be reported in units of electrical power - KWH design rate.

(5) Environmental Manager:

(6) Telephone No.:

(7) Emissions:[1]

Contaminant	Rate or Concentration

(8) Process Rate:[1]

b. (1) Company:

(2) Mailing Address:

(3) City: (4) State:

(5) Environmental Manager:

(6) Telephone No.:

(7) Emissions:[1]

Contaminant	Rate or Concentration

(8) Process Rate:[1]

10. Reason for selection and description of systems:

[1] Applicant must provide this information when available. Should this information not be available, applicant must state the reason(s) why.

SECTION VII - PREVENTION OF SIGNIFICANT DETERIORATION

A. Company Monitored Data: Not required: SEE APPENDIX IV

1. ______no. sites ______ TSP ______( ) SO^2* ______ Wind spd/dir

Period of Monitoring ____/____/____ to ____/____/____
month day year month day year

Other data recorded ____________________

Attach all data or statistical summaries to this application.

*Specify bubbler (B) or continuous (C).

2. Instrumentation, Field and Laboratory

a. Was instrumentation EPA referenced or its equivalent? ☐ Yes ☐ No

b. Was instrumentation calibrated in accordance with Department procedures?

☐ Yes ☐ No ☐ Unknown

B. Meteorological Data Used for Air Quality Modeling

1. 5 Year(s) of data from 1 / 1 / 81 (month / day / year) to 12 / 31 / 85 (month / day / year)

2. Surface data obtained from (location) Ft. Myers, Florida

3. Upper air (mixing height) data obtained from (location) Ruskin, Florida

4. Stability wind rose (STAR) data obtained from (location) Ft. Myers, Florida

C. Computer Models Used

1. PTPLU Modified? If yes, attach description.

2. ISCST Modified? If yes, attach description.

3. ISCLT Modified? If yes, attach description.

4. ______ Modified? If yes, attach description.

Attach copies of all final model runs showing input data, receptor locations, and principle output tables.

D. Applicants Maximum Allowable Emission Data

Pollutant	Emission Rate	
TSP	SEE APPENDIX III	grams/sec
SO^2		grams/sec

E. Emission Data Used in Modeling SEE APPENDIX IV

Attach list of emission sources. Emission data required is source name, description of point source (on NEDS point number), UTM coordinates, stack data, allowable emissions, and normal operating time.

F. Attach all other information supportive to the PSD review. SEE APPENDICES

G. Discuss the social and economic impact of the selected technology versus other applicable technologies (i.e., jobs, payroll, production, taxes, energy, etc.). Include assessment of the environmental impact of the sources. SEE APPENDIX VI

H. Attach scientific, engineering, and technical material, reports, publications, journals, and other competent relevant information describing the theory and application of the requested best available control technology.

SEE APPENDICES

APPENDIX I

FACILITY DESCRIPTION

APPENDIX I

FACILITY DESCRIPTION

1.0 OVERALL FACILITY DESCRIPTION

The Collier County Waste to Energy Plant will be located in the Southeast corner of the Collier County Sanitary Land Fill Property. The facility will process municipal solid waste (MSW) to Refuse Derived Fuel (RDF). The RDF, as well as chipped tires and woodchips will be used as fuel by two circulating fluidized bed combustion (CFB) units to produce 23 megawatts gross electric power. The two CFB units combined will be capable of firing up to 868 tons per day (TPD) of RDF. The RDF system will use established commercial technology from National Ecology to process the MSW into RDF with the recovery of ferrous, aluminum and glass materials.

The RDF will be conveyed with tire chips, wood, limestone, and bed material (sand) into the CFB combustion system furnished by Gotaverken. This combustion system will provide for low emissions, efficient conversion of fuel energy into power plant grade steam. The steam will be used to drive a condensing steam turbine generator.

At certain times during the year it will be necessary to densify the RDF into pellets. This pelletization step is desired when tires and/or wood chips are not available for combustion or when one or both boilers are shut down for more than two or three days. Pelletization gives the project the ability to process MSW during these boiler outages instead of diverting MSW to the landfill. Pelletization increases the RDF bulk density from 4 lbs./cu. ft. to 25 lbs./cu. ft., thereby making it practical to store larger quantities of the fuel.

1.1 Ventilation/Dust Collection

The tipping area, RDF process area, and RDF storage area are designed such that no odorous emissions will be detectable beyond site property lines. These areas are kept under slightly negative pressure by the aspiration points in the RDF process that are used for dust control.

The dust control of the RDF process begins on the tipping floor where a hood aspirates any dust produced when the MSW is placed upon the apron conveyor which feeds the primary shredder. Transfer points in the process are enclosed with the inlets and outlets sealed with rubber flaps. Aspiration points are strategically located in the process in order to control dust. Aspirated air and dust are ducted to two bag houses. Each baghouse is sized to handle a minimum flow of 25000 SCFM. Each baghouse discharge will have a dust loading of 0.01 gr/ft^3.

The baghouse discharge is ducted to the boiler(s) as combustion air. After combustion, the particulate is reduced to a fraction of a ton/year. During infrequent periods when one or both boilers are shut down for maintenance the baghouse discharge air will be vented thru the boiler stack. (See Section 5.0 "Summary of Particulate Emissions").

1.2 Circulating Fluidized Bed Combustion System

1.2.1 General

A high efficiency, sand/limestone, circulating, fluidized bed combustion system, as is in commercial use in several RDF, wood chip, and peat fueled installations in Sweden, is proposed for the Collier County Waste to Energy Plant. The system is designed, fabricated, and installed by Gotaverken, under Westinghouse overall supervision and responsibility. The design basis for the system is the generation of 23 gross MW of electric power which requires a nominal fuel input of 319 million BTU/hour (HHV). The fuel input is provided from four sources:

1) Nominally 4250 tons/week or 850 tons/weekday of MSW is processed in the 60 ton/hour capacity MSW to RDF system which is designed, fabricated, and installed by National Ecology under the overall supervision and responsibility of Westinghouse. The system nominally produces 3570 tons/week (84% conversion) of RDF in 71 hours of operation, with the remaining 97 hours available for maintenance and repair.

2) Average 200 tons/week of tires shredded to 100% minus 2 inch size.

3) Average 1200 tons/week of wood chips.

4) No. 2 fuel oil is utilized as a supplemental fuel during start-up and shut-down.

1.2.2 Combustion Process

Combustion in the two circulating fluidized bed boilers can be characterized as an exothermic process taking place in a suspension of fine limestone particles. The furnace consists of a water cooled panel wall boiler with two, high efficiency refractory lined cyclones in parallel at its outlet and a refractory protected water cooled air distributed grid at its bottom inlet. The bed material, primarily limestone, sized to be between 1/125 and 1/40 inch, is entrained in the upward flow of air along with the fuel, and the exothermic combustion reactions take place at the controlled temperature range of 1520°F to 1700°F as the upward flowing gas stream traverses the height of the furnace. The velocity is such that typically 5 seconds or so are required for this traverse, during which close to 100% of the gaseous fuel constituents and most of the solid combustibles are consumed.

Large pieces of fuel remain in the lower section of the boiler until they have been combusted to the point where they are small enough to be entrained upward. Uncombusted pieces of solid fuel are separated from the gases exiting the furnace by the cyclones, along with the entrained limestone, and are recirculated to the bottom of the furnace where they are re-entrained and repeat the traverse of the furnace as often as necessary to consume them. Heat extraction from the furnace by the boiler water walls can be controlled by varying the solids/gas ratio in the combustion zone which in turn will vary the heat transfer coefficient to the water walls. That variation is mainly controlled by the ratio of primary to secondary air injection above the refractory protected bottom section of the furnace.

The circulating fluidized bed has proven to be a combustion system with great efficiency and environmental protection capability compared to conventional bubbling fluidized beds and to mass burn techniques. The in-situ removal of sulfur and chlorine chemical species can easily be achieved by the injected limestone. Calcium carbonate ($CaCO_3$), is calcined by the high furnace temperature to lime (CaO) which in turn reacts with the sulfur and chlorine compounds to form gypsum ($CaSO_4$) and calcium chloride ($CaCl_2$). The small limestone particle size permitted by the circulating fluidized bed, along with the long residence time (approximately 5 seconds) and the very intense mixing in the entrained bed system provides a superior emissions control which eliminates the need for stack gas scrubbing.

1.2.3 Emissions from Combustion

NOx emissions are minimized by the relatively low temperature (1700°F maximum compared to up to 3000°F maximum in conventional furnaces) and by the fact that the combustion occurs in a two stage regime. As discussed in the preceeding paragraph, secondary air to complete combustion is injected into the furnace above the relatively dense phase bottom section of the fluidized bed. Thermal NOx is produced by the combination of nitrogen in the air (N_2) with oxygen in the air (O_2) to make NOx. Chemical NOx is produced by the combination of fuel nitrogen compounds with the oxygen in air to form NO and NO_2. Staged combustion in combination with the low operating temperature minimizes the formation of thermal NOx as well as chemical NOx.

The discharge level of carbon monoxide (CO) is also very low from the circulating fluidized bed because of low combustion temperature and low excess air. The vigorous mixing of the combustibles with the air that the high velocity entrained bed provides, plus the long residence time of the gases in the furnace, plus the very uniform temperatures provided by the thermal mass of the circulating hot solids all combine to give very low CO emissions. Those same features that provide low CO emissions also provide low volatile organic hydrocarbon and dioxin emissions.

1.2.4 Boiler Operation

The heat is extracted from the gaseous products of combustion leaving the cyclones by a series of convective heat transfer sections. The superheater section, providing 770°F steam (110,000 pounds per hour, each boiler) to the steam turbine-generator, is designed to operated at tube wall temperatures that provide for very low levels of chloride induced corrosion. Likewise, the economizer section is operated with tubewall temperatures that avoid, under all load conditions, temperatures low enough to provide corrosion from acid condensates. Oil firing is furnished for supplemental fuel during start-up and shutdown operations. Fly ash and spent limestone fines are collected in bag filters conservatively rated to remove dust to 0.015 grains per dry standard cubic foot of exit gas at 12% CO_2. Bottom ash along with any chunks of material that may have formed during combustion are removed from the bottom of the boiler via a slot in the air distributor inlet. The slot is provided with an upward air flow so that a controlled amount of bed material is constantly removed and is sent to the ash handling system. The fine material collected in the bag houses is pneumatically conveyed to the ash handling system.

1.2.5 Ash Handling System

The base load ash quantity for the plant is estimated to be 2.2 tons/hr. (max.) and will be split approximately 20/80 between Furnace Ash and Flyash. Furnace ash will be transmitted by a vibrator/conveyor system while the finer flyash will be transported using a pneumatic conveying system. Both the furnace ash and flyash will be stored in a steel silo prior to removal from the site.

The furnace ash collection system will consist of water cooled screw conveyors from each combustion unit which will cool the ash to 400°F and feed it to a pneumatic conveyor system. This heat is recovered and used to heat the turbine cycle feedwater. The bottom ash is then conveyed via a bucket elevator to the top of the ash silo.

The flyash will be collected from the two bag houses and pneumatically conveyed to the ash storage silo. A mechanical bag dust filter is also located atop the ash silo to filter the carrier air before it is exhausted to the boiler baghouse.

Transport and storage of both furnace ash and flyash will be by means of a closed dry system, with four day on-site storage capacity planned. Ash removal from the site to the landfill will be by truck. Just prior to loading into the truck, the ash will be conditioned with a small amount of water spray. This will minimize dust when the truck is unloaded at the landfill.

2.0 ACCESS AND TRAFFIC CONTROL

All roads and parking areas within the plant will be heavy duty paved roads capable of handling truck traffic. The main entrance road and roads carrying Municipal Solid Waste and other fuel will be two lane roads. Other roads which carry much less traffic will be one lane. All roads will be elevated above the finish plant grade to facilitiate drainage.

Traffic will be controlled by an operator in the gate house/weighing station.

There is ample room for parking, convenient access throughout the plant for delivery of tires and miscellaneous items and pick up of non-burnable items.

3.0 BOILER EMISSION/PERFORMANCE MONITORING

Each boiler will be equipped with instruments for continuously monitoring and recording temperature, oxygen, carbon monoxide, and opacity. Temperature, CO, and O_2 monitors and recorders shall be located prior to air pollution control devices.

Compliance with the NSPS for PM will be demonstrated through source emission tests as specified in 40 CFR 60, Subpart E and by the Federal Reference Methods in 40 CFR 60, Appendix A. These methods are as follows:

- Particulate matter - Method 5
- Sample and velocity traverses - Method 1
- Velocity and volumetric flow rate - Method 2
- Gas analysis and excess air - Method 3

If source testing of pollutants other than PM is required by permit condition, approved DER and EPA test methods will be utilized.

In accordance with 40 CFR 60.53, the daily charging rate and hours of operation of the facility will be recorded. Stack sampling access and ports for the two proposed baghouse units will be installed in conformance with FAC Chapter 17-2.700(4). A drawing detailing the sampling access and sampling ports will be submitted to DER prior to construction of the ESP's and associated stack.

4.0 ODOR CONTROL METHODS

The waste receiving (tipping)/storage area; the RDF storage-area ventilation system; and the RDF process are designed such that no odorous emissions will be detectable over property lines. With respect to the waste receiving/storage area, odor control depends on containment of the odorants and on limiting the residence time of the waste in the storage area. The waste receiving/storage area is in an enclosed structure which is kept under a slightly negative pressure which serves to contain potential odorants. In addition, the design of the waste receiving/storage area facilitates regular and thorough cleaning.

Regarding control of odors from the RDF process, the RDF process is a "closed" system, i.e., dust and odors are contained by a system of aspirated enclosures for the processing machinery. RDF process air, and the odorants it contains, are ducted through baghouses for dust removal, then ducted to the combustion air plenum, where the odorants are thermally destroyed.

During that portion of the annual boiler shutdown when waste will continue to be processed into RDF in order to fill the storage area, RDF process air will be vented through the boiler stack.

5.0 SUMMARY OF PARTICULATE EMISSIONS

Total Plant emissions of particulate matter will not exceed 50 TPY.

Total Plant emissions of particulate matter result from four potential sources: the boilers, the RDF process, the waste tipping/storage area and the sand, limestone, and ash silos. Particulate emissions from the two CFB boiler units will be controlled to a total of 47 TPY by means of fabric filters installed on each of the two boiler units. These fabric filters will each achieve a particulate emission limit of 0.015 gr/dscf at 12 percent CO_2 (corresponding to a maximum of 0.36 lb/ton of fuel as fired), based on a design, maximum, normal inlet concentration of 13 gr/dscf at 12 percent CO_2 and a fabric filter particulate removal efficiency of 99.89 percent. The design inlet grain loading has been theoretically calculated.

Dust generated during RDF processing will be controlled by a succession of containment, fabric filtration, and thermal reduction to an emission rate of 0.1 TPY. The RDF process is a "closed" process which serves to contain dust generated by the processing equipment. Dust control in the RDF process begins on the tipping floor which is totally enclosed and kept under a slightly negative pressure by aspirators in the RDF process. At the tipping floor a hood aspirates any dust produced when the MSW is placed upon the apron conveyor which feeds the primary shredder. Transfer points in the process are enclosed, with the inlets and outlets sealed with rubber flaps. Aspiration points on the apron conveyor, primary shredder, magnetic disc screen enclosure, and the flexowall conveyor to RDF storage are ducted to a baghouse. Also controlled by this baghouse, is dust from the area that houses both RDF and wood chip storage. Aspiration from the stoner, air knife and classifer are ducted to a separate baghouse. Each baghouse discharge will have a dust loading of 0.01 gr/dscf. If the process were to run 365 days per year, 24 hours per day this would provide a discharge of 18.7 TPY of particulate. (The RDF process will normally only run 5 days per week, 16 hours per day). The discharge from the RDF area baghouse is ducted to the boilers, where it is used as part of the combustion air. After combustion, the 18.7 TPY of particulate matter is reduced to approximately 0.1 TPY.

During infrequent limited periods when one or both boilers are shut down for maintenance, the discharges from the RDF area baghouse (18.7 TPY = 4.3 lb/hr) will be vented through the boiler stack without further thermal reduction. Under this worst case scenario, (one boiler out of service for one year) maximum Plant emissions of particulate matter would be 4.3 lb/hr RDF dust plus 5.37 lb/hr particulate from one boiler, for a total of 9.67 lb/hr. Emissions in this case, therefore, would be less than during normal Plant operations (48 TPY = 11 lb/hr).

With regard to the sand silo and the two limestone silos, each silo is equipped with an air filter which has an efficiency of 99.5%. These filters are used during silo "filling". The discharge of these filters is ducted into the combustion air flow to the boilers so that no dust is emitted during the filling operation. It is conservatively estimated that no more than .02 tons/year of sand limestone particulate will be liberated as trucks hook-up to transfer material into the silos.

The ash handling silo will hold both bottom ash and fly ash which is neumatically transported from the boiler house. The transport air will pass thru a 99.5% efficient air filter and then be ducted to the flue gas ducts before the boiler baghouses. Thus, no quantifiable amount of particulate will be liberated from this part of the ash handling process. However, a small amount of particulate will be liberated when trucks remove wetted-ash from the ash silo. This amount of particulate is conservatively estimated to be 0.4 TPY.

TABLE 5.1

SUMMARY OF PARTICULATE EMISSIONS

SOURCE	QUANTITY (TONS/YEAR)
Boilers	47
Waste Receiving, RDF Process, RDF & Wood Chip Storage	0.1
Ash Handling	0.4
Sand (Bed Material)	0.01
Limestone	0.01
Total	47.52 ~ 48 TPY

Note: The 48 TPY total particulate emissions results from the assumption that both boilers will run continuously at full load, 24 hours/day, 365 days/year. The actual capacity factor will most likely be 85%. At this level the particulate emission from the boilers will be only 40 TPY.

6.0 GOOD ENGINEERING PRACTICE (GEP) STACK HEIGHT

The Plant will employ a GEP height stack to preclude the possibility of stack emissions being entrained into the aerodynamic wakes of Plant buildings, with resultant high ground-level impacts. A GEP stack height of 260 ft (above ground) has been calculated for the Plant. The "controlling" structure aerodynamically for calculating GEP stack height is the Plant boiler building, as is the case with most waste-to-energy facility designs today. The key dimensions for the boiler building are summarized as follows:

<u>Boiler Building Dimensions</u>

Height - 104 ft (784 ft roof elev. - 682 ft base elev.)
Length - 95 ft
Width - 74 ft
Diagonal Width - 120.4 ft (Stack will be influenced by the diagonal width aerodynamically)

The GEP stack height is calculated using the formula:

$$S = H + (1.5)B \qquad (1)$$

where,

S = GEP stack height (ft)
H = building height (ft)
B = lesser of building height or aerodynamic width

The boiler building height (104 ft) is less than the aerodynamic width (120.4 ft); therefore, the GEP stack height is calculated by Equation 1 as two and one half times the building height, i.e. 2.5 x 104 ft, or 260 ft above ground.

APPENDIX II
BOILER DESCRIPTION

APPENDIX II
BOILER DESCRIPTION

1.0 COMBUSTION

The proposed unit is a GOTAVERKEN top supported, single-drum circulating fluidized bed boiler (CFB). The CFB offers optimal flexibility for burning a wide range of fuels. High combustion efficiency is achieved with all types of fuels. The boiler will be designed for firing RDF, supplemented by tires and/or wood chips, with No. 2 fuel oil used during startup, shutdown and upset conditions. RDF and the supplemental fuels will be fed into the furnace using screw feeders. Combined start-up/load burners will be used for fuel oil.

Combustion takes place in the relatively narrow temperature band of 1520-1700°F. This temperature band is sufficient to maintain high combustion efficiency, but at the same time is below the ash melting point. Therefore, slagging of the furnace and fouling of convection banks are prevented. Sulfur oxide emissions are also minimized since this temperature range is optimum for sulfur absorption on limestone and dolomite.

Hydrochloric acid is absorbed on the elutriated calcium oxide while passing through the down pass and finally when passing through the filter cake in the baghouse filter.

Intense mixing of solids provides high and even rates of combustion without flue gas stratification. The combustion temperature is kept well below the level at which thermal NOx is formed. Formation of NOx from fuel nitrogen is minimized by utilization of staged combustion. Further reduction of NOx is achieved by operating with low excess air. The furnace temperature is relatively constant over the complete furnace height.

Flue gas is ducted from the furnace outlet to the hot gas cyclones. From the cyclone outlets flue gas travels to the down pass while bed material captured in the cyclones is returned to the furnace.

Coarse ash particles, stones and inert bed material are removed from the bottom of the combustion chamber by the bottom ash handling system.

2.0 AIR SYSTEM

Combustion air will be supplied to the furnace as primary and secondary air. The system will be comprised of two fans. The main fan will supply total air. The main fan supplies air to the suction inlet of the primary air fan and to the secondary air windboxes. Primary air is supplied to the furnace bottom, and secondary air is supplied at a higher level in the lower part of the furnace.

3.0 HOT CYCLONES

Two (2) ceramic lined, high efficiency hot cyclones will be installed, in parallel, between the furnace and the second pass of the boiler.

The cyclones will be made of carbon steel with internal gas outlet tubes of stainless steel.

The inside of the cyclones will be covered with two layers of lining to provide heat insulation and erosion protection.

All header welds and return bends will be maintained outside the gas stream.

4.0 SOOTBLOWING

Sootblowing will be done by retractable and semiretractable steam sootblowers.

5.0 FURNACE

Width	9-7	ft-in
Depth	14-10 3/4	ft-in
Height from hopper arch to roof	58-7/8	ft-in
Heating surface	2,185	ft^2

6.0 ASH HANDLING SYSTEM

The ash quantity for the plant will be split 20/80 between bottom ash and flyash. The bottom ash and flyash will be stored in a steel silo prior to removal from the site.

The bottom ash collection system will consist of water cooled screw conveyors from each combustion unit which will cool the ash to 400°F and feed it to a pneumatic conveyor system. This heat will be recovered to heat the turbine cycle feed water. The bottom ash will then be conveyed via a bucket elevator to the top of the common ash silo.

The flyash will be collected from two baghouses (one per boiler) and pneumatically conveyed to ash storage silo. A mechanical bag dust filter will be located at the top of the flyash silo to filter the carrier air before it is exhausted to the boiler baghouse.

For bottom ash and flyash a three day on-site storage capacity will be planned. Fly ash removal from the site to the landfill will be by truck. Just prior to loading into the truck, the ash will be conditioned with a small amount of moisturizing water. This will minimize dust when the truck is unloaded at the landfill.

7.0 DESIGN CRITERIA FOR ENVIRONMENTAL PERMITTING

The plant will include two (2) Gotaverken CFB boilers. The fuel used will be 100% RDF or a mixtures of RDF, tires and wood chips. The emission has been identified based on three cases.

<u>Case 1</u>: Fuel is 100% RDF.

<u>Case 2</u>: Fuel consists of 70% RDF and 30% tires based on heat input.

<u>Case 3</u>: Fuel consists of 45% RDF, 13% tires and 42% wood chips based on heat input.

In Tables 1, 2, 3, 4 and 5 the design basis data is given for the obtained emission factors and emission rates shown in Tables 6, 7 and 8.

NOTE: No. 2 fuel oil is used during start-up/shutdown periods.

TABLE 1

DESIGN PARAMETERS FOR CASE 1, 100% RDF; THE DATA IS GIVEN FOR ONE CFB BOILER AT MCR CONDITIONS

Fuel feed as received	18.08 tons/hr
Fuel heat value (HHV as received)	4536 BTU/lb
Heat input (HHV)	164.0 million BTU/hr
Annual operation (hrs/year)	8760 hours/year
Availability	100 %
Flue gas flow rate (@ 7% O_2, wet, 351°F)	71495 ACFM
Flue gas flow rate (@ 7% O_2, 60°F)	37714 DSCFM
Flue gas flow rate (@ 12% CO2, 8.4% O_2, 60°F)	42038 DSCFM
Flue gas temperature (°F)	351 °F

TABLE 2

DESIGN PARAMETERS FOR CASE 2; 70% RDF AND 30% TIRES BASED ON ENERGY INPUT. THE DATA IS GIVEN FOR ONE CFB BOILER AT MCR CONDITIONS.

Fuel feed RDF - as received	12.66 tons/hr
Tires - as received	1.34 tons/hr
Fuel heat value (HHV as received) RDF	4536 BTU/lb
Tires	15845 BTU/lb
Heat input (HHV)	157.4 million BTU/hr
Annual operation	8760 hours/year
Availability	100 %
Flue gas flow rate (@ 7% O_2, wet, 351°F	66046 ACFM
Flue gas flow rate (@ 7% O_2, 60°F)	36029 DSCFM
Flue gas flow rate (@ 12% CO2, 8.0% O_2, 60°F)	38930 DSCFM
Flue gas temperature	351 °F

TABLE 3

DESIGN PARAMETERS FOR CASE 3; 45% RDF, 13% TIRES AND 42% WOODCHIPS. THE DATA IS GIVEN FOR ONE CFB BOILER AT MCR CONDITIONS

Fuel feed as received	
RDF	8.13 tons/hr
Tires	0.60 tons/hr
Woodchips	7.08 tons/hr
Fuel heat values (HHV as received)	
RDF	4536 Btu/lb
Tires	15845 Btu/lb
Woodchips	4928 Btu/lb
Heat input (HHV)	162.6 Million Btu/hr
Annual operations per year	8760 hours/year
Availability	100%
Flue gas flow rate (@ 7% O_2, wet, 360°F)	69605 ACFM
Flue gas flow rate (@ 7% O_2, 60°F)	36504 DSCFM
Flue gas flow rate (@ 8.3% O_2, 12% CO_2, 60°F)	40567 DSCFM
Flue gas temperature	360°F

TABLE 4

ULTIMATE ANALYSIS FOR DESIGN FUEL

	RDF %	TIRES %	WOODCHIPS %
Moisture	35.00	0.80	44.00
Ash	12.74	9.90	1.23
Carbon	26.39	77.90	27.66
Hydrogen	3.24	7.44	3.40
Nitrogen	0.61	0.24	-
Sulfur	0.26	1.34	-
Chlorine	0.35	0.14	-
Oxygen	21.41	2.24	23.71
	100.00	100.00	100.00
Heating value GCHV	4536 Btu/lb	15845 Btu/lb	4928 Btu/lb

TABLE 5

TRACE ELEMENTS IN RDF AND TIRES (DRY BASIS)

	100% RDF(1)	100% Tires(2)	100% Wood Chips(2)
	ppm (mg/kg)	ppm (mg/kg)	ppm (mg/kg)
Cd	5.0	0.2	0.36
Co	2.0	0.2	1.10
Cr	25.0	3.0	2.00
Cu	80.0	120.0	5.40
Hg	3.6	0.1	0.018
Mn	--	--	162.0
Ni	8.0	0.8	1.1
Pb	100.00	10.0	12.6
Zn	400.00	10000.0	36.0
As	1.0	--	0.09
Be	1.0	--	--
Ba	100.0	--	--

(1) Estimated by Gotaverken based on a review of RDF/organic-fraction analyses for 15 Swedish Plants, plus the Santa Clara, California facility.

(2) Estimated by Gotaverken based on tire and wood chip analysis data on file.

TABLE 6

ESTIMATED CONTROLLED POLLUTANT EMISSIONS FOR THE PROPOSED COLLIER COUNTY WASTE-TO-ENERGY PLANT(1)

	100 percent RDF(3)			
Criteria Pollutants	(lb/ton RDF as fired)	(g/sec)	(lbs/hr)	(tons/year)
Particulate matter(2)	0.30	1.4	11	48
Sulfur dioxide (SO_2)	2.1	9.6	76	335
Nitrogen oxides (as NO_2)	2.6	12	94	411
Carbon monoxide (CO)	0.92	4.2	33	146
VOC (as CH_4)	0.05	0.3	2	8
Lead (Pb)	4.7×10^{-3}	0.02	0.17	0.8
Noncriteria Pollutants				
Asbestos	(5)	(5)	(5)	(5)
Beryllium (Be)	1.0×10^{-5}	4.5×10^{-5}	3.6×10^{-4}	1.6×10^{-3}
Mercury (Hg)	4.7×10^{-3}	0.02	0.17	0.7
Vinyl chloride	(5)	(5)	(5)	(5)
Fluorides (as HF)	3.0×10^{-3}	0.01	0.1	0.5
Sulfuric acid mist (H_2SO_4)	(4)	(4)	(4)	(4)
Total reduced sulfur (TRS), includes H_2S	(4)	(4)	(4)	(4)
Reduced sulfur compounds, includes H_2S	(4)	(4)	(4)	(4)
Hydrogen sulfide (H_2S)	(4)	(4)	(4)	(4)
Other Acid Gases				
Hydrogen chloride (HCl)	0.72	3.3	26	114
Other Trace Metals				
Arsenic (As)	7.5×10^{-5}	3.3×10^{-4}	2.6×10^{-3}	1.2×10^{-2}
Cadmium (Cd)	7.5×10^{-4}	3.4×10^{-3}	2.7×10^{-2}	0.12
Hexavalent chromium (as Cr)	3.5×10^{-4}	1.6×10^{-3}	1.3×10^{-2}	5.5×10^{-2}
Nickel (Ni)	1.8×10^{-4}	8.5×10^{-4}	6.7×10^{-3}	2.9×10^{-2}
Other Trace Organics				
PCDD	1.1×10^{-6}	5.1×10^{-6}	4.0×10^{-5}	1.8×10^{-4}
TCDD	1.1×10^{-7}	5.1×10^{-7}	4.0×10^{-6}	1.8×10^{-5}
2,3,7,8 TCDD	3.0×10^{-9}	1.4×10^{-8}	1.1×10^{-7}	4.7×10^{-7}
2,3,7,8 TCDD toxic equivalents(6)	5.2×10^{-8}	2.4×10^{-7}	1.9×10^{-6}	8.2×10^{-6}
PCDF	1.5×10^{-6}	6.8×10^{-6}	5.4×10^{-5}	2.3×10^{-4}

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(1) Emissions estimates based on Plant operating at 100% capacity. and 100% availability (i.e.. 24 hours/day. 365 days/year).

(2) Includes particulate emissions from the two boilers (47TPY), plus process-dust emissions totalling 1 TPY from waste receiving/storage area. RDF processing; RDF and wood-chip storage area; and material storage silos.

(3) Percentage based on HHV heat input.

(4) Less than limits of detection of analytical method.

(5) Designated as Unacceptable Waste--Unacceptable Waste will not be processed at Collier County Plant.

(6) Calculated by Gotaverken using the Eadon (N.Y. State Dept. of Health) Method.

TABLE 7

ESTIMATED CONTROLLED POLLUTANT EMISSIONS FOR THE PROPOSED COLLIER COUNTY WASTE-TO-ENERGY PLANT(1)

	70 percent RDF/30 percent Tires(3)			
Criteria Pollutants	(lb/ton Fuel as fired)	(g/sec)	(lbs/hr)	(tons/year)
Particulate matter(2)	0.36	1.3	10	45
Sulfur dioxide (SO_2)	2.6	9.2	73	320
Nitrogen oxides (as NO_2)	3.2	11	90	393
Carbon monoxide (CO)	1.1	4.0	32	140
VOC (as CH_4)	0.06	0.3	2	8
Lead (Pb)	4.2×10^{-3}	0.02	0.12	0.5
Noncriteria Pollutants				
Asbestos	(5)	(5)	(5)	(5)
Beryllium (Be)	8.9×10^{-6}	3.2×10^{-5}	2.5×10^{-4}	1.1×10^{-3}
Mercury (Hg)	4.3×10^{-3}	0.02	0.12	0.5
Vinyl chloride	(5)	(5)	(5)	(5)
Fluorides (as HF)	3.6×10^{-3}	0.01	0.1	0.5
Sulfuric acid mist (H_2SO_4)	(4)	(4)	(4)	(4)
Total reduced sulfur (TRS), includes H_2S	(4)	(4)	(4)	(4)
Reduced sulfur compounds, includes H_2S	(4)	(4)	(4)	(4)
Hydrogen sulfide (H_2S)	(4)	(4)	(4)	(4)
Other Acid Gases				
Hydrogen chloride (HCl)	0.71	2.5	20	90
Other Trace Metals				
Arsenic (As)	6.4×10^{-5}	2.3×10^{-4}	1.8×10^{-3}	7.9×10^{-3}
Cadmium (Cd)	6.4×10^{-4}	2.3×10^{-3}	1.8×10^{-2}	7.9×10^{-2}
Hexavalent chromium (as Cr)	3.5×10^{-4}	1.3×10^{-3}	1.0×10^{-2}	4.3×10^{-2}
Nickel (Ni)	1.6×10^{-4}	7.6×10^{-4}	4.5×10^{-3}	1.9×10^{-2}
Other Trace Organics				
PCDD	1.4×10^{-6}	4.8×10^{-6}	3.8×10^{-5}	1.7×10^{-4}
TCDD	1.4×10^{-7}	4.8×10^{-7}	3.8×10^{-6}	1.7×10^{-5}
2,3,7,8 TCDD	3.6×10^{-9}	1.3×10^{-8}	1.0×10^{-7}	4.5×10^{-7}
2,3,7,8 TCDD toxic equivalents(6)	6.4×10^{-8}	2.3×10^{-7}	1.8×10^{-6}	7.8×10^{-6}
PCDF	1.8×10^{-6}	6.4×10^{-6}	5.1×10^{-5}	2.2×10^{-4}

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(1) Emissions estimates based on Plant operating at 100% capacity and 100% availability (i.e., 24 hours/day, 365 days/year).

(2) Includes particulate emissions from the two boilers (44TPY), plus process-dust emissions totalling 1 TPY from waste receiving/storage area, RDF processing; RDF and wood-chip storage area; and material storage silos.

(3) Percentage based on HHV heat input

(4) Less than limits of detection of analytical method.

(5) Designated as Unacceptable Waste--Unacceptable Waste will not be processed at Collier County Plant.

(6) Calculated by Gotaverken using the Eadon (N.Y. State Dept. of Health) Method.

TABLE 8

ESTIMATED CONTROLLED POLLUTANT EMISSIONS FOR THE PROPOSED COLLIER COUNTY WASTE-TO-ENERGY PLANT(1)

	45% RDF/13% TIRES/42% WOOD CHIPS(3)			
Criteria Pollutants	(lb/ton Fuel as fired)	(g/sec)	(lbs/hr)	(tons/year)
Particulate matter(2)	0.34	1.4	11	47
Sulfur dioxide (SO_2)	2.3	9.3	74	324
Nitrogen oxides (as NO_2)	2.8	12	91	398
Carbon monoxide (CO)	0.99	4.0	32	142
VOC (as CH_4)	0.06	0.3	2	8
Lead (Pb)	3.2×10^{-3}	0.01	0.10	0.5
Noncriteria Pollutants				
Asbestos	(5)	(5)	(5)	(5)
Beryllium (Be)	5.1×10^{-6}	2.0×10^{-5}	1.6×10^{-4}	7.1×10^{-4}
Mercury (Hg)	2.4×10^{-3}	0.01	0.08	0.34
Vinyl chloride	(5)	(5)	(5)	(5)
Fluorides (as HF)	3.1×10^{-3}	0.01	0.1	0.5
Sulfuric acid mist (H_2SO_4)	(4)	(4)	(4)	(4)
Total reduced sulfur (TRS), includes H_2S	(4)	(4)	(4)	(4)
Reduced sulfur compounds, includes H_2S	(4)	(4)	(4)	(4)
Hydrogen sulfide (H_2S)	(4)	(4)	(4)	(4)
Other Acid Gases				
Hydrogen chloride (HCl)	0.66	2.7	21	91
Other Trace Metals				
Arsenic (As)	4.9×10^{-5}	2.0×10^{-4}	1.6×10^{-3}	6.8×10^{-3}
Cadmium (Cd)	4.9×10^{-4}	2.0×10^{-3}	1.6×10^{-2}	6.8×10^{-2}
Hexavalent chromium (as Cr)	2.3×10^{-4}	9.1×10^{-4}	7.2×10^{-3}	3.2×10^{-2}
Nickel (Ni)	1.3×10^{-4}	5.1×10^{-4}	4.0×10^{-3}	1.8×10^{-2}
Other Trace Organics				
PCDD	1.2×10^{-6}	4.9×10^{-6}	3.9×10^{-5}	1.7×10^{-4}
TCDD	1.2×10^{-7}	4.9×10^{-7}	3.9×10^{-6}	1.7×10^{-5}
2,3,7,8 TCDD	3.2×10^{-9}	1.3×10^{-8}	1.0×10^{-7}	4.6×10^{-7}
2,3,7,8 TCDD toxic equivalents(6)	5.7×10^{-8}	2.3×10^{-7}	1.8×10^{-6}	7.9×10^{-6}
PCDF	1.6×10^{-6}	6.6×10^{-6}	5.2×10^{-5}	2.3×10^{-4}

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(1) Emissions estimates based on Plant operating at 100% capacity, and 100% availability (i.e., 24 hours/day, 365 days/year).

(2) Includes particulate emissions from the two boilers (46TPY), plus process-dust emissions totalling 1 TPY from waste receiving/storage area, RDF processing; RDF and wood-chip storage area; and material storage silos.

(3) Percentage based on HHV heat input.

(4) Less than limits of detection of analytical method.

(5) Designated as Unacceptable Waste--Unacceptable Waste will not be processed at Collier County Plant.

(6) Calculated by Gotaverken using the Eadon (N.Y. State Dept. of Health) Method.

8.0 DESCRIPTION OF CONTROL TECHNOLOGY FOR CRITERIA AND NON-CRITERIA POLLUTANTS

PARTICULATE MATTER

Each boiler will be equipped with a baghouse filter. The maximum emission will be 0.015 gr/dry standard cubic feet (@ 12% CO2) or less. This level of control has been demonstrated at several baghouse installations.

The total emission of dust from the boilers will not be greater than 47 tons/year.

SO2

The maximum sulfur content in fuel is 0.5%.

In the CFB technology the sulphur will be captured directly in the bed by reaction with limestone. The operating temperature in the bed of 1570°F is chosen to maximize the absorption efficiency.

Maximum emission is given to be 100 ppmv or 70% reduction, whichever is least stringent.

At the Gotaverken installation in Nykoping southwest of Stockholm a reduction efficiency of 90-95% has been demonstrated when firing 0.6% sulphur coal. In Figure 1 on page 14, the sulphur dioxide is given as a function of calcium to sulphur molar ratio.

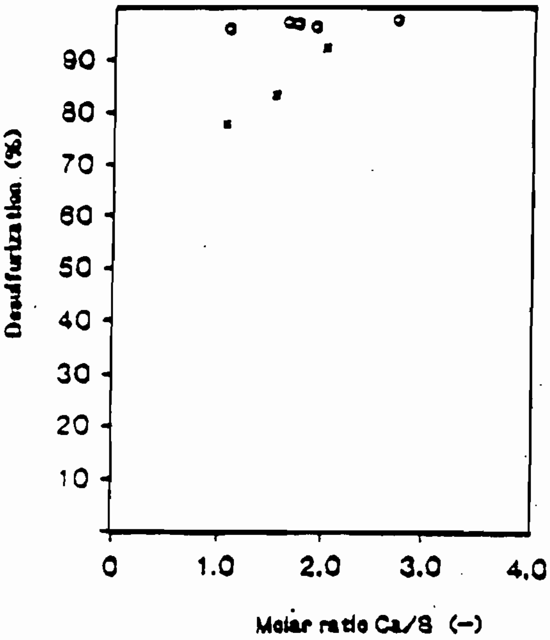

Figure 2-1

Desulfurization as a Function of Molar Ratio Ca/S
(X fine particles 0 to 500 µm)
(O coarser particles 200 to 1 500 µm)

CO (Carbon Monoxide)

Carbon monoxide is controlled thru use of proper combustion design and practice. This is achieved by creating high turbulence. This turbulence is an inherent characteristic in fluidized bed systems especially circulating fluidized bed systems. In the circulating fluidized bed a major portion of the solids is recirculated. The recirculation flow is an order of magnitude greater than the fuel feed. This extremely large flow of hot particles at combustion reaction temperature gives the circulating fluidized bed its characteristic of a thermal flywheel system. Extremely even temperatures throughout the whole combustion chamber is a result of this. The furnace in itself is voluminously sized giving a residence time of more than 3-1/2 seconds in the furnace and additional 1-2 seconds in the hot return cyclones. This is a larger residence time than good engineering practice demands, for example spreader stoker boilers and pulverized coal furnaces. Carbon monoxide emissions will be controlled to 100 ppmv at 7%O_2.

NOx (Nitrogen Oxides)

NOx is controlled by good design practice and proper combustion technology. The combustion takes place at a temperature of about 1570°F. At this low combustion temperature there is none or very little formation of thermal NOx. In order to minimize the NOx generated from fuel nitrogen, the combustion takes place in two steps. This is accomplished by having primary air as grate air and at least one level of secondary air injection. Actual test data from Sundsvall has shown less than 110 ppm volume when burning different fuels and fuel mixes with RDF, peat, wood chips or tires.

As a long time average, 170 ppmv is guaranteed.

VOC (Volatile Organic Compounds)

VOC has been estimated based on an experience relationship between CO and VOC. This relation has shown to be 10 to 1.

Pb (Lead)

The reduction of lead takes place in conjunction with the collection of dust. The amount of lead emitted depends upon the original amount of lead in fuel and the amount of dust escaping the particulate collecting equipment. Experience based distribution factors have been used in order to establish the emission rate of lead.

Hg (Mercury)

Mercury has been assumed to be emitted as gas phase. One hundred percent of fuel mercury is emitted to the atmosphere.

HF (Hydrogen Fluoride)

The emission of hydrogen fluoride is based on test data from Sundsvall firing RDF tires, and wood chips.

H_2SO_4 (Sulfuric Acid)

Sulfuric acid mist does not form at temperatures above flue gas acid dew point.

HCl (Hydrochloric Acid)

By adding limestone to the circulating fluidized bed a portion of the limestone is calcined and elutreated through the cyclone. The elutriated calcined limestone will capture hydrogen chloride while traveling through the down pass, the convective heating surfaces and out to the baghouse. In the filter cake developed on the bags in the baghouse the final reduction of hydrochloric gas takes place. The expected emission is dependent on the original content of chlorides in the fuel. HCl emissions will be controlled to 50 ppmv or 90% reduction, whichever is least stringent.

Hydrogen Sulfide, Reduced Sulfur and Sulfur Compounds

The combustion in the circulating fluidized bed boiler is a sub stochiometric combustion, which means that reduced sulfur compounds do not form. This means there will be no detectable emission of reduced sulfur compounds.

Dioxins and Dibenzofurans

The estimated emissions of dioxins and dibenzofurans are based on actual testing done at Sundsvall CFB plant. The testing was done with a fuel mix that is normally fired at this plant, i.e. RDF, peat and wood chips. The test results are reported in Appendix III, Section 1.0. In Appendix VIII, Attachment A, a description is given of the method of analysis. The analysis is conducted by Professor Christoffer Rappe at the Institution of Organic Chemistry at the University of Umea.

The demonstrated low emissions of dioxins and related compounds is due to the use of proper combustion design and practice as well as the long residence time (5 seconds), and intense mixing.

8. Boiler Start-up Procedure

A. "Cold" Start Condition

The start-up/load oil burner will heat the boiler to a suitable temperature (approx. 1000 - 1200F in furnace) before the solid fuel will be fed into the boiler. The fuel oil supply can then be decreased and turned off. Start procedure from cold conditions will take some 12 hours.

B. "Warm" Start-up

After a short stop of the boiler, the start-up/load burner has to heat the boiler to a sufficient temperature before solid fuel can be fed to the boiler.

After a stop of approx. 24 hours, the restarting time will be a couple of hours.

APPENDIX III
AIR POLLUTANT EMISSIONS ESTIMATES

APPENDIX III

AIR POLLUTANT EMISSIONS ESTIMATES

1.0 INTRODUCTION

Estimated pollutant emissions for the Plant are shown in Table 1-1. Emission factors and emission rates are provided for three fuel-mix scenarios: 1) 100 percent RDF; 2) a mixture of 70 percent RDF and 30 percent tires; and 3) a mixture of 45 percent RDF, 13 percent tires, and 42 percent wood chips. The second scenario above represents the maximum possible fraction of tires (30 percent on a heat-input basis). The third scenario is based on the respective amounts of RDF and woodchips actually expected to be available when the Plant goes on-line, with the balance of Plant capacity being satisfied with tires. It is also possible that a mixture of RDF and woodchips will be fired at times; however, pollutant emissions in this case would be less than those for 100 percent RDF firing, as can be readily deduced from a review of the data in Table 1-1.

The emissions data are based on 100 percent plant capacity and 100 percent plant availability, i.e., operating 24 hours per day, 365 days per years. Emissions estimates are provided for the pollutants regulated by EPA and the Florida DER (i.e., the criteria and noncriteria pollutants), plus other pollutants (certain acid gases, trace metals, and trace organic compounds) for which impacts, although not formally regulated, are nonetheless commonly assessed for waste-to-energy facilities.

Regarding the estimated emissions of particulate matter, the particulate emission rates shown in Table 1-1 include particulate emissions from the combustion process, as well as process-dust emissions from the waste receiving/storage area; the RDF production process and RDF/wood-chip storage area; and the sand, limestone and ash storage silos.

Distillate oil will be burned in auxiliary burners during Plant startup and shutdown periods. Two startups and shutdowns are expected per year, with each shutdown lasting approximately 10 hours. It is expected by Gotaverken that less than 100,000 gallons of fuel oil per unit per year will be used for these purposes. This fuel use, expressed on a heat input basis, is approximately equal to one percent of maximum continuous rated heat input to the Collier County Plant incinerators. Consequently, emissions associated with the minimal usage of fuel oil are considered negligible when compared with overall Plant emissions.

The projected emission rates for the Collier County Plant have been based on control technology guarantees; actual emissions measured at the Gotaverken circulating-fluidized-bed (CFB) incinerator operating in Korsta, Sundsvall, Sweden; emissions measured at facilities in the United States; and theoretical calculations.

Gotaverken's Sundsvall plant, commissioned in 1984, and tested for emissions in 1985, is rated at 66,000 lb. steam/hour and is similar in size and design to the Collier County Plant. The unit is capable of firing a variety of fuels singly or in mixtures. A mixture of fuels was used during the emissions test program. Three tests were run while a mixture of RDF and peat was fired and three tests were run while a mixture of RDF, wood chips, and tires was fired (i.e. the same fuels planned for the Collier County Plant). Table 1-2 summarizes the results of these emissions tests. The Sundsvall facility, as tested, was equipped with an ESP for particulate control, but employed no acid gas control. The bed material consisted of sand and ash. By way of comparison, The Collier County Plant will be equipped with a fabric filter for particulate control, and in addition, will employ limestone injection for acid gas control.

Basic boiler design data considered by Gotaverken in estimating the pollutant emission rates is summarized in Tables 1-3, 1-4, and 1-5, respectively for the three fuel-mix scenarios. Design-basis ultimate-analysis data for the RDF, tires, and wood chips are presented in Table 1-6.

The design-basis ultimate analysis for RDF shown in Table 1-6 has been developed by Gotaverken to be conservatively representative of Collier County waste. With regard to air pollutant emission estimates, the sulfur and chlorine contents of the waste are of summary interest, as the waste contents of these elements are related to emissions of sulfur dioxide and hydrogen chloride, respectively.

Measurements of the actual sulfur and chlorine contents of Florida municipal waste are available for comparison with the design values for the Collier

County Plant RDF shown in Table 1-6. The sulfur content of waste has been measured recently in both Broward County(1) and Hillsborough County(2). For the waste in an "as-received" basis, the sulfur content was found to be 0.05-0.17% for Broward County and 0.1% for Hillsborough County wastes. For the waste on a "dry" basis, the corresponding sulfur-content percentages would range from approximately 0.07% to 0.23%. The design RDF sulfur content for the Collier County Plant shown in Table 1-6 of 0.26% is representative of the high end of the range of measured values, and therefore, represents a conservative design value.

The chlorine content of waste was measured in Broward County, but not Hillsborough County. In Broward County, the chlorine content of the waste was determined to be 0.10-0.19% on an as-received basis. For this waste, the chlorine content on a dry basis would be approximately 0.15-0.30%. The design RDF chlorine content of 0.35% shown in Table 3-6 for the Collier County Plant is representative of the high end of the range of measured values, and is, therefore, conservative.

The design ultimate analysis for tires shown in Table 1-6 was developed by Gotaverken based on chemical-analysis data or tires. The sulfur content of tires is somewhat higher than that of RDF on wood chips; however, at a maximum, tires will comprise less than 10% of the fuel mix on a mass input basis (less than 30% on a heat input basis.

The design ultimate analysis data for wood shown in Table 1-6 was developed by Gotaverken based on chemical-analysis data on wood fuels. The analytical data indicated that wood-fuel sulfur and chlorine contents are at trace levels. EPA has summarized wood-sulfur content data and reports a representative sulfur contant for wood to be 0.02%.(3)

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(1) Broward County Sampling Program; Malcolm Pirnie, 1985.
(2) Hillsborough County Sampling Program; Camp, Dress & McKee, Inc. 1984.
(3) U. S. EPA, "Non-Fossil Fuel Fired Industrial Boilers - Background Information," EPA 450/3-82-007, March 1982.

TABLE 1-1

ESTIMATED CONTROLLED POLLUTANT EMISSIONS FOR THE PROPOSED COLLIER COUNTY WASTE-TO-ENERGY PLANT(1)

	100 percent RDF(3)			
Criteria Pollutants	(lb/ton RDF as fired)	(g/sec)	(lbs/hr)	(tons/year)
Particulate matter(2)	0.30	1.4	11	48
Sulfur dioxide (SO_2)	2.1	9.6	76	335
Nitrogen oxides (as NO_2)	2.6	12	94	411
Carbon monoxide (CO)	0.92	4.2	33	146
VOC (as CH_4)	0.05	0.3	2	8
Lead (Pb)	$4.7\text{x}10^{-3}$	0.02	0.17	0.8
Noncriteria Pollutants				
Asbestos	(5)	(5)	(5)	(5)
Beryllium (Be)	$1.0\text{x}10^{-5}$	$4.5\text{x}10^{-5}$	$3.6\text{x}10^{-4}$	$1.6\text{x}10^{-3}$
Mercury (Hg)	$4.7\text{x}10^{-3}$	0.02	0.17	0.7
Vinyl chloride	(5)	(5)	(5)	(5)
Fluorides (as HF)	$3.0\text{x}10^{-3}$	0.01	0.1	0.5
Sulfuric acid mist (H_2SO_4)	(4)	(4)	(4)	(4)
Total reduced sulfur (TRS), includes H_2S	(4)	(4)	(4)	(4)
Reduced sulfur compounds, includes H_2S	(4)	(4)	(4)	(4)
Hydrogen sulfide (H_2S)	(4)	(4)	(4)	(4)
Other Acid Gases				
Hydrogen chloride (HCl)	0.72	3.3	26	114
Other Trace Metals				
Arsenic (As)	$7.5\text{x}10^{-5}$	$3.3\text{x}10^{-4}$	$2.6\text{x}10^{-3}$	$1.2\text{x}10^{-2}$
Cadmium (Cd)	$7.5\text{x}10^{-4}$	$3.4\text{x}10^{-3}$	$2.7\text{x}10^{-2}$	0.12
Hexavalent chromium (as Cr)	$3.5\text{x}10^{-4}$	$1.6\text{x}10^{-3}$	$1.3\text{x}10^{-2}$	$5.5\text{x}10^{-2}$
Nickel (Ni)	$1.8\text{x}10^{-4}$	$8.5\text{x}10^{-4}$	$6.7\text{x}10^{-3}$	$2.9\text{x}10^{-2}$
Other Trace Organics				
PCDD	$1.1\text{x}10^{-6}$	$5.1\text{x}10^{-6}$	$4.0\text{x}10^{-5}$	$1.8\text{x}10^{-4}$
TCDD	$1.1\text{x}10^{-7}$	$5.1\text{x}10^{-7}$	$4.0\text{x}10^{-6}$	$1.8\text{x}10^{-5}$
2,3,7,8 TCDD	$3.0\text{x}10^{-9}$	$1.4\text{x}10^{-8}$	$1.1\text{x}10^{-7}$	$4.7\text{x}10^{-7}$
2,3,7,8 TCDD toxic equivalents(6)	$5.2\text{x}10^{-8}$	$2.4\text{x}10^{-7}$	$1.9\text{x}10^{-6}$	$8.2\text{x}10^{-6}$
PCDF	$1.5\text{x}10^{-6}$	$6.8\text{x}10^{-6}$	$5.4\text{x}10^{-5}$	$2.3\text{x}10^{-4}$

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(1) Emissions estimates based on Plant operating at 100% capacity and 100% availability (i.e., 24 hours/day, 365 days/year).

(2) Includes particulate emissions from the two boilers (47TPY), plus process-dust emissions totalling 1 TPY from waste receiving/storage area, RDF processing; RDF and wood-chip storage area; and material storage silos.

(3) Percentage based on HHV heat input.

(4) Less than limits of detection of analytical method.

(5) Designated as Unacceptable Waste--Unacceptable Waste will not be processed at Collier County Plant.

(6) *Calculated by Gotaverken using the Eadon (N.Y. State Dept. of Health) Method.*

TABLE 1-1 (continued)

ESTIMATED CONTROLLED POLLUTANT EMISSIONS FOR THE PROPOSED COLLIER COUNTY WASTE-TO-ENERGY PLANT(1)

	70 percent RDF/30 percent Tires(3)			
Criteria Pollutants	(lb/ton Fuel as fired)	(g/sec)	(lbs/hr)	(tons/year)
Particulate matter(2)	0.36	1.3	10	45
Sulfur dioxide (SO_2)	2.6	9.2	73	320
Nitrogen oxides (as NO_2)	3.2	11	90	393
Carbon monoxide (CO)	1.1	4.0	32	140
VOC (as CH_4)	0.06	0.3	2	8
Lead (Pb)	4.2×10^{-3}	0.02	0.12	0.5
Noncriteria Pollutants				
Asbestos	(5)	(5)	(5)	(5)
Beryllium (Be)	8.9×10^{-6}	3.2×10^{-5}	2.5×10^{-4}	1.1×10^{-3}
Mercury (Hg)	4.3×10^{-3}	0.02	0.12	0.5
Vinyl chloride	(5)	(5)	(5)	(5)
Fluorides (as HF)	3.6×10^{-3}	0.01	0.1	0.5
Sulfuric acid mist (H_2SO_4)	(4)	(4)	(4)	(4)
Total reduced sulfur (TRS), includes H_2S	(4)	(4)	(4)	(4)
Reduced sulfur compounds, includes H_2S	(4)	(4)	(4)	(4)
Hydrogen sulfide (H_2S)	(4)	(4)	(4)	(4)
Other Acid Gases				
Hydrogen chloride (HCl)	0.71	2.5	20	90
Other Trace Metals				
Arsenic (As)	6.4×10^{-5}	2.3×10^{-4}	1.8×10^{-3}	7.9×10^{-3}
Cadmium (Cd)	6.4×10^{-4}	2.3×10^{-3}	1.8×10^{-2}	7.9×10^{-2}
Hexavalent chromium (as Cr)	3.5×10^{-4}	1.3×10^{-3}	1.0×10^{-2}	4.3×10^{-2}
Nickel (Ni)	1.6×10^{-4}	7.6×10^{-4}	4.5×10^{-3}	1.9×10^{-2}
Other Trace Organics				
PCDD	1.4×10^{-6}	4.8×10^{-6}	3.8×10^{-5}	1.7×10^{-4}
TCDD	1.4×10^{-7}	4.8×10^{-7}	3.8×10^{-6}	1.7×10^{-5}
2,3,7,8 TCDD	3.6×10^{-9}	1.3×10^{-8}	1.0×10^{-7}	4.5×10^{-7}
2,3,7,8 TCDD toxic equivalents(6)	6.4×10^{-8}	2.3×10^{-7}	1.8×10^{-6}	7.8×10^{-6}
PCDF	1.8×10^{-6}	6.4×10^{-6}	5.1×10^{-5}	2.2×10^{-4}

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(1) Emissions estimates based on Plant operating at 100% capacity and 100% availability (i.e., 24 hours/day, 365 days/year).

(2) Includes particulate emissions from the two boilers (44TPY), plus process-dust emissions totalling 1 TPY from waste receiving/storage area, RDF processing; RDF and wood-chip storage area; and material storage silos.

(3) Percentage based on HHV heat input.

(4) Less than limits of detection of analytical method.

(5) Designated as Unacceptable Waste--Unacceptable Waste will not be processed at Collier County Plant.

(6) Calculated by Gotaverken using the Eadon (N.Y. State Dept. of Health) Method.

TABLE 1-1 (continued)

ESTIMATED CONTROLLED POLLUTANT EMISSIONS FOR THE PROPOSED COLLIER COUNTY WASTE-TO-ENERGY PLANT(1)

	45% RDF/13% TIRES/42% WOOD CHIPS(3)			
Criteria Pollutants	(lb/ton Fuel as fired)	(g/sec)	(lbs/hr)	(tons/year)
Particulate matter(2)	0.34	1.4	11	47
Sulfur dioxide (SO_2)	2.3	9.3	74	324
Nitrogen oxides (as NO_2)	2.8	12	91	398
Carbon monoxide (CO)	0.99	4.0	32	142
VOC (as CH_4)	0.06	0.3	2	8
Lead (Pb)	3.2×10^{-3}	0.01	0.10	0.5
Noncriteria Pollutants				
Asbestos	(5)	(5)	(5)	(5)
Beryllium (Be)	5.1×10^{-6}	2.0×10^{-5}	1.6×10^{-4}	7.1×10^{-4}
Mercury (Hg)	2.4×10^{-3}	0.01	0.08	0.34
Vinyl chloride	(5)	(5)	(5)	(5)
Fluorides (as HF)	3.1×10^{-3}	0.01	0.1	0.5
Sulfuric acid mist (H_2SO_4)	(4)	(4)	(4)	(4)
Total reduced sulfur (TRS), includes H_2S	(4)	(4)	(4)	(4)
Reduced sulfur compounds, includes H_2S	(4)	(4)	(4)	(4)
Hydrogen sulfide (H_2S)	(4)	(4)	(4)	(4)
Other Acid Gases				
Hydrogen chloride (HCl)	0.66	2.7	21	91
Other Trace Metals				
Arsenic (As)	4.9×10^{-5}	2.0×10^{-4}	1.6×10^{-3}	6.8×10^{-3}
Cadmium (Cd)	4.9×10^{-4}	2.0×10^{-3}	1.6×10^{-2}	6.8×10^{-2}
Hexavalent chromium (as Cr)	2.3×10^{-4}	9.1×10^{-4}	7.2×10^{-3}	3.2×10^{-2}
Nickel (Ni)	1.3×10^{-4}	5.1×10^{-4}	4.0×10^{-3}	1.8×10^{-2}
Other Trace Organics				
PCDD	1.2×10^{-6}	4.9×10^{-6}	3.9×10^{-5}	1.7×10^{-4}
TCDD	1.2×10^{-7}	4.9×10^{-7}	3.9×10^{-6}	1.7×10^{-5}
2,3,7,8 TCDD	3.2×10^{-9}	1.3×10^{-8}	1.0×10^{-7}	4.6×10^{-7}
2,3,7,8 TCDD toxic equivalents(6)	5.7×10^{-8}	2.3×10^{-7}	1.8×10^{-6}	7.9×10^{-6}
PCDF	1.6×10^{-6}	6.6×10^{-6}	5.2×10^{-5}	2.3×10^{-4}

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(1) Emissions estimates based on Plant operating at 100% capacity and 100% availability (i.e., 24 hours/day, 365 days/year).

(2) Includes particulate emissions from the two boilers (46TPY), plus process-dust emissions totalling 1 TPY from waste receiving/storage area, RDF processing; RDF and wood-chip storage area; and material storage silos.

(3) Percentage based on HHV heat input.

(4) Less than limits of detection of analytical method.

(5) Designated as Unacceptable Waste--Unacceptable Waste will not be processed at Collier County Plant.

(6) Calculated by Gotaverken using the Eadon (N.Y. State Dept. of Health) Method.

TABLE 1-2

EMISSIONS TEST RESULTS FROM THE GOTAVERKEN CFB INCINERATOR IN SUNDSVALL, SWEDEN

Date	4/12/85	4/12/85	4/12/85*	9/27/85	9/27/85*	9/27/85	Mean
Test #	1	2	3	4	5	6	
Fuel Mixture	RDF/Peat	RDF/Peat	RDF/Peat	RDF/Chips/ Tires	RDF/Chips/ Tires	RDF/Chips/ Tires	
% RDF	30-60	30-60	60-90	15-70	15-70	15-70	
% Peat	70-40	70-40	40-10	-	-	-	
% Wood Chips	-	-	-	20-60	20-60	20-60	
% Tires	-	-	-	10-25	10-25	10-25	
Particulate Matter**	11.3	36.4	43.2	6.7	5.4	34	22
SO_x**	251	177	197	543	103	226	299
NO_x (as NO_2)**	217	191	203	101	115	115	156
CO**	35	39	251	114	401	24	53
HCl**	122	188	489	265	446	281	214
HF**	0.5	0.6	0.8	-	-	-	0.6
Dioxin***	0.4	1.3	4.5	0.6	11	1.8	1.0
Combustion Temperature (°)	1562	1508	1526	1598	1526	1598	1567

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* Unstable firing due to temporary feed problems, results not included in mean values.

** mg pollutant/normal cubic meter corrected to 7 percent O_2.

*** ng dioxin as 2,3,7,8 TCDD equivalent/normal cubic meter corrected to 10 percent CO_2. 2,3,7,8 TCDD equivalents calculated according to: Eadon, G., et al., Comparisons of Chemical and Biological Data on Soot Samples from the Binghampton State Office Building, unpublished report, 1982.

TABLE 1-3

BOILER DESIGN PARAMETERS FOR 100 PERCENT RDF*

Fuel feed as received	18.08 tons/hr.
Fuel heat value (HHV as received)	4,536 Btu/lb.
Heat input (HHV)	164.0 million Btu/hr.
Annual operation	8,760 hours/year
Availability	100 percent
Flue gas flow rate	71,495 acfm wet, at 7% O_2 37,714 dscfm, at 7% O_2, 60°F 42,038 dscfm, at 12% CO_2, 60°F and 8.4% O_2
Flue gas temperature	351°F

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* Data given for one boiler at maximum charge rate conditions.

TABLE 1-4

BOILER DESIGN PARAMETERS FOR 70 PERCENT RDF/30 PERCENT TIRES*

RDF feed as received	12.66 tons/hr.
Tires feed as received	1.34 tons/hr.
Fuel heat value (HHV as received) RDF	4,536 Btu/lb.
Tires	15,845 Btu/lb.
Heat input (HHV)	157.4 million Btu/hr.
Annual operation	8,760 hours/year
Availability	100 percent
Flue gas flow rate	66,046 acfm wet, at 7% O_2 36,029 dscfm, at 7% O_2, 60°F 38,930 dscfm, at 12% CO_2, 60°F and 8% O_2
Flue gas temperature	351°F

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* Data given for one boiler at maximum charge rate conditions.

TABLE 1-5

BOILER DESIGN PARAMETERS FOR 45 PERCENT RDF/13 PERCENT TIRES/ 42 PERCENT WOOD CHIPS

RDF feed as received	8.13 tons/hr.
Tires feed as received	0.60 tons/hr.
Wood-chips feed as received	7.08 tons/hr.
Fuel heat value (HHV as received) RDF	4,536 Btu/lb.
Tires	15,845 Btu/lb.
Wood Chips	4,928 Btu/lb.
Heat input (HHV)	162.6 million Btu/hr.
Annual operation	8,760 hours/year
Availability	100 percent
Flue gas flow rate	69,605 acfm wet, at 7% O_2 36,504 dscfm, at 7% O_2, 60°F 40,567 dscfm, at 12% CO_2, 60°F and 8.3% O_2
Flue gas temperature	360°F

TABLE 1-6

ULTIMATE ANALYSIS FOR DESIGN FUEL

	RDF (%)	TIRES (%)	WOOD CHIPS (%)
Moisture	35.00	0.80	44.00
Ash	12.74	9.90	1.23
Carbon	26.39	77.90	27.66
Hydrogen	3.24	7.44	3.40
Nitrogen	0.61	0.24	--
Sulphur	0.26	1.34	--
Chlorine	0.35	0.14	--
Oxygen	21.41	2.24	23.71
	100.00	100.00	100.00
Heating Value GCHV	4536 Btu/lb	15845 Btu/lb	4928 Btu/lb

2.0 PARTICULATE MATTER

Total plant emissions are comprised of particulate emissions from the CFB boilers, plus process-dust emissions from the waste tipping/storage area; the RDF process; RDF/wood-chip storage area; and the sand, limestone, and ash silos. As indicated in Table 2-1, total plant emissions of particulate matter will not exceed 48 TPY, i.e., 47 TPY from the two CFB boilers plus 1 TPY of process dust. The bases for the estimated particulate emissions for the boilers and ancillary plant processes are discussed below.

Particulate emissions from the two CFB boiler units will be controlled to a total maximum of 47 TPY by means of fabric filters installed on each of the two boiler units. These fabric filters will each be designed to achieve a particulate emission limit of 0.015 gr/dscf, at 12 percent CO_2, based on a design, maximum, normal inlet concentration of 13 gr/dscf at 12 percent CO_2 and a fabric filter particulate removal efficiency of 99.89 percent. The design inlet grain loading has been theoretically calculated. Uncontrolled particulate emissions from conventional mass burn and RDF incineration facilities average 1.4 and 5.0 gr/dscf at 12 percent CO_2, respectively*; thus, the 13 gr/dscf inlet loading used by Gotaverken is conservative. The particulate emission rates in Table 2-1 are based on the maximum outlet loading of 0.015 gr/dscf.

Dust generated during waste receiving, RDF processing, and RDF/wood-chip storage will be controlled by a succession of containment, fabric filtration, and thermal reduction to an emission rate of 0.1 TPY. The RDF process is a "closed" process which serves to contain dust generated by the processing equipment. Dust control in the RDF process begins on the tipping floor which is totally enclosed and kept under a slightly negative pressure by aspirators in the RDF process. At the tipping floor a hood aspirates any dust produced when the MSW is placed upon the apron conveyor which feeds the primary shredder.

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*California Air Resources Board, Air Pollution Control at Resource Recovery Facilities, p. 1968, May 24, 1984.

TABLE 2-1

SUMMARY OF MAXIMUM PARTICULATE EMISSIONS

SOURCE	QUANTITY (TONS/YEAR)
Boilers	47
Waste Receiving; RDF Process; RDF/Wood-Chip Storage	0.1
Ash Handling	0.4
Sand (Bed Material)	0.01
Limestone	0.01
Total	47.52 ~ 48 TPY

NOTE: The 48 TPY total particulate emissions results from the assumption that both boilers will run continuously at full load, 24 hours/day, 365 days/year. The actual capacity factor will most likely be 85%. At this level the particulate emission from the boilers will be only 40 TPY.

Transfer points in the process are enclosed, with the inlets and outlets sealed with rubber flaps. Aspiration points on the apron conveyor, primary shredder, magnetic disc screen enclosure, and the flexowall conveyor to RDF storage are ducted to a baghouse. Also controlled by this baghouse, is dust from the area that houses both RDF and wood-chip storage. Aspiration from the stoner, air knife and classifer is ducted to a separate baghouse. Each baghouse discharge will have a dust loading of 0.01 gr/dscf. If the process were to run 365 days per year, 24 hours per day this would provide a discharges of 18.7 TPY of particulate. (The RDF process will normally only run 5 days per week, 16 hours per day). The discharge from the RDF area baghouse is ducted to the boilers, where the discharges are used as part of the combustion air. After combustion, the 18.7 TPY of particulate matter is reduced to approximately 0.1 TPY.

During infrequent limited periods when one or both boilers are shut down for maintenance, the discharges from the RDF area baghouses (18.7 TPY = 4.3 lb/hr) will be vented through the boiler stack without further thermal reduction. Under this worst case scenario, (one boiler out of service for one year) maximum Plant emissions of particulate matter would be 4.3 lb/hr RDF dust plus 5.37 lb/hr particulate from one boiler, for a total of 9.67 lb/hr. Emissions in this case, therefore, would be less than those during normal Plant operations (48 TPY = 11 lb/hr).

With regard to the sand silo and the two limestone silos, each silo is equipped with a fabric filter which has an efficiency of 99.5%. These filters are used during silo "filling". The discharge of these filters is ducted into the combustion air flow to the boilers for thermal reduction, so that no dust is emitted by the filling operation. It is conservatively estimated that no more than .02 tons/year of sand/limestone particulate will be liberated as trucks hook-up to transfer material into the silos.

The ash handling silo will hold both bottom ash and fly ash which is pneumatically transported from the boiler house. The transport air will pass through a 99.5% efficient air filter and then be ducted to the flue gas ducts before the boiler baghouses. Thus, no quantifiable amount of particulate will be liberated from this part of the ash handling process. However, a small amount of particulate will be liberated when trucks remove wetted-ash from the ash silo. This amount of particulate is conservatively estimated to be 0.4 TPY.

3.0 SULFUR DIOXIDE

The projected SO_2 emissions for the Collier County Plant are shown in Table 3-1. The emission factors for firing 100% RDF, 70% RDF/30% tires, and 45% RDF/13% Tires/42% wood chips are 2.1 lb/ton, 2.6 lb/ton, and 2.3 lb/ton, respectively, each corresponding to an in-stack SO_2 concentration of 100 ppm by volume. Gotaverken has guaranteed the SO_2 emissions to be at a maximum 100 ppm (by volume corrected to 7 percent O_2, dry basis) or 70 percent SO_2 removal efficiency, whichever is least restrictive. SO_2 control is attained by the continuous feeding of limestone with the fuel into the CFB incinerator. The calcium in the limestone reacts in the fluidized bed with SO_2 to form the solid, calcium sulfate, which is subsequently removed either as bottom ash or as flyash collected in the fabric filter.

The ability of limestone to remove SO_2 in fluidized bed combustion processes has been demonstrated in facilities in Sweden and the United States. SO_2 removal efficiencies exceeding 90 percent while burning 0.6 to 4.2 percent sulfur coal in fluidized bed combustors have been achieved. For example, at a Gotaverken installation in Nykoping, Sweden, an SO_2 reduction efficiency of 90-95 percent has been demonstrated when firing 0.6 percent sulfur coal. Figure 3-1 shows the relationship between SO_2 removal efficiency and the Ca/S molar ratio as demonstrated at Nykoping.

Similar Ca/S molar ratios have been utilized at fluidized bed coal combustors in the United States and have been demonstrated to achieve SO_2 removal efficiencies up to 90 percent while burning high sulfur coal. The fuel sulfur content at these facilities is from 2 to 8 times that of the design sulfur content in the RDF/tires/wood chips fuel mixtures to be used in the Collier County Plant. For example, emissions tests were conducted on a fluidized bed boiler at the Iowa Beef Processors plant in Amarillo, Texas.* This boiler, at 70,000 lb steam/hr. generating capacity, is of a similar size to the proposed

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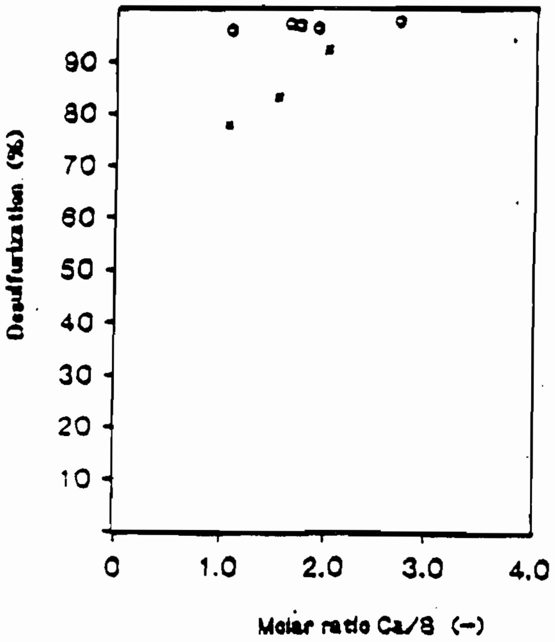
* Peduot, E. F., et al., <u>Continuous Monitoring of Wormser Fluidized Bed Combustor-Draft Report</u>, Environmental Protection Agency, June, 1984.

FIGURE 3-1

RELATIONSHIP BETWEEN SO_2 REMOVAL EFFICIENCY AND CA/S MOLAR RATIO AT NYKOPING



Desulfurization as a Function of Molar Ratio Ca/S

(X fine particles 0 to 500 µm)

(0 coarser particles 200 to 1 500 µm)

Collier County Plant, at 110,000 lb. steam/hr each boiler. Four percent sulfur coal was fired while limestone was injected at a Ca/S ratio ranging from 2-3.2. SO_2 removal efficiency ranged from 80-90 percent. Emissions tests have also been conducted on a fluidized bed boiler at Georgetown University firing high sulfur coal.* This facility was also of a size similar to the proposed Collier County Plant, generating approximately 100,000 lb. steam/hr. Ca/S molar ratios ranged from 1-10, but were typically in the range of 4-6. SO_2 removal efficiencies ranging from 75-85 percent were achieved with Ca/S molar ratios from 4-6. Higher removal efficiencies were achievable at higher molar ratios.

* Young, C. W., et al., Monitoring of Air Emissions from the Georgetown University Fluidized Bed Boiler-Draft Report, Environmental Protection Agency, September, 1982.

4.0 HCI

The projected HCl emissions for the Collier County Plant are shown in Table 1-1. The projected emission factors for firing 100% RDF; 70% RDF / 30% tires; and 45% RDF/13% tires/42% Wood chips are 0.72 lb./ton, 0.71 lb/ton, and 0.66 lb/ton, respectively. Gotaverken has guaranteed the HCl emissions to be at maximum 50 ppm (by volume, corrected to 7 percent O_2, dry basis) or to be controlled with 90 percent removal efficiency, whichever is less stringent. The emission factor (0.72 lb/ton) and emission rate (114 TPY) for the 100% RDF firing scenario are based on 90 percent removal efficiency, and are equivalent to an in-stack HCl concentration of 61 ppmv. The HCl emission factors and rates for the other two fuel scenarios are based on an in-stack HCl concentration of 50 ppmv.

In the same manner that has been clearly demonstrated for SO_2, HCl can be controlled with high efficiency by the continuous feeding of limestone with the fuel into the CFB incinerator. The calcium in the limestone reacts with HCl to form the solid calcium chloride which is subsequently removed either as bottom ash or as flyash collected in the fabric filter. In addition, unreacted calcium which is captured by the fabric filter and retained in the filter cake, continues to react with any remaining HCl (as well as SO_2), and further enhances removal efficiency. Indeed, the EPA recognizes that use of limestone in the combustion process is one advantage of fluidized bed combustion in that this can greatly reduce emissions of both HCl and SO_2.*

Sufficient amounts of calcium must be provided for reaction with HCl and SO_2 to achieve 90 and 70 percent removal respectively. The appropriate molar ratio of calcium to sulfur and chlorine is:

$$\frac{Ca}{S+2Cl} = 3.$$

This molar ratio provides an ample margin of safety to account for non-stoichiometric reactions between calcium and sulfur and chlorine.

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* Roeck, D. R., and McInnes, R. G., <u>Fluidized Bed Combustion of Wastes and Low-Grade Fuels-Draft Final Report</u>, p. 13, Environmental Protection Agency, April, 1982.

5.0 NITROGEN OXIDES

NO_X emissions are guaranteed by Gotaverken not to exceed 170 ppm by volume (as NO_2) on an 8 hour average. This corresponds to emission factors of 2.6 lb/ton, 3.2 lb/ton, and 2.8 lb/ton, respectively, for firing 100% RDF, the RDF/tires mixture, and the RDF/tires/wood-chips mixture. The Gotaverken CFB incinerator has combustion design features that enable it to achieve low emissions of NO_X as compared to grate burn incinerators. These design features include low peak flame temperatures, low excess air, and staged combustion. Actual test data from the Sundsvall CFB facility (see Table 1-2) shows average NO_X emissions of 156 mg NO_2/NM^3 at 7 percent O_2 and individual test results less than 110 ppm by volume.

Results of NO_X emissions tests at 21 mass burn incineration facilities show a range of concentrations from 117-274 ppm NO_X by volume at 12 percent CO_2, with an average of approximately 197 ppmv at 12 percent CO_2.* Based on a recent and, as yet, unpublished survey by Alternative Resources, Inc., (ARI), projected and actual NO_X emissions from five RDF incineration facilities** in various stages of permitting, construction, and operation, show a range of emission factors from 2.7-4.9 lb. NO_X (as NO_2)/ton of RDF fired. Therefore, the NO_X emissions projected for the Collier County Plant (2.6-3.2 lb/ton) are consistent with the range given for other existing and planned MSW incineration facilities.

6.0 CARBON MONOXIDE

The projected CO emissions for the Collier County Plant are shown in Table 1-1. The CO emission factor for the Plant is approximately 1 lb./ton of fuel mix for all three fuel scenarios. This corresponds to 125 mg CO/NM^3 at 7% percent O_2 or 100 ppm by volume at 7 percent O_2.

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* California Air Resources Board, Air Pollution Control at Resource Recovery Facilities, p. 81, May 24, 1984.

** The five facilities are the Mid-Connecticut, San Francisco, Detroit, Rochester, MA, and Albany, NY projects.

The CO emission factors have been based, with an extra margin of safety, on testing on the Sundsvall facility, where average CO emissions are 53 mg CO/NM^3 at 7 percent O_2 (see Table 1-2). Based on the ARI survey noted above, 13 MSW incinerators* in various stages of permitting, construction, and operation, show a range of emission factors from 0.3-14.4 lb. CO/ton of waste fired, with a mean value of 2.8 lb. CO/ton of waste fired. The CO emission factor for the Collier County Plant of approximately 1 lb/ton is within the range.

7.0 VOLATILE ORGANIC COMPOUNDS

The projected VOC emissions for the Collier County Plant are shown in Table 1-1. As indicated in the table, Plant emissions of VOC are estimated to be 8 TPY. The VOC emission factor for the Plant is 0.05 lb./ton of RDF as fired, and 0.06 lb./ton for each of the two fuel mixes. This corresponds to 7 mg VOC/NM^3 at 7 percent O_2. These emission factors have been based on the ratio, CO concentration/VOC concentration = 10, which has been derived by Gotaverken from tests on Swedish MSW incinerators. Typical data from two Swedish facilities were:

Plant A	CO	500-700 ppm
	THC	20- 40 ppm
Plant B	CO	30- 40 ppm
	THC	2- 3 ppm

This relationship, as an approximation, is maintained with other MSW incinerators operating elsewhere. For example, tests on five mass burn waterwall incinerators in the United States and Japan had a mean CO emission concentration of 64 ppm by volume dry at 12 percent CO_2, while the VOC emission concentration mean was 4.3 ppm by volume dry at 12 percent CO_2.**

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* The 13 facilities are the St. Lawrence County, NY; Mid-Connecticut; Agawam, MA; San Francisco; Detroit; Essex County, NJ; Millbury, MA; Brooklyn Navy Yard; Holyoke, MA; Rochester, MA; Bristol, CT; Bridgeport, CT; and Albany, NY; projects.

** California Air Resources Board, Air Pollution Control at Resource Recovery Facilities, p. 175, May 24, 1984.

8.0 HYDROGEN FLUORIDE

The projected HF emissions for the Collier County Plant are shown in Table 1-1. The HF emission factor for the Plant is 3-4 x 10^{-3} lb/ton fuel for all three fuel scenarios. This corresponds to approximately 0.4 mg HF/NM^3 at 7 percent O_2. These emission factors have been based on testing on the Sundsvall facility, where average HF emissions are 0.6 mg HF/NM^3 at 7 percent O_2, achieved without the benefit of limestone injection. HF emissions ranged from 0.5 - 0.8 mg/NM^3 at 7 percent O_2. Based on uncontrolled emissions of 0.6 mg/NM^3 and controlled emissions of 0.4 mg/NM^3 at 7 percent O_2, Gotaverken has conservatively assumed a 33 percent control efficiency with limestone injection.

9.0 DIOXIN

The projected total dioxin (PCDD) and furan (PCDF) emissions on a mass basis and on a "toxic equivalents" basis for the Collier County Plant are shown in Table 1-1, as well as estimated emissions of the key homologue (TCDD) and isomer (2,3,7,8 TCDD) in the dioxin-compound family. These emission factors have been based on testing at the Sundsvall facility. The projected dioxin emission factors for the Collier County Plant are 5-6x10^{-8} pounds dioxin (as 2,3,7,8 TCDD toxic equivalents) per ton fuel as fired for the three fuel scenarios. These emission factors have been calculated by Gotaverken based on the Eadon Method of toxic equivalency, a method developed by the New York State Department of Health. The emission estimates were based on actual emissions at the Sundsvall facility, but adjusted upward by a factor of approximately seven for conservatism. The proposed dioxin emissions for the Plant, while based on the Sundsvall data, have been conservatively adjusted upward to a level consistent with that estimated for other recently proposed MSW incineration projects in the United States. For example, the Brooklyn Navy Yard Facility project, proposed for New York City, and having recently undergone extensive regulatory and public review, has projected an emission factor for 2,3,7,8 TCDD of 4.4x10^{-9} lb./ton. The Collier County Plant is projecting a similar emission factor of 3-4x10^{-9} lb/ton for the three fuel scenarios.

Average dioxin emissions from the Sundsvall CFB facility are measured at 1.0 ng dioxin as 2,3,7,8 TCDD toxic equivalents per normal cubic meter corrected to 7 percent O_2, with toxic equivalency calculated by the Eadon method. The analysis of the Sundsvall dioxin samples and calculation of toxic equivalency was performed for Gotaverken by Dr. Cristoffer Rappe of Umea University, Sweden. Detailed analytical results from Dr. Rappe have been included in Appendix VII, Attachment A - "Dioxin Test Report." The Sundsvall measurement of 1 ng/Nm^3 of dioxin toxic equivalents can be compared with measurements made recently in the United States. For example, the New York Department of Environmental Conservation (NYDEC) has reported* the results of its recent testing at the Albany Answers Waste-to-Energy Plant that burns 600 TPD of RDF. Dioxin toxic equivalents emitted from the Answers Plant, also calculated by the Eadon method, were determined by NYDEC to be in the range of 9-16 ng/Nm^3, which is a full order of magnitude greater than emissions measured at the Sundsvall facility. Based on such comparisons, Gotaverken believes that the superior combustion efficiency of circulating fluidized-bed technology leads to significantly lower dioxin emissions than with conventional RDF and mass-burn grate technologies.

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* New York Department of Environmental Conservation, Emission Source Test Report -- Sheridan Avenue RDF Plant, "Answers," Albany, NY, August, 1985.

10.0 TRACE METALS

In Table 1-1, projected emissions from the Collier County Plant of trace metals are presented, both those trace metals regulated by EPA and DER (Be, Hg) and certain other trace metals (As, Cd, Cr, Ni) for which impacts, although not formally regulated, are nonetheless commonly at issue for waste-to-energy facilities.

With the exception of beryllium and barium, annual trace metal emission rates have been based on the following equation which was provided by Gotaverken:

$$E = C_{part.} * C_{fuel} * D * G * \text{constant} + Mn$$

where: E = annual trace metal emission rate, short ton/year

$C_{part.}$ = concentration of particulate matter in the stack flue gas, mg/NM^3 dry at 7 percent O_2

C_{fuel} = concentration of trace metal in fuel, mg/Kg (see Table 10-7)

D = distribution factor (see Table 10-2)

G = flue gas flow, dry standard cubic feet per minute at 7 percent O_2 (see Table 1-3, 1-4 and 1-5)

Constant = 3.13×10^{-11} (a dimensional constant)

Mn = a conservative margin of safety selected by Gotaverken

TABLE 10-1

TRACE METALS IN RDF, TIRES, AND WOOD CHIPS (DRY BASIS)

	100% RDF(1) ppm (mg/kg)	100% TIRES(2) ppm (mg/kg)	100% WOOD CHIPS(3) ppm (mg/kg)
Cd	5.0	0.2	0.36
Co	2.0	0.2	1.1
Cr	25.0	3.0	2.0
CU	80.0	120.0	5.4
Hg	3.6	0.1	0.018
Mn	--	--	162
Ni	8.0	0.8	1.1
Pb	100.00	10.0	12.6
Zn	400.00	10000.0	36
As	1.0	--	0.09
Be	1.0	--	--
Ba	100.0	--	--

(1) Estimated by Gotaverken based on a review of RDF/organic-fraction analyses for 15 Swedish Plants, plus the Santa Clara, California facility.

(2) Estimated by Gotaverken based on tire-analysis data on file.

(3) Based by Gotaverken on wood-chip analysis data on file.

TABLE 10-2

TRACE METAL DISTRIBUTION FACTORS*

Zinc	50
Lead	100
Cadmium	400
Chromium	50
Copper	50
Nickel	50
Arsenic	200
Cobalt	50

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* $\text{Distribution factor} = \frac{\text{Trace metal concentration in flyash}}{\text{Trace metal concentration in fuel}}$

The following is an example for cadmium, assuming the fuel is 100% RDF.

$$\begin{array}{ll}
E = 36 * 5 * 400 * 37{,}714 * 3.13 \times 10^{-11} & = 8.5 \times 10^{-2} \\
M_n \text{ for cadmium} = 3.5 \times 10^{-2} & \underline{+\ 3.5 \times 10^{-2}} \\
\text{estimated cadmium emission rate} = & \quad 12.0 \times 10^{-2} \text{ TPY}
\end{array}$$

Emissions of the criterion pollutant, lead, from the Collier County Plant are 3.2×10^{-3} lb/ton to 4.7×10^{-3} lb/ton, depending on the fuel mix. These emission factors are similar to actual measurements made at operating facilities. For example, The Answers Plant in Albany, New York, a 600 TPD RDF facility, has a lead emission factor of 9×10^{-3} lb/ton of RDF fired. The Westchester County, New York plant, a 2250 TPD mass burn facility, has a lead emission factor of 3×10^{-3} lb/ton of waste fired.

Projected maximum emission factors for the Collier County Plant of trace metals of principal interest are shown in Table 10-3 to be comparable to projected emission factors for the Brooklyn Navy Yard Facility, a 3000 TPD mass burn facility planned for New York City that has recently undergone extensive review by regulatory agencies and the public.

TABLE 10-3

COMPARISON OF TRACE METAL EMISSION FACTORS

	Emission Factor	
	Collier County Plant	Brooklyn Navy Yard Project
Trace Metal	lb/ton of Fuel as Fired	lb/ton of Waste as Fired
Beryllium (Be)	1.0×10^{-5}	3.5×10^{-6}
Mercury (Hg)	4.7×10^{-3}	9.6×10^{-3}
Arsenic (As)	7.5×10^{-5}	1.2×10^{-4}
Cadmium (Cd)	7.5×10^{-4}	8.9×10^{-4}
Chromium (Cr)	3.5×10^{-4}	4.4×10^{-4}
Nickel (Ni)	1.8×10^{-4}	3.1×10^{-4}

Beryllium and barium have not been the subject of emission tests as yet in Swedish incinerators and therefore distribution factors are not available for these pollutants. Beryllium emissions have been based on estimated emissions from mass burn incinerators in the United States that are either in the permitting process, have received permits to construct, or are in construction. Emission factors for these facilities have ranged from 1.4 x 10^{-6} to 2.7 x 10^{-5} lb./ton waste fired.* The maximum beryllium emission factor (1.0 x 10^{-5} lb/ton) for the Collier County Plant has been conservatively set at the upper end of this range.

Emission factors for barium have been estimated by Gotaverken based on the concentration of barium in the fuel compared with the fuel concentration for other metal compounds having similar physical properties and for which distribution factors are known. The emission factor for barium is proportional, on an order of magnitude basis, to the emission factors for metal compounds with physical properties similar to those of barium compounds. These compounds, including copper, nickel, and beryllium, are classified as low volatility compounds (i.e., similar boiling points).

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* These facilities include the Brooklyn Navy Yard, NY; Essex County, NJ; Millbury, MA; Agawam, MA; St. Lawrence County, NY; and Holyoke, MA projects.

APPENDIX IV

AIR QUALITY IMPACT ANALYSIS

APPENDIX IV

Table of Contents

1.0 REGULATORY REQUIREMENTS

In this section, pertinent air quality regulations promulgated by EPA and Florida Department of Environmental Regulation (FDER) are summarized, and the applicability of each regulation to the planned Plant is discussed.

The Plant is potentially subject to the following Federal and State of Florida regulations:

- Prevention of Significant Deterioration (PSD)
- New Source Performance Standards (NSPS)
- National Emission Standards for Hazardous Air Pollutants (NESHAP)
- Florida DER Air Pollution Control Regulations.
- Ambient Air Quality Standards

The site of the planned Plant is in an area designated as attainment for all pollutants. As a result, the planned Plant is not subject to state or federal nonattainment regulations.

1.1 Prevention of Significant Deterioration (PSD)

EPA has established regulations (40 CFR 52.21) for preventing significant degradation of air quality in "clean" areas, i.e., areas where air quality currently is better than ambient standards. This is accomplished by limiting future emissions from major new sources (or major modifications of existing sources) in the area such that air quality will never degrade by more than a specified increment over the baseline air quality. The EPA nondegradation limits are referred to as the PSD increments (Table 1-1). In Florida, DER implements the Federal PSD regulations in accordance with Chapter 17-2, Florida Adminstration Code (FAC).

To be subject to the PSD regulations, a proposed new source (or modification) must be classified as "major." A source is considered major if it is one of 28 source categories listed by EPA and its potential emissions (i.e. emissions after pollution controls) of any Federally-regulated pollutant are more than

TABLE 1-1

Federal* and State+ PSD Allowable Increments

Pollutant/Averaging Time	Allowable Increment (ug/m^3) Class I	Class II	Class III
Particulate Matter			
Annual Geometric Mean	5	19	37
24-Hour Maximum**	10	37	75
Sulfur Dioxide			
Annual Arithmetic Mean	2	20	40
24-Hour Maximum**	5	91	182
3-Hour Maximum**	25	512	700

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*40 CFR Part 52, Section 52.21.

+Ch 17-2, FAC

**Maximum concentration not to be exceeded more than once per year.

100 TPY. If the proposed source is not in one of the listed source categories, its potential emissions must exceed 250 TPY of a regulated pollutant for it to be deemed a major source.

Municipal incinerators charging more than 250 tons per day (TPD) of waste represent a listed EPA source category. The planned Plant will charge up to 868 TPD of RDF and the Plant, therefore, falls within this source category. Because the Plant will have annual emissions of CO, SO_2 and NO_x each in excess of 100 TPY, the Plant will be considered a major source.

For any major source, including the planned Plant, a PSD Permit is required, and an application must be filed that addresses the following: Best Available Control Technology (BACT) for the source; existing ambient air quality and the need for ambient monitoring; the impact of the source in relation to the National Ambient Air Quality Standards (NAAQS) and PSD increments; the impact of the source on soils/vegetation and visibility; and air quality impacts associated with indirect growth created by the new source.

1.2 New Source Performance Standards (NSPS)

EPA has promulgated national emission standards (40 CFR 60) for new sources of air pollution. The emission standards have been set on a pollutant-by-pollutant basis for specific source categories. EPA has established a particulate matter (PM) emission limit of 0.08 gr/dscf a 12% CO_2 for incinerators charging in excess of 50 TPD of waste. The planned Plant will readily comply with the existing NSPS because PM emissions from the two boilers will be limited to 0.015 gr/dscf at 12% CO_2.

A NSPS has been proposed for Industrial-Commercial-Institutional steam generating units with a heat input rate of greater than 100×10^6 Btu/hr (Federal Register, Vol 49, No. 119, June 19, 1984). However, these have not yet been promulgated as final regulations by EPA. In the event that NSPS for this source category are promulgated, they may apply retroactively to the proposed Collier County facility. The numerical emission limits or form of the final standards cannot be anticipated at this time. The proposed standards limit PM due to wood or solid waste firing to 0.10 $lb/10^6$ Btu heat input. As derived from Appendix III, the PM emission limit for the planned Plant is equivalent to a maximum of 0.034 $lb/10^6$ Btu, and thus would comply with the proposed NSPS. No other emission limitations for wood or solid waste firing were included in the proposed NSPS.

1.3 National Emission Standards for Hazardous Pollutants (NESHAPS)

EPA has published, and periodically updates, a list of hazardous air pollutants for which it has established national emission standards for specific source categories (40 CFR 61). The NESHAPS do not apply to waste-to-energy facilities which utilize municipal solid waste, RDF, wood waste or tires. The NESHAPS for mercury (40 CFR 61, Subpart E) would apply if the planned Plant were to burn sewage sludge. However, the proposed facility will not burn sewage sludge and therefore, will not be subject to the NESHAP for mercury.

1.4 State of Florida Emission Limitations

The Florida Department of Environmental Regulation (FDER) emission limiting standards that apply to the proposed facility are contained in FAC, Chapter 17-2.600(1)(c). Incinerators with a charging rate equal to or greater than 50 tons per day are restricted to PM emissions of 0.08 gr/dscf, corrected to 50 percent excess air. This is very nearly identical to the NSPS found in the federal code. The Florida regulation further requires that no objectionable odors be emitted from the facility. The general capacity rule found in FAC, Chapter 17-2.610 does not apply to a source for which either a specific particulate standard or specific opacity standard is provided elsewhere in Chapter 17-2. Because the proposed SWERF is subject to the specific particulate standard in Rule 17-2.600(1)(c), the general opacity standard does not apply.

1.5 Ambient Air Quality Standards (AAQS)

National AAQS (NAAQS) and State of Florida AAQS are presented in Table 1-2. The AAQS comprise six pollutants and various averaging times. These AAQS cannot be exceeded due to operation of the planned Plant.

TABLE 1-2

Federal and State AAQS (ug/m^3) Applicable to the Proposed Project

Pollutant	Averaging Time	Federal Primary Standard	Federal Secondary Standard	State of Florida
Suspended Particulate Matter	Annual Geometric Mean	75	60	60
	24-Hour Maximum*	260	150	150
Sulfur Dioxide	Annual Arithmetic Mean	80	N/A	60
	24-Hour Maximum*	365	N/A	260
	3-Hour Maximum*	N/A	1,300	1,300
Carbon Dioxide	8-Hour Maximum*	10,000	10,000	10,000
	1-Hour Maximum*	40,000	40,000	40,000
Nitrogen Dioxide	Annual Arithmetic Mean	100	100	100
Ozone	1-Hour Maximum+	235	235	235
Lead	Calendar Quarter	1.5	1.5	1.5

*Maximum concentration not to be exceeded more than once per year.

+Maximum concentration not to be exceeded more than an average of 1 calendar day per year.

Sources: 40 CFR, Parts 50 and 52.
Ch 17-2, FAC.

2.0 SOURCE AND POLLUTANT APPLICABILITY

2.1 Source Applicability

The Plant will be classified as a major source for PSD review because (1) it is a municipal waste incinerator capable of charging in excess of 250 TPD of waste, and (2) it will have potential (i.e. controlled) emissions of certain regulated pollutants (CO, NO_x, SO_2) in excess of 100 TPY each.

2.2 Pollutant Applicability

The potential emissions from the Plant of EPA-regulated pollutants are summarized in Table 2-1 for comparison with the EPA de minimus emission rates. A PSD/BACT review is required for any attainment pollutant with potential emissions in excess of the de minimus emission rates. From Table 2-1, it is apparent that PSD/BACT analysis requirements will apply for Plant emissions of particulate matter (PM), carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide (SO_2), lead (Pb), beryllium (Be), and mercury (Hg).

Irrespective of PSD rule applicability, the emissions and air quality impacts of certain pollutants not regulated by EPA or FDER will also be assessed. These pollutants include hydrogen chloride (HCl), arsenic (As), cadmium (Cd), hexavalent chromium (Cr), nickel (Ni), and dioxin (TCDD).

TABLE 2-1

SIGNIFICANT EMISSION RATES AND PLANT POTENTIAL-TO-EMIT VALUES FOR EPA-REGULATED POLLUTANTS

	Significant Emission Rates(1) (tons/year)	Potential to Emit (tons/year)(2)	Pollutant Subject to PSD
Particulate matter	25	48	Yes
Carbon monoxide	100	146	Yes
Nitrogen oxides	40	411	Yes
Sulfur dioxide	40	335	Yes
Ozone (VOCs)	40	8	No
Lead	0.6	0.8	Yes
Beryllium	0.0004	0.0016	Yes
Mercury	0.1	0.7	Yes
Fluorides	3	0.5	No
Sulfuric acid mist	7	*	No
Total reduced sulfur	10	*	No
Reduced sulfur	10	*	No
Hydrogen sulfide	10	*	No
Asbestos	0.007	(3)	No
Vinyl Chloride	1.0	(3)	No

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(1) SOURCE: 40 CFR 52.21 (b) (23)
(2) Emission estimates at 100% system availability based upon worst case fuel scenario.
(3) Unacceptable waste -- will not be processed at the plant

*Less than limits of detection

3.0 AIR QUALITY IMPACT ANALYSIS METHODOLOGY

3.1 General Approach

The air quality impact analysis includes determination of the Good Engineering Practice (GEP) stack height for the proposed Plant; estimation of the existing background air quality levels in the project site area; and determination of the air quality impacts resulting from Plant emissions of both criteria and noncriteria air pollutants. The significance of the air quality impacts is assessed by comparing the impacts with the EPA Significant Impact Levels (SILs), EPA/DER ambient air quality standards, and EPA Prevention of Significant Deterioration (PSD) Increments. The air quality analysis also includes an assessment of the impact of Plant emissions on soils, vegetation, and visibility. Plant secondary emissions (i.e. vehicles) impacts are addressed, as is the impact of the planned Plant on regional growth.

Because of the proximity of the planned Plant site to the Everglades National Park (ENP) Class I area and Big Cypress National Preserve (BCNP), impacts of the plant upon these areas are also addressed. Ambient air quality impacts and impacts upon Air Quality Related Values (AQRV) within these two areas are evaluated.

3.2 GEP Stack Height Analysis

The Collier County SWERF will utilize a stack with a height equal to the GEP height. An elevation view of the proposed boiler and turbine buildings and stack are shown in Appendix VIII. The stack will be dual-flue, with each flue serving one of the boiler units. As shown in the elevation view, the "controlling" structure at the site will be the boiler/auxiliary building. The dimensions of this structure are as follows:

Height (above grade): 104 ft.
Length: 74 ft.
Width: 95 ft.

The area of influence of this structure is defined as five times the lesser of the height or projected width of the structure. The projected width of the boiler/auxiliary building structure in relation to the stack is dependent upon the wind direction. The projected width is 95 feet for a wind direction oriented perpendicular to the long side of the structure. The projected width would increase to 124 feet for a wind oriented across the corner of the structure (i.e. approximately 35° from perpendicular to the long side of the structure). The minimum area of influence of the boiler/ auxiliary building is then based upon the minimum projected width of 95 feet. For this case, the projected width is less than the height of the structure, and the area of influence is calculated based upon the projected width.

Area of influence = 5 x 95 feet = 475 feet.

The stack will be located approximately 73 feet from the boiler/auxiliary building, and therefore will be in the area of influence of this structure.

The greatest GEP height is calculated using the greatest projected width of the influencing structure (124 feet). For this case, the building height of 104 feet is the lesser of the height or projected width, and GEP height is calculated as:

$$H_g = H + 1.5\ L = 104 + (1.5 \times 104) = 260 \text{ ft}$$

Projected widths associated with other wind directions would result in a lower GEP height.

The planned Plant will utilize a dual-flue stack, i.e. two flues contained side-by-side in a single stack. Because the two flues are located adjacent to each other, they have been treated as a single stack in the dispersion modeling analysis (i.e. a merged exhaust gas stream). The GEP regulations exempt merged gas streams from the definition of a prohibitive dispersion technique if allowable SO_2 emissions from the source do not exceed 5,000 TPY. Since the planned Plant will emit only 335 TPY of SO_2, credit for the merged gas streams in the dispersion modeling analysis is allowed.

3.3 Air Quality Modeling Approach - Site Area

Air quality models were used to assess the impact of the planned Plant in regard to NAAQS and allowable PSD increments. An atmospheric dispersion modeling protocol was developed which describes in detail the models and modeling procedures to be used. This document, included in Attachment A, was submitted to and reviewed for concurrence by FDER. The methodology is summarized below; the reader is referred to Attachment A for a more detailed description.

The EPA ISCST model was used for the short term evaluation (i.e. averaging times of 24-hours or less). Stack parameters input to the models were based upon the fuel scenario which would result in maximum ground-level concentrations (i.e., minimum plume rise). Stack parameters for the planned Plant for the three fuel scenarios are presented in Table 3-3. Review of this table shows that the scenario of 70% RDF/30% tires results in the lowest flue gas flow rate (66,046 acfm), while the flue gas temperature (351°) is the lowest for any of the scenarios. Since the lower flow rate for 70% RDF/30% tires will result in greater ground-level impacts than the other two scenarios, it was used as input to the models. A generic emission rate of 10.0 g/sec was used in the modeling to generate normalized pollutant concentrations.

The EPA PTPLU model was used to determine receptor distances for input to the ISCST model. The PTPLU model output consists of predicted maximum 1-hour concentrations and the downwind distances at which they occur for various meteorological conditions.

Based on the PTPLU results, the first receptor distance selected was 600m (rounded from 632m). Per EPA guidance, a geometric progression was then utilized to generate additional receptor distances, as shown in Table 3-4. To facilitate interpretation of model results, the calculated receptor distances were rounded to the nearest 100m. Copies of the PTPLU model printout are supplied in Volume II.

The ISCST model was applied in a refined analysis of Plant impacts, utilizing hour-by-hour meteorological data as input and a full polar grid of receptor locations. Surface meteorological data measured by the National Weather

TABLE 3-3

Stack Parameters for Air-Quality-Model Input
(Single Stack Housing Two Flues)

Fuel/Mix Scenario (1)		100% RDF	70% RDF/30% Tires	45% RDF/13% Tires 42% Wood Chips
Stack Height (2)	(ft) (m)	260 79.25	260 79.25	260 79.25
Flue Diameter, Each Flue	(in) (m)	48.0 1.22	48.0 1.22	48.0 1.22
Effective Diameter, Two Flues (3)	(ft) (m)	5.657 1.724	5.657 1.724	5.657 1.724
Gas Temperature, Both Flues	(°F) (°K)	351 450	351 450	360 455
Gas Flow Rate, Each Flue	(acfm) (m^3/s)	71,495 33.8	66,046 31.2	69,605 32.9
Gas Exit Velocity Each Flue	(ft/s) (m/s)	94.8 28.9	87.6 26.7	92.3 28.1

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(1) Fuel-mix percentages based on HHV heat input.
(2) Height of single stack that houses two flues.
(3) Diameter of a circle having an area equal to twice the area of one flue. For multiflue stacks, the effective diameter is used as the required "stack diameter" input to the air quality models.

TABLE 3-4

RECEPTOR DISTANCES BASED ON EPA - RECOMMENDED GEOMETRIC PROGRESSION

Geometric Factor	Calculated Receptor Distance (meters)	Receptor Distance Input to ISCST Model (meters)
Base	600	600
1.3	780	800
1.7	1020	1000
2.3	1380	1400
3.0	1800	1800
3.9	2340	2300
5.2	3120	3100
6.8	4080	4000
9.0	5400	5400

Service at Ft. Myers (Page Field) was used as input to the ISCST model. A five-year (1981-1985) record of hourly surface meteorological observations from Ft. Myers was obtained from the National Climatic Center, Asheville, NC. These data were merged with mixing-height data from the Tampa National Weather Service Office. The resulting five-year record of surface and upper-air meteorological data was then utilized as input to the ISCST model.

Receptors for the refined ISCST modeling analysis were located on a polar coordinate network with nine (9) ring distances spaced 10^o azimuth apart. The network was centered on the proposed Plant. The ring distances selected were these shown in Table 3-4, and ranged from 600m to 5.4km from the Plant.

As described previously, a generic pollutant emission rate of 10 g/sec was input to the ISCST model. The ISCST model identifies the second highest short-term (i.e. 1, 3, 8 and 24-hour average) ground-level concentrations at all receptor points for each of the five years of meteorological data. From this information, the highest, second-highest, concentration over all receptor points were identified.

The maximum short-term impacts identified by this methodology were further refined with the ISCST model using a receptor grip comprised of 49 receptors, spaced at approximately 0.1 km intervals, and centered about the location of maximum impact identified from the previous model output (see modeling protocol, Attachment A, for a more detailed description of the refined grid). For this refined analysis, only the meteorological periods resulting in the highest, second-highest short-term impacts were analyzed. These maximum impacts were used for comparison to AAQS, PSD increments, and threshold effects levels.

The EPA ISCLT model was used to predict annual average impacts due to the planned Plant. Inputs to the ISCLT model were similar to the ISCST model, and the long-term modeling was performed in a manner similar to the short-term modeling, including using the generic 10 g/sec emission rate. The primary differences in inputs were related to meteorological data and receptor locations.

The ISCLT model requires the joint frequency of occurrence of wind speed, wind direction and atmospheric stability. The five-year hourly surface data from Ft. Myers, described for the ISCST model, was used as input to the EPA "STAR" program to generate the required inputs for the ISCLT model. This was performed for each year of meteorology (1981-1985). The ISCLT model was then executed for each year to determine maximum annual impacts.

A cartesian (rectangular) receptor grid system was used in the ISCLT model. The grid consisted of a 10 km x 10 km array of receptors, spaced at 0.5 km increments, with the grid centered about the planned Plant site. The annual average concentrations were not refined further because the spatial variability in annual concentrations does not warrant a denser receptor spacing.

Plant impacts, both short-term and long-term, were then determined on a pollutant-specific basis by multiplying the model results by the emission rate (in g/sec) of the specific pollutant and then dividing by ten (10). The calculations were made using the maximum plant emission rate for any of the three fuel scenarios (See Appendix III).

As discussed in the modeling protocol document (Attachment A), the planned Plant site is located is a rural, remote area of Collier County, with no significant point sources of emissions located nearby. As a result, other point sources were not explicitly included in the modeling analysis. The effects of other point emission sources, as well as other anthropogenic sources, were accounted for in the conservatively estimated background concentrations (discussed in Sections 4.0 and 5.0). The estimated background concentrations were added to the predicted maximum impacts of the planned Plant in order to estimate total projected air quality impacts.

3.4 Air Quality Modeling Approach - Class I and Sensitive Areas

The air quality modeling approach for the Class I and sensitive areas was identical to that used for the site area (Section 3.3), except for receptor locations. The receptor locations used are depicted and listed in the modeling protocol (Attachment A). These locations are along the borders of the sensitive areas which are closest to the planned Plant site. Because concentrations decrease with distance at large downwind distances, receptors located within the sensitive area would exhibit lower predicted concentrations. In addition, no refinements of predicted concentrations with a dense receptor grid was performed, since the spatial variability in concentrations at such large distances is small.

4.0 AIR QUALITY IMPACT ANALYSIS RESULTS - SITE AREA

4.1 Background Air Quality

Representative monitoring data must be available to characterize existing air quality levels in the project site area. Background concentration estimates are required for criteria pollutants in order to estimate total air quality impacts due to operation of the planned Plant. The criteria pollutants are PM, SO_2, NO_2, CO, O_3, and Pb.

Background concentrations have been estimated based on air quality data from monitoring stations operated in Southwest Florida by the FDER Bureau of Air Quality Management (BAQM). The background concentrations have been determined using the second-highest short-term concentrations (1, 3, 8, 24 hour) and highest long-term concentrations (quarterly, annual) measured during 1985 at the BAQM monitoring stations nearest the project site. A description of the sites and summary of the monitoring data are presented in the modeling protocol, Attachment A. The monitoring locations are in heavily populated areas; therefore, the measured concentrations should provide conservative estimates of the background levels in the project site area, which is rural and remote.

The background concentrations estimated for the project site using the BAQM monitoring data are summarized in Table 4-1. The BAQM data are of high quality; they are recent; and they were obtained at locations that lead to a conservative representation of the background conditions at the project site. On this basis, there is no need to consider a pre-construction air quality monitoring program at the project site. This conclusion is further substantiated by the fact that the maximum air quality impacts calculated for the Plant are less than de minimis levels set by EPA for exempting projects from air quality monitoring requirements. This comparison is shown in Table 4-2.

4.2 Normalized Air Quality Impacts

The results of the ISCST and ISCLT modeling analysis, using the generic emission rate of 10 g/sec, are presented in Tables 4-3 and 4-4. Screening

TABLE 4-1

ESTIMATED BACKGROUND AIR QUALITY CONCENTRATIONS

Pollutant	Averaging Period	Estimated Background* Concentration ug/m^3
TSP	24-Hour	57
	Annual	33
SO_2	3-hour	90
	24-hour	26
	Annual	4
NO_2	1-Hour	139
	Annual	28
CO	1-hour	575
	8-hour	575
Pb	3-Month	0.1
O_3	1-Hour	145

*Second-highest short-term (1, 3, 8, 24 hour) concentrations and highest quarterly and annual concentrations measured during 1985 at the DER-BAQM monitoring locations nearest the project site.

**Monitoring data from representative site not available; background level assumed equal to _de minimis_ monitoring level.

Source: FDER, 1985

TABLE 4-2

DE MINIMIS CONCENTRATIONS FOR MONITORING EXEMPTION

Pollutant	Averaging Time	De Minimis Concentration* (ug/m^3)	Plant Impact (ug/m^3)
PM	24-hour	10	0.29
SO_2	24-hour	13	2.0
NO_2	Annual	14	0.19
CO	8-hour	575	2.6
Pb	3-month	0.1	0.0013**
Be	24-hour	0.0005	9.3×10^{-6}
Hg	24-hour	0.25	0.004
Fl	24-hour	0.25	0.002
O_3	-	100 TPY VOC Emissions	8 TPY VOC Emissions

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*FAC, Chapter 17-2

**Based upon four times the annual average concentration.

analysis results for each year of meteorology evaluated are presented in Table 4-3. Presented in Table 4-4 are the refined impacts, using a denser receptor grid for the short-term averaging times.

Plant impacts on a pollutant-specific basis were scaled directly from the values in Table 4-4 by multiplying the values there by the emission rate (in g/sec) of the specific pollutant, and dividing by 10. These calculations have been made using Plant pollutant emission rates that were summarized previously in Appendix III for three Plant fueling scenarios: (1) 100% RDF, (2) 70% RDF/30% tires, and (3) 45% RDF/13% tires/42% wood chips. To ensure a conservative analysis, the emission rate used for each pollutant was the higher of the values shown for the three fueling scenarios in Appendix III.

4.3 Air Quality Impacts for Criteria Pollutants

Maximum ground-level impacts from Plant emissions of criteria pollutants (i.e., those pollutants with NAAQS) have been determined using the results of the refined analysis with the ISCST and ISCLT models. Maximum Plant impacts, based on the ISC model results, are compared below with (1) the Significant Impact Levels (SILs) established by EPA, (2) the NAAQS, and (3) the PSD increments.

4.3.1 Plant Impacts Versus Significant Impact Levels

Maximum Plant impacts are compared in Table 4-5 with SIL established by EPA for TSP, SO_2, NO_2, and CO. Maximum impacts for each of these pollutants are shown to be less than significant levels. As a result, there is no specific requirement for additional analyses of these pollutant impacts. Nonetheless, a comparison of these impacts with the NAAQS and PSD increments will be presented in the subsequent subsections.

4.3.2 Plant Impacts Versus the NAAQS

Maximum Plant impacts are compared in Table 4-6 with the NAAQS. As indicated in Table 4-6, the projected air quality levels (Plant impact plus background concentration) will not result in violation of any NAAQS. In fact, the maximum Plant impacts represent exceedingly-small percentages of the NAAQS, i.e., 1% or less of the NAAQS.

TABLE 4-3

Maximum Normalized Ground-Level Concentrations Predicted for Each Year of Meteorology for the Planned Plant.

Averaging Time	Maximum Normalized Concentration (ug/m^3)*				
	1981	1982	1983	1984	1985
Annual	0.157	0.142	0.159	0.152	0.157
24-Hour	1.39	1.53	1.62	1.94	1.59
8-Hour	4.15	4.51	4.58	5.80	4.65
3-Hour	7.80	8.69	7.95	8.60	8.76
1-Hour	16.33	17.44	16.11	16.50	16.35

*Based upon generic emission rate of 10 g/sec. Highest, second-highest predicted concentration for short-term (24-hours or less) averaging times.

TABLE 4-4

MAXIMUM NORMALIZED CONCENTRATIONS FOR THE PLANNED PLANT

Averaging Time	Maximum Concentration* (µg/m^3)	Receptor Location+		Meteorological Period		
		Direction (o)	Distance (km)	Year	Day	Peri
Annual	0.159	270	1500	1983	-	-
24-Hour	2.07	184	1300	1984	228	-
8-Hour	6.21	184	1300	1984	228	2
3-Hour	10.74	176	1000	1985	183	4
1-Hour	17.44	240	800	1982	235	14

+With respect to planned Plant location.

*Based upon generic emission rate of 10 g/sec. Highest, second highest concentrations are shown for averaging times of 24 hours and less.

TABLE 4-5

AIR QUALITY IMPACTS COMPARED WITH EPA SIGNIFICANT IMPACT LEVELS (SIL)

Pollutant	Maximum Plant Impact* ($\mu g/m^3$)	EPA SIL ($\mu g/m^3$)
TSP - 24 hour	0.29	5
- Annual	0.022	1
SO_2 - 3 hour	10.3	25
- 24 hour	2.0	5
- Annual	0.15	1
NO_2 - Annual	0.19	1
CO - 1 hour	7.3	2,000
- 8 hour	2.6	500

*Highest, second-highest concentration for short-term averaging times.

TABLE 4-6

AIR QUALITY IMPACTS COMPARED WITH AMBIENT STANDARDS (NAAQS)

			Plant Impact (2)			
Pollutant	Averaging Period	Florida DER Ambient Standard[1] (μg/m^3)	Maximum Concentration[3] (μg/m^3)	Impact as Percent of Standard	Backgrnd Concentration[4] (μg/m^3)	Projected Air (i.e. Plant I Plus Backgr (μg/m^3)
TSP	24-Hour	150	0.29	0.2%	57	57.3
	Annual	60	0.022	0.04%	33	33
SO_2	3-Hour	1,300	10.3	0.8%	90	100.3
	24-Hour	260	2.0	0.8%	26	28.0
	Annual	60	0.15	0.25%	4	4.15
NO_2	Annual	100	0.19	0.2%	28	28.19
CO	1-Hour	40,000	7.3	0.02%	575	582.3
	8-Hour	10,000	2.6	0.03%	575	577.6
Pb	3-Month	1.5	0.0013(5)	0.09%	0.1	0.10013
O_3	1-Hour	235	0	0%	145	145

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(1) Florida DFR Standards are equal to or more stringent than EPA NAAQS

(2) Based on operation at 100% design capacity, 24 hours per day, 365 days per year.

(3) Highest, second highest concentration shown for averaging times of 24-hours or less

(4) Based on FDER ambient monitoring data -- See Table 4-1.

(5) A value four times the annual average Pb impact was used to conservatively represent the 3-month average impact.

Based upon present state-of-the-art, the impact of VOC emissions upon O_3 levels cannot be modeled. However, based upon the extremely small VOC emissions of 8 TPY due to the planned Plant, no discernable increase over present O_3 levels in the area of the site is expected.

4.3.3 Plant Impacts Versus PSD Increments

EPA has established Prevention of Significant Deterioration (PSD) increments for SO_2 and TSP in order to maintain the favorable quality of the air in areas currently attaining the NAAQS. The SO_2 PSD Class II increments apply in Collier County because the county is in compliance with the SO_2 and TSP NAAQS.

No significant PSD increment consuming sources are located in Collier or Lee Counties (representing over a 60 km radius surrounding the planned Plant site - see Attachment A). As a result, the full PSD increments are available.

The maximum predicted impacts of the planned Plant are compared to the PSD Class II increments in Table 4-7. The maximum Class II increment consumption is predicted to be 0.8% for TSP and 2% for SO_2. These impacts are well below the allowable increments and allows for future growth in the area.

4.3.4 Air Quality Impacts of Non-Criteria Pollutants

Maximum predicted air quality impacts of non-criteria pollutants due to operation of the planned plant are presented in Table 4-8. Various averaging times are shown for each pollutant. There are no NAAQS or Florida ambient air standards which to compare these predicted impacts; however, an assessment of the potential impacts on health for these pollutants is presented in Appendix V.

4.3.5 Fugitive Dust Impacts

The Plant grounds will be seeded and regularly maintained. Likewise, all paved surfaces onsite will be well maintained and regularly swept. No quantifiable fugitive dust resulting from surface disruptions and vehicular activity onsite is expected.

TABLE 4-7

MAXIMUM PLANT IMPACTS COMPARED WITH CLASS II PSD INCREMENTS

Pollutant	Averaging Period	EPA/DER Class II PSD Increment (µg/m3)	Maximum Concentration(1) (µg/m3)	Impact as % of Standard
TSP	24-Hour	37	0.29	0.8%
	Annual	19	0.022	0.1%
SO_2	3-Hour	512	10.3	2%
	24-Hour	91	2.0	2%
	Annual	20	0.15	0.8%

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(1) Based on operation at 100% design capacity, 24 hours per day, 365 days per year. Highest, second highest concentrations shown for averaging time of 24-hours or less.

TABLE 4-8

MAXIMUM AIR QUALITY IMPACTS OF NON-CRITERIA POLLUTANTS

Pollutant	Maximum Concentration* ($\mu g/m^3$) Annual Average	24-Hour	8-Hour	3-Hour	1-Hour
Beryllium (Be)	7.2×10^{-7}	9.3×10^{-6}	2.8×10^{-5}	4.8×10^{-5}	7.8×10^{-5}
Mercury (Hg)	0.00030	0.0041	0.012	0.021	0.035
Arsenic (As)	5.2×10^{-6}	6.8×10^{-5}	0.00020	0.00035	0.00058
Fluorides (Fl)	0.00016	0.0021	0.0062	0.011	0.017

*Highest, second-highest concentration shown for short-term averaging times.

4.3.6 Visibility Impacts

The planned plant will emit a plume which exhibits less than 20% opacity, and will be virtually invisible to the naked eye. Therefore, no impacts upon visibility in the area of the Plant are expected.

4.3.7 Soils and Vegetation Impacts

The analysis of impacts upon soils and vegetation in the area of the planned Plant are discussed in Section 6.0.

4.3.8 Secondary Emissions Analysis

The secondary emissions associated with the Plant would be primarily attributed to truck traffic generated by solid waste/tires/wood chips delivery, residue removal, and miscellaneous deliveries (sand, limestone, etc.). A major portion of this traffic will be trucks which currently go to the Collier County landfill, which is adjacent to the planned Plant site.

The small increase in traffic due to other associated Plant operations is likely to represent an insignificant fraction of the existing vehicular traffic levels in the area. No significant increase in vehicle-related emissions and air quality impacts, therefore, is expected over existing levels.

4.3.9 Growth Analysis

The planned Plant will employ approximately 45 persons. It is anticipated most of these positions will be filled from the local labor force. Operation of the Plant will not lead to significant in-migration to the area, and no significant population increase will occur, nor increased demand for housing units.

The planned Plant will have a minor positive influence on industrial and commercial development in Collier County. The Plant would facilitate development in Collier County by providing a reliable, long-term means for solid waste disposal.

5.0 AIR QUALITY IMPACT ANALYSIS RESULTS -- CLASS I AND SENSITIVE AREAS

5.1 Introduction

The Everglades National Park (ENP) is a PSD Class I area located about 35 km south-southeast of the site of the planned Plant (see Attachment A for location map). The Big Cypress National Preserve (BCNP) is located about 30 km east of the site, and although not a PSD Class I area, is considered a sensitive area by the National Park Service (NPS). There also exists certain sensitive ecological areas within Collier County as identified by the State of Florida. This section addresses the potential impacts that the planned plant may have upon the Class I and sensitive areas.

5.2 Background Concentrations

Historic monitoring data is not available for the ENP or BCNP. Florida DER does not currently operate ambient air monitors in or near these areas. The nearest FDER monitors are located in Naples and Ft. Myers (see Section 4.1). The NPS currently monitors ozone and SO_2 at the park entrance at Royal Palm Station (located over 100 km from the site), but the data does not meet quality assurance requirements.

In order to conservatively estimate background concentrations for the ENP and BCNP, the background levels were assumed to be the same as estimated for the plant site area (Section 4.1). Since these background levels are based upon monitoring data from Naples, Ft. Myers and Tampa, they are considered to be extremely conservative of levels actually existing in the ENP and BCNP.

5.3 Normalized Air Quality Impacts

The results of the ISCST and ISCLT modeling analysis for the ENP and BCNP, based upon the generic 10 g/sec emission rate, are presented in Tables 5-1 and 5-2, respectively. Comparison of the two tables indicates that higher impacts are predicted for the BCNP for all the short-term averaging time, while the highest annual average impact occurs at the ENP.

TABLE 5-1

PREDICTED MAXIMUM NORMALIZED CONCENTRATIONS DUE TO THE PLANNED PLANT AT THE EVERGLADES NATIONAL PARK CLASS I AREA

Averaging Time	Maximum Concentration* (ug/m^3)	Receptor Location+		Meteorological Period		
		UTM East (km)	UTM North (km)	Year	Day	Period
Annual	0.010	448.0	2857.0	1981	-	-
24-Hour	0.43	448.0	2857.0	1981	54	-
8-Hour	1.23	448.0	2857.0	1981	258	3
3-Hour	1.85	448.0	2857.0	1981	23	1
1-Hour	3.59	455.5	2863.0	1985	227	20

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*Based upon generic emission rate of 10 g/sec. Highest, second highest concentrations are shown for averaging times of 24-hours and less.

+Planned Plant UTM coordinates are 434.4 km east, 2892.9 km north.

TABLE 5-2

PREDICTED MAXIMUM CONCENTRATIONS NORMALIZED DUE TO THE PROPOSED PLANT AT THE BIG CYPRESS NATIONAL PRESERVE

Averaging Time	Maximum Concentration* (ug/m3)	Receptor Location+		Meteorological Period		
		UTM East (km)	UTM North (km)	Year	Day	Period
Annual	0.0077	466.5	2887.2	1981	-	-
24-Hour	0.50	466.5	2893.6	1983	357	-
8-Hour	1.49	466.5	2893.6	1983	357	1
3-Hour	2.18	466.5	2893.6	1983	62	1
1-Hour	3.99	466.5	2900.0	1983	311	22

*Based upon generic emission rate of 10 g/sec. Highest, second-highest concentrations are shown for averaging times of 24-hours and less.

+Planned Plant UTM coordinates are 434.4 km East, 2892.9 km north

5.4 Air Quality Impacts for Criteria Pollutants

5.4.1 Plant Impacts Versus for NAAQS

Maximum ground-level impacts from Plant emissions of criteria pollutants at the ENP or BCNP boundaries are presented in Table 5-3. The concentrations reflect the highest impacts regardless whether they occurred at the ENP boundary or the BCNP boundary. However, as discussed in Section 5.3, the maximum impacts within both areas are predicted to be similar. Concentrations for additional averaging times, other than those reflected in the NAAQS, are also shown in the table. These concentrations will be used in later discussions of Air Quality Related Values (AQRV). Background concentrations were not available for most of these additional averaging times, and therefore total projected air quality was not estimated for these averaging times. In the case of ozone concentrations, which cannot be predicted from modeling, the planned Plant emission rate of 8 TPY VOC will have no measurable effect upon levels in the ENP or BCNP.

As shown in Table 5-3, maximum predicted concentrations due to the proposed Plant at the ENP and BCNP are a very small percentage of the Florida AAQS (less than 0.2%). As discussed in Section 5.2, the background concentrations are considered extremely conservative of actual background levels at the ENP or BCNP. The total projected air quality impacts, even considering the conservative background levels, are still well below the AAQS. It is important to realize that the predicted impacts of the planned Plant are so low as to generally be not measurable. Regardless of the existing or future background levels, the planned Plant will have no discernible air quality impact upon the ENP or BCNP areas.

5.4.2 PLANT IMPACTS VERSUS THE PSD INCREMENTS

Shown in Table 5-4 are the maximum PSD increment consumption values at the ENP Class I area due to operation of the planned Plant. Maximum PSD increment consumption is less than 1 percent for TSP and 10 percent for SO_2. As discussed in Section 4.3.3, there are no other significant PSD increment

TABLE 5-3
MAXIMUM AIR QUALIT MPACTS OF CRITERIA POLLU TS AT THE ENP AND BCNP

Pollutant	Averaging Period	Florida DER Ambient Standard (μg/m³)(1)	Plant Impact(3) Maximum Concentration(2) (μg/m³)	Plant Impact(3) Impact as Percent of Standard	Background Concentration(4) (μg/m³)	Projected Air Quality (Plant Impact plus Background) (μg/m³)
TSP	Annual	60	0.001	0.002%	33	33
	24-Hour	150	0.07	0.05%	57	57.07
	8-Hour	NA	0.21	-	-	-
	3-Hour	NA	0.31	-	-	-
	1-Hour	NA	0.56	-	-	-
SO_2	Annual	60	0.010	0.02%	4	4.01
	24-Hour	260	0.5	0.2%	26	26.5
	8-Hour	NA	1.4	-	-	-
	3-Hour	1300	2.1	0.2%	90	92.1
	1-Hour	NA	3.8	-	-	-
NO_2	Annual	100	0.012	0.01%	28	28.012
	24-Hour	NA	0.6	-	-	-
	8-Hour	NA	1.8	-	-	-
	3-Hour	NA	2.6	-	-	-
	1-Hour	NA	4.9	-	139	143.9
CO	Annual	NA	0.0042	-	-	-
	24-Hour	NA	0.21	-	-	-
	8-Hour	10,000	0.63	0.006%	575	575.6
	3-Hour	NA	0.92	-	-	-
	1-Hour	40,000	1.7	0.004%	575	576.7
Pb	3-Month	1.5	0.00008	0.005%	0.1	0.10008
	24-Hour	NA	0.001	-	-	-
	8-Hour	NA	0.003	-	-	-
	3-Hour	NA	0.004	-	-	-
	1-Hour	NA	0.008	-	-	-
O_3	1-Hour	235	0	0%	145	145

NA Not Applicable

(1) Florida DER standards are equal to or more stringent than EPA NAAQS

(2) Highest, second highest concentrations for short term averaging times (i.e., 24 hours or less)

(3) Based upon operation at 100% design capacity, 24 hours per day, 365 days per year

(4) Based upon FDER ambient monitoring data - see Section 4.1

(5) A value four times the annual average Pb impact was used to conservatively estimate the 3 month average impact

TABLE 5-4

MAXIMUM PLANT IMPACTS AT ENP CLASS I AREA COMPARED WITH PSD INCREMENTS

Pollutant	Averaging Period	Class I PSD Increment ($\mu g/m^3$)	Maximum Concentration ($\mu g/m^3$)	Impact as Percent of Standard
TSP	24-Hour	10	0.07	0.7%
	Annual	5	0.001	0.02%
SO_2	3-Hour	25	2.1	8.4%
	24-Hour	5	0.5	10%
	Annual	2	0.010	0.5%

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(1) Based on operation at 100% design capacity, 24 hours per day, 365 days per year.

consuming sources in the area. Based on the relatively small Plant impact on the Class I area, a major portion of the allowable PSD increments will be available for future growth subsequent to startup of the planned Plant.

5.5 Air Quality Impacts of Non-Criteria/Non-Regulated Pollutants

Maximum ground-level impacts of non-criteria and non-regulated pollutants upon the ENP or BCNP areas, due to operation of the planned Plant, are presented in Table 5-5. Annual, 24-hour, 8-hour, 3-hour, and 1-hour averaging times are shown. The maximum impacts are small and in general would not be measurable. The potential effects these pollutants may have upon the ENP and BCNP area are discussed in Section 6.0.

5.6 Visibility Impacts

For any source subject to EPA PSD review, an analysis is required of the potential for visibility impairment on Federal Class I areas as a result of air emissions from that source. A visibility impact analysis of the planned Plant was performed using the EPA's Workbook for Estimating Visibility Impairment*. These procedures provide the capability for studying the incremental increase of a single source on background visibility. In addressing visibility impacts of the proposed source, both atmospheric discoloration and visual range reduction (increased haze) were examined. Atmospheric discoloration is generally a result of NO_x emissions, while increased haze is primarily a result of particulate emissions and secondary aerosols as sulfates.

The EPA Workbook provides a two level approach for screening visibility impacts. The level-1 analysis is the simplest and most conservative of the two methods, and requires a minimal amount of input data. If the source passes the criteria set forth by the level-1 approach, potential for visibility impairment is not expected and no further analysis is required. In the event a source fails the level-1 analysis, a level-2 analysis is required.

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*EPA, Workbook for Estimating Visibility Impairment, EPA 450/4-80-031, November 1980.

TABLE 5-5

MAXIMUM AIR QUALITY IMPACTS OF NON-CRITERIA/ NON-REGULATED POLLUTANTS AT THE ENP AND BCNP

Pollutant	Annual Average	Maximum Concentration* ($\mu g/m^3$)			
		24-Hour	8-Hour	3-Hour	1-Hour
<u>Non-Criteria Pollutants</u>					
Beryllium	$4.5x10^{-8}$	$2.3x10^{-6}$	$6.7x10^{-6}$	$9.8x10^{-6}$	$1.8x10^{-5}$
Mercury	$2.0x10^{-5}$	0.001	0.003	0.004	0.008
Arsenic	$3.3x10^{-7}$	$1.7x10^{-5}$	$4.9x10^{-5}$	$7.2x10^{-5}$	0.00013
Fluorides	$1.0x10^{-5}$	0.0005	0.0015	0.0022	0.0040
<u>Non-Regulated Pollutants</u>					
Hydrogen Chloride	0.0033	0.17	0.49	0.72	1.32
Cadmium	$3.4x10^{-6}$	0.00017	0.00051	0.00074	0.0014
Chromium	$1.6x10^{-6}$	$8.0x10^{-5}$	0.00024	0.00035	0.00064
Nickel	$8.5x10^{-7}$	0.00043	0.00013	0.00019	0.00034

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*Highest, second-highest concentrations shown for short-term averaging times (i.e., 24-hour or less)

For the proposed Plant, a level-1 analysis was performed. The required inputs and results are presented in Table 5-6. The criterion for passing the level-1 visibility screening analysis is that the absolute value of the contrast parameters C_1, C_2, and C_3* be no greater than 0.10. The results in Table 5-6 demonstrate this to be the case for the proposed Plant. Therefore, there is considered to be no potential for visibility impairment at any Federal Class 1 area as a result of operation of the proposed Plant.

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*C_1: plume contrast against sky parameter
*C_2: plume contrast against terrain parameter
*C_3: change in sky/terrain contrast parameter

TABLE 5-6

VISIBILITY LEVEL-1 SCREENING MODEL RESULTS
COLLIER CO. SWERF - BIG CYPRESS PRESERVE
UNITS 1 & 2

Input Parameters:

Particulate Matter Emission Rate = .13 tons/day
Sulfur Dioxide Emission Rate = .92 tons/day
Nitrogen Oxides Emission Rate = 1.13 tons/day
Background Visual Range = 25.0 km
Distance to Class I Area = 32.0 km

Calculated Parameters:

Sigma Z = 70.07 m
Plume Dispersion Parameter = 89202.0
Optical Thickness (Particulates) = .01052
Optical Thickness (NOX) = .01554
Optical Thickness (Aerosol) = .000321

Plume Contrast Against the Sky, C1 = -.0057
Plume Contrast Against Terrain, C2 = .0027
Change in Sky/Terrain Contrast, C3 = .000118

6.0 AIR QUALITY RELATED VALUES (AQRV) ANALYSIS

This section presents the analysis of air quality related values (AQRV) in regards to the planned Plant's impact upon the ENP Class I area, BCNP, and other potentially sensitive areas in Collier County. In this analysis, the existing baseline ecological conditions, including plants, animals, soils, and aquatic systems are described. AQRV are then defined and identified for these areas. Finally, the predicted impacts of the planned Plant upon the AQRV of the area are analyzed. The analysis shows that, due to the extremely low predicted impacts the planned Plant will have, AQRV within the ENP, BCNP and other sensitive areas, will not be affected by operation of the Plant.

6.1 Baseline Conditions

6.1.1 Ecological Communities

The following discussion describes all major terrestrial and wetland communities within 50 km of the site. There are a number of tropical communities in Everglades National Park (ENP) which are not discussed because they are concentrated in the eastern part of the ENP end are out of the area of concern. Marine communities are not included because they are less vulnerable to air pollution and those within the region are ten miles or more away and generally upwind of the study site.

The classification used below was developed by the Florida Natural Areas Inventory (FNAI). It has been adopted for state parks mapping and is under consideration for "official" use by Park Service's classification of natural history themes. The fauna of each ecological community is briefly outlined below. Tables describing the importance of each habitat type to each vertebrate species can be found in the Resource Inventory and Analysis of the Big Cypress National Preserve (Duever et al. 1979).

Two communities, Marl Prairie/Wet Prairie and Wet Flatwoods/Pine Rockland, dominate the area around the planned Plant site and ten miles to the east. Near the site, the prairies are a cypress savanna type with a sparse forest of stunted cypress trees. Further east there are more patches of open prairie.

Originally, pine and cypress covered approximately equal acreages in this region (Davis 1943), but with drainage, slash pine is moving into areas that were formerly cypress and the area of flatwoods is expanding.

6.1.1.1 Marl Prairie

Marl Prairie occurs only in Southwest Florida. These are grasslands or savannas dotted with dwarf cypress trees (Taxodium ascendens). Common species include spikerush (Eleocharis cellulosa), sawgrass (Cladium Jamaicensis), hairgrass (Muhlenbergia capillaris), glades bluestem (Schizachyrium rhizomatum), beakrush (Rhynchospora tracyi), black sedge (Schoenus nigricans), swamp lily (Crinum americanum), whitetop sedge (Dichomena colorata), and yellowtop (Flaveria linearis).

Marl Prairies occur on seasonally flooded sites where limestone is near the surface. Calcium carbonate, precipitated by blue-green algae, forms the fine white mud (marl) that covers the rock. Since there is a layer of sand over the northwest corner of the Big Cypress region, Marl Prairies are increasingly common to the southeast where there are larger areas of limestone at the surface. Consequently, Marl Prairie grades into sandy Wet Prairie over the study region and it may be meaningless to attempt to classify a given prairie as one or the other. To the south, there is a gradual transition from Marl Prairie to coastal prairie or saltmarsh (Estuarine Tidal Marsh).

During the wet season, both Marl Prairie and Wet Prairie are important feeding grounds for wading birds and breeding sites for frogs and fish. Kildeers, nighthawks, and other ground-nesting birds use them in the spring, as do foraging snakes, skunks, and other terrestrial animals. Deer graze here all year around.

6.1.1.2 Wet Prairie

Wet Prairie grades southeastward across the Big Cypress into Marl Prairie and is common all over Florida and the southeastern coastal plan. For this reason, it is not a conservation concern.

Wet Prairies are seasonally flooded grasslands growing on sandy soils. Among the most common of the great variety of species in this community are wiregrass (Aristida spp.) sand cordgrass (Spartina bakeri), maidencane (Panicum hemitomon), tickseed (Coreopsis leavenworthii), hatpins (Eriocaulon decanqulare), musky mint (Hyptis alata), redroot (Lachnanthes caroliniana), marsh fleabane (Pluchea rosea), bladderworts (Utricularia spp.), St. John's wort (Hypericum spp.), and yellow-eyed grass (Xyris spp.). Between fires, wax myrtle (Myrica cerifera) and deer hider (Stillingia spp.) shrubs become prominent.

6.1.1.3 Wet Flatwoods

The type of Wet Flatwoods found in southwest Florida are generally Wet Prairie with scattered slash pines (Pinus elliottii var. densa). On higher spots grading towards Mesic Flatwoods, there is saw palmetto (Serenoa repens) in the understory. Since Mesic Flatwoods do not cover extensive areas southeast of Lee County, they are not discussed separately.

The fauna includes most prairie species plus pine-dependent animals and those attracted by the heavier cover and slightly higher ground. Hence this is habitat for rabbits, mice, bobcats, woodpeckers, squirrels, towhees, pine warblers, loggerhead shrikes, quail, turkey, doves, hognose snakes, corn snakes, skunks, and toads. The following species would probably not occur in the Big Cypress region if the pinelands were eliminated; red-cockaded woodpecker, brown-headed nuthatch, eastern bluebird, eastern meadowlark, Bachman's sparrow, gopher tortise, six-lined racerunner, eastern coachwhip, scarlet kingsnake, and grey fox.

Wet Flatwoods grade southeast across the Big Cypress into Pine Rockland and are one of the most common communities throughout Florida and the southeastern coastal plain. They are not of conservation concern as a rarity.

6.1.1.4 Pine Rockland

Pine Rocklands are open slash pine forests growing on exposed limestone. They are best known from the Miami area and the Lower Keys, where they have a unique tropical understory with many endemic plants. The Collier County Pine

Rocklands lack most of these rare species; their flora and fauna are generally the same as those of pine flatwoods growing on sand. Cabbage palm (Sabal palmetto) is often abundant, especially where there is shallow sand over a calcareous substrate.

Wet Flatwoods grade southeastward into Pine Rockland across the northwest corner of the BCNP. There are two major areas of Pine Rockland in the Big Cypress region: the Interior Pinelands in the center of the preserve and Lostman's Pines just northeast of the southern part of the "stairsteps" boundary between the BCNP and ENP.

Pine Rocklands occur nowhere in the United States except South Florida, so they are of conservation concern. But, since most of the species endemic to the community are absent from the planned Plant site. These Pine Rockland communities occur in the ENP and BCNP.

6.1.1.5 Strand Swamp

A Strand Swamp is a broad, shallow forested channel flooded with flowing water from June through February. Bald cypress (Taxodium districhum) grows in the deep central part of the strand and Pond cypress (Taxodium ascendens) grows along the edges. Associated species, which may dominate the canopy where the cypress has been logged, include royal palm (Roystonea elata), red maple (Acer rubrum), sweet bay (Magnolia virginiana), swamp bay (Persea palustris), and willow (Salix caroliniana). Wax myrtle (Myrica cerifera), cocoplum (Chrysobalanus icaco), and dahoon (Ilex cassine) are common in the understory. Ferns and epiphytes are abundant.

Wading birds both feed and nest in Strands. The habitat is especially important to wood storks, little blue herons, and night herons, as well as owls, woodpeckers, warblers, raccoons, snakes, and treefrogs.

The nearest Strand Swamp to the study site is the Fakahatchee Strand, 15 miles to the east. There are fine examples of the habitat farther east in the BCNP and 15 miles to the northeast at Corkscrew Swamp, but none of them approach the Fakahatchee in size or species diversity. Many rare species occur therein, making the Strand Swamp of prime conservation importance.

6.1.1.6 Dome

Cypress Domes typically occur where sand has slumped around or over a sinkhole, creating a conical depression. There is often a pond in the center, surrounded by marsh vegetation, then tall cypress trees. The cypress trees are progressively smaller towards the periphery of the dome, which gives it a characteristic rounded profile. The trees are usually Pond cypress (Taxodium ascendens) and the rest of the flora and fauna is similar to that of a Strand Swamp, with less diversity in smaller domes. Maidencane (Panicum hemitomon) and fire flag (Thalia geniculata) are common around the central ponds.

Domes are common over most of the state and liberally dot the interior of southwest Florida, so they cannot be considered a rare community. They are relatively poor wildlife habitat compared to the pinelands and strands. They are nevertheless of interest to environmentalists because they are wetlands and wetlands serve important functions in hydrological processes and nutrient recycling.

6.1.1.7 Swale

Swales are the marsh types most common in the Big Cypress region. These are the "rivers of grass" where water flows slowly over nearly flat peatlands. Cattail (Typha spp.), sawgrass (Cladium jamaicensis), sagittaria (Sagittaria lancifolia), a pickerel weed (Ponterderia lanceolata), and fire flag (Thalia geniculata) are among the more common plants. Swales are important to minks, round-tailed muskrats, sandhill cranes, marsh hawks, rails, bitterns, ibis, water snakes, frogs, sirens, and dragonflies, as well as many other animals.

Southwest Florida's largest swale system, the Okaloacoochee Slough, is about 20 miles northeast of the planned Plant site. Horsehoe Marsh and Corkscrew Marsh, 15 miles away and a bit more to the north, are similar ecosystems, as is marsh south of East Hinson Strand in the BCNP.

Swale systems cover extensive areas of South Florida. (Most of the Everglades falls into this category.) They have few rare plants, but since they are valuable as wildlife habitat and serve important hydrological functions, they require conservation attention.

6.1.1.8 Slough

The erratic channels that meander through swamps are classified as Sloughs. They are usually lined with little pond apple (Annona glabra) and pop ash (Fraxinus caroliniana) trees growing as a subcanopy beneath large baldcypresses (Taxodium distichum). The rough bark of the pond apple and pop ash trees makes an excellent substrate for epiphytes, which flourish in the sheltered humid atmosphere. The fauna is basically the same as that of a Strand Swamp, with alligators, otters, wood ducks and other creatures that prefer a little deeper water especially prominent.

There are Sloughs scattered throughout southwest Florida's swamps, but those in the Fakahatchee are unquestionably the most outstanding. The huge size of the strand provides a large mass of water to hold heat through winter freezes and moisture through spring droughts, so tropical epiphytes that would be killed elsewhere survive here. In some Fakahatchee Sloughs, rare bromeliads, orchids, ferns, and peperomias form a shaggy cover over every available surface.

Sloughs are better developed in Collier County than anywhere else in Florida. They require special conservation consideration because they are critical habitat for a large number of rare tropical plants. Most of these are epiphytes, which are especially sensitive to air pollution.

6.1.1.9 Swamp Lake

The largest ponds within a swamp slough system are genuinely aquatic systems classified as Swamp Lakes. The water surface is often covered with water lettuce (Pistia stratiotes), duckweed (Lemna spp.), and mosquito fern (Azolla caroliniana), and marsh plants grow around the edges and on floating tussocks.

These ponds are critical drought refuges for practically all of the strand fauna. The fish populations vital to swamp food chains could not be maintained without them. Mosquitofish (Gambusia affinis), flagfish (Jordanella floridae), sailfin molly (Poecilia latipinna), and other fast-reproducing small forage fish are the dominant species. The habitat is also particularly important to alligators, turtles, anhingas, and gallinules.

There are small swamp lakes scattered through Sloughs in most Strand Swamps, but most of the largest ones are in the Fakahatchee. The best known are the Lettuce Lakes along the Corkscrew Swamp Sanctuary boardwalk.

Swamp Lakes are important to preserve because they are essential to wildlife, but they support few rare or especially sensitive plant species.

6.1.1.10 Shell Mound

Indian mounds of shell vegetated with tropical trees are scattered throughout Collier County, with the greatest concentrations along the coast. The Florida Natural Areas Inventory has documented none of consequence within five miles of the study site. There are some major mounds in the Fakahatchee and the BCNP to the east, but the most valuable ones vegetation-wise are to the southwest from Rookery Bay south through Everglades National Park's Ten Thousand Islands and to the northwest around Estero Bay. These scarce habitats do support many rare plants, a number of which are sensitive epiphytes, so they are of conservation concern.

6.1.1.11 Coastal Berm

Ridges of shelly storm debris form Coastal Berm habitats along the coasts of Collier, Lee, and Monroe Counties. These support a variety of mostly hammock and mangrove vegetation, including many rare plant species, some of them epiphytic. Lee County's coastal berms are the best examples known.

6.1.1.12 Scrub

White sand Scrub with occasional sand pines amongst shrubby oaks and rosemary bushes remains in small patches along the Collier County coast from Marco Island north. This is a disappearing habitat found only in Florida and Collier County's examples are the southernmost and most tropical. A number of rare species grow here.

6.1.1.13 Beach Dune

There are beaches backed by patches of sprawling dune vegetation here and there along the Lee and Collier County coasts. These support a number of tropical plants uncommon in Florida, but they are relatively tough species.

6.1.1.14 Coastal Strand

Behind many of the Beach Dunes are shrubby Coastal Strand thickets, which also have scarce tropical plants of kinds unlikely to be sensitive to minor variations in air quality.

6.1.1.15 Maritime Hammock

Coastal Strand still grades inland into forest in a few places. These Maritime Hammocks have a variety of uncommon tropical trees and some rare epiphytes.

6.1.1.16 Rockland Hammock

There are a few patches of Rockland Hammock in the Fakahatchee, but the habitat is more common farther to the southeast in the Pinecrest area. Rockland hammocks support tropical trees, rare epiphytes, and liquus tree snails, and they are critical habitats to the east in the Everglades, but in the Big Cypress region they are much less important and sensitive than the nearby Strand Swamps and Sloughs.

6.1.1.17 Sinkhole Lake

Deep Lake, between the Fakahatchee and the BCNP, is probably Florida's finest Sinkhole Lake. The lake and surrounding environment are more important geologically than biologically. There are other smaller sinkhole lakes scattered around the region, most of them within Sloughs and Domes.

6.1.1.18 Scrubby Flatwoods

There are some Scrubby Flatwoods intermediate between Scrub and Mesic Flatwoods just inland from the Collier County coast and along the Hendry County border, but this is a very minor habitat in the Big Cypress. It is, however, important to protect as much of it as possible because it provides upland habitat which is very scarce in this region.

6.1.1.19 Dry Prairie

There are a few areas of dry prairie in the northern part of Collier County, but this is not a major habitat in the area of the site. However, existing habitats are important because they support upland species including burrowing owls, caracaras, and grasshopper sparrows, which do not use wooded habitats to any significant extent.

6.1.1.20 Estuarine Tidal Marsh

The Big Cypress Marl Prairies grade seaward into coastal prairies classified as Estuarine Tidal Marsh. The common plants include gulf cordgrass (Spartina spartinae), needle rush (Juncus roemerianus), saltgrass (Distichilis spicata), glades spikerush (Eleocharis cellulosa), sea purslane (Sesuvium portulacastrum), glasswort (Salicornia perennis), and saltwort (Batis maritima). These prairies are very valuable feeding grounds for wading birds and important habitat for the Cape Sable sparrow and many other animals. Prairies of this type are restricted to South Florida and are important, even though they do not have a great number of rare species.

6.1.1.21 Estuarine Tidal Swamp

Seaward of the coastal prairies is a band of mangrove islands classified as Estuarine Tidal Swamp. This is the Ten Thousand Islands, Florida's finest mangrove swamp. Red mangrove (Rhizophora mangle), black mangrove (Avicennia germinans), white mangrove (Laguncularia racemosa), and buttonwood (Conocarpus erecta) are the dominant species. The habitat is important to roseate spoonbills, Louisiana herons, reddish egrets, and other wading birds, as well as ospreys, cormorants, pelicans, mangrove water snakes, diamondback terrapins, and an occasional crocodile. It supports a rich variety of fish, crabs, molluscs, and small invertebrates and serves as a vital nursery area for many important seafood species.

6.1.2 Natural Areas

The planned Collier County Plant is ideally located in terms of maximizing the distances to valuable natural areas. The area to the west of the site is urbanized and there is little of natural significance. The valuable coastal sites are to the north and south of this, at least eight to ten miles away. Corkscrew Swamp is 15 miles to the north. To the east, it is 15-20 miles to the Fakahatchee Strand and 20 miles to the Big Cypress National Preserve (BCNP). The closest corner of Everglades National Park (ENP) is 22 miles to the southeast.

Florida Natural Areas Inventory (FNAI) has no official records of rare plants or communities between the Collier County coastal habitats and the Fakahatchee. This is generally a bleak drainage-damaged are of relatively commonplace communities. Fakahatchee Strand State Preserve is closer to the planned Plant site than the BCNP or ENP, and is a far more important natural area than any other in the inland part of the region. The adjacent areas of the BCNP have more of the same natural communities, but they are not of such outstanding quality as those in the Fakahatchee and many of the rare species are absent.

The Fakahatchee is the world's only cypress/royal palm forest and it has the richest epiphytic plant flora in the continental United States. Forty-four species of orchids grow there and twelve of them occur nowhere else in Florida. This is one of the state's most important endangered species habitats. Atleast 26 genuinely rare, native plants occur in the Fakahatchee (Austin et al. 1982) and there are many more on agency lists of endangered, threatened, or special plants. (Listed species are discussed in Section 6.1.3.) The preserve supports most of the remaining breeding population of the critically endangered Florida panther and serves as habitat for at least a dozen other rare animals. The stand of virgin cypress at Big Cypress Bend is a registered National Natural Landmark (NNL) and it has been officially recommended that the entire Fakahatchee Strand State Preserve be included this designation (Duever et al. 1982).

The National Audubon Society's Corkscrew Swamp Sanctuary is also NNL. This area is a well-known natural tourist attraction with a mile-and-three-quarter boardwalk that takes visitors through unlogged pine flatwoods and into the heart of a virgin cypress swamp with a major wood stork rookery.

Rookery Bay National Estuarine Sanctuary has also been recommended for NNL status. This area has excellent mangrove habitats as well as a remnant scrub.

The Loop Road Unit of the BCNP, where there are superb examples of dwarf cypress savanna type Marl Prairie and many rockland hammocks, is also under NNL review, as is the Ten Thousand Islands mangrove region of Everglades National Park.

Collier-Seminole State Park is less significant from a national perspective, but is still a very valuable natural area with excellent tropical hammocks, mangroves, marshes, and other estuarine habitats.

Small tracts of special value have been set aside within several of the coastal residential developments. Most noteworthy are the Indian mound and maritime hammock communities on and near Horrs Island and the Pelican Bay scrub with the southernmost stand of turkey oak (Quercus laevis).

6.1.3 Rare and Endangered Plants

Table 6-1 lists rare plants known to occur in Collier County and gives their status on the lists used by the Florida Game and Fresh Water Fish Commission (FGFWFC), the Florida Department of Agriculture and Consumer Services (FDA), the Florida Natural Areas Inventory (FNAI), the U.S. Fish and Wildlife Service (USFWS), and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). List status information was compiled from the FGFWFC official lists (Wood 1985) and the March 1986 FNAI "Special Plants List." The list of Collier County species was synthesized from lists of species reported from the Big Cypress National Preserve (BCNP) (Duever et al. 1979) and the Fakahatchee Strand State Preserve, and supplemented with additional plants recorded for Collier County by FNAI. This list includes virtually all relevant species from the site area and the Big Cypress region.

The asterisks beside names in Table 6-1 indicate rare and endangered species located within the Big Cypress region. This list was synthesized from Duever et al.'s (1979) table of plants dependent upon the BCNP, Luer's (1972) statements about plants endemic to the Fakahatchee extracted from the Fakahatchee Strand State Preserve Management Plan, and FNAI files.

These plants fall into several distinct taxonomic/ecological groups, most of which are epiphytic. Epiphytes grow on trees, logs, cypress knees, etc., and derive nourishment from airborne debris and materials dripping and draining off the trees. Such plants can readily absorb substances through foliage and/or aerial roots directly exposed to the air.

The following discussion focuses on species of the interior Big Cypress region (including Fakahatchee and Corkscrew swamps). There are two other major groups of rare and endangered plants in Collier County: tropical coastal species and scrub/dry prairie species. Most of the rare tropical coastal plants are found on high sandy or shelly spots along the coast. They include cacti, dune shrubs, Iguana hackberry, wild cotton, and a few ferns, among them southern lip fern. The scrub/dry prairie species are concentrated just inland from the coast and in the northern part of the county near the Hendry line. They include the pinweeds and dwarf redbay (silkbay).

6.1.3.1 Epiphytic Orchids

Within the Big Cypress, most epiphytic orchids grow on pond apple and pop ash trees in the deepest sloughs of the largest strands. This is mainly because these are sensitive tropical species that would be killed by freezes anywhere less moist and sheltered.

Southwest Florida's orchids can be grouped into four categories of regional adaptation. The butterfly and cowhorn orchids, which grow out in open cypress savannas and pine flatwoods as well as within the swamps, are well-adapted species that can tolerate light frost, scorching, and severe drought. The common butterfly orchid is found only in south and central Florida and the Bahamas. The cowhorn orchid is widely distributed through tropical America, but grows as an epiphyte only in Florida. It was formerly abundant, but has become rare due to over-collecting.

TABLE 6-1

STATE AND FEDERAL LISTED SPECS OF ENDANGERED AND THREATENED PLANTS

SCIENTIFIC NAME	COMMON NAME	DESIGNATED BY FDA	USFWS	CITES
Acacia choriophylla	Tamarindillo	X		
Acoelorrhaphe wrightii	Paurotis palm or Everglades palm	X		
Acrostichum aureum	Golden leather ferm	X		
Acrostichum danaeifolium	Giant leather ferm	X		
Actaea pachypoda	Baneberry	X		
Adiantum capillus-veneris	Venus-hair fern	X		
Adiantum melanoleucum	Fragrant maidenhair fern	X		
Adiantum tenerum	Maidenhair ferm (unnamed)	X		
Agalinis purpurea var. carteri	Carter's larger purple false foxglove		X	
Agalinis stenophylla	Narrow-leaved false foxglove		X	
Agrimonia incisa	Incised groove bur or harvest lice		X	
Amorpha crenulata	Crenulate lead plant or Miami lead plant	X	X	
Andropogon arctatus	Pinewoods bluestem		X	
Anemia adiantifolia	Pine ferm	X		
Anemonella thalictroides	Rue anemone	X		
Aquilegia canadensis	Wild columbine or southern columbine			
Argythamnia blodgettii	Blodgett's wild-mercury		X	
Aristida floridana	Florida three-awned grass or Key West three-awn	X	X	
Aristida simpliciflora	Southern three-awned grass		X	
Aristolochia tomentosa	Dutchman's pipe	X		
Asclepias curtissii	Curtiss milkweed	X		
Asclepias viridula	Southern milkweed or green milkweed	X	X	
Asimina tetramera	Four-petal pawpaw or opossum pawpaw	X	X	
Asplenium abscissum	Spleenwort (unnamed)	X		
Asplenium auritum	Auricled spleenwort	X		
Asplenium cristatum	Spleenwort (unnamed)	X		
Asplenium dentatum	Slender spleenwort	X		
Asplenium heterochorum	Spleenwort (unnamed)	X		
Asplenium heteroresiliens	Wagner's spleenwort	X	X	
Asplenium monanthes	Single sorus spleenwort or San Felasco spleenwort	X		
Asplenium platyneuron	Ebony spleenwort	X		
Asplenium plenum	Double spleenwort	X	X	
Asplenium pumilum	Dwarf spleenwort or chervil spleenwort	X		
Asplenium resiliens	Little ebony spleenwort	X		
Asplenium serratum	Bird's nest spleenwort or wild birdnest fern	X		

TABLE 6-1 (continued)

STATE AND FEDERAL LISTED SPECS OF ENDANGERED AND THREATENED PLANTS

SCIENTIFIC NAME	COMMON NAME	DESIGNATED BY FDA	USFWS	CITES
Asplenium subtile	Spleenwort (unnamed)	X		
Asplenium trichomanes -dentatum	Spleenwort (unnamed)	X		
Asplenium verecundum	Spleenwort (unnamed)	X		
Aster brachypholis	Apalachicola River aster		X	
Aster pinifolius	Pale-violet aster		X	
Aster plumosus	Plumose aster		X	
Aster spinulosus	Pinewoods aster	X	X	
Athyrium asplenioides	Southern lady fern	X		
Azolla caroliniana	Mosquito fern	X		
Balduina atropurpurea	Purple balduina		X	
Baptisia calycosa	Pineland wild indigo		X	
Baptisia hirsuta	Hairy wild indigo	X	X	
Baptisia megacarpa	Apalachicola wild indigo	X	X	
Baptisia riparia	Streamside wild indigo		X	
Baptisia simplicifolia	Coastal plain wild indigo or scare weed	X	X	
Basiphyllaea corallicola	Orchid (unnamed)	X		X
Blechnum occidentale	Sinkhole ferm	X		
Bletia patula	Orchid (unnamed)	X		X
Bletia purpurea	Pine pink	X		X
Bonamia grandiflora	Florida bonamia or large-flowered bonamia	X	X	
Botrychium biternatum	Southern grape fern	X		
Botrychium dissectum	Grap fern (unnamed)	X		
Botrychium lunarioides	Winter grape fern	X		
Botrychium virginianum	Rattlesnake fern	X		
Brassia caudata	Long-tailed spider orchid	X	X	X
Brickellia cordifolia	Flyr's brickell-bush	X	X	
Brickellia eupatorioides var. floridana	Florida thoroughwort brickell-bush or Florida boneset		X	
Brickellia mosieri	Brickell-bush (unnamed)		X	
Bulbophyllum pachyrrhachis *	Rattail orchid	X		X
Bumelia lycioides	Buckthorn	X		
Burmannia flava *	Fakahatchee burmannia	X		
Cacalia diversifolia	Variable-leaved Indian plantain	X	X	
Calamintha ashei	Ashe's savory or Ashe's basil	X	X	
Calamintha dentatum	Toothed savory or toothed basil		X	
Calamovilfa curtissii	Curtiss' reedgrass		X	
Callirhoe papaver	Poppy mallow	X		
Calopogon barbatus	Bearded grass pink	X		X
Calopogon multiflorus	Many-flowered grass pink	X		X

TABLE 6-1 (continued)

STATE AND FEDERAL LISTED SPECS OF ENDANGERED AND THREATENED PLANTS

SCIENTIFIC NAME	COMMON NAME	DESIGNATED BY		
		FDA	USFWS	CITES
Calopogon pallidus	Pale grass pink	X		X
Calopogon pulchellus	Grass pink (unnamed)	X		X
Calopogon tuberosus	Grass pink (unnamed)	X		X
Calycanthus floridus	Sweetshrub	X		
Campanula robinsiae	Robins' bellflower or Chinsegut bellflower	X	X	
Campylocentrum pachyrrhizum	Leafless orchid	X		X
Campyloneurum angustifolium	Narrow strap fern	X		X
Campyloneurum costatum	Strap fern (unnamed)	X		
Campyloneurum latum	Strap fern (unnamed)	X		
Campyloneurum phyllitidus	Strap fern (unnamed)	X		
Canna pertusa	Maraca or tattered canna		X	
Carex baltzelli	Baltzell's sedge		X	
Carex chapmanii	Chapman's sedge		X	
Cassia keyensis	Big pine partridge pea or Florida keys senna	X	X	
Catesbaea parviflora	Small-flowered lilly-thorn or dune lily-thorn	X		
Catopsis berteroniana	Powdery catopsis	X		
Catopsis floribunda	Air plant (unnamed)	X		
Catopsis nutans	Nodding catopsis	X		
Celtis iguanaea	Iguana hackberry	X		
Celtis pallida	Spiny hackberry	X		
Centrosema arenicola	Sand butterfly pea		X	
Centrogenium cetaceum	Spurrd neottia	X		X
Ceratophyllum floridanum	Florida hornwort		X	
Ceratopteris pterioides	Water-horn fern (unnamed)	X		
Ceratopteris thalictroides	Water-horn fern (unnamed)	X		
Cereus eriophorus var. fragrans	Fragrant wool-bearing cereus or fragrant pickly apple	X	X	X
Cereus gracilis	West Coast prickly apple	X	X	X
Cereus pentagonus	Dildoe cactus	X		X
Cereus robinii	Tree cactus	X	X	X
Cereus undatus	Night-blooming cereus or queen of the night	X		X
Chamaesyce garberi	Garber's spurge	X		
Cheilanthes microphylla	Southern lip fern	X		
Chionanthus pygmaea	Pigmy fringetree	X	X	
Chrysophyllum olivaeforme	Satinleaf	X		
Chrysopsis cruiseana	Cruise's golden aster	X	X	

TABLE 6-1 (continued)

STATE AND FEDERAL LISTED SPECS OF ENDANGERED AND THREATENED PLANTS

SCIENTIFIC NAME	COMMON NAME	DESIGNATED BY		
		FDA	USFWS	CITES
Chrysopsis floridana	Florida golden aster	X	X	
Cienfuegosia heterophylla	Yellow hibiscus	X		
Cleistes divaricata	Rosebud orchid or spreading pogonia	X		X
Clematis micrantha	Old-man's beard or virgin's bower		X	
Clitoria fragrans	Pigeon-wing butterfly-pea or sweet-scented butterflypea	X	X	
Clusia Flava	Yellow balsam apple		X	
Clusia rosea	Balsam apple (unnamed)	X		
Coccothrinax argentata	Silver palm	X		
Cocos nucifera	Coconut palm	X		
Coelorachis tuberculosa	Florida jointtail or piedmont joint grass		X	
Commelina gigas	Climbing dayflower	X	X	
Conradina breviflora	Short-leaved rosemary		X	
Conradina glabra	Apalachicola rosemary or panhandle rosemary	X	X	
Conradina grandiflora	Large-flowered rosemary		X	
Corallorhiza odontorhiza	Autumn coralroot	X		X
Corallorhiza wisteriana	Spring coralroot or Wister's coralroot	X		X
Cordia sebestena	Geiger tree	X		
Cormus alternifolia	Pagoda dogwood	X		
Cranichis muscosa	Orchid (unnamed)	X		X
Croomia pauciflora	Few-flowered croomia	X	X	
Croton elliottii	Elliott's croton		X	
Croton glandulosa var. simpsonii	Simpson's glandular croton		X	
Cryptotaenia canadensis	Honewort	X		
Ctenitis sloanei	Comb fern (unnamed)	X		
Ctenitis submarginalis	Comb fern (unnamed)		X	
Ctenium floridanum	Florida orange-grass		X	
Cucurbita okeechobeensis	Okeechobee gourd or Indian pumpkin	X	X	
Cupania glabra	Cupania	X		
Cuphea aspera	Tropical waxweed		X	
Cyrtopodium andersonii	Orchid (unnamed)	X		X
Cyrtopodium punctatum	Cowhorn orchid or cigar orchid	X		X
Deeringothamnus pulchellus	White squirrel-banana or slim-petal pawpaw	X	X	
Deeringothamnus rugelii	Yellow squirrel-banana or Rugel's pawpaw	X	X	
Dennstaedtia bipinnata	Cuplet fern or hay-scented fern	X		
Dicerandra cornutissima	Long-spurred balm or Robins' mint	X	X	

TABLE 6-1 (continued)

STATE AND FEDERAL LISTED SPECS OF ENDANGERED AND THREATENED PLANTS

SCIENTIFIC NAME	COMMON NAME	DESIGNATED BY FDA	DESIGNATED BY USFWS	DESIGNATED BY CITES
Dicerandra frutescens	Scrub balm or Lloyd's mint	X	X	
Dicerandra immaculata	Spotless-petaled balm or Lakela's mint	X	X	
Dicerandra odoratissima	Rose dicerandra		X	
Dicranopteris flexuosa	Net fern	X		
Digitaria floridana	Florida crabgrass		X	
Digitaria gracillima	Crabgrass (unnamed)		X	
Digitaria pauciflora	Crabgrass (unnamed)		X	
Drostera intermedia	Water sundew	X		
Dryopteris ludoviciana	Florida shield fern	X		
Elytraria carolinensis var. angustifolia	Narrow-leaved Carolina scalystem		X	
Elytraria carolinensis var. carolinensis	Carolina scalystem		X	
Encyclia boothiana	Dollar orchid or dogtooth orchid	X	X	X
Encyclia cochleata	Shell orchid or clamshell orchid	X		X
Encyclia pygmaea	Dwarf epidendrum	X		X
Encyclia tampensis	Butterfly orchid	X		X
Epidendrum acunae	Acuna's epidendrum	X		X
Epidendrum anceps	Dingy-flowered epidendrum	X		X
Epidendrum canopseum	Greenfly orchid	X		X
Epidendrum difforme	Unbelled epidendrum	X		X
Epidendrum nocturnum	Night-scent orchid or night-smelling spidendrum	X		X
Epidendrum rigidum (Strobiliferum)	Rigid epidendrum	X		X
Epigaea repens	Trailing arbutus	X		
Equisetum hymale	Scouring rush	X		
Eragrostis tracyi	Sanibel Island lovegrass	X	X	
Eriochloa michauxii var. simpsonii	Longleaf cup grass or Simpson's cup grass		X	
Eriogonum floridanum	Scrub buckwheat	X		
Eriogonum longifolium var. gnaphalifolium	Scrub wild buckwheat		X	
Ernodia littoralis	Beach creeper	X		
Eryngium cuneifolium	Wedge-leaved button snakeroot		X	
Erythrodes querceticola	Low erythrodes	X		X
Erythronium umbilicatum	Dogtooth lily or dimpled dogtooth violet	X		
Eugenia confusa	Redberry ironwood	X		
Eugenia rhombea	Red stopper	X		
Eriogonum floridanum	Scrub backwheat	X		
Eulophia alta	Wild coco or ground coco	X		X
Eulophia ecristata	False coco	X	X	X
Euphorbia austrina	Pineland spurge		X	
Euphorbia cumulicola	Sand dune spurge		X	

TABLE 6-1 (continued)

STATE AND FEDERAL LISTED SPECS OF ENDANGERED AND THREATENED PLANTS

SCIENTIFIC NAME	COMMON NAME	DESIGNATED BY		
		FDA	USFWS	CITES
Euphorbia deltoidea deltoidea	Wedge spurge		X	
Euphorbia deltoidea serpyllum	Wild thyme spurge		X	
Euphorbia discoidalis	Appalachicola spurge		X	
Euphorbia exserta	Exserted fruited spurge		X	
Euphorbia garberi	Garber's spurge		X	
Euphorbia porteriana var. keyensis	Keys hairy-podded spurge		X	
Euphorbia porteriana var. porteriana	Porter's hairy-podded spurge		X	
Euphorbia porteriana var. scoparia	Porter's broom spurge		X	
Euphorbia telephioides	Telephus spurge		X	
Forestiera segregata var. pinetorum	Pinewood privet or Florida privet		X	
Fothergilla gardenii	Dwarf witch alder		X	
Galactia pinetorum	Milkpea (unnamed)		X	
Galactia smallii	Small's milkpea		X	
Galeandra beyrichii	Orchid (unnamed)	X		X
Garberia heterophylla	Garberia	X		
Gentiana penneliana	Wiregrass gentian	X	X	
Goniophlebium triseriale	Polypody fern (unnamed)	X		
Gossypium hirsutum	Wild cotton	X		
Govenia utriculata	Orchid (unnamed)	X		X
Guaiacum sanctum	Lignum-vitae tree	X		X
Guzmania monostachia	Fuch's bromeliad	X		
Gymnopogon floridanus	Florida beardgrass or Chapman skeletongrass		X	
Habenaria distans	Rein orchid (unnamed)	X		X
Habenaria nivea	Bog torch	X		X
Habenaria odontopetala	Rein orchid (unnamed)	X		X
Habenaria quinquesta	Michaux's orchid or long-horned orchid	X		X
Habenaria repens	Water spider orchid or creeping orchid	X		X
Harperocallis flava	Harper's beauty	X	X	
Harrisella filiformis	Orchid (unnamed)	X		X
Harrisella porrecta	Orchid (unnamed)	X		X
Hartwrightia floridana	Florida hartwrightia	T	X	
Hedeoma graveolens	Mock pennyroyal	X	X	
Hedyotis nigricans var. pulvinata	Diamondflowers or mat-forming narrow-leaved bluet	X		
Helianthus carnosus	Lakeside sunflower		X	

TABLE 6-1 (continued)

STATE AND FEDERAL LISTED SPECS OF ENDANGERED AND THREATENED PLANTS

SCIENTIFIC NAME	COMMON NAME	DESIGNATED BY		
		FDA	USFWS	CITES
Helianthus debilis vestitus	Hairy cucumber-leaf sunflower		X	
Heliotropium polyphyllum var. horizontale	Prostrate many-leaved turnsole or heliotrope		X	
Hepatica americana	Liverleaf	X		
Heterotheca flexuosa	Bent golden aster		X	
Hexalectris spicata	Crested coralroot	X		X
Hexastylis arifolia	Heartleaf	X		
Hippomane mancinella	Manchineel	X		
Hydrangea arborescens	Wild hydrangea	X		
Hymenocallis coronaria	Stream-bank spider lily		X	
Hymenocallis latifolia	Broad-leaved spider lily		X	
Hypelate trifoliata	Inkwood	X		
Hypericum cumulicola	Highlands scrub hypericum	X	X	
Hypericum edsonianum	Edison's St. John's-wort or Edison ascyrum	X	X	
Hypericum lissophloeus	Smooth-barked St. John's wort	X	X	
Hypolepis repens	Flakelet fern	X		
Ilex ambigua	Carolina holly or sand holly	X		
Ilex amelanchier	Serviceberry holly		X	
Ilex decidua	Possumhaw	X		
Ilex krugiana	Krug's holly	X		
Ilex montana	Mountain winterberry	X		
Ilex opaca var. arenicola	Scrub holly or sand-loving American holly	X		
Ilex verticillata	Common winterberry	X		
Illicium floridanum	Florida anise	X		
Illicium parviflorum	Yellow ansie tree or star anise	X	X	
Ionopsis utricularioides	Delicate ionopsis or violet orchid	X		X
Isoetes chapmanii	Chapman's quillwort	X		
Isoetes engelmanii	Engelmann's quilwort	X		
Isoetes flaccida	Florida quillwort	X	X	
Isotria verticillata	Whorled pogonia	X		X
Jacquemontia curtissii	Pineland clustervine or Curtiss' clustervine	X	X	
Jacquemontia reclinata	Beach clustervine or reclined clustervine	X	X	
Jacquinia keyensis	Joewood	X		
Juncus gymnocarpus	Coville's rush		X	
Justicia cooleyi	Cooley's water-willow	X	X	
Justicia crassifolia	Thick-leaved water-willow		X	
Kalmia latifolia	Mountain laurel	X		
Kosteletzkya smilacifolia	Southern seashore mallow or saltmarsh mallow		X	

TABLE 6-1 (continued)

STATE AND FEDERAL LISTED SPECS OF ENDANGERED AND THREATENED PLANTS

SCIENTIFIC NAME	COMMON NAME	DESIGNATED BY FDA	USFWS	CITES
Lachnocaulon beyrichianum	Southern bogbuttons or hairy pipewort		X	
Lechea cernua	Nodding pinweed		X	
Lechea divaricata	Pine pinweed		X	
Lechea lakelae	Lakela's pinweed		X	
Leitneria floridana	Florida corkwood	X	X	
Leochilus labiatus	Orchid (unnamed)	X		X
Lepanthopsis melanantha	Harris' tiny orchid	X	X	X
Liatris ohlingerae	Florida gayfeather or scrub blazing star	X	X	
Liatris provincialis	Godfrey's blazing star or Godfrey's gayfeather	X	X	
Licaria triandra	Licaria	X		
Lilaeopsis carolinensis	Parsley (unnamed)		X	
Lilium catesbaei	Catesby lily	X		
Lilium iridollae	Panhandle lily	X	X	
Limonium carolinianum var. angustatum	Narrow-leaved sea lavender		X	
Lindera melissifolia	Swamp spicebush or Jove's fruit		X	
Linum arenicola	Sand flax	X	X	
Linum carteri var. carteri	Carter's small-flowered flax		X	
Linum carteri var. smallii	Carter's large-flowered flax		X	
Linum sulcatum var. harperi	Harper's grooved yellow flax		X	
Linum westii	West's flax	X	X	
Liparis elata	Tall liparis orchid	X		X
Listera australis	Southern twayblade	X		X
Litsea aestivalis	Pond spice or pond bush	X	X	
Lobelia cardinalis	Cardinal flower	X		
Lomariopsis kunzeana	Holly fern	X		
Lupinus aridorum	McFarlin's lupine	X	X	
Lupinus tracyi	Tracy's lupine		X	
Lupinus westianus	Gulfcoast lupine or panhandle lupine	X	X	
Lycopodium alopecuroides	Foxtail club moss	X		
Lycopodium appressum	Southern club moss	X		
Lycopodium carolinianum	Slender club moss	X		
Lycopodium cernuum	Nodding club moss	X		
Lycopodium dichotomum	Hanging club moss or coneless club moss	X		
Lycopodium prostratum	Prostrate club moss or Harper's club moss	X		

TABLE 6-1 (continued)

STATE AND FEDERAL LISTED SPECS OF ENDANGERED AND THREATENED PLANTS

SCIENTIFIC NAME	COMMON NAME	DESIGNATED BY FDA	USFWS	CITES
Lygopodium microphyllum	Climbing fern (unnamed)	X		
Lygopodium palmatum	Climbing fern (unnamed)	X		
Lythrum curtissii	Curtiss' lythrum		X	
Lythrum flagellare	Lowland lythrum		X	
Macbridea alba	White birds-in-a-nest	X	X	
Macradenia lutescens	Trinidad macradenia	X		X
Magnolia acuminata	Cucumber tree	X		
Magnolia ashei	Ashe's magnolia	X	X	
Magnolia pyramidata	Pyramidal magnolia	X		
Malaxis spicata	Florida malaxis or Flordia's adder's mouth			
Malaxis unifolia	Green adder's mouth	X		X
Mallotonia gnaphalodes	Sea lavender	X		
Malus angustifolia	Crabapple	X		
Marshallia mohrii	Mohr's barbara's buttons		X	
Marshallia obovata	Barbara's buttons (unnamed)	X		
Marshallia ramosa	Southern barbara's buttons		X	
Marsilea mucronata	Hairy pepperwort or hairy waterclover	X		
Matela alabamensis	Alabama milkweed or Alabama anglepod		X	X
Matela floridana	Florida milkweed or Florida anglepod		X	X
Maxillaria crassifolia	Hidden orchid	X		X
Medeola viginiana	Indian cucumber-root	X		
Melanthera parvifolia	Small-leaved melanthera		X	
Microgramma heterophylla	Polypody fern (unnamed)	X		
Minuartia godfreyi	Pink (unnamed)		X	
Monotropa brittonii	Indian pipes or Britton's pinesap		X	
Monotropa hypopithys	Pinesap (unnamed)	E		
Monotropsis reynoldsiae	Pigmy-pipes	X	X	
Myrcianthes fragrans var. simpsonil	Simpson's stopper or twinberry		X	
Myriophyllum laxum	Piedmont water milfoil		X	
Nemastylis floridana	Fall-flowering pleat-leaf or celestial lily	X	X	
Nephrolepis biserrata	Boston fern (unnamed)	X		
Nolina atopocarpa	Florida beargrass	X	X	
Nolina brittoniana	Britton's beargrass		X	
Nuphar luteum ulvaceum	West Florida cow lily		X	
Okenia hypogaea	Burrowing four-o'clock	X		
Oncidium carthagenense	Coot Bay dancing lady or spread-eagle oncidium	X	X	X
Oncidium floridanum	Florida oncidium	X		X
Oncidium luridum	Mule-ear orchid or dingy flowered oncidium	X		X

TABLE 6-1 (continued)

STATE AND FEDERAL LISTED SPECS OF ENDANGERED AND THREATENED PLANTS

SCIENTIFIC NAME	COMMON NAME	DESIGNATED BY FDA	USFWS	CITES
Oncidium variegatum	Dancing-lady orchid or Florida variegated oncidium	X		X
Onoclea sensibilis	Sensitive fern or bead fern	X		
Ophioglossum crotalophoroides	Bulbous adder's tongue	X		
Ophioglossum dendroneuron	Adder's tongue fern (unnamed)		X	
Ophioglossum engalmannii	Limestone adder's tongue fern	X		
Ophioglossum nudicaule	Adder's tonge fern (unnamed)	X		
Ophioglossum palmatum	Hand adder's tongue fern	X	X	
Ophioglossum petiolatum	Adder's tongue fern (unnamed)	X		
Ophioglossum vulgatum	Adder's tongue fern (unnamed)	X		
Opuntia compressa	Twistspine prickly pear cactus	X		X
Opuntia cubensis	Prickly pear cactus (unnamed)	X		X
Opuntia spinosissima	Semaphore cactus	X	X	X
Opuntia stricta	Prickly pear cactus (unnamed)	X		X
Opuntia triacantha	Three-spined prickly pear		X	X
Osmunda regalis	Royal fern	X		
Oxypolis greenmanii	Giant water dropwort or giant water cowbane	X	X	
Pachysandra procumbens	Allegheny spurge	X		
Paltonium lanceolatum	Ribbon fern	X		
Panicum nudicaule	Naked-stemmed panic grass		X	
Panicum pinetorum	Pineland panic grass		X	
Parnassia caroliniana	Coastal parnassia or Carolina grass-of-parnassus		X	
Parnassia grandifolia	Grass-of-parnassus	X		
Paronychia chartacea	Paper-like nailwort		X	
Paronychia rugelii var. interior	Rugel's interior nailwort or sand squares		X	
Pellaea atropurpurea	Cliff brake fern	X		
Peperomia floridana	Everglades peperomia	X	X	
Peperomia glabela	Cypress peperomia	X		
Peperomia humilis	Pepper (unnamed)	X		
Peperomia obtusifolia	Florida peperomia	X		
Peperomia simplex	Pale-green peperomia	X		
Peperomia spathulifolia	Spatulate peperomia	X		
Pereskia aculeata	Lemon vine or blade apple cactus	X		X
Persea borbonia var. humilis	Dwarf redbay or redbay persa		X	
Persicaria paludicola	Everglades knotweed		X	
Phlebodium aureum	Golden polypody	X		
Phoradendron rubrum	Mahogany mistletoe	X		
Phyllanthus liebmannianus	Pinewood dainties or Florida leaf flower	X	X	

TABLE 6-1 (continued)

STATE AND FEDERAL LISTED SPECS OF ENDANGERED AND THREATENED PLANTS

SCIENTIFIC NAME	COMMON NAME	DESIGNATED BY FDA	USFWS	CITES
Phyllanthus pentaphyllus floridanus	Florida five-petaled leaf flower		X	
Physalis vicosa var. elliotii	Elliot's sticky ground cherry		X	
Physotegia leptophyllum	Slender-leaved false dragonhead		X	
Physotegia veroniciformis	False dragonhead or Veronica dragonhead		X	
Pieris phillyreaefolia	No common name		X	
Pinckneya pubens (=bracteata)	Hairy fevertree	X	X	
Pinguicula ionantha	Violet-flowered butterwort		X	
Pinguicula planifolia	Chapman's butterwort		X	
Pisonia floridana	Rock Key devil's claws		X	
Pityopsis flexuosa	Golden aster (unnamed)	X	X	
Pityopsis ruthii	Ruth's golden aster		X	
Plantago cordata	Heart-leaved plantain		X	
Platanthera blephariglottis	Large white fringed orchid	X		X
Platanthera ciliaris	Yellow fringed orchid	X		X
Platanthera clavellata	Little club-spur orchid or small green wood orchid	X		X
Platanthera cristata	Golden fringed orchid or crested fringed orchid	X		X
Platanthera flava	Southern tubercled orchid or gypsy-spikes	X		X
Platanthera integra	Yellow fringeless orchid or orange rain orchid	X	X	X
Platanthera nivea	Snowy orchid or bog torch	X		X
Pleopeltis revoluta	Star-scale fern	X		
Pleurothallis gelida	Orchid (unnamed)	X		X
Pogonia ophioglossoides	Rose pogonia	X		X
Polygala boykinii var. sparsifolia	Boykin's few-leaved milkwort		X	
Polygala lewtonii	Lewton's milkwort	X	X	
Polygala rugelii	Big yellow milkwort	X		
Polygala smallii	Tiny milkwort or Small's milkwort	X	X	
Polygonella Ciliata var. basiramia	Hairy jointweed		X	
Polygonella macrophylla	Large-leaved jointweed	X	X	
Polygonella myriophylla	Small's jointweed or woody wireweed		X	
Polygonum meisnerianum	Mexican tear-thumb	X		

TABLE 6-1 (continued)

STATE AND FEDERAL LISTED SPECS OF ENDANGERED AND THREATENED PLANTS

			DESIGNATED BY	
SCIENTIFIC NAME	COMMON NAME	FDA	USFWS	CITES
Polymnia laevigata	Tennessee leaf cup		X	
Polypodium dispersum	Polypody fern (unnamed)	X		
Polypodium plumula	Polypody fern (unnamed)	X		
Polypodium ptilodon	Polypody fern (unnamed)	X		
Polyrrhiza lindenii	Ghost orchid or palm polly	X		X
Polystachya flavescens (=concreta; =extinctoria)	Pale-flowered polystachya	X		X
Polystichum acrostichoides	Christmas fern	X		
Ponthieva racemosa	Shadow witch	X		X
Potamogeton floridanus	Florida pondweed		X	
Prescottia oligantha	Orchid (unnamed)	X		X
Prunus geniculata	Scrub plum	X	X	
Pseudophoenix sargentii	Buccaneer palm or Sargent's	X		
Psilotum nudum	Whisk fern or fork fern	X		
Pteris cretica	Cretan brake fern	X		
Pteris longifolia	Ladder brake fern	T		
Pteris tripartita	Giant brake fern	X		
Pteris vittata	Brake fern (unnamed)	X		
Pteroglossaspic ecristata	Orchid (unnamed)	X	X	X
Pycnanthemum floridanum	Florida mountain mint		X	
Remirea maritima	Beach star	X	X	
Restrepiella ophiocephala	Snake orchid	X		X
Rhapidophyllum hystrix	Needle palm	X	X	
Rhexia lutea	Yellow meadowbeauty	X		
Rhexia parviflora	Small-flowered meadowbeauty or Apalachicola meadowbeauty	X	X	
Rhexia salicifolia	Panhandle meadowbeauty		X	
Rhipsalis baccifera	Mistletoe cactus	X	X	X
Rhodendron alabamense	Alabama azalea	X		
Rhododendron austrinum	Orange azalea or Florida azalea	X	X	
Rhododendron canescens	Pink azalea	X		
Rhododendron chapmanii	Chapman's rhododendron	X	X	
Rhododendron viscosum	Swamp honeysuckle	X		
Rhynchosia cinera	Brown-haired snoutbean		X	
Rhynchospora culixa	Georgia beak rush		X	
Rhynchospora punctata	Pineland beak rush		X	
Ribes echinellum	Miccosukee gooseberry or Florida gooseberry	X	X	
Roystonea elata	Florida royal palm	X	X	

TABLE 6-1 (continued)

STATE AND FEDERAL LISTED SPECS OF ENDANGERED AND THREATENED PLANTS

SCIENTIFIC NAME	COMMON NAME	DESIGNATED BY FDA	USFWS	CITES
Rudbeckia nitida	St. John's-susan	X	X	
Rudbeckia triloba var. pinnathiloba	Pinnate-lobed brown-eyed coneflower		X	
Ruellia noctiflora	Night-flowering ruellia	X		
Sabal etonia	Scrub palmetto	X		
Sabal minor	Dwarf palmetto or blue stem	X		
Sachsia bahamensis	Bahama sachsia	X		
Sageretia minutiflora	Tiny-leaved buckthorn		X	
Salix floridana	Florida willow	X	X	
Salvia blodgetti	Blodgett's sage		X	
Salvinia rotundifolia	Water spangles	X		
Sarracenia leucophylla	White-top pitcherplant	X		
Sarracenia minor	Hooded pitcherplant	X		
Sarracenia psittacina	Parrot pitcherplant	X	X	
Sarracenia rubra	Red-flowered pitcherplant	X	X	
Scaevola plumieri	Inkberry	X		
Schisandra glabra	Schisandra	X		
Schizachyrium niverum	Riparium autumngrass	X	X	
Schizachyrium rhizomatum	Florida autumngrass or bluestem		X	
Schizaea germanii	Tropical curly-grass fern or ray fern	X	X	
Scutellaria floridana	Florida skullcap or helmet-flowers		X	
Selaginella apoda	Meadow spikemoss	X		
Selaginella arenicola	Sand spikemoss	X		
Selaginella armata	Armored spikemoss	X		
Selaginella ludoviciana	Spikemoss (unnamed)	X		
Selaginella plana	Spikemoss (unnamed)	X		
Selaginella uncinata	Spikemoss (unnamed)		X	
Sida rubromarginata	Red-margined mallow		X	
Silene polypetala	Fringed campion		X	
Sium floridanum	Florida water parsnip		X	
Solanum bahamense var. rugelii	Rugel's Bahama horse nettle or Rugel's cankerberry		X	
Solanum carolinense var. floridanum	Florida horse-nettle		X	
Sphenomeris clavata	Parsley fern	X		
Sphenostigma coelestinum	Bartram's ixia	X	X	
Spigelia gentianoides	Gentian pinkroot	X	X	
Spigelia loganioides	Florida pinkroot or Levy pinkroot	X	X	
Spiranthes brevilabris var. brevilabris	Texas ladies' tresses	X		X
Spiranthes brevilabris var. floridana	Florida ladies' tresses	X		X

TABLE 6-1 (continued)

STATE AND FEDERAL LISTED SPECS OF ENDANGERED AND THREATENED PLANTS

SCIENTIFIC NAME	COMMON NAME	DESIGNATED BY FDA	USFWS	CITES
Spiranthes cernua var. odorata	Fragrant ladies' tresses	X		X
Spiranthes costaricensis	Ladies' tresses (unnamed	X		X
Spiranthes cranichoides	Ladies tresses (unnamed)	X		X
Spiranthes elata	Tall neottia	X		X
Spiranthes gracilis	Slender ladies' tresses	X		X
Spiranthes laciniata	Lace-lip ladies' tresses or lace-lip spiral orchid	X		X
Spiranthes lanceolata var. lanceolata	Leafless beaked orchid	X		X
Spiranthes lanceolata var. luteoalba	Ladies' tresses (unnamed)	X		X
Spiranthes lanceolata var. paludicola	Red-flowered ladies' tresses	X	X	X
Spiranthes longilabris	Long-lip ladies' tresses	X		X
Spiranthes orchioides	Scarlet ladies tresses	X		X
Spiranthes ovalis	Oval ladies' tresses	X		X
Spiranthes polyantha	Florida keys ladies' tresses or green ladies' tresses	X	X	X
Spiranthes pracox	Giant ladies' tresses or grass-leaved ladies' tresses	X		X
Spiranthes tortilis	Southern ladies' tresses	X		X
Spiranthes tuberosa	Little ladies' tresses or little pearl twist	X		X
Spiranthes vernalis	Spring ladies' tresses	X		X
Stachys lythroides	Talllahassee hedge-nettle		X	
Staphylea trifolia	Bladdernut	X		
Stewartia malacodendron	Silky camellia	X		
Stillingia sylvatica	Slender queen's delight tenuis		X	
Strukmpfia maritima	Pride-of-big-pine	X		
Suriana maritima	Bay cedar	X		
Swietenia mahogani	West Indian mahogany	X		
Taxus floridana	Florida yew	X	X	
Tectaria amesiana	Ames' halberd fern	X	X	
Tectaria coriandrifolia	Hattie Bauer halberd fern or hairy halberd fern	X		
Tectaria heracleifolia	Halberd fern (unnamed)	X		
Tectaria incisa	Halberd fern (unnamed)	X		
Tectaria lobata	Halberd fern (unnamed)	X		
Tephrosia angustissima	Narrow-leaved hoary pea		X	
Tephrosia mohrii	Pineland hoary pea		X	
Tetramicra canaliculata bicolor	Orchid (unnamed)	X		X

TABLE 6-1 (continued)

STATE AND FEDERAL LISTED SPECS OF ENDANGERED AND THREATENED PLANTS

SCIENTIFIC NAME	COMMON NAME	DESIGNATED BY FDA	 USFWS	 CITES
Tetrazygia bicolor	Tetrazygia	X		X
Thalictrum cooleyi	Cooley's meadowrue		X	
Thelypteris augescens	Aspidium fern (unnamed)	X		
Thelypteris dentata	Downy shield fern	X		
Thelypteris hexagonoptera	Southern beech fern	X		
Thelypteris hispidula	Aspidium fern (unnamed)	X		
Thelypteris interrupta	Aspidium fern (unnamed)	X		
Thelypteris kunthii	Aspidium fern (unnamed)	X		
Thelypteris ovata	Aspidium fern (unnamed)	X		
Thelypteris palustris	Marsh fern	X		
Thelypteris quadrangularis	Aspidium fern (unnamed)	X		
Thelypteris reptans	Creeping fern	X		
Thelypteris resinifera	Aspidium fern (unnamed)	X		
Thelypteris reticulata	Aspidium fern (unnamed)	X		
Thelypteris sclerorphylla	Aspidium fern (unnamed)	X		
Thelypteris serrata	Aspidium fern (unnamed)	X		
Thelypteris tetragona	Aspidium fern (unnamed)	X		
Thrinax floridana	Florida thatch palm	X		
Thrinax microcarpa	Brittle thatch palm	X		
Tillandsia balbisiana	Wild pine or air plant (unnamed)	X		
Tillandsia bartramii	Wild pine or air plant (unnamed)	X		
Tillandsia cicinata	Wild pine or air plant (unnamed)	X		
Tillandsia fasciculata	Common wild pine or common air plant		X	
Tillandsia flexuosa	Twisted air plant	X		
Tillandsia paucifolia	Wild pine or air plant (unnamed)	X		
Tillandsia polystachia	Wild pine or air plant (unnamed)	X		
Tillandsia pruinosa	Fuzzy-wuzzy air plant	X		
Tillandsia setacea	Wild pine or air plant (unnamed)	X		
Tillandsia simulata	Wild pine or air plant (unnamed)	X		
Tillandsia utriculata	Giant wild pine or giant air plant	X		
Tillandsia valenzuelana	Wild pine or air plant (unnamed)	X		
Tipularia discolor	Crane-fly orchid	X		X
Torreya taxifolia	Florida torreya	X	X	
Tragia saxicola	Florida keys noseburn		X	
Trichomanes holopterum	Filmy fern (unnamed)	X		
Trichomanes krausii	Filmy fern (unnamed	X		
Trichomanes lineolatum	Filmy fern (unnamed)	X		
Trichomanes petersii	Filmy fern (unnamed)	X		
Trichomanes punctatum	Filmy fern (unnamed)	X		
Trillium lancifolium	Lance-leaved wake-robin	X		

TABLE 6-1 (continued)

STATE AND FEDERAL LISTED SPECS OF ENDANGERED AND THREATENED PLANTS

SCIENTIFIC NAME	COMMON NAME	DESIGNATED BY FDA	USFWS	CITES
Triphora craigheadii	Craighead's nodding-caps or Craighead's pogonia	X	X	X
Triphora cubensis	Nodding caps (unnamed)	X		X
Triphora gentianoides	Nodding-caps (unnamed)	X		X
Triphora latifolia	Broad-leaved nodding-caps or broad-leaved pogonia	X	X	X
Triphora rickettii	Nodding-capes (unnamed)	X		X
Triphora trianthophora	Nodding pogonia or three-birds orchid	X		X
Tripsacum floridanum	Florida gramagrass		X	
Trismeria trifoliata	Braken fern (unnamed)	X		
Tropidia polystachya	Young-palm orchid	X		X
Vanilla barbellata	Worm-vine orchid or link vine	X		X
Vanilla dilloniana	Leafless vanilla	X		X
Vanilla inodora	Scentless vanilla	X		X
Vanilla mexicana	Vanilla (unnamed)	X		X
Vanilla phaeantha	Leafy vanilla or oblong-leaved vanilla	X		X
Vanilla planifolia	Commercial vanilla	X		X
Veratrum woodii	Woods' false hellebore	X	X	
Verbena maritilma	Coastal vervain		X	
Verbena tampensis	Tampa vervain		X	
Verbesina chapmanii	Chapman's crownbeard	X	X	
Verbesina heterophylla	Variable-leaf crownbeard		X	
Vicia ocalensis	Ocala vetch	X	X	
Viola hastata	Halberd-leaved yellow violet	X		
Vittaria lineata	Shoestring fern	X		
Warea amplexifolia	Clasping warea	X	X	
Warea carteri	Carter's warea	X	X	
Warea sessilifolia	Sessile-leaved ware		X	
Woodsia obtusa	Blunt-lobed woodsia	X		
Woodwardia areolata	Netted chain fern	X		
Xyris drummondii	Drummond's yellow-eyed grass		X	
Xyris isoetifolia	Quillwort yellow-eyed grass		X	
Xyris longisepala	Karst pond yellow-eyed grass or Kral's yellow-eyed grass	X	X	
Xyris scabrifolia	Harper's yellow-eyed grass	X	X	
Zamia floridana	Florida coontie	X		X
Zamia integrifolia	Florida arrowroot	X	X	X
Zamia umbrosa	East coast coontie	X		X
Zanthoxylum flavum	Yellowheart	X		
Zephyranthes (all white species)	Rain lilies	X		
Zephyranthes simpsonii	Simpson zephyr lily	X	X	
Zephyranthes treatiae	Rain lily (unnamed)		X	
Zizia latifolia	Bristol golden alexanders		X	

The second group of orchids consists of those that may suffer from freezes and droughts, but are not liable to be eliminated from the Big Cypress by natural stresses. Of these, the relatively cold-sensitive ghost orchid does not have an extensive range outside this region. The following well-established species also occur over large areas in the tropics: clamshell orchid, night-blooming epidendrum, ionopsis, dollar orchid, brown epidendrum, umbelled epidendrum, mule-ear orchid, and oblong-leaved vanilla.

The third group encompasses very rare species. Many of these are assumed to be legitimately native, but some are tropical orchids found only once or twice in spots where they may have been accidentally established or purposefully introduced. Hidden orchid and the following species restricted to the Fakahatchee belong in this category: Harris' tiny orchid, tall liparis orchid, rattail orchid, leafless orchid, dwarf epidendrum, rigid epidendrum, Acuna's epidendrum, Leochilus labiatus, and snake orchid.

Worm vine occurs in the Big Cypress, but it more often found farther to the southeast.

6.1.3.2 Terrestrial Orchids

Most terrestrial orchids grow in wet prairies, but a few species are found in damp hammocks or on fallen logs in wetlands. Most of these are species that are widespread on the southeastern coastal plain, but red-flowered ladies' tresses is endemic to the Fakahatchee area.

6.1.3.3 Bromeliads

There are two basic structural types of Bromeliads: those with wiry curving leaves that allow rain to run off fairly easily, and "tank bromeliads" whose broad leaves channel water into a central cup.

Big Cypress tank bromeliads include Fuch's bromeliad, powdery catopsis, and nodding catopsis. Fuch's bromeliad is a spectacular orange-flowered species abundant in certain Fakahatchee slough areas, but found in only one other Florida location. Powdery catopsis grows fully exposed on the upper branches of trees in pine flatwoods, hammocks, and mangrove habitats; it is more often encountered in the Everglades/Key Largo area. Nodding catopsis is found in a very few places growing on former understory trees in logged cypress swamps.

Of the other bromeliads, the fuzzy-wuzzy airplant is the one most dependent upon the strand habitats of the Big Cypress. It typically grows on cypress trees.

6.1.3.4 Ferns

Rare ferns of the Asplenium species are found in the Big Cypress area. The auricled spleenwort grows on the inclined branches of big live oaks (Quercus virginiana) in Fakahatchee and Deep Lake strand hammocks. The birdnest fern has been found in only ten locations, always growing on a log or stump in a dark moist swamp or hammock.

Narrow strap fern is an endangered species that grows in the same live oak habitats as auricled spleenwort. The golden leather fern occurs in Collier County, but prefers coastal habitats. The hand fern or hand adder's tongue fern is a drooping staghorn-like fern that grows from the dead leaf bases of cabbage palms (Sabal palmetto) in damp shady places that have not burned for many years. Drainage and consequent increasing fire frequency are contributing to its growing rarity.

6.1.3.5 Other Epiphytes

There are four Peperomia species in the Big Cypress, all of which may grow as either epiphytes or terrestrials. Hanging club moss is one of the region's rarest plants. It also grows in tropical America, but it is rare throughout its range. The four plants known in the Big Cypress area are all growing on pond apple trees along sloughs in mature cypress forest.

6.1.3.6 Other Terrestrial Plants

Fakahatchee burmannia is included on most lists of rare Big Cypress plants, but only two have ever been found and botanists question whether it should be considered part of the regions's flora. Simpson's stopper occurs in the Big

Cypress, but the bulk of its habitat is further east. Southern three-awned grass inhabits wet flatwoods.

Florida privet, pineland clustervine, Krug's holly, small-leaved melanthera, Stillingia sylvatica var. tenuis) and Carter's large-flowered flax are usually found in pine rocklands. Florida beardgrass occurs in pinelands and sandy prairies. Catesby lilies and Simpson zephyr lilies grow in grassy pinelands and prairies. Catesby lilies seem to prefer the drier types and zephyr lilies the wetter ones. The royal palm occurs on only three Florida sites and the Fakahatchee population is by far the largest and healthiest.

6.1.4 Federal and State Listed Endangered and Threatened Animal of ENP and BCNP

Table 6-2 shows federal and state listed animal species found in BCNP and ENP. These are taken from U.S. Fish and Wildlife and Florida Game and Freshwater Commission lists.

6.2 AQRVs for the Big Cypress National Preserve (BCNP) and Everglades National Park (ENP)

6.2.1 Definition of AQRVs and Criteria Applied to BCNP and ENP

The National Park Service has defined Air Quality Related Values (AQRVs) as being:

> All those values possessed by an area except those that are not affected by changes in air quality and include all those assets of an area whose vitality, significance, or integrity is dependent in some way upon the air environment. These values include visibility and those scenic, cultural, biological, and recreational resources of an area that are affected by air quality.
>
> Important attributes of an area are those values or assets that make an area significant as a national monument, preserve, or primitive area. They are the assets that are to be preserved if the area is to achieve the purposes for which it was set side. (Federal Register, 1978)

TABLE 6-2

FEDERAL AND STATE LISTED ENDANGERED AND THREATENED ANIMALS IN BCNP AND ENP

	STATE	FEDERAL
<u>Mammals</u>		
Florida Panther	End.	End.
Mangrove Fox Squirrel	End.	-
Florida Black Bear	Thr.	-
Everglades Mink	Thr.	-
Manatee	Thr.	End.
<u>Birds</u>		
Wood Stork	End.	-
Everglade Kite	End.	End.
Red-cockaded Woodpecker	End.	End.
Cape Sable Sparrow	End.	End.
Peregrine Falcon	End.	End.
Southern Bald Eagle	Thr.	End.
Osprey	Thr.	-
Florida Sandhill Crane	Thr.	-
Audubon's Caracara	Thr.	-
Brown Pelican	Thr.	End.
Ivory-billed Woodpecker	End.	End.
Great White Heron	Thr.	-
Southeastern American Kestrel	Thr.	-

TABLE 6-2 (Continued)

FEDERAL AND STATE LISTED ENDANGERED, AND THREATENED ANIMALS IN BCNP AND ENP

	STATE	FEDERAL
<u>Reptiles</u>		
American Alligator	Thr.	Thr.
Eastern Indigo Snake	Thr.	Thr.
American Crocodile	End.	End.

End. - endangered
Thr. - threatened

6.2.2 AQRVs of BCNP and ENP

Those values of the BCNP and ENP which are directly dependent upon the air environment are the water, soils and vegetation resources. Less directly dependent upon the air environment are the wildlife resources. Table 6-3 lists important aquatic, vegetational, and wildlife attributes of the these areas which make the BCNP and ENP significant. Table 6-4 describes the reported general effects on aquatic, vegetational and wildlife resources from significant degradation in air quality. All interior vegetational resources including all threatened and endangered plant species of BCNP and ENP, are dependent upon the air environment and are considered AQRVs. Terrestrial wildlife and threatened and endangered wildlife are also considered AQRVs for BCNP and ENP. Table 6-5 lists those threatened and endangered species associated with terrestrial habitats of BCNP and ENP.

6.3 Air Quality/AQRV Sensitivity Analysis

6.3.1 Predicted Ambient Concentrations for BCNP and ENP and Potential Effects to Sensitive Aquatic, Vegetation and Wildlife Resources.

Sections 4.0 and 5.0 presented the predicted maximum air quality impacts (annual 24-hr, 8-hr, 3-hr, and 1-hr) pollutant concentrations in the vicinity of the site and at the boundaries of BCNP and ENP. Maximum concentrations within the ENP and BCNP will be less than these levels.

A review of the literature on controlled-laboratory and field-crop field studies indicates that general background levels of particulate matter are relatively unimportant from a vegetational effects point of view (EPA, 1982a). The lowest exposure regime reported to produce a physiologic response (reduction in carbon dioxide uptake) is 0.6 g/m^2/day of cement dust for 8-10 hours/day. Foliar injury was reported at higher exposures. Based upon the predicted annual average TSP impact of 0.001 $\mu g/m^3$ due to the planned Plant, particulate deposition in BCNP and ENP will be several orders of magnitude less than the lowest reported exposure level.

TABLE 6-3

Important Aquatic Vegetational and Water Resource Attributes or AQRVs of BCNP and ENP Dependent Upon The Air Environment

Attributes	Location
Aquatic	
Freshwater ponds, lakes, and sloughs	BCNP, ENP
Vegetation	
Ecological Communities including	
Wet Flatwoods	BCNP, ENP
Wet prairies	BCNP, ENP
Hardwood hammocks	BCNP, ENP
Cypress wetlands	BCNP, ENP
Swale	BCNP, ENP
Unique ecological communities	
Marl prairies	BCNP, ENP
Dwarf cypress prairies	BCNP, ENP
Pine rocklands	BCNP, ENP
Unique plants	
Threatened and endangered species (see Table 6-1)	ENP, BCNP
Ephiphytic plantsincluding orchids and bromeliads	ENP, BCNP
Air quality bioindicators - lichens	ENP, BCNP
Wildlife	
Birds, mammals, reptiles and amphibians	ENP, BCNP
Threatened and endangered species (see Table 6-2)	ENP, BCNP

Source: KBN, 1986

TABLE 6-4

Reported General Effects on Aquatic, Vegetation and Wildlife Resources From Significant Degradation of Air Quality

Attributes	Potential Effects and Associated Air Quality Change
Aquatic Resources	Acidification of waters and subsequent changes (loss and replacement) of ecological components; sensitive systems have low buffering capacity
Vegetation Resources	Most common effects include reduced growth, injury, and species replacement; species show specific sensitivity
Wildlife Resources	Potential effects include avoidance and increased body burdens of contaminants

Source: KBN, 1986

TABLE 6-5

Habitat of Federal and State Listed, Endangered and Threatened Animals in the BCNP and ENP (Continued)

	Habitat								
Species	Pine Forest	Hammock Forest	Cypress Forest	Mixed Swamp Forest	Inland Marshes, Ponds, Sloughs	Prairies	Coastal Forest	Coastal Marshes	Saltwater Prairies or Marshes
Great White Heron				X			X	X	
Wood Stork			X	X	X	X	X	X	
Florida Sandhill Crane					X	X		X	
Ivory-billed Woodpecker				X					
Red-Cockaded Woodpecker									
Cape Sable Seaside Sparrow					X	X		X	X
American Crocodile							X		
American Alligator			X	X	X	X	X		
Eastern Indigo Snake	X	X	X			X	X		

Source: Duever et al. 1979)

TABLE 6-5

Habitat of Federal and State Listed Endangered and Threatened Animals in the BCNP and ENP

	Habitat								
Species	Pine Forest	Hammock Forest	Cypress Forest	Mixed Swamp Forest	Inland Marshes, Ponds, Sloughs	Prairies	Coastal Forest	Coastal Marshes	Saltwater Prairies or Marshes
Florida Black Bear	X	X	X	X		X	X	X	
Everglades Mink			X	X	X	X			
Florida Panther	X	X	X	X		X	X	X	
Mangrove Fox Squirrel	X	X	X	X			X		
Manatee							X		
Brown Pelican							X	X	
Everglade Kite					X	X			
Southern Bald Eagle	X		X		X		X	X	X
Osprey	X		X			X	X	X	X
Audubon's Caracara	X					X			
Peregrine Falcon	X				X	X	X	X	X
Southeastern American Kestrel	X				X	X			

Of the pollutants emitted from the facility, SO_2 is the pollutant of potential concern because of its recognized history of effects to vegetation. Plants may be exposed to SO_2 through dry and wet deposition. Injury is caused by entrance into a plant through leaf openings or stomata. A number of plant responses are possible, including:

1) increased growth or yield,
2) injury reflected in reduced growth and yield,
3) foliar changes, and
4) at high concentrations, plant death.

Concentrations of SO_2 from point sources may fluctuate widely within short periods. Short term exposures at high concentrations are relatively more toxic than longer-term exposures with the same total dose rate. Environmental conditions also influence the susceptibility of plants to SO_2. For example, high temperatures, humidity, and abundant sunlight result in active plant growth and also enhance the responsiveness of plants to SO_2. The response of plants to SO_2 is hard to generalize because each species is genetically different and its genetic susceptibility and the influence of the environment at the time of exposure will influence the response. Except for on-going research sponsored by the National Park Service information on the sensitivity of plant species of BCNP and ENP is lacking.

Table 6-6 compares the relationship between the predicted concentrations of SO_2 and known effects on vegetation. For sensitive grasses, shrubs and trees and for slash pine the predicted values for BCNP and ENP are over two orders of magnitude less than reported values causing measurable changes. The threshold levels reported for the lichen species, Ramalina denticulata, found in the ENP (National Park Service letter, dated 2/24/86) are above the predicted values for the Park. It is emphasized that the background SO_2 air quality values used in the predictions are from Ft. Myers. Ft. Myers data were used since no data are available for the ENP or BCNP. The use of Ft. Myers data for background values provides a very conservative estimate for these pristine areas. The SO_2 impacts of the planned plant constitute less than 20 percent of the total predicted air quality impacts in the vicinity of the Plant site, and less than 5% of the total impacts upon the ENP/BCNP areas.

The predicted maximum NO_x concentration of 28 µg/m^3, annual average for both the site area and the ENP/BCNP areas, as three orders of magnitude lower than known vegetation injury thresholds (McLean, 1975). The planned Plant is predicted to increase existing NO_x levels by a very small amount (less than 5%).

Predicted ozone concentrations with the Plant in operation will not change from the existing background levels (conservatively estimated at 0.08 ppm, 1-hr) and are less than threshold values for agricultural crops (0.10 to 0.25 ppm for 1-hr) and for trees and shrubs (0.20 to 0.51 ppm for 1-hr) that have been determined to induce foliar injury. For sensitive species the range of 1-hour ozone concentrations that may produce 5% injury is 0.15 to 0.25 ppm. (U.S. Environmental Protection Agency, 1978).

The predicted maximum impacts of other pollutants (i.e. C_O, P_b, trace metals, HC_1, etc.) due to operation of the Plant are so small as to have no measurable affect upon vegetation AQRVs.

In summary, the predicted air quality conditions associated with the proposed facility will have no adverse impacts on vegetation, including vegetation AQRVs, of BCNP and ENP.

Laboratory studies of animals exposed to particulates indicate that threshold values for particulates shown to cause physiological changes to the respiratory system are above 100 µg/m^3 for 1 hour to several months exposure depending upon the animal and the type of particulate (EPA, 1982a). This injury threshold level of 100 µg/m^3 is at least two orders of magnitude greater than the predicted maximum impacts of the planned Plant upon the ENP/BCNP (i.e. 0.6 µg/m^3, 1-hour average).

Threshold values of SO_2 reported to cause physiological changes in animals, range from 400 µg/m^3 for 1-hour to 13 µg/m^3 daily for seven months (EPA, 1982b). These values are also several orders of magnitude larger than predicted concentrations for the planned Plant. No significant effects on terrestrial wildlife AQRVs are expected.

TABLE 6-6

Comparison of Reported Lowest SO_2 Values Causing Injury to Vegetation Types With Predicted Plant Impacts

Type of Vegetation	Representative Low Values	Predicted Values Site	Park/ Preserve
General Vegetation: sensitive species of grasses, shrubs and trees	1-hr 1310-2620 µg/m^{3}*	107	94
	3-hrs 790-1570 µg/m^{3}*	100	92
Slash pine	2-hrs 660 µg/m^{3}[a]	100-107	92-94
Lichens Ramalina denticulata	6-hrs/week 100 µg/m^{3}** for 10 weeks	28-107	27-94
	annual 5-30 µg/m^{3}**	4	4

source: KBN, 1986

* From EPA, 1982b.

** From NPS letter M. Flores, February 24, 1986

***Includes conservative background SO_2 levels. 1-hour background level assured to equal 3-hour background of (90 µg/m^3). (See Section 4.1).

Information on background levels of ozone is limited to 1-hr values (0.08 ppm) from Ft. Myers (an urbanized area). The proposed facility will contribute no detectible increase over existing levels. Threshold values for laboratory animals showing detectable respiratory changes have been reported only for 3-hour and greater averaging times. Concentrations resulting in physiological changes in laboratory animals have ranged from 0.06 to 0.1 ppm for these averaging times. Because of the limited data, species differences and differences in response between laboratory and field animals, no valid conclusions can be drawn on predicted effects. Since the facility will contribute no detectable increase over existing levels, operation of the facility will not cause adverse impacts on BCNP and ENP.

Reported threshold effects in animals for NO_x with averaging times of 3-hours is 376 $\mu g/m^3$ and for 24-hr. is 752 $\mu g/m^3$. These values are two to three orders of magnitude higher than predicted impacts due to the planned plant. No effects on wildlife AQRVs are expected.

6.3.2 Impacts to Soil and Aquatic Systems

6.3.2.1 Current Acid-deposition Loading in BCNP and ENP

Monitoring data collected by the Florida Acid Deposition Study provides current information on the estimated annual average dry and wet deposition for the BCNP and ENP. Three monitoring stations were located in the vicinity of the BCNP and ENP during Phase I and II of the study with one monitoring station continuing to be operated for a 3 1/2 year period (FCG, 1986). Statistical analyses performed on these data indicated that the southern peninsula of Florida is statistically distinct from the more northern portions of Florida, and sites within this region are not significantly different, (ESE, 1983; ESE, 1984, ESE, 1985, FCG, 1986). As a result, values obtained from the study will be representative of values observed over the BCNP and ENP. The results of these monitoring data are summarized in Table 6-7.

TABLE 6-7

CURRENT ESTIMATED ANNUAL ACID-DEPOSITION LOADING IN BCNP AND ENP

Parameter		Site 11*	12*	13+
Location		Hendry County	Collier County Corkscrew Swamp Sanctuary	Monroe County Pinecrest
Wet Deposition				
VWM pH		4.78	4.77	4.86
H+	(eq/ha)	235	236	180
SO_4^{-2}	(eq/ha)	238	179	206
NO_3-	(eq/ha)	126	102	119
Ca^{+2}	(eq/ha)	110	85	117
NH_4	(eq/ha)	71	40	63
Dry Deposition				
SO_x	(eq/ha)			100
NO_x	(eq/ha)			129
Ca^{+2}	(eq/ha)			273
NH_4+	(eq/ha)			24
Total Deposition				
SO_x	(eq/ha)			306
NO	(eq/ha)			248
Ca^{+2}	(eq/ha)			390
NH_4+	(eq/ha)			87

eq/ha = equivalents/hectare

VWM = Volume weighted mean

* Phase II only - Sept. 15, 1981, through Sept. 14, 1982
\+ 3 year average - Sept. 15, 1981, through Sept. 11, 1984

Source: FCG, 1986

6.3.2.2 Comparison of Atmospheric Emissions from Collier County Resource Recovery Facility and Statewide and Regional Emissions

A comparison of the emissions of acidic deposition from the planned Plant with state and regional emissions, and results from a statewide mass balance model performed under the Florida Acid Deposition Study, is presented in Table 6-8 (FCG, 1986). These data are being compared to demonstrate the relative amount of atmospheric loading the planned Plant will likely contribute to the BCNP and ENP.

The maximum annual sulfur and nitrogen emissions are 168 and 125 tons, respectively. As seen from Table 6-8 this magnitude of emissions is extremely small compared to statewide anthropogenic or biogenic emissions. Even if the entire annual emissions of sulfur and nitrogen from the facility were to be deposited in the BCNP and ENP. This would amount to less than 3% of the existing total annual deposition to the BCNP and ENP from all sources. The actual deposition from facility emissions will be nondetectably small. Because of complex chemical transformation and physical dispersion and deposition processes, little of the proposed facility's emissions will be deposited in either the BCNP or ENP. Estimates of transboundary flux of sulfur and nitrogen across Florida's extreme southern boundary, for which the BCNP and ENP make up a part, are several orders of magnitude greater than that emitted by the facility. Consequently, the influence of the proposed facilities emissions on atmospheric deposition is expected to be immeasurably small.

6.3.2.3 POTENTIAL IMPACTS OF SOIL TYPES OF BCNP AND ENP

Recently, the final report of the Florida Acid Deposition Study was completed and included a detailed evaluation of the potential sensitivity of Florida soils to acid deposition (FCG, 1986). The potential and hypothesized effects of atmospheric deposition on soils as determined by the study include:

1) Increased soil acidification
2) Alteration in cation exchange
3) Loss of base cations
4) Mobilization of trace metals

TABLE 6-8

Comparison of Emissions from the Planned Plant with Sources and Sinks of Atmospheric Sulfur and Nitrogen

Sources/ Sinks	Sulfur (tons/yr)	Nitrogen (tons/yr)
SOURCES		
Collier County Resource Recovery Facility	168	125
Statewide Anthropogenic Emissions	468,356	246,523
Biogenic Emissions	22,000	19,000
Regional Emissions (southern peninsula)	157,000	170,000
Imported Emissions		
Across all of Florida's boundaries	440,000	200,000
Across Florida's southern boundary	33,000	3,300
SINKS		
Deposition Statewide		
Wet	80,000	31,000
Dry	44,000	50,000
Total	124,000	81,000
BNCP/ENP		
Wet	4,300	2,200
Dry	2,100	2,400
Total	6,400	4,600

Source: FCG, 1986
KBN, 1986

The potential sensitivity of specific soils to atmospheric inputs (presumably acidic deposition) is related to two factors. First, the physical ability of a soil to conduct water vertically through the soil profile is important in influencing the interaction with deposition. Second, the ability of the soil to resist chemical changes, as measured in terms of pH and soil Cation Exchange Capacity (CEC), is important in determining how a soil responds to atmospheric inputs. The relevance of these two factors to the potential sensitivity of soils in the BCNP and ENP are a function of the soil order, suborder, and great group of the soils in the BCNP and ENP.

The soils of the BCNP and ENP are generally classified as histosols or entisols. Histosols are organic in nature and have extremely high buffering capacities [765 Kilo-equivalents per hectare (keq/ha)] based on CEC, base saturation and bulk density over the surfical 25 cm of the soil column (ESE, 1982). The large CEC of histosols is afforded by weak functional group (e.g., carboxylic acid groups) and would be considered relatively insensitive to atmospheric inputs. Entisols, although having an overall buffering capacity of 203 keq/ha, exhibit considerable heterogeneity with buffering capacities ranging from 52 keq/ha for a Psamment Quartzipsammet entisol to 2,510 keq/ha for a Aquent Sulfaquent entisol (FCG, 1986; Calhoun et al., 1974; Carlisle et al., 1978, 1981). The Typic Quartzipsammet soils are characterized as quartz sands with virtually no weatherable minerals.

Distribution of the type of entisols and their resultant buffering capacity within the BCNP and ENP are unknown. However, the pine flat wood and turkey oak areas which are more prevalent in the BCNP would be more indicative of entisols that may exhibit potential sensitivity to atmospheric inputs. The potential sensitivity of soils in these areas is however, considered to be extremely low for three reasons. First, the entisols of BCNP are shallow soils underlined with limestone, as evidenced by frequent limestone outcroppings. Several ecological communities, such as marl prairies and pine rocklands, are influenced by the calcareous substrate. This direct connection with subsurface limestone would tend to neutralize any acidic inputs. Second, the ground water table is highly buffered due to the interaction with subsurface limestone formations and results in high total alkalinity (as $CaCO_3$). Finally, the observed atmospheric inputs are already relatively low for this area of the state and approach a level of that observed in more remote areas of the tropics.

The relatively low sensitivity of soils in the BCNP and ENP, coupled with the small magnitude of emissions from the planned Plant would preclude significant impact on soils in the BCNP and ENP by this facility.

6.3.2.4 Potential Sensitivity of Aquatic Systems

Aquatic systems in Florida with the greatest potential for undergoing responses to acidic deposition are those with: (FCG, 1986)

1) Low Acid Neutralizing Capacity (ANC)
2) Watershed soils dominated by acidic soils with low CEC, and
3) Hydrologic budgets dominated by precipitation

Such characteristics are generally confined to seepage lakes located in the sandhills of the highlands and ridge physiographic regions of the Florida panhandle and northern peninsula. Conversely, surface waters in the BCNP and ENP are generally characterized as having high ANC and high total alkalinity (i.e., >100 mg/1 of $CaCO_3$). The hydrological budgets of aquatic systems in the BCNP and ENP are not dominated by precipitation but from surfical aquifers which have considerable interaction with the underlining limestone and thereby provide considerable ANC.

The influence of the planned Plant on aquatic systems in the BCNP and ENP is considered insignificant since the facility's emissions and resultant deposition are small compared to current deposition levels and the relative insensitivity of aquatic systems in BCNP and ENP to atmospheric (i.e., acidic) inputs.

6.3.3 Conclusions

BCNP and ENP have a large number of AQRVs. The air quality/AQRV sensitivity analysis has shown that emissions and predicted impacts are significantly below values known to cause effects in sensitive vegetation and wildlife. Effects on soils and aquatic systems are shown to be insignificant because of the relative insensitivity of these systems and because the impacts from the proposed facility on these systems are immeasurably small in magnitude.

APPENDIX IV

ATTACHMENT A

ATMOSPHERIC DISPERSION MODELING PROTOCOL

FOR

COLLIER COUNTY

SOLID WASTE RESOURCE RECOVERY FACILITY

Prepared by
KBN ENGINEERING AND APPLIED SCIENCES, INC.
April, 1986

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APPENDICES

1.0 GENERAL MODELING PROCEDURES

The general modeling procedures used in the air quality impact analysis for the Collier County solid waste resource recovery facility (SWERF) followed U.S. Environmental Protection Agency (USEPA) recommended procedures. Four primary documents provide guidance and current policy in USEPA modeling procedures:

1. "Guideline on Air Quality Models" (USEPA, 1978)
2. "Prevention of Significant Deterioration Workshop Manual" (USEPA, 1980)
3. "Regional Workshops on Air Quality Modeling: A Summary Report" (USEPA, 1983)
4. "Guideline on Air Quality Models (Revised), Draft" (USEPA, 1984)

The 1978 guideline document provides general guidance on the application of atmospheric dispersion models, but does not give guidance on special situations, such as atmospheric downwash, or use of specific model options. In addition, only a handful of models were "recommended" for use by USEPA. This was primarily due to the limited number and applicability of available models prior to 1978.

Since 1978, a number of new models have emerged, which are generally enhanced versions of the previous models, and have more options and capabilities. In response to the development of the new models, the increased concern over a number of modeling related issues (e.g. long-range transport, fugitive dust, particle deposition, etc.) and the desire to maintain consistency in the application of dispersion models, EPA conducted a series of modeling workshops in the period 1981 to 1983. The result of the workshops was a summary report which clarified preferred EPA models and modeling policy for a number of specific issues.

The PSD workshop manual, published in 1980, does not recommend specific models or modeling procedures. The manual addresses the general application of models for determining maximum air quality impacts and Prevention of Significant Deterioration (PSD) increment consumption.

In November 1984, EPA published a draft of the revised guideline for air quality modeling. This document is by far the most comprehensive of the guidance documents issued to date. The draft addresses preferred models, as well as the specific options which are recommended for each model. Although this publication is a draft, it generally represents current EPA modeling policy.

The specific model proposed for application to the Collier County SWERF, as well as the specific model options and procedures to be utilized in the modeling evaluation, are described in the following sections.

2.0 ATMOSPHERIC DISPERSION MODEL

2.1 MODEL DESCRIPTION

2.1.1 General

The Industrial Source Complex (ISC) model is proposed to predict maximum air quality concentrations due to the proposed Collier County SWERF. The ISC model (Bowers, et al., 1979) is a Gaussian plume model which can be used to assess the air quality impact of emissions from a wide variety of sources associated with an industrial source complex. The model is contained in EPA´s User´s Network for Applied Modeling of Air Pollution (UNAMAP), Version 5 (USEPA, 1982). The model is applicable to sources located in either flat or rolling terrain, where terrain heights do not exceed stack heights. The model can be used to predict ambient concentrations of gaseous pollutants or particulate matter. The ISC model can account for the effects on ambient particulate concentrations of gravitational settling and dry deposition. Alternately, the ISC model can be used to calculate dry deposition.

The ISC consists of two computer codes. The ISC short-term model (ISCST), an extended version of the Single Source (CRSTER) Model (USEPA, 1977), is designed to calculate hour-by-hour concentrations or deposition values and to provide averages for time periods of 2, 3, 4, 6, 8, 12 and 24 hours. If used with a year of sequential hourly meteorological data, ISCST can also calculate annual concentration or deposition values. The ISC long-term model (ISCLT) is a sector-averaged model that extends and combines basic features of the Air Quality Display Model (AQDM) and the Climatological

Dispersion Model (CDM). The long-term model uses statistical wind frequencies to calculate seasonal (quarterly) and/or annual ground-level concentration or deposition values. Both ISCST and ISCLT use either a polar or a Cartesian receptor grid.

The ISC model programs accept stack, area, and volume source types. The volume source option is also used to simulate line sources. The steady-state Gaussian plume equation for a continuous source is used to calculate ground-level concentrations for stack and volume sources. The area source equation in the programs is based on the equation for a continuous and finite crosswind line source. Consideration of time-dependent exponential decay of pollutants is directed through specification of a decay rate.

The generalized Briggs (1971 and 1975) plume rise equations, including the momentum terms, are used to calculate plume rise as a function of downwind distance. Procedures suggested by Huber and Snyder (1976) and Huber (1977) are used to evaluate the effects of the aerodynamic wakes and eddies formed by buildings and other structures on plume dispersion. A wind-profile exponent law is used to adjust the observed mean wind speed from the measurement height to the emission height for the plume rise and concentration calculations. Procedures utilized by the Single Source (CRSTER) model (USEPA, 1977) are used to account for variations in terrain height over the receptor grid.

The Pasquill-Gifford curves (Turner, 1970) are used to calculate lateral (σ_y) and vertical (σ_z) plume spread. The ISC model has rural and urban options. In the Rural Mode, rural mixing heights and the σ_y and σ_z values for the input stability category are used in the calculations. In Urban Mode 1, the stable E and F stability categories are redefined as neutral D stability. In Urban Mode 2, the E and F stability categories are combined and the σ_y and σ_z values for the stability category one step more unstable than the input stability category (except A) are used in the calculations. Urban mixing heights are used in both urban modes.

2.1.2 ISC Short-term Model

The ISCST program allows the user to select from a number of model options. A brief description of these options is provided below:

- Concentration/Deposition Option - Selects average concentration or total deposition calculations
- Receptor Grid System Option - Selects a Cartesian or a polar receptor grid system
- Discrete Receptor Option - Allows the specification of individually located receptors
- Receptor Terrain Elevation Option - Allows the use of terrain elevations for each receptor
- Tape Output Option - Allows output results to be written to tape
- Print Input Data Option - Directs the printing of program control parameters, source data, meteorological data, and receptor data
- Meteorological Data Option - Directs the reading of hourly data from either the meteorological preprocessor format or a card image format
- Rural/Urban Option - Specifies whether the concentration or deposition calculations are made in the Rural Mode, Urban Mode 1 or Urban Mode 2
- Wind-Profile Exponent Option - Allows user-provided wind-profile exponents or the use of default values
- Vertical Potential Temperature Gradient Option - Allows user-provided vertical potential temperature gradients or the use of default values

- Source Combination Option - Allows the user to specify the combinations of sources for which concentration or deposition estimates are required

- Single Time Period Interval Option - Directs the printing of concentration or deposition values for a specific time interval within a day

- Variable Emission Rate Option - Allows the user to vary a source´s emission rate by season or month, by hour of the day, by season and hour of the day, or by wind speed and stability

- Plume Rise as a Function of Distance Option - Directs the program to calculate plume rise as a function of downwind distance or to use final plume rise for all downwind distances

- Stack-Tip Downwash Option - Allows use of the Briggs (1973) procedures for evaluating stack-tip downwash for all stack sources

- Building Wake Effects Option - Allows the evaluation of building wake effects due to adjacent or nearby structures

2.1.3 ISC Long-term Model

The options available within the ISCLT model are generally the same as those available for the ISCST model. Additional or different options are described below:

- Print Seasonal/Annual Results Option - Print seasonal and/or annual concentration or deposition values

- Maximum 10 Options - Prints the maximum 10 concentration (deposition) values and receptors, the results of the calculations at all receptors without maximums, or other related scenarios

- o Combined Sources Option - Allows the user the flexibility of specifying multiple sets of sources to use in forming combined sources output.

2.2 MODEL SELECTION

The ISC model is listed as a "preferred" model in both the draft revised modeling guideline (USEPA, 1984) and the regional workshop summary document (USEPA, 1983). It is regarded as a flat or simple terrain model applicable to industrial complexes and complicated sources in rural or urban settings. The ISCST is recommended for short-term averaging times (1 to 24 hours), while the ISCLT is recommended for long-term averaging times (i.e., seasonal or annual). The Collier County SWERF is most appropriately a single source (i.e., one stack) with no special problems (i.e., absence of volume or area sources, downwash, fugitive emissions, etc.). For this type source, the guideline documents recommend the Single Source (CRSTER) as the preferred model. However, it is stated in the draft revised modeling guideline that the ISCST can be substituted for CRSTER if model options are selected which result in equivalent concentration estimates. The options selected for the ISCST in order to achieve equivalency are discussed in Section 5.0.

Simple terrain is defined in the draft revised modeling guideline as "an area where terrain features are all lower in elevation than the top of the stack of the sources in question." The top of the stack serving the two Collier County units will be approximately 260 feet above ground elevation. Review of U.S.G.S. maps of the site area reveals virtually no change in ground elevations within a 10 km radius (i.e., flat terrain) (see Figure 2-1 and 2-2). Ground elevations are approximately 10 feet above mean sea level (MSL). Ground elevations gradually decrease south of the site and reach approximately 5 feet above MSL along the northwest boundary of the Everglades National Park, which is about 35 km south-southeast of the site (see Figure 2-2). Ground elevations increase gradually east of the site to about 15 feet above MSL at a distance of about 10 km. The western boundary of the Big Cypress National Preserve is located approximately 30 km east of the SWERF site, and ground elevations remain at 10 to 15 feet above MSL. Since the terrain is virtually flat in the area

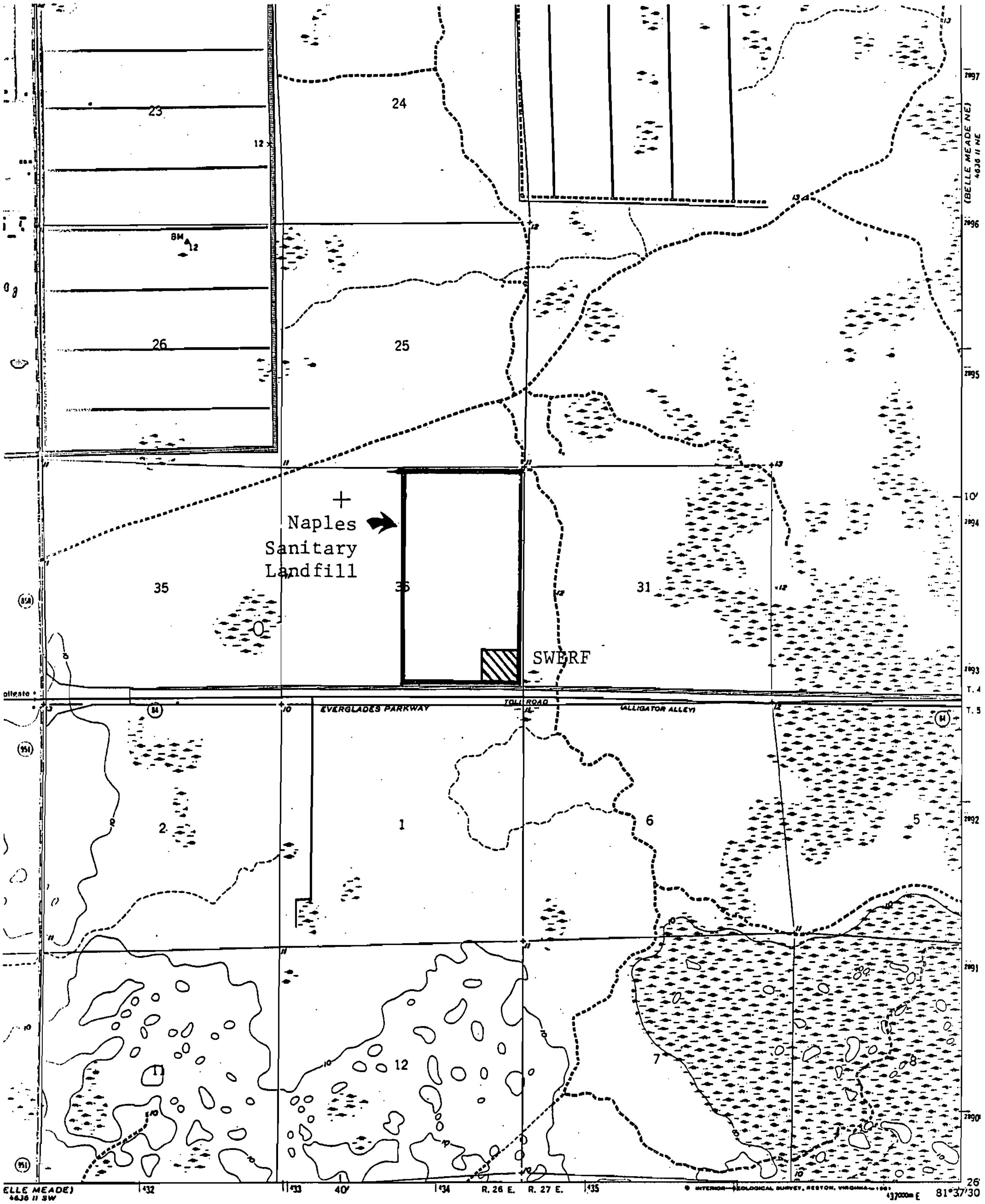
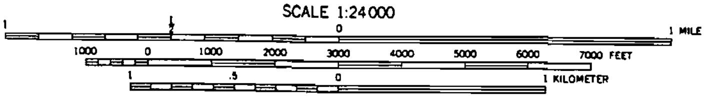


FIGURE 2-1. LOCATION OF PROPOSED COLLIER COUNTY SWERF

Source: U.S. Geological Survey, 1973



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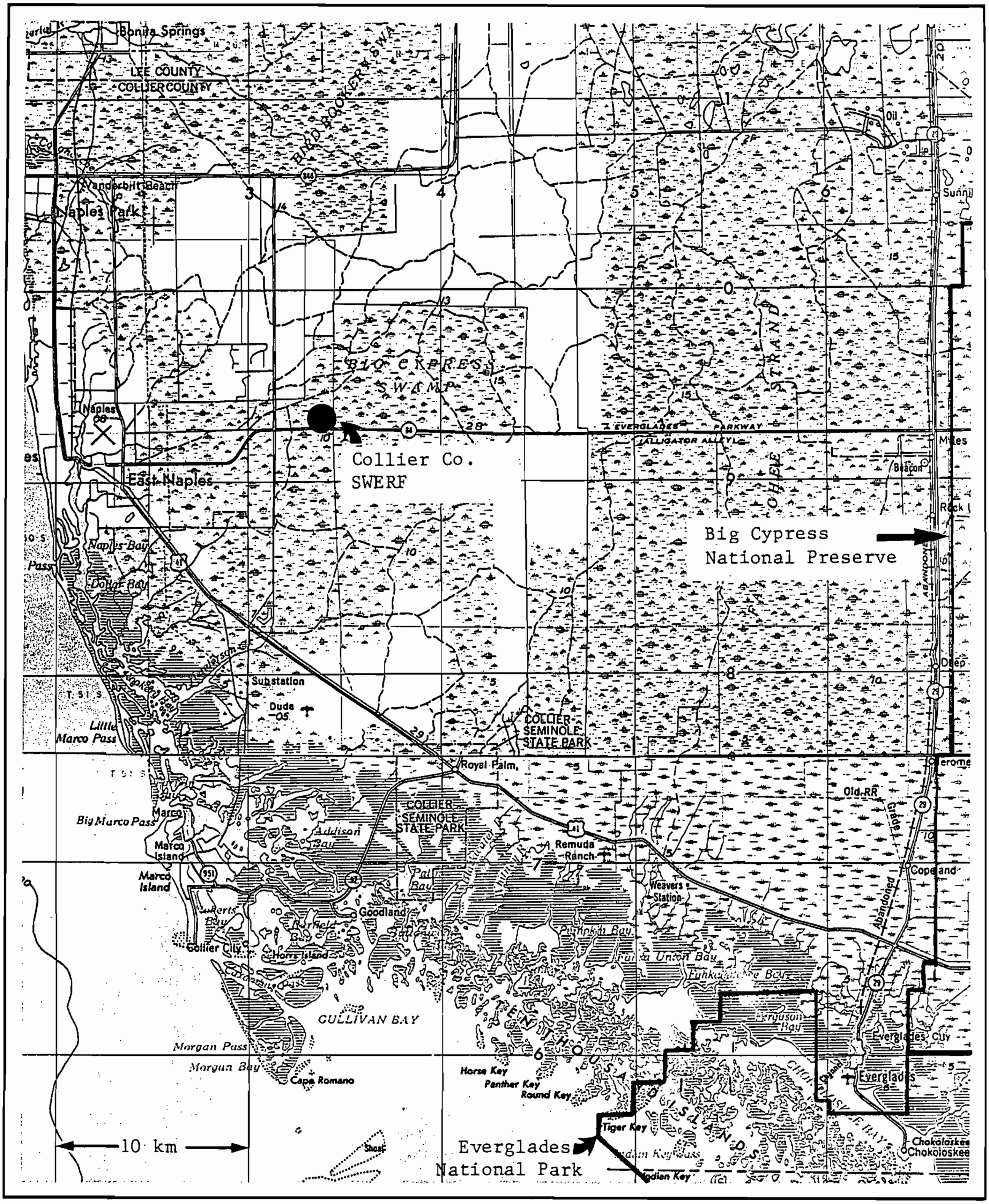

FIGURE 2-2. LOCATION OF EVERGLADES NATIONAL PARK AND BIG CYPRESS NATIONAL PRESERVE

Source: U.S. Geological Survey 1972, 1973

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of the site and the gradual changes over long distances will not affect the transport or dispersion of emissions, the ISC model is applicable for estimating concentrations in the vicinity of the site as well as in the Everglades National Park Class I area and Big Cypress National Preserve.

3.0 METEOROLOGICAL DATA

USEPA (1983, 1984) recommends the use of five (5) years of representative meteorological data for use in air quality modeling. The most recent, readily available 5-year period is preferred. The meteorological data may be collected either onsite or at the nearest National Weather Service (NWS) station.

Meteorological data used in the ISCST and ISCLT will consist of a 5-year record of surface weather observations (1981-1985) from the NWS office located at Page Field in Ft. Myers. The database consists of hourly surface data (i.e., wind speed, wind direction, etc.) which are recorded and then sent to the National Climatic Center (NCC) in Asheville, North Carolina. The NCC digitizes the recorded data onto magnetic tape for sale to the public.

The NWS in Ft. Myers is the nearest weather station which routinely records the hourly surface data required by the air dispersion models. The Ft. Myers NWS office is located approximately 50 km north-northwest of the Collier County SWERF site (see Figure 3-1). Both the SWERF site and the NWS office are located about 15 km inland. Due to the proximity of the Ft. Myers NWS office to the proposed SWERF site, its similar location relative to the Florida west coast, and the use of five years of hourly data, the Ft. Myers meteorological data is considered to be representative of weather conditions occurring at the SWERF site.

The ISCST model also requires mixing height data for the same time period as the hourly surface data. The mixing height data consists of morning and afternoon mixing depths for each day. Mixing height data are developed from upper air soundings, which are performed at a limited number of NWS stations throughout the U.S. In peninsular Florida, the only stations for which upper air data were recorded for the period 1981 through 1985 are Miami, Tampa and West Palm Beach. Tampa, being on the west coast of

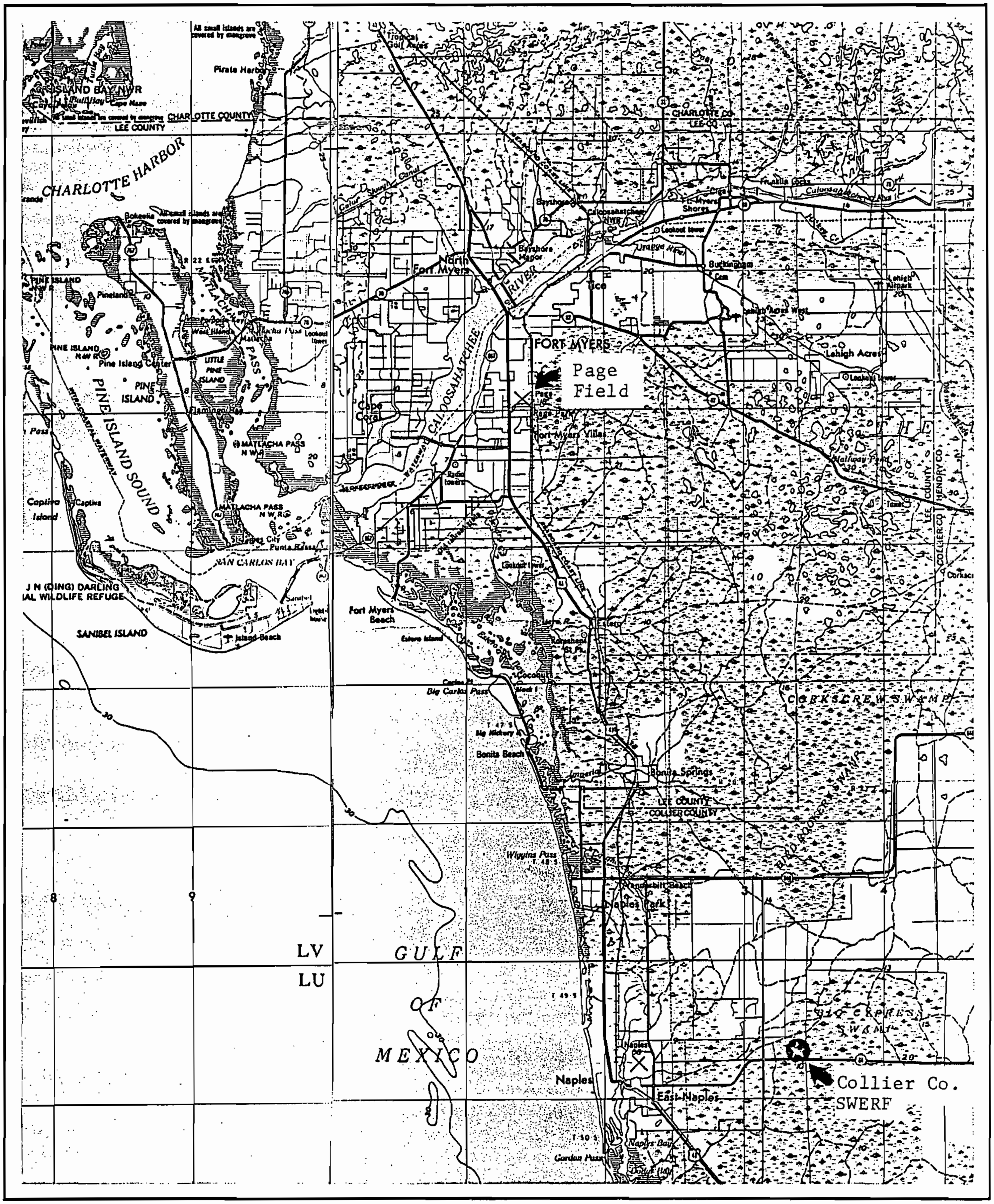

FIGURE 3-1. LOCATION OF PAGE FIELD, FT. MYERS, IN RELATION TO COLLIER COUNTY SWERF SITE

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Florida, is the most representative site and therefore was used in the dispersion modeling analysis. The NCC processed the raw upper air data from Tampa, in conjunction with the surface weather data from Ft. Myers, to produce the Ft. Myers mixing height data.

The hourly surface data and twice daily mixing heights will be input into the USEPA meteorological preprocessor program (RAMMET) in order to produce acceptable data for the ISCST model. The RAMMET preprocessor calculates hourly mixing heights and atmospheric stabilities for use in the model, along with the recorded hourly wind direction, wind speed, and air temperature.

The hourly surface data will also be input into the USEPA "STAR" preprocessor program. The STAR program converts the hourly data into the joint frequency of occurrence of wind direction, wind speed and atmospheric stability. The program can produce monthly, seasonal and annual stability arrays. For the proposed Collier County SWERF, both seasonal (for lead impacts) and annual (for other pollutant impacts) stability arrays will be produced for each year of meteorological data. The ISCLT model will then be executed for each year, and the maximum impact from any year will be used for comparison to air quality standards.

4.0 RECEPTOR LOCATIONS

Receptor locations used in the dispersion modeling analysis will be selected based upon the recommended USEPA procedures (USEPA, 1983). The first step in this procedure is to apply the PTPLU model (USEPA, UNAMAP Version 5) to the SWERF facility to identify the distance to the maximum air quality impact for each of several combinations of atmospheric stability class and wind speed. The smallest distance identified is then chosen as the distance to the first receptor point. Eight more receptor distances are then selected by multiplying the first receptor distance by the following constants: 1.3, 1.7, 2.3, 3.0, 3.9, 5.2, 6.8 and 9.0.

Screening modeling will then be performed using a coarse receptor grid in both the ISCST and ISCLT models. For the ISCST model, a radial grid with the center of the grid coinciding with the location of the proposed facility will be utilized. Radials will be spaced at 10° increments from 10° to 360°. Receptors will be located along each radial outward from the proposed facility, at the distances defined by the PTPLU modeling.

The screening modeling analysis also evaluated a total of 19 discrete receptors. Six (6) of these receptors were located along the northern boundary of the Everglades National Park (Class I area). The remaining 13 receptors were located along the western boundary of the Big Cypress National Preserve (see Figure 4-1). Due to the large distances to these areas, the maximum air quality impact within each area due to the proposed SWERF will occur along the respective borders.

Both the Everglades National Park and Big Cypress Preserve are located approximately 32 km from the SWERF site. A receptor spacing of 10 percent of this distance (i.e., 3.2 km) will be used in the modeling analysis to evaluate the spatial variability of predicted impacts. A listing of the receptor point locations are presented in Table 4-1.

A rectangular grid system centered on the proposed SWERF facility will be used in the long-term ISCLT model, consisting of 10 km-by-10 km square array with 0.5 km separation between grid points. As for the ISCST modeling, receptors will also be placed along the Everglades National Park and Big Cypress Preserve boundaries.

Refined modeling will be performed for short-term averaging times only (ISCST model). The meteorological conditions which produce the highest, second-highest short-term concentrations in the vicinity of the proposed facility will be evaluated using a refined receptor grid. The refined receptor grid will consist of seven (7) receptors located along each of seven (7) radials (see Figure 4-2). One radial will be aligned along the direction of maximum impact, as defined in the screening modeling. The remaining six radials will be placed at 2° increments from the first radial, three on either side of the maximum impact radial. Along each radial, receptor spacing will be 0.1 km, with the receptors centered about the point of maximum impact identified from the screening modeling. Refined modeling will not be performed for the Class I and Big Cypress area receptors because of the large distance to these areas. At such distances,

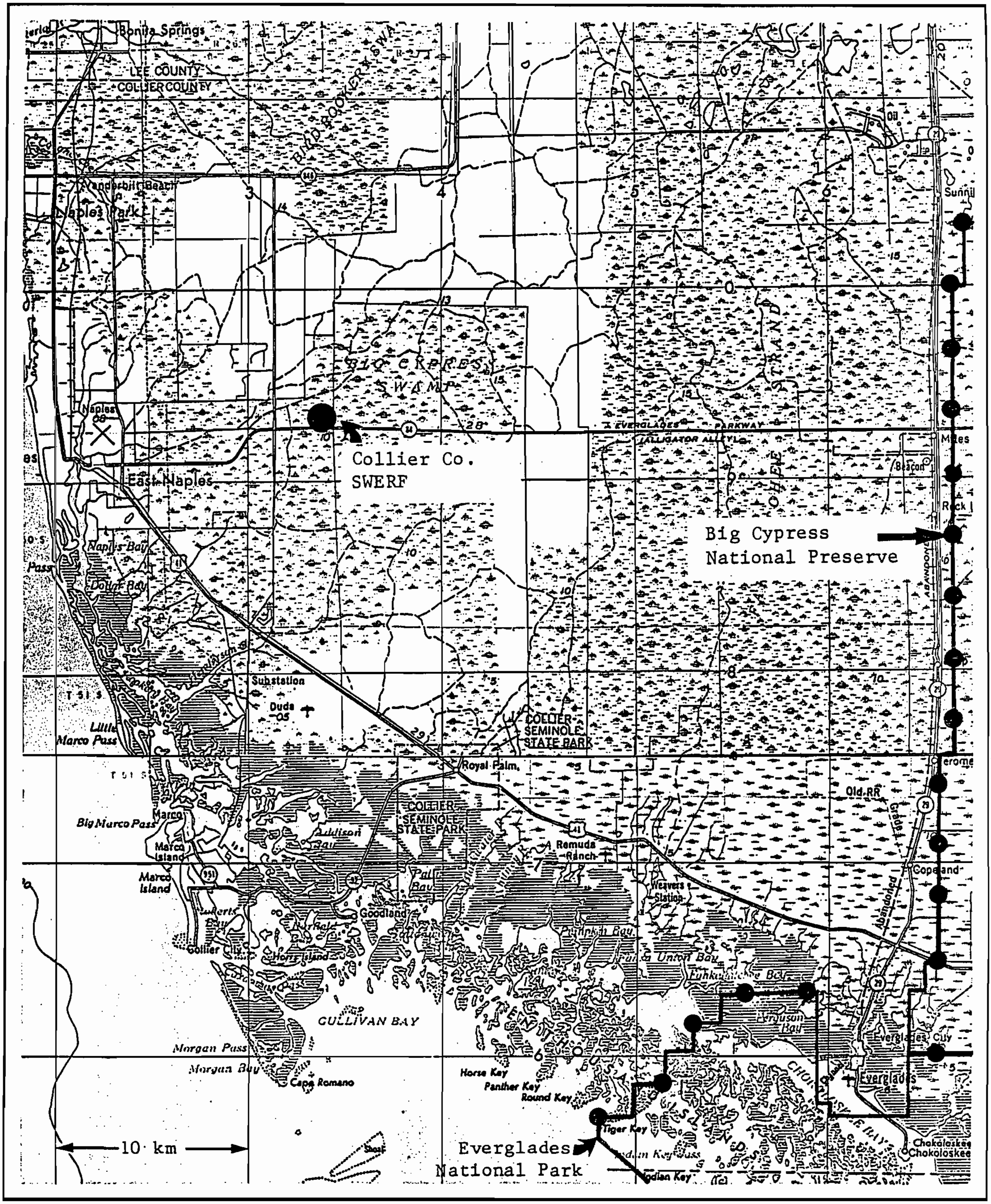

FIGURE 4-1. LOCATION OF RECEPTORS ALONG THE EVERGLADES NATIONAL PARK AND BIG CYPRESS NATIONAL PRESERVE BOUNDARIES

KBN

Table 4-1. Receptor Locations for Everglades National Park and Big Cypress National Preserve

Area	Receptor Location UTM East (km)	 UTM North (km)
Everglades National Park	448.0	2857.0
	451.5	2858.5
	453.0	2862.0
	455.5	2863.0
	459.0	2863.0
	465.5	2860.0
Big Cypress National Preserve	467.0	2903.2
	466.5	2900.0
	466.5	2896.8
	466.5	2893.6
	466.5	2890.4
	466.5	2887.2
	466.5	2884.0
	466.5	2880.8
	466.5	2877.6
	465.8	2874.4
	465.8	2871.2
	465.8	2868.0
	465.8	2864.8

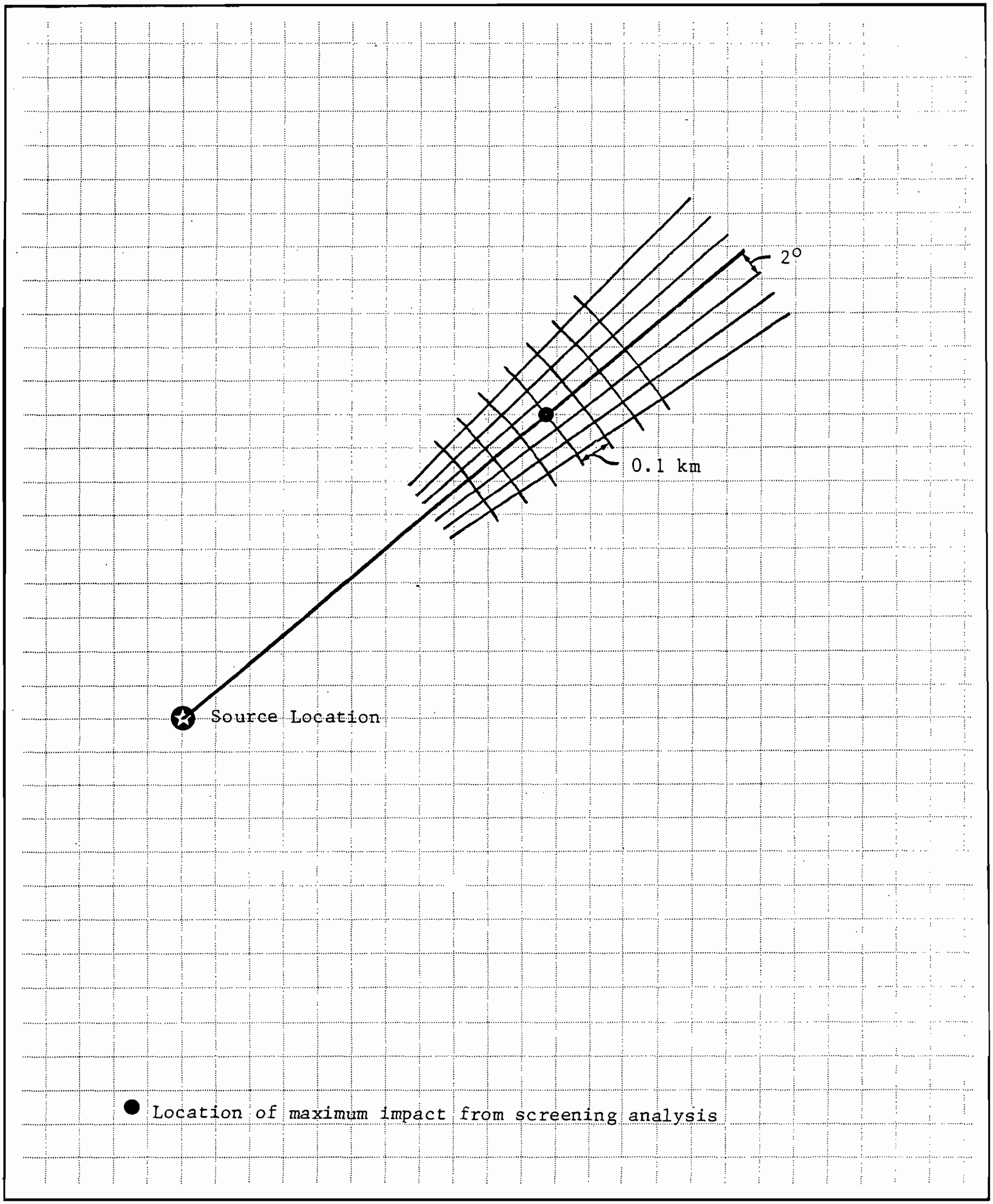

Figure 4-2. Example of Refined Receptor Grid Used in the ISCST Model Analysis

the spatial variability of concentrations is not significant to warrant a more refined grid.

5.0 MODEL OPTIONS

5.1 RURAL/URBAN CLASSIFICATION

According to the regional modeling workshop summary and draft revised modeling guideline, the selection of either the rural or urban dispersion coefficients should be based upon the land use classification procedure developed by Auer (1978) or a population density procedure. The land use method is preferred over the population density method. If the land use within a 3 km radius circle centered on the proposed source is more than 50 percent industrial (I1 or I2), commercial (C1) or compact residential (R2 and R3), then the urban option should be used in the dispersion model. Based upon review of U.S.G.S. maps of the site area and a visual field survey, it is estimated that greater than 75% of the land area within a 3 km radius of the site is undeveloped (A3) or undeveloped rural (A4). The remainder could be considered agricultural rural (A2) (i.e., the Collier County landfill) and estate residential (R4) (i.e., Golden Gate development). As a result, the site is properly classified as rural for dispersion modeling purposes.

5.2 WIND SPEED PROFILE EXPONENTS

Recommended default values for rural wind speed profile exponents will be utilized. The recommended values are:

Stability A - 0.10
Stability B - 0.15
Stability C - 0.20
Stability D - 0.25
Stability E - 0.30
Stability F - 0.30

5.3 VERTICAL POTENTIAL TEMPERATURE GRADIENT

Recommended default values for the vertical potential temperature gradient will be used in the analysis. The default values are:

Stability A - 0.0 °K/m
Stability B - 0.0 °K/m
Stability C - 0.0 °K/m
Stability D - 0.0 °K/m
Stability E - 0.20 °K/m
Stability F - 0.35 °K/m

5.4 PLUME RISE AND BUILDING DOWNWASH

The stack height of the proposed SWERF facility will be equal to Good Engineering Practice stack height and therefore building downwash will not occur. As a result, the building downwash option will not be used in the impact analysis. Since the building downwash option will not be utilized, the final plume rise option will be used in the dispersion models, in conformance with USEPA guidelines.

5.5 DECAY COEFFICIENT AND PARTICLE DEPOSITION

No chemical transformation or pollutant deposition will be accounted for in the modeling analysis (i.e., decay coefficient = 0). Particulate matter emitted from the SWERF facility will be assumed to remain suspended in the atmosphere. This assumption will result in maximum ambient air concentrations.

5.6 STACK TIP DOWNWASH

In accordance with USEPA policy, the stack tip downwash option will not be utilized (i.e., stack tip downwash is not simulated).

6.0 EMISSION INVENTORY

The PSD Workshop manual (USEPA, 1980) sets forth the general guidance on establishing emission inventories for use in the air quality impact analysis. The first step in developing the emission inventories is the establishment of the significant impact area for the proposed facility. The significant impact area should be established for each pollutant and averaging time for which an ambient air quality standard (AAQS) exists. The significant impact area is a circle, centered on the proposed facility, whose radius is equal to the greatest distance at which impacts fall below the "significance level". Significance levels for each pollutant, except lead, are shown in Table 6-1. A significance level has not been established by EPA for lead.

The significant impact area for each pollutant and averaging time associated with the proposed SWERF will be determined with the ISC model, using the same general methodology described previously. The only difference will be the receptor grid employed: a much coarser grid will be employed (e.g., 5 km spacing) in order to define a conservative impact area while efficiently utilizing computer resources.

Emission inventories for point sources located in Collier and Lee Counties are contained in Appendix A. These inventories were developed from Florida Department of Environmental Regulation (FDER) latest APIS listings (Air Pollutant Inventory System). This two county area encompasses more than a 50 km area surrounding the proposed SWERF site. Pertinent information contained in Appendix A includes the distance the source is from the proposed SWERF site, the reported annual emissions of the source, and the identification of PSD increment consuming sources. Many of the sources are insignificant, such as concrete batch plants and pathological incinerators, and are not required to report annual emissions. A source is a PSD increment consuming source if it is a major source and received a construction permit after January 1, 1975, or if it is a minor source and received a construction permit after December 27, 1977 (i.e., PSD baseline date for state of Florida).

Review of the Collier and Lee County emission inventories reveal that there are no existing or permitted point sources within 7.9 km of the proposed SWERF site. There are no point sources of greater than 25 tons per year (TPY) emissions located within 14 km. There are no point sources greater than 100 TPY (i.e., major source) located within 60 km of the site. The only major sources located in either Collier or Lee County is Exxon (158 TPY VOC) located 78 km from the site, and Florida Power & Light's Ft. Myers plant, located 61 km from the site. All of the PSD increment consuming sources (PM and SO_2 emissions only) are minor sources (i.e., less than 100 TPY).

Table 6-1. SIGNIFICANCE LEVELS FOR AIR QUALITY IMPACTS

	Concentration (ug/m^3)				
Pollutant	Annual	24-hour	8-hour	3-hour	1-hour
Sulfur Dioxide	1	5	-	25	-
Particulate Matter	1	5	-	-	-
Nitrogen Dioxide	1	-	-	-	-
Carbon Monoxide	-	-	500	-	2000

Source: USEPA, 1980

Based upon the magnitude and location of existing or permitted point sources in the area, it is proposed to include the affects of other emission sources in the background air quality concentrations (see Section 8.0) in order to estimate total air quality concentrations (i.e., other point sources will not be specifically included in the modeling analysis). Similarly, based upon the minor nature and location of PSD increment consuming sources, these sources will not be included in the PSD increment consumption analysis.

7.0 PRECONSTRUCTION MONITORING REQUIREMENTS

The results of the atmospheric dispersion modeling analysis and existing pollutant levels at the project site will determine the need to conduct preconstruction ambient air quality monitoring for the proposed facility. According to USEPA and state of Florida PSD regulations (40 CFR 52.21(i)(8) and FAC, Chapter 17-2), a proposed source is exempt from preconstruction monitoring for a particular pollutant if:

1. The increase in emissions causes impacts less than de minimis amounts (see Table 7-1), or
2. The existing concentrations in the area that the proposed source would locate are less than the de minimis levels, or
3. There is no established de minimis level for the pollutant (reflective of no acceptable ambient monitoring technique).

If any of these criteria are satisfied for a particular pollutant emitted by the proposed Collier County SWERF, preconstruction monitoring will not be conducted for that pollutant.

The regulated pollutants emitted by the proposed SWERF will include particulate matter (PM), sulfur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOC), carbon monoxide (CO), lead (Pb), fluorides (Fl), beryllium (Be), mercury (Hg), and arsenic (As). A de minimis monitoring level has been established for all these pollutants except As. Therefore, no preconstruction monitoring for As is required.

If the de minimis monitoring level for any of the other pollutants is exceeded due to emissions from the proposed facility, the following approach will be followed to satisfy preconstruction monitoring requirements. This approach follows "Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD)" (USEPA, 1981). The proposed approach assumes that it will be demonstrated in the permit application that the proposed SWERF will have no adverse impact on any PSD Class I area and will not pose a threat to the ambient air quality standards or PSD increments.

Table 7-1. State of Florida PSD De Minimis Impact Levels

Pollutant	De Minimis Air Quality Impact Level (ug/m^3)
Sulfur Dioxide	13, 24-hour
Particulate Matter	10, 24-hour
Nitrogen Oxides	14, annual
Carbon Monoxide	575, 8-hour
Ozone	100 tons/yr*
Lead	0.1, 24-hour
Sulfuric Acid Mist	†
Total Fluorides	0.25, 24-hour
Total Reduced Sulfur	10, 1-hour
Reduced Sulfur Compounds	10, 1-hour
Hydrogen Sulfide	0.04, 1-hour
Asbestos	†
Beryllium	0.0005, 24-hour
Mercury	0.25, 24-hour
Vinyl Chloride	15, 24-hour
Benzene	†
Radionuclides	†
Inorganic Arsenic	†

* Increase in VOC emissions.
† No ambient air measurement method; no monitoring required.

Representative existing ambient monitoring data will be used to satisfy preconstruction monitoring requirements (if applicable). The monitoring guidelines present three criteria to determine if existing monitoring data are "representative". These criteria are: 1) quality of the data, 2) currentness of the data, and 3) monitor location. Data quality requirements consist of the use of continuous monitors (except for PM), 80 percent data recovery, and conformance to procedures in Appendix A or B of 40 CFR, Part 58. Monitoring data are generally considered as "current" if the data were obtained during the 3-year period prior to permit application submittal, provided the data are still representative of current emission conditions.

In terms of monitor location, the existing data should be representative of the maximum impact areas due to existing sources, the proposed source, and the combined effects of existing and proposed sources. However, if no monitoring data is available for such areas, monitors located outside these areas may be used. If the area where the proposed source is to be located is generally free from the impact of other point sources and area sources associated with human activities (i.e., vehicular traffic), then monitoring data from a "regional" site can be used. The site should be similar in nature to the proposed facility location and representative of air quality across the region.

The site of the proposed Collier County SWERF is in a remote area of Collier County, adjacent to the Collier County landfill. As discussed in Section 5.1, the land use within 3 km of the site is predominantly undeveloped or undeveloped rural. The area is generally free from the impact of point sources and significant anthropogenic area sources (see discussion in Section 6.0). Because of the location of the proposed site (i.e., rural remote and absence of significant existing point sources), a "regional" monitor may be used to satisfy preconstruction monitoring requirements.

For the proposed Collier County SWERF, existing monitoring data from a regional monitoring site(s) operated by the FDER, or approved local program, will be used to satisfy preconstruction monitoring requirements (if applicable). These data meet the quality assurance requirements discussed previously. The monitoring data which are proposed to satisfy PSD preconstruction monitoring requirements for each regulated pollutant are discussed below.

PM

Ambient PM measurements are obtained in East Naples at the Fire Department (S.R. 858), located approximately 10 km from the SWERF site. This is the closest PM monitoring station to the proposed site, and would reflect higher PM levels than at the proposed site due to anthropogenic influences (i.e., vehicular traffic and urbanization). Data for the year 1985 are summarized in Table 7-2a. PM concentrations in the vicinity of the site would be expected to be lower than those shown in the table, because of the site´s remote, rural nature.

SO_2

The nearest site for which continuous SO_2 monitoring data is available is Ft. Myers (Ft. Myers Water Treatment Plant). Although approximately 50 km from the proposed facility site, the data from this monitor is considered to overestimate existing SO_2 levels at the proposed facility site. The monitor is located in the urban area of Ft. Myers, which has a greater population than Naples, and is influenced by a large oil-fired power plant (Florida Power & Light Ft. Myers plant). The monitoring site is located approximately 15 km from the power plant. A summary of the continuous SO_2 data from the Ft. Myers site is presented in Table 7-2b.

Nitrogen Oxides

There exists limited continuous NO_2 data for the state of Florida, with only 12 continuous monitors located throughout the state. The nearest such monitors to the proposed site are located in Hillsborough County. The monitor exhibiting the lowest concentrations is proposed for use as the PSD "regional" monitor for the proposed Collier County SWERF. Because both monitors are influenced significantly by the Tampa urban area (i.e., vehicular traffic, etc.), the monitor reflecting the lowest concentrations should provide an overestimate of the levels existing at the proposed

Table 7-2a. Summary of Ambient PM Data, 1985, Naples, Florida (Site 2880-003)

		Measured Concentrations (ug/m^3)			
				24-Hour Average	
Number of Obs.	Data Recovery	Arithmetic Mean	Geometric Mean	Highest	Second-Highest
60	98%	33	31	57	57

Table 7-2b. Summary of Continuous SO_2 Data, 1985, Ft. Myers, Florida (Site 1300-005).

				Measured Concentrations (ug/m^3)				
UTM Location					24-Hour Average		3-Hour Average	
East (km)	North (km)	Number of Obs.	Data Recovery	Arithmetic Mean	Highest	Second-Highest	Highest	Second-Highest
412.5	2942.6	7453	85%	4	37	26	132	90

Table 7-2c. Summary of Continuous NO_2 Data, 1985, Tampa, Florida (Site 4360-055).

		Measured Concentrations (ug/m^3)		
			1-hour Average	
Number of Obs.	Data Recovery	Arithmetic Mean	Highest	Second-Highest
8141	93%	28	143	139

Table 7-2d. Summary of Continuous Ozone Data, 1985, Ft. Myers, Florida (Site 1300-005).

		Measured Concentrations - ug/m^3 (ppm)	
		1-Hour Average	
Number of Obs.	Data Recovery	Highest	Second-Highest
6726	77%	157 (0.080)	145 (0.074)

Table 7-2e. Summary of Pb Data, 1985, Dade County, Florida (Site 0860-021).

Number of Observations By Quarter				Data	Quarterly Arithmetic Average (ug/m^3)			
Jan/Mar	Apr/Jun	July/Sep	Oct/Dec	Recovery	Jan/Mar	Apr/Jun	Jul/Sep	Oct/Dec
15	16	13	14	95%	0.0	0.1	0.1	0.0

Source: FDER, 1985

facility site. A summary of the NO_2 data for the selected monitor is presented in Table 7-2c.

Ozone

The nearest ozone monitor to the proposed facility site is located in Ft. Myers at the Water Treatment Plant. Ozone is produced in the atmosphere due to both anthropogenic and natural sources. Urban areas exhibit higher ozone levels than rural areas due to anthropogenic emissions of NO_x and VOC. Ft. Myers, being a larger urban area than Naples, is expected to exhibit higher ozone levels than Naples and the proposed facility site area. As a result, the monitor is considered to be a representative regional monitoring site. Ozone data from this site for 1985 are presented in Table 7-2d.

Pb

There presently are no ambient lead monitors in the vicinity of the proposed site. Several monitors are located in Dade County, and one of these sites was used to represent a regional monitor. The selected site was Thompson Park (0860-021), which is located along the western urban fringe of Miami and the eastern fringe of the everglades. This site would display some influences from the Miami urbanized area (vehicular related) and therefore should provide an overestimate of existing Pb levels at the Collier County SWERF site. Pertinent data from this site for 1985 are presented in Table 7-2e.

CO, Fl, Be, Hg

No representative air monitoring data is available for these pollutants. Due to the remote, rural nature of the proposed site area, it is expected that existing levels of these pollutants will be less than the de minimis monitoring levels. There are no known sources of Fl, Be or Hg emissions in the county. Therefore, preconstruction monitoring for these pollutants is not required.

8.0 BACKGROUND CONCENTRATIONS

Background concentrations will be estimated for each regulated pollutant and for applicable averaging times. The background concentrations will be representative of natural, unidentified sources which impact the proposed SWERF site area, as well as point sources not explicitly included in the modeling analysis. According to USEPA guidelines (USEPA, 1984), air quality data should be used to establish background concentrations. As in the case of PSD preconstruction monitoring, a "regional" monitor may be used to determine the background concentration for a particular pollutant if no monitors are located in the vicinity of the source. As discussed in Section 7.0, there are presently no existing monitors in the vicinity of the SWERF site. Therefore, the regional monitors described in Section 7.0 will be used as the basis for estimating background air quality concentrations.

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APPENDIX A

COLLIER AND LEE COUNTY

POINT SOURCE EMISSION INVENTORIES

COLLIER COUNTY EMISSION INVENTORY

PLANT ID	POINT ID	SOURCE NAME	SOURCE TYPE	UTM COORDINATES		DISTANCE TO SWERF SITE (KM)	PSD SOURCE*	ANNUAL EMISSIONS (TONS/YEAR)				
				EAST (KM)	NORTH (KM)			PM	CO	SO2	NOX	VOC
2	1	BETTER ROADS	ASPHALT PLANT	422.0	2899.4	14.0	X	8	31	10**	31	2
3	1	KREHLING INDUSTRIES	CONCRETE BATCHING PLANT	-	-			-	-	-	-	-
6	1	NAPLES HUMANE SOCIETY	PATHOLOGICAL INCINERATOR	423.2	2893.0	11.3		-	-	-	-	-
12	1	COLLIER CO. CONCRETE	CONCRETE BATCHING PLANT	422.6	2893.0	11.9	X	-	-	-	-	-
14	1	CEMENT PRODUCTS CO	CONCRETE BATCHING PLANT	422.2	2890.0	12.7		4	-	-	-	-
15	1	BRISSON ENTERPRISES	ASPHALT PLANT	424.0	2893.1	10.5	X	2	1	6**	2	-
16	1	NAPLES CREMATORIUM	PATHOLOGICAL INCINERATOR	422.3	2900.1	14.1		-	-	-	-	-
18	1	NAPLES READY MIX	CONCRETE BATCHING PLANT	421.3	2892.1	13.2		-	-	-	-	-
19	1	DELTONA CORP.***	PORTABLE ASPHALT PLANT	443.2	2875.8	19.3		14	5	3	66	3
23	1	MACASPHALT	ASPHALT PLANT	429.2	2898.8	7.9		10	13	25**	6	3
31	1	EXXON	SMOKELESS FLARE	509.6	2873.2	77.7	X	-	-	-	-	-
31	2		STORAGE TANKS				X	-	-	-	-	158
31	3		HEATER TREATERS				X	1	1	-	2	1
31	4		GAS ENGINE PUMPING UNITS				X	-	1	-	11	3
31	5		OIL LOADING PUMPS				X	-	1	-	2	1
31	6		DISPOSAL PUMPS				X	-	1	-	2	1
31	7		CIRCULATING PUMPS				X	-	1	-	1	1
31	8		OIL PIPELINE PUMP				X	-	1	-	11	3
31	9		ELECTRIC GENERATOR				X	-	1	-	4	1
31	10		TRUCK OIL LOADING				X	-	-	-	-	20
34	1	GENERAL ASPHALT CO.	ASPHALT PLANT	467.1	2905.6	35.0	X	4	-	82	-	-

SOURCE: FDER APIS, 1985

* FOR MAJOR SOURCE: CONSTRUCTION PERMIT ISSUED AFTER JAN. 1, 1975
FOR MINOR SOURCE: CONSTRUCTION PERMIT ISSUED AFTER DEC. 27, 1977

** BASED UPON ANNUAL OPERATING REPORT

*** NOT CURRENTLY OPERATING

LEE COUNTY EMISSION INVENTORY

PLANT ID	POINT ID	SOURCE NAME	SOURCE TYPE	UTM COORDINATES EAST (KM)	UTM COORDINATES NORTH (KM)	DISTANCE TO SWERF SITE (KM)	PSD SOURCE*	ANNUAL EMISSIONS (TONS/YEAR) PM	CO	SO2	NOX	VOC
1	1	CEMENT INDUSTRIES	CONCRETE BLOCK PLANT	414.9	2943.6	54.3		-	-	-	-	-
1	2		CONCRETE BATCHING PLANT					-	-	-	-	-
2	1	FLORIDA POWER & LIGHT	UNIT #1 150 MW OIL-FIRED	422.2	2953.0	61.2		607	209	6687	2802	-
2	2		UNIT #2 402 MW OIL-FIRED					1572	541	19306	7251	-
2	3		PEAKING UNITS					-	315	860	1377	-
3	1	HARPER BROS.	ASPHALT BATCH PLANT	400.3	2947.0	63.9		17	-	9	4	-
4	1	GULF PAVING CO.	ASPHALT BATCH PLANT	415.2	2944.1	54.6		7	-	9	4	-
4	2		CONCRETE BATCH PLANT					-	-	-	-	-
5	1	HARPER BROS.	ASPHALT BATCH PLANT	413.6	2934.1	46.1		10	-	16	7	-
5	2		CONCRETE BATCH PLANT					-	-	-	-	-
5	3		ASPHALT BATCH PLANT					10	2	4	2	-
6	1	LEE CO. CONCRETE	CONCRETE BATCH PLANT	415.6	2944.9	55.2		-	-	-	-	-
7	1	MUNTERS CORP.	ASBESTOS CUTTING OPERATION	414.8	2939.9	50.9		-	-	-	-	-
7	3		BIUILDING #4					-	-	-	-	-
7	4		CELLULOSE SAW ROOM					2	-	-	-	-
9	1	GULF COAST CENTER	BOILER #1	448.5	2949.5	58.2		-	-	7	<1	-
9	2		BOILER #2					-	-	7	<1	-
9	3		BOILER #3					-	-	12	1	-
9	4		BOILER #4					-	-	12	1	-
10	1	WARREN BROS. CO.	ASPHALT BATCH PLANT	412.4	2933.7	46.3		26	-	2	1	-
13	1	BELCHER OIL CO.	PACKAGE BOILER	374.8	2955.9	86.7		2	-	58	22	-
14	1	LEE CO. CONCRETE	CONCRETE BATCHING PLANT	416.8	2932.0	42.8		-	-	-	-	-
14	2		CONCRETE BLOCK PLANT					-	-	-	-	-
15	1	WEST COAST IND	CONCRETE BLOCK PLANT	415.0	2934.0	45.4		-	-	-	-	-
16	1	LEE CO. HUMANE SOCIETY	PATHOLOGICAL INCINERATOR	417.8	2946.7	56.2		-	-	-	-	-
17	1	LEE MEMORIAL HOSPITAL	PATHOLOGICAL INCINERATOR	412.9	2945.1	56.4		-	-	-	-	-
18	1	LEHIGH ACRES GEN HOSP.	PATHOLOGICAL INCINERATOR	444.2	2943.8	51.7		-	-	-	-	-
21	1	FT MYERS COMM HOSPITAL	PATHOLOGICAL INCINERATOR	414.9	2942.8	53.6		-	-	-	-	-
24	1	J SHANNON SUPPLY	CONCRETE BATCHING PLANT	421.4	2911.4	22.6		-	-	-	-	-
24	2		CONCRETE BLOCK PLANT					-	-	-	-	-
25	1	TOLLES READYMIX	CONCRETE BATCHING PLANT	407.4	2949.3	62.5		-	-	-	-	-
28	1	CEMENT PRODUCTS CORP.	CONCRETE BATCHING	414.4	2946.7	57.3		-	-	-	-	-
32	1	LEE CO. CREMATORIUM	PATHOLOGICAL INCINERATOR	412.1	2941.8	53.7		-	-	-	-	-
39	1	PRODUCERS FERTILIZER	HANDLING FACILITY	414.2	2944.4	55.3		-	-	-	-	-
43	1	LEE CO. ANIMAL CONTROL	PATHOLOGICAL INCINERATOR	419.8	2950.0	58.9		-	-	-	-	-
47	1	CAPE CORAL HOSPITAL	PATHOLOGICAL INCINERATOR	406.2	2946.7	60.7	X	-	-	-	-	-
49	1	FT MYERS VAULT SER	CONCRETE BATCHING OPERATION	414.5	2938.3	49.5		-	-	-	-	-
53	1	PAGE READYMIX SUPPLY	CONCRETE BATCH PLANT	415.6	2931.0	42.4	X	-	-	-	-	-
54	1	WEST COAST IND	CONCRETE BATCHING PLANT	412.5	2920.0	34.8		-	-	-	-	-
65	1	MACASPHALT	ASPHALT PLANT	424.3	2930.2	38.6	X	5	-	9	-	-

SOURCE: FDER APIS, 1985

* FOR MAJOR SOURCE: CONSTRUCTION PERMIT ISSUED AFTER JAN. 1, 1975
FOR MINOR SOURCE: CONSTRUCTION PERMIT ISSUED AFTER DEC. 27, 1977

APPENDIX V

PUBLIC HEALTH IMPACTS

APPENDIX V

PUBLIC HEALTH IMPACTS OF TRACE-METAL AND TRACE-ORGANIC POLLUTANT EMISSIONS

There are a number of trace-metal and trace-organic pollutants emitted from waste-to-energy facilities for which the potential health impacts are at present the subject of considerable public interest nationally. The trace metals of particular concern are the EPA noncriteria pollutants: beryllium (Be) and mercury (Hg), as well as the non-regulated trace metals: arsenic (As), cadmium (Cd), hexavalent chromium (Cr), and nickel (Ni). Regarding trace-organic pollutants, clearly, the pollutants of primary public concern are dioxins (PCDD) and furans (PCDF).

EPA has not promulgated ambient air quality standards for these trace-metal and trace-organic pollutants, nor has the state of Florida established ambient standards on a state level. A number of eastern states, notably New York, Pennsylvania, and Massachusetts, however have been active in developing Acceptable Ambient Levels (AALs) for toxic substances, including these trace pollutants. The AALs developed by these states are based on established occupational-health standards, but with a sizeable safety factor added to ensure protection of all segments of the general public. The AALs, therefore, are designed to protect public health with a margin of safety.

To assess the potential impacts on public health due to trace-pollutant emissions from the Collier County Plant, the plant impacts for the trace pollutants of greatest concern have been compared with the AALs established by Pennsylvania, New York, and Massachusetts. Plant impacts, based on the maximum emission rates given previously in Appendix III, TABLE 1-1, are compared in Table 1 with the AALs. Without exception, the impacts for trace metals are shown to be well within the AAL limits set by all three states to protect public health. Specifically, the trace-metal impacts are one to four orders of magnitude less than the AAL limits.

The impact of total mass emissions of dioxins (PCDD) plus furans (PCDF) is compared in Table 1 with the Massachusetts AAL for total dioxins/furans of 2.2×10^{-6} µg/m^3. The maximum plant impact of 1.9×10^{-7} µg/m^3

TABLE 1
AIR QUALITY IMPACTS OF TRACE-METAL AND TRACE-ORGANIC POLLUTANTS

Pollutant	Averaging Period	Plant Maximum Impact $(\mu g/m^3)$	State Ambient Acceptable Levels(1)		
			Pennsylvania $(\mu g/m^3)$	Massachusetts $(\mu g/m^3)$	New York $(\mu g/m^3)$
Noncriteria Pollutants					
Beryllium (Be)	Annual	7.2×10^{-7}	.01	--	--
	24-hour	9.3×10^{-6}	--	.007	.01(2)
Mercury (Hg)	Annual	3.2×10^{-4}	.24	--	.17
Non-Regulated Pollutants					
Arsenic (As)	Annual	5.2×10^{-6}	.024	--	.67
Cadmium (Cd)	Annual	5.4×10^{-5}	.12	.05	2.0
Hexavalent Cromium (Cr)	Annual	2.6×10^{-5}	.12	--	.17
	24-hour	3.3×10^{-4}	--	.001	--
Nickel (Ni)	Annual	1.3×10^{-5}	.24	--	3.3
	24-hour	1.8×10^{-4}	--	.02	--
Dioxins/Furans:					
PCDD+PCDF	Annual	1.9×10^{-7}	--	2.2×10^{-6}(3)	--
TCDD	Annual	8.1×10^{-9}	3.5×10^{-5}	--	--
2,3,7,8 TCDD Toxic Equivalents(4)	Annual	3.8×10^{-9}	--	--	--

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(1) Ambient Acceptable Levels (AAls) set by New York Department of Environmental Conservation (DEC) for annual-average impacts of toxic substances; AALs set by Massachusetts Department of Environmental Quality Engineering (DEQE) for 24-hour impacts of toxic substances, except an annual AAL is set for dioxins/furans; and Ambient Air Quality Guideline (AAQG) levels adopted by Pennsylvania Department of Environmental Regulation for annual impacts of toxic substances.

(2) AAL for 1-month average impact

(3) AAL applies to total mass emissions of dioxins and furans combined, i.e., PCDD plus PCDF, assumed to be emitted in an all-gaseous form.

(4) Total dioxin and furan impacts expressed as 2,3,7,8 TCDD toxic equivalents, calculated by the Eadon (New York State Dept. of Health) Method.

is a full order of magnitude less than the Massachusetts AAL. This is particularly significant as the Massachusetts dioxin/furan AAL is the strictest of any state in the nation, and is stricter than the national standards set by any other country.

The impact of plant emissions of the "tetra" homologue (TCDD) of dioxin has also been compared with the AAL adopted by Pennsylvania for TCDD of 3.5 x $10^{-5}\mu g/m^3$. The TCDD impact of 8.1 x $10^{-9}\mu g/m^3$ is four orders of magnitude less than the Pennsylvania AAL.

Besides the estimate on a mass basis of the maximum plant impact due to emissions of all dioxins (PCDD) and all furans (PCDF) a second estimate is provided in Table 1, expressed in terms of toxic equivalency to the most toxic isomer in the dioxin "family," 2,3,7,8 TCDD. The toxic-equivalents impact of 3.8 x $10^{-9}\mu g/m^3$ was calculated by Gotaverken using the Eadon (New York State Department of Health) Method. For this impact, an estimate has been made of the carcinogenic risk associated with air inhalation. The risk assessment was carried out using the procedures developed by the EPA Carcinogen Assessment Group (CAG). The calculated estimate of cancer risk associated with this impact is very conservative as it assumes that the population is exposed to the maximum plant impact for 24 hours per day, 365 days per year, during a 70-year lifetime. The following standard assumptions were also made in the risk calculation:

- Average breathing rate is 20 m^3/day
- Average body weight is 70 kg
- 100% of inhaled dioxins/furans are retained by the body and are then 100% bioavailable
- The "potency slope" for 2,3,7,8 TCDD is the current EPA value of 1.54 x 10^5 (mg/kg-day)-1

The calculated(1) risk for Plant dioxin/furan impacts is 0.2 cancer cases per million population exposed for a lifetime. This level of risk is at the low end of the risk range which has been deemed by EPA to be acceptable risk--1 to 10 cases per million exposed.

In summary, the comparisons of plant impacts of trace-metals and dioxins/furans with state Ambient Acceptable Levels (AALs) shows that plant impacts are, without exception, less than the AALs. In fact, plant impacts are 10 to 10,000 times <u>less</u> than the AAL values. Further, an assessment of carcinogenic risk associated with plant dioxin/furan emissions demonstrates the risk to be insignificant, i.e., two cases per <u>10</u> million people exposed for a lifetime. These analyses clearly show that plant impacts of trace-metals and dioxins/furans will pose no significant threat to public health.

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(1) Risk $= [3.8 * 10^{-9}\ \mu g/m^3 * 20 m^3/day * 1.54 * 10^5\ (mg/kg\text{-}day)^{-1} * 10^{-3}\ mg/\mu g]/70\ kg$

$= 0.2 \times 10^{-6}$, or 0.2 cases per million exposed.

APPENDIX VI

BEST AVAILABLE CONTROL TECHNOLOGY (BACT) ANALYSIS

TABLE OF CONTENTS

1.0 INTRODUCTION

The purpose of this analysis is to demonstrate the rationale for selecting control technologies for the pollutants regulated by EPA and DER, as well as a number of other pollutants (certain acid gases, trace metals, and trace organic compounds) emitted from waste-to-energy facilities. This analysis will also satisfy the formal requirement under PSD regulations for an assessment of Best Available Control Technology (BACT) for each of the EPA/DER-regulated pollutants emitted in quantities exceeding EPA-defined significant emissions levels. For the Collier County Plant, the pollutants requiring a formal BACT analysis include particulate matter, CO, NO_X, SO_2, Pb, Be, and Hg.

The control technology alternatives have been evaluated based on environmental and economic concerns, as well as current industry practice and engineering reliability. For each regulated pollutant, the Plant will utilize the best control technology available for the circulating fluidized bed (CFB) incineration technology, giving both the lowest emissions for the alternatives evaluated and a high degree of reliability. In the sections that follow, the control alternatives for each pollutant are identified; the alternatives are evaluated; and the rationale for the selected control technology is presented.

2.0 PARTICULATE MATTER

The particulate control technology proposed as BACT for the Plant, fabric filtration (baghouses), will limit total Plant particulate emissions to a maximum of 48 tons/yr. To achieve this, the boiler baghouses will be designed to achieve a maximum outlet concentration of 0.015 gr/dscf corrected to 12% CO_2. This latter concentration equals an emission rate from the two boiler units of 47 TPY of particulate matter for 100 percent RDF firing and for firing a mixture of 45% RDF/13% Tires/42% wood chips, and an emission rate of 45 TPY for a mixture of 70% RDF/30% tires. As will be detailed below, process dust from the Plant will be controlled to a total of less than 1 TPY. For process dust from MSW tipping/storage; RDF processing; and RDF/wood-chip/tires storage, control will be achieved with baghouses and subsequent thermal reduction of the baghouse discharge. Likewise, baghouses with subsequent thermal reduction of the discharge, will control dust generated by materials (sand, limestone) handling and storage. Finally, baghouses will be utilized to control process dust generated by the ash handling silo. With maximum boiler emissions of 47 TPY, and maximum process dust emissions of 1 TPY, total plant emissions will be controlled to a maximum of 48 TPY.

2.1 Alternative Control Technologies

Particulate matter control technologies most frequently proposed for waste-to-energy facilities include fabric filtration (baghouse) and electrostatic precipitation (ESP). Fabric filters consist of multiple modular units, each containing numerous tubular filter bags, typically woven from fiberglass for MSW incinerator applications. As a fabric filter operates, a thick porous cake of collected particulate matter builds on the bag surface. It is the cake that efficiently filters the particulates from the gas stream, principally by the mechanisms of inertial impaction, interception, and diffusion. The cake is periodically removed from the fabric bags by reverse-air-flow or pulsed-air-jet techniques.

ESPs work on the principle of electrostatic attraction. As the combustion gas enters an ESP, it is subjected to a high voltage field which imparts an electric charge to the particulate matter in the gas stream. The charged particulate matter is then removed by collection on plates of opposite polarity. Rappers are operated periodically to remove the dust from the collector plates into hoppers for subsequent disposal.

ESPs are the most commonly utilized particulate control technology at MSW incineration facilities in the United States and Europe. They have demonstrated both very good particulate removal efficiency and high reliability in numerous installations, and are capable of routinely achieving outlet particulate concentrations of 0.02 to 0.03 gr/dscf corrected to 12 percent CO_2.

Disadvantages of ESPs include reduced collection efficiency for the small, respirable-size particles (< 2 microns) that are of concern for public health; sensitivity of overall collection efficiency to variations in waste and flue gas composition; and the potential for corrosion from acid gases.

The primary advantage of a baghouse is its superior particle-removal efficiency compared with standard ESP devices. Of particular note is that baghouses are unsurpassed at removal of respirable sized (< 2 micron) particles, the size of greatest concern for public health. Because baghouses are physical filtration devices, control efficiency is less sensitive to process variation (i.e. such factors as inlet particulate loading, particle size distribution, variability in the waste composition, variability in flue gas flow, and particle resistivity) than with an ESP.

The disadvantages of baghouses include moisture-induced clogging or "blinding" of the fabric filter, susceptibility to fires, and uncertain bag life. The most important disadvantage of a baghouse, however, is that long-term experience with baghouses at waste-to-energy facilities is limited. In the United States, extended experience with a baghouse is limited to the Framingham, Massachusetts municipal waste incinerator, for which the baghouse outlet loading is reported to be 0.02 gr/dscf (CARB, 1984)*.

Despite the limited operating experience with baghouses at waste-to-energy facilities, they are being proposed for many planned facilities (e.g. Brooklyn, NY, San Francisco, CA, Erie, PA, and Holyoke, MA) and are specified for many facilities under construction (e.g. Rochester, MA, Dutchess County, NY, and the Mid-Connecticut Facility). In fact, certain states--notably California and Connecticut, now require baghouses, appearing not to make a distinction between BACT and LAER (Lowest Achievable Emissions Rate). Past testing of baghouses at MSW incinerators operating in Framingham, MA and Malmo, Sweden indicated baghouse outlet loadings of 0.02 gr/dscf. Testing of baghouses on slip-streams at facilities in Saugus, MA and

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* California Air Resources Board (CARB), Air Pollution Control at Resource Recovery Facilities, p. 168, May 1984.

Nashville, TN, as well as recent testing at a full-scale facility in Tsushima, Japan, have demonstrated that baghouse-equipped waste-to-energy facilities may achieve emission levels as low as 0.01 gr/dscf for total particulate and 0.008 gr/dscf for respirable (<2 micron) particulates*. However, the test data and limited operational experience is not sufficient to demonstrate that such levels can be achieved on a continuous basis over the operating life of the plant.

2.2 Selected Particulate Control Technology

2.2.1 Incineration

Fabric filtration has been selected as BACT for control of particulate matter emitted from the Collier County Plant combustion units. The design outlet maximum loading is 0.015 gr/dscf corrected to 12 percent CO_2 for each unit's baghouse. This maximum grain loading is considered to be the lowest level achievable on a continuous basis over all potential operating conditions. Under typical operating conditions, the actual outlet grain loading is expected to be less than 0.015 gr/dscf, corrected to 12 percent CO_2. Fabric filtration has been selected because of its advantages over ESPs in attaining very low outlet particulate loading, high collection efficiency, superior control of fine particulate, and relative insensitivity to variations in waste composition; the technology inlet flue gas conditions; and particulate physical, chemical and electrical properties. Filter bags will be cleaned of built-up dust cake by the pulsed-air-jet technique.

2.2.2 Process Dust

Dust from the waste receiving (tipping) and storage area will be contained by the slightly negative pressure in the enclosed structure in which these operations take place. Dust build-up will be precluded by regular sweeping and washing of the tipping floor. Small quantities of dust generated during waste tipping and storage operations will be aspirated into the RDF process area for control there, as described below.

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* California Air Resources Board, Air Pollution Control at Resource Recovery Facilities, p. 168, May 1986.

Dust generated during the RDF processing and RDF/wood-chip storage will be controlled by a succession of containment, fabric filters, and thermal reduction to an emission rate of 0.1 TPY. Dust control in the RDF process begins in the tipping floor where a hood aspirates any dust produced when the MSW is placed upon the apron conveyor which feeds the primary shredder. Transfer points in the process are enclosed with the inlet and outlet sealed with rubber flaps. Aspiration points on the apron conveyor, primary shredder, magnetic disc screen enclosure, and the flexowall conveyer to RDF storage are ducted to a baghouse. Also controlled by this baghouse will be dust from the area that houses both RDF and wood-chip storage. Aspiration from the stoner, air knife and classifier are ducted to a separate baghouse. Each baghouse discharge will have a dust loading of 0.01 gr/dscf. If the process were to run 365 days per year, 24 hours per day this would provide a discharge of 18.7 TPY of particulate. (The RDF process will normally operate 5 days per week, 16 hours per day). The discharge from the RDF area baghouse is ducted to the boilers, where it is used as part of the combustion air. After combustion, the 18.7 TPY of particulate matter is reduced to approximately 0.1 TPY.

Approximately seven days per year, both boilers will be shut down for annual maintenance. During that time, waste will be processed until the RDF storage has reached capacity. This filling period may last from one hour (in the case of an already full storage building), up to two and one half days at 16 hrs/day (in the case of an empty storage building). During this period, when the boilers are out of operation, dust produced in the RDF processing area will continue to be controlled by the RDF-area fabric filter, but would not be further reduced in mass by incineration. Fabric filter outlet emissions would, however, continue to be vented through the incinerator stack. It has been demonstrated in Appendix III, Section 2.0 that the particulate emission rate under this scenario (one or two boilers down) would be less than that under normal Plant operations.

For control of dust from the sand silo and the two limestone silos, each silo will be equipped with a fabric filter which has an efficiency of 99.5%. These filters will be used during silo "filling". The discharge of these filters will then be ducted into the combustion air flow to the boilers for thermal reduction so that no dust is emitted by the filling operation. It is conservatively estimated that no more than .02 tons/year of sand/limestone particulate will be liberated as trucks hook-up to transfer material into the silos.

The ash handling silo will hold both bottom ask and fly ash which is pneumatically transported from the boiler house. The transport air will be passed through a 99.5% efficient fabric filter and then be ducted to the flue gas ducts before the boiler baghouses. Thus, no quantifiable amount of particulate will be liberated from this part of the ash handling process. However, a small amount of particulate will be liberated when trucks remove wetted-ash from the ash silo. This amount of particulate is conservatively estimated to be 0.4 TPY.

3.0 SULFUR DIOXIDE AND HCl

Although Florida DER currently places no specific limitation on emissions of SO_2 and HCl from waste-to-energy facilities, a rapidly growing number of states have formally determined that scrubbing technology represents BACT for control of SO_2 and HCl emission. The Collier County Plant will employ acid-gas scrubbing technology designed to limit HCl and SO_2 emissions to 50 ppmv and 100 ppmv, respectively. Gotaverken will guarantee HCl emissions to be restricted to 50 ppm (by volume, corrected to 12 percent CO_2, dry basis) or less, or be reduced by 90 percent by weight within the combustion process, whichever is least restrictive. Likewise, SO_2 emissions will be restricted to 100 ppm (by volume, corrected to 12 percent CO_2, dry basis) or less, or be reduced by 70 percent by weight within the combustion process, whichever is least restrictive. These guarantees reflect the performance levels commonly being required by those states that have deemed scrubbing technology to be BACT for acid-gas control. The Collier County Plant will provide state-of-the-art control of acid-gas emissions.

The acid-gas scrubbing technology selected for the Collier County Plant is the injection of limestone sorbent with the RDF (or fuel mixture), into the CFB incinerator. Powdered limestone is continuously fed from a storage hopper to the waste stream before entering the incinerator. Limestone ($CaCO_3$) is calcined by high furnace temperatures to lime (calcium oxide - CaO), whereupon the lime reacts in the circulating fluidized bed with sulfur and chlorine compounds (SO_2 and HCl) to form gypsum ($CaSO_4$) and calcium chloride ($CaCl_2$). The relatively small limestone particles used for control of SO_2 and HCl, extreme turbulence, and long residence times available for reaction, provide excellent conditions for a high degree of limestone utilization in reactions with SO_2 and HCl. This results in a high degree of SO_2 and HCl control.

Although the technique is utilized successfully in Europe, there are currently no fluidized bed incinerators for municipal solid waste in the United States that utilize limestone for control of SO_2 or HCl. The EPA, however, recognizes that one of the primary advantages of fluidized bed technology is that the injection of sorbent materials (e.g. limestone, dolomite, sodium carbonate) can greatly reduce emissions of hydrogen chloride and sulfur oxides.*

Tests on a Gotaverken CFB boiler at Nykoping, Sweden, burning 0.6 percent sulfur coal and utilizing limestone for SO_2 control, have demonstrated 90-95 percent removal of SO_2. The maximum sulfur content of the Collier County Plant fuel mix is 0.4 percent by comparison, and is associated with the mixture of 70% RDF/30% tires. The test results at NY Koping, therefore, provide strong evidence that SO_2 control with 70 percent efficiency should be achieveable at the Collier County Plant with the limestone-injection scrubbing technology proposed.

In the same manner that has been clearly demonstrated for SO_2, HCl will be controlled with high efficiency by the continuous feeding of limestone with the fuel into the CFB incinerator. The calcium in the limestone reacts with HCl to form the solid calcium chloride which is subsequently removed either as bottom ash or as flyash collected in the fabric filter. HCl and SO_2 continue to react with calcium on the baghouse cake, further enhancing removal efficiency. Indeed, the EPA recognizes that use of limestone in the combustion process is one advantage of fluidized bed combustion in that this can greatly reduce emissions of both HCl and SO_2.*

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* Roeck, D.R. and McInnes, R.G., Fluidized Bed Combustion of Wastes and Low-Grade Fuels - Draft Final Report, p. 13, EPA, April, 1982.

The molar ratio of calcium to sulfur and chlorine to be used for the Plant will be:

$$\frac{Ca}{S + 2\ Cl} = 3$$

This molar ratio provides an ample margin of safety to account for non-stoichiometric reactions of calcium with sulfur and chlorine.

In summary, limestone-injection scrubbing is proposed as BACT for control of SO_2 and HCl emissions from the Collier County Plant. With fluidized-bed technology, acid gas scrubbing is efficiently achieved within the combustion process via the limestone-injection technique; thus, acid gas control is an integral part of the combustion process with CFB combustion technology. The acid gas removal efficiencies achieved by limestone injection scrubbing within the fluidized bed (minimum of 90% control of HCl, and 70% control of SO_2 guaranteed by Gotaverken) are the same removal efficiencies that vendors of flue-gas dry-scrubbers typically guarantee for waste-to-energy facilities. There is no reason, therefore, to consider flue-gas scrubbing for the Collier County Plant when the proposed limestone-injection scrubbing will accomplish equally high removal efficiencies within the combustion process.

4.0 NITROGEN OXIDES

BACT for control of nitrogen oxide emissions is required for the Collier County Plant. Nitrogen oxides emission control technologies are in various stages of development and demonstration on full-scale waste-to-energy facilities. Potential control technologies include combustion controls (design and operation) and flue gas treatment (e.g. ammonia injection). Combustion controls include flue gas recirculation, low excess air operation, and staged combustion. Combustion controls have accumulated significant operating experience in fossil fuel boilers, and are also now widely incorporated in MSW incineration designs. Flue gas treatment methods are still in the developmental stage for MSW incineration and thus should not be considered as a BACT alternative. Consequently, BACT for NO_x emitted from MSW incinerators is good combustion design and operation.

NO_x emissions from combustion sources are produced by two mechanisms; one involves oxidation of atmospheric nitrogen at high temperatures (thermal NO_x) and is strongly dependent on oxygen concentration and peak flame temperatures, while the other involves oxidation of fuel-bound nitrogen (fuel NO_x) and is a function of the fuel nitrogen content. The Gotaverken CFB incinerator has design features that minimize NO_x emissions from both formation mechanisms. Due to extremely efficient heat transfer between gases and solid particles of fuel, peak flame temperatures can be maintained somewhat lower than those in grate burn incinerators. Also, CFB incinerators operate at lower excess air percentages than grate burn incinerators. Both of these conditions minimize thermal NO_x formation. The CFB incinerator also employs two-stage combustion, thus minimizing conversion of fuel nitrogen to NO_x.

5.0 CARBON MONOXIDE

Good combustion design and operation is nationally accepted as the only viable alternative as BACT for control of CO emissions from waste-to-energy facilities. CO emissions from the Plant will be controlled by good combustion design and operation to a design concentration of 100 ppm (by volume, corrected to 7% O_2, dry base, four-day average). Design features of the Gotaverken CFB that provide low CO emissions include the following:

- vigorous mixing of combustibles with combustion air within the bed
- long gas residence time (5 seconds)
- uniform temperatures within the combustion zone provided by the thermal mass of circulating hot solids.

6.0 VOLATILE ORGANIC COMPOUNDS (VOC)

VOC emissions from the Plant will be controlled by good combustion design and operation to a maximum of 8 TPY, which is well below the EPA significant emission level of 40 TPY. The Plant, therefore, is not a major source of

VOC. The same design features of CFB incineration that control CO emissions (see Section 5.5) also control VOC emissions.

7.0 TRACE METALS (Lead, Beryllium, Mercury and Other Trace Metals)

Trace quantitites of metals are volatilized in the combustion process and carried downstream with the flue gas to the particulate control equipment. As the flue gas temperature decreases, most metals will condense onto particulate matter, showing a particular affinity for the smaller sized particles. This process describes small-particle "enrichment" with trace metals. Mercury, however, is generally thought to remain primarily in gaseous form and be released to the atmosphere as such. The partitioning of condensed trace metals onto fine particulates, particularly the respirable size particles, emphasizes the importance of a particulate control device's ability to capture fine particulate. Fabric filters, when compared to other particulate control techniques, such as the ESP, excel in removal of these fine particles that tend to be enriched with condensed trace metals.

The Plant, because it will be equipped with a high-efficiency fabric filter as BACT for particulate control, provides the highest possible degree of emissions control for condensible trace metals, including those of particular interest: arsenic, cadmium, hexavalent chromium, nickel, and lead.

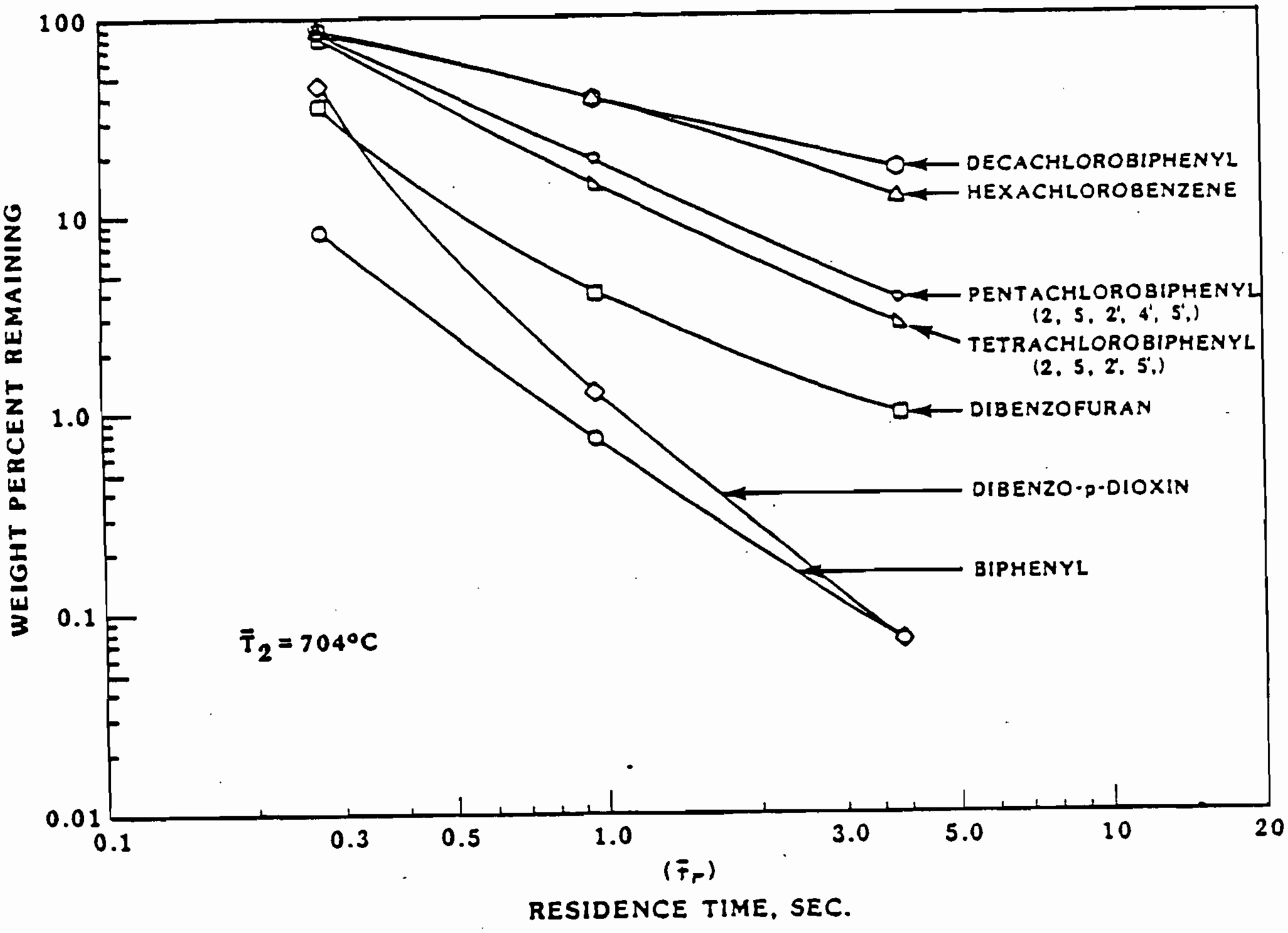
8.0 TRACE ORGANICS (Dioxin)

There are no Federal or Florida DER regulations for control of emissions of trace organics that apply to the Plant. Numerous other states, however, have recently developed operating requirements for waste-to-energy facilities, requirements designed to control emissions of dioxin and other trace organic compounds. These operating requirements are intended to ensure that the combustion design and operation provides a sufficiently high combustion-gas temperature (typical requirement: 1500°-1800°F), a sufficient gas residence time (typical requirement: 1 second), plus sufficient oxygen and turbulent mixing to ensure complete combustion, thereby, minimizing dioxin emissions.

One of the primary benefits of CFB technology is its superior combustion efficiency when compared to conventional grate burn incinerators. Combustion in CFB incinerators takes place in a suspension of fine limestone particles, RDF, ash, calcium sulfate and calcium chloride (reaction products of limestone, SO_2, and HCl). The suspension decreases in density as it flows upward through the furnace. The furnace consists of a water cooled panel wall boiler with two high-efficiency, refractory-lined cyclones in parallel at its outlet and a refractory-lined water-cooled, air-distributed grid at its bottom inlet. The limestone bed material, sized to be between 1/125 and 1/40 inch, is entrained in the upward flow of air along with the fuel, while combustion occurs as the upward flowing gas stream traverses the height of the furnace. The velocity during this traverse is such that the residence time for combustible gases and fine particles is 5 seconds. This is significantly longer than for conventional grate burn technologies, which have residence times of approximately one second. Figure 8-1 shows the relationship between residence time and the destruction of dioxin and other chlorinated organic species. In the case of dibenzo-p-dioxin, a residence time of four seconds has yielded a significantly greater destruction efficiency than at one second (approximately seven percent of the weight remaining after one second, remains after four seconds). The residence time at the Plant will be five seconds, providing an even greater degree of destruction. Combustion temperatures during operation, as measured from the furnace bottom to the furnance top (at the inlet of the hot cyclones), will not vary by more than 50°F (10°C). The design combustion temperature is 1560°F (849°C). The combustion temperature during operation may be at any point in the range 1520-1700° (827-927°C), although never varying by more than 50°F throughout the furnace. Figure 8-2 shows the relationship between combustion temperature and the destruction of dioxin and other chlorinated organic species. These data indicate that destruction of dibenzo-p-dioxin is maximized at approximately 725°C (1337°F) under the conditions tested. Note that the Plant will operate in the range 1520-1700°F (827-927°C), providing a significant margin of safety above 725°C (1337°F) for excellent destruction of trace organics. In addition, the inherently-turbulent nature of CFB combustion process provides thorough and intimate mixing of combustibles (including trace organics) with oxygen and yields uniform bed temperatures. Such conditions tend to promote complete

FIGURE 8-1

EFFECT OF RESIDENCE TIME ON DESTRUCTION EFFICIENCY

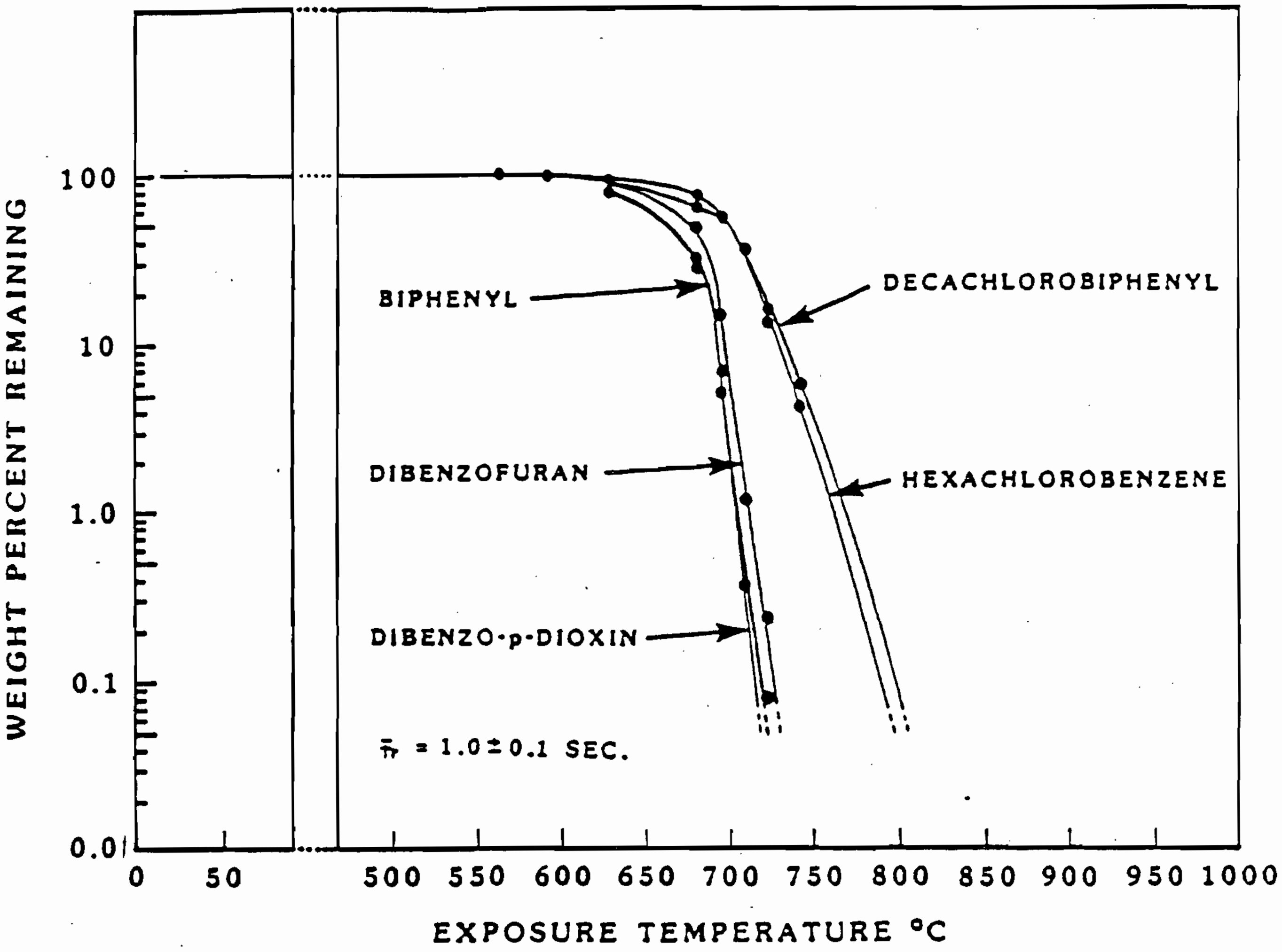


Source: Duvall, D. S. and Rubey, W. A., EPA, Laboratory Evaluation of High-Temperature Destruction of Polychlorinated Biphenyls and Related Compounds, Report No. 600/2-77-228, December 1977.

Taken From: California Air Resources Board, Air Pollution Control at Resource Recover Facilities, p. 221, May, 1984.

FIGURE 8-2

THERMAL DESTRUCTION PROFILES FOR SELECTED ORGANIC COMPOUNDS



Source: Duvall, D. S. and Rubey, W. A., EPA, Laboratory Evaluation of High-Temperature Destruction of Polychlorinated Biphenyls and Related Compounds, Report No. 600/2-77-228, December 1977.

Taken From: California Air Resources Board, Air Pollution Control at Resource Recover Facilities, p. 216, May, 1984.

combustion of trace organics, including dioxin, and they also serve to minimize the occurance of cold spots, unburned fuel, and localized fuel-rich conditions, which tend to be more prevalent in grate burn incinerators.

Emissions estimates of dioxin for the Plant have been based on tests conducted at the Sundsvall Facility, a commercial, full-scale, Gotaverken CFB incinerator in Sweden of similar design and size to the proposed Collier County Plant. A series of six emissions tests was conducted during 1985. Three tests were with a fuel mixture of RDF and peat, and three with a fuel mixture of RDF, wood chips, and tires. The percentage of RDF varied from 15-90 percent, the percentage of tires varied from 10-25 percent, and the percentage of wood chips from 20-60 percent. Combustion conditions included combustion temperatures of 1520-1700°F (827-927°C) and five seconds residence time. Preliminary results indicate that dioxin emissions are significantly lower than for conventional RDF and mass burn grate technologies (See Appendix III, Section 9.0).

In summary, emissions of dioxin and other trace organic compounds from the Collier County Plant will be minimized as a consequence of the exceptionally-high combustion efficiency inherent to CFB incinerator technology. Preliminary emissions test results from a Gotaverken CFB facility in Sweden of a design and size similar to the proposed Collier County Plant indicates dioxin emissions significantly less than those from conventional RDF and mass burn grate incinerators. Theoretical considerations of the combustion design and firing characteristics of the CFB process indicate that very low emissions of trace organics are achievable. This is due to combustion efficiencies certainly equivalent to, and likely greater than those of grate burn technology. Furthermore, EPA laboratory testing has shown the importance of long residence times and high combustion temperatures in maximizing destruction of trace organics. The CFB technology provides the required high combustion temperature, and compared with conventional grate-burn technologies, provides a longer residence time and greater turbulent mixing of the combustion gases.

9.0 ODOR CONTROL

The waste receiving (tipping)/storage area; the RDF storage-area heating and ventilation system; and the RDF process are designed to comply with state and local regulations which typically require that no odorous emissions may be detectable beyond property lines. With respect to the waste receiving/storage area, this area is in an enclosed structure which is kept under a slightly negative pressure, thus serving to contain potential odorants. In addition, the design of the waste receiving/storage area for the Collier County Plant (i.e., a tipping floor) facilitates regular and thorough cleaning. Such thorough cleaning cannot be achieved as easily with the alternative design -- a refuse "pit." At the Plant, the tipping floor will be regularly swept clean and washed and under no circumstance will waste be allowed to remain on the tipping floor for longer than a 24 hour period. Waste residence time, and therefore, the potential for producing odors is minimized by the design.

Regarding control of odors from the RDF process, the RDF process is a "closed" system, i.e., dust and odors are contained by a system of aspirated enclosures for the processing machinery. RDF process air, and the odorants it contains, are ducted through baghouses for dust removal, then ducted through the combustion air plenum to the boiler(s), where the odorants are thermally destroyed.

During that portion of the annual boiler shutdown when waste will continue to be processed into RDF in order to fill the storage area, RDF process air will be vented through the boiler stack. Sufficient dilution will occur, even without thermal destruction of odorants, such that odors are not expected to be detectable beyond the facility boundaries. This has in fact, been the experience of National Ecology, Inc. at their Timonium, Maryland RDF plant, i.e., that odors are not detectable outside of the processing building. The Timonium plant is in a mixed residential/commercial area and since the original plant start-up in January, 1976, no odor complaints have been received.

10.0 SUMMARY OF PROPOSED BACT

The preceding sections have outlined, on a pollutant-by-pollutant basis, the control technologies selected for controlling air pollutant emissions from the proposed Plant. Alternative technologies have been evaluated on the basis of environmental and economic considerations, as well as current industry practice and engineering reliability.

Based on the above criteria, the following are being proposed as BACT: (1) particulate matter and trace metals - fabric filtration and thermal reduction, (2) SO_x and HCl - limestone injection scrubbing, and (3) NO_x, CO, VOC, and trace organics (dioxin) - good combustion control and operation.

Environmental impacts (ambient air concentrations) from the Plant utilizing the proposed BACT will not result in exceedances of any ambient air quality standard or PSD increments; rather, the incremental increases in pollutant ambient air concentrations due to the Plant will be a minor fraction of such standards. No alternative control technologies are available for any pollutant that would result in lower ground-level ambient air concentrations than the proposed BACT.

The estimated capital costs for the control technologies proposed as BACT are presented in the "Application to Operate/Construct Air Pollution Sources," page 2.

APPENDIX VII

ADDITIONAL REFERENCE MATERIAL

ATTACHMENT A: DIOXIN TEST REPORT

APPENDIX VII

ATTACHMENT A

DETERMINATION OF PCDDs AND PCDFs IN INCINERATION SAMPLES AND PYROLYTIC PRODUCTS

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INTRUDUCTION

On Feburary 13, 1985 the Swedish EPA issued a moratorium on the construction of new municipal solid waste (MSW) incinerators. The main reason for this moratorium was the dioxin issue, especially the potential connection between incineration and background levels of PCDDs and PCDFs found in human adipose tissue and mother's milk. The 1,2,3,7,8-penta-CDD, which has never been reported as a contaminant in technical products but always found in incineration samples, can serve as a marker. (1,2,3)

During 1985 a research program was launched in Sweden in order to investigate the emission from various types of incinerators and also to correlate these data with potential health risks. In this report we will discuss some of the data collected so far for various types of incinerators or incineration models.

Emissions from incinerators constitute a multitude of different PCDD and PCDF isomers, a few of these have been found to have much higher toxicity than others, see Rappe et al.(1) and Nygren et al. (3). Various models have been used to convert a multitude of levels of more or less toxic PCDDs and PCDFs into a more simple expression like "TCDD equivalents" or "toxic equvivalents". For a discussion of different approaches see Milby et al (4) and Ahlborg (5). In Sweden and in this report the approach discussed by Eadon (6) has been used.

EXPERIMENTAL

Sampling and clean-up

The sampling from the MSW incinerators studied here was performed by Lars Lunde'n and Curt-Åke Boström, IVL-IPK, Gothenburg, Sweden and should be described elsewhere. In the sampling train the following samples were collected:

Particulate (glassfiber filter)
Condensate
Adsorbent tube(XAD-2)

In order to validate the sampling procedure, 13-C labelled surrogates were added to the filter and to the XAD-2 adsorbent before the collection. The sample volume varied between 1 and 3 Nm^3 dry gas (dg).

For the extraction and sample clean-up we have mainly used conventional methods, see figures 1, 2 and 3. However the final step using a Carbopack C clean-up system has been slightly modified and a validation of this column is presented here.

Validation of Carbopack C column

We mixed 0.5 g Carbopack C and 2.3 g Celite 545 and activated this mixture at 130 °C for six hours. The mixture was packed in a disposable pipet fitted with a small plug of glass wool, see Figure 3. The column was preeluted with 20 ml of toluene followed by 9 ml of a mixture methylene chloride / c-hexane (1:1) and 9 ml of n-hexane. The extract or the combined extracts were dissolved in 3x1 ml of n-hexane and added onto the column followed by 3ml of methylene chloride / c-hexane (1:1). The PCDD and PCDF fraction was collected by elution with 20 ml of toluene. To the extract 10 ul of tetradecane was added and the volume was reduced to 10 ul.

In the validation study, 3 levels with 12 diffrent PCDF congeners (Table 1) were eluted through the Carbopack C column. The levels were 250, 2500 and 12500 pg/congener. Every level was studied in triplicate. The results are shown in Table 1 and the mean values Figure 4. No significant trend or difference could be found between isomers of the same chlorination level.

HRGC/MS

We were using a 60 m Supelco SP2330 or a SP2331 fused silica capillary column for the isomer specific analysis of PCDDs and PCDFs. This column separates all toxic congeners from the less toxic congeners except 1,2,3,7,8-PeCDF from 1,2,3,4,8-PeCDF and 1,2,3,4,7,8-HxCDF from 1,2,3,4,7,9-HxCDF. Separation of 1,2,3,7,8-PeCDF from 1,2,3,4,8-PeCDF can be done on a 50 m OV-1701 column (1).

All samples were analyzed on a updated Finnigan 4021 mass spectrometer in negative ion chemical ionization (NCI) mode using methane as reagent gas. However due to the poor response of TCDD using NCI mode, electron impact (EI) mode was used to quantify 2,3,7,8-TCDD. This resulted in somewhat less sensitivity for TCDD, than for the other homologs.

MATERIAL

MSW Incinerator Umeå

During the fall 1984, an extensive investigation took place at the MSW Incinerator in Umeå, Sweden. This incinerator is of the cross grate type, build in 1970 and equipped with a boiler and an electrostatic precipitator. The incinerator is charged with raw refuse at a rate of 6 metric ton/hr and the effect is 10 MW. We performed 15 experiments during the fall 1984 and 3 additional measurements were done during the spring 1985, see Table 2. Bottom ash and fly ash from the ESP were also analyzed from every experiment. The results are not reported here. These experiments indicate that, totally, about 20% of the PCDDs and PCDFs are found in the bottom ash. Additionally 20 % are in the fly ash and the rest are in the true emissions.

Peat incineration

This incinerator also in Umeå was built in 1981 and it is a cross-grate type equipped with a bolier and an ESP. The capacity of this incinerator using peat, wood chips or oil as fuel is 6 metric tons/hr and the maximum effect is 25 MW. In our experiment peat was the only fuel used.

Copper Melter

Scrap-copper containing PVC-plastic, PVC-coated wires and cords were burned and melted in a converter. The temperature in the converter was about 1500 °C but during the feeding process the temperature was much lower. Two samples of gas exhaust were collected during the feeding process and analyzed.

Steel Mill

A dust sample from the bag-house of a Swedish steel mill was collected. In this steel mill a high portion of the metal (stainless steel) was recycled. This recycled material can be contaminated by PVC or by other organochlorine additives, like polychlorinated paraffins used in cutting oils and similar products for metal treatment.

Smoke Generator

A military smoke torch containing hexachloroethane and zink was burned in a hood. Two gas samples were collected on an adsorbent (XAD-2) and analyzed.

Laboratory Pyrolyses

Pyrolysis experiments of PVC and Saran were performed by the group in Tallahassee and this procedure was desribed during this conference.

In addition, in our Umeå laboratory we have studied the pyrolysis of a mixture of octachlorodibenzofuran and octachlorodibenzo-p-dioxin in the following way. In a glass ampole 2 mg of OCDF and 1.4 mg of OCDD were added. The glass ampole was sealed and heated during 90 sec in an oven preheated to 600 °C. After cooling the ampole was opened and the content extracted with methylene chloride. The extract was cleaned as decribed above for the samples from the MSW incinerator.

RESULTS

MSW incinerator, Umeå

The levels of 2,3,7,8-substituted isomers as well as the total amount of each group of congener and the levels of TCDD equvivalents are given in Table 3. The isomeric pattern of the PeCDFs in a typical sample is shown in Figure 5 upper curve.

Before the fall measurements we spiked each filter and adsorbent with 1 ng of ^{13}C- 2,3,7,8-TCDD, ^{13}C- 2,3,7,8-TCDF and ^{13}C- OCDD. We analyzed the filter, the condensate and the adsorbent separately and found the distribution given in Table 4.

During the spring measurements we added a second adsorbent tube after the first one. We found that less than 5% of the total amount of TCDD-equvivalents were collected on the second XAD2 adsorbent tube.

Other MSW incinerators and industrial incineration

In Table 5 we have summarized the results from various Swedish incinerators. Umeå 1 is the average of the the fall measurments and Umeå 2 is the spring value. Avesta 1 is before and Avesta 2 is after the oven was modified.

Peat Incineration and Laboratory Pyrolysis

Table 6 shows the value of 2,3,7,8-substituted isomers and total congeners from peat incineration, a smoke generator and laboratory pyrolysis. Due to the low amount, it was not possible or impractical to calculate the TCDD-equvivalents. The pattern of individual penta-CDF isomers from PVC pyrolysis and the smoke generators given in Figure 5.

In the OCDD and OCDF pyrolysis it was not possible to detect higher chlorinated isomers than penta, due to overload from unpyrolysed octa- CDD and octa- CDF on the hexa- and hepta channels. The pattern of penta- CDF congeners is given in Figure 6.

CONCLUSIONS

The formation of PCDDs and PCDFs in MSW incinerators is now well documented and not controversail. However this seems to be the first report where the stack sampling and laboratory clean up operations have been controlled and validated by the use of ^{13}C-labelled standard compounds. The low recovery of the ^{13}C-2,3,7,8-tetra-CDF in the filter is worth noticing: Smpling of particulates at elevated temperatures without appropriate back-up equipment yields erroneous results.

The levels of PCDDs and PCDFs in the MSW incinerator in Umeå was found to vary quite little over the period of time the samples were taken (10 days) even in the case where the burning conditions were quite different, see Table 3. However in all cases the burning conditions were fully acceptable.

We have analyzed samples from a series of MSW incinerators in Sweden. The levels are given in Table 5 where we also have collected data from other types of industrial incinerators.

In another Swedish MSW incinerator (Avesta), the emissions were orginally quite high. Later, when the turbulence within the incinerator was optimized and the air flow leaking into the oven was minimized the levels were reduced by a factor of about 50.

We have made another interesting observation. The emissions were found to be higher in the fall when the amount of wet leaves in the MSW incinerator was quite high compared to winter and spring.

It is interesting to compare the PCDD and the PCDF emissions from MSW incinerators with other energy sources. In Table 6 we have given the results from incineration of peat. The emission here was much lower than in the MSW incinerator, close to a factor of 10^3. This observation is in agreement with earlier observations from coal-fired power plants where Junk and Richard (7) and Kimble and Gross (8) were unable to identyify 2,3,7,8-tetra-CDDs in the fly ash samples they analyzed.

The levels found in the emission of industrial incinerators seems to be quite similar to those found in properly operating MSW incinerators. Both the copper melter and the steel mill produced PCDDs and PCDFs. This strongly indicates that the total emissions from industrial incinerators could be of the same magnitude or even higher than the emissions from MSW incinerators.

The laboratory pyrolysis of PVC and Saran clearly shows that PVC and other organochlorine polymers can be precursors to the PCDDs and PCDFs found in various incinerators. This is a very important observation because New York City Department of Sanitation (9) recently claimed "PVC has never been shown to be a precursor of PCDF/PCDD". This statement is based on investigations by Karasek et al (10) and Olie at al (11). A recent German pamphlet arrives at the same erroneous conclusion (12).

In a recent study in Baltimore County, MD, and Brooklyn, NY, USA it is found that plastics and paper are the two major sourses of water insoluble chlorine content of MSW incinerators. The total level of chlorine was found to be about 1% (13).

In addition to the levels of PCDDs and PCDFs found in the emissions of various incinerators, it can be of interest to study the pattern of individual PCDD and PCDF congenes found in these samples. In Figure 5 we have made a comparision of the penta-CDF patterns found in a typical sample from a MSW incinerator, from PVC pyrolysis and from the pyrolysis of hexachloroethane (smoke generator). The pattern of individual isomers in these samples are very much the same in spite of the fact that the chlorine content was found to vary between 1% and 90%.

However the laboratory pyrolysis of OCDD and OCDF shows a completely different isomeric pattern, see Figure 6. Here the 2,3,7,8-substituted isomers were found to dominate, indicating a preferential loss of chlirine atoms in the peri positions.

The identification of lower chlorinated PCDFs like penta-CDFs in pyrolysis of hexachloroethane indicates dechlorination to be an important pathway for the formation of PCDDs and PCDFs. This is in agreement with our earlier observations of tetra- and penta-CDDs from the pyrolysis of very pure pentachlorophenol (14).

The environmental and human health impact of the emissions of PCDDs and PCDFs from MSW incinerators have been discussed in Umeå as well as at other places in Sweden and in other countries. Using the observed stack gas levels in Umeå, the Swedish Meteorological Institute has calculated the average air concentration in different parts of the surrounding area

(15). The highest levels were calculated for two hills about 3 km N of the MSW incinerator. One of these is a residental area. The annual mean level here was calculated to be 0.055 pg/m^3. The daily exposure by inhalation (20 m^3/day for a 55 kg person) is 0.02 pg/kg b w, day. This value should be compared to the ADI value discussed (5) which is 1-5 pg/kg b w, day, and also compared to some other calculated exposure values via the food, see Table 7.

From this table it is clear that the inhalation exposure is marginal compared to the exposure via the food, especially fish and other food stuffa from the aquatic food web. However, a correlation between incinerators of various kinds and the environmental levels of PCDDs and PCDFs cannot be excluded, consequently all such emissions should be controlled and minimized.

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Table 1 Recovery of all added PCDF congeners in every experiment (%).

Level	250pg			2500pg			12500pg		
Experiment	1	2	3	1	2	3	1	2	3
PCDFs									
1,3,6,8-	108	112	112	116	102	105	109	102	92
2,3,7,8-	105	121	113	120	105	106	105	102	106
1,3,4,6,8-	106	124	114	101	127	101	118	108	119
1,2,3,7,8-	105	107	104	101	107	101	99	105	98
2,3,4,8,9-	115	77	107	105	126	95	107	113	104
2,3,4,6,7-	124	113	117	98	117	111	117	105	113
1,2,3,4,6,8-	110	90	94	95	98	104	97	90	99
1,2,3,4,7,8-	119	112	105	102	104	103	102	100	105
1,2,3,7,8,9-	66	67	51	90	87	94	103	89	101
2,3,4,6,7,8-	116	93	94	99	88	103	97	91	101
1,2,3,4,7,8,9-	118	122	104	99	109	98	101	103	95
Octa-	77	74	60	57	48	50	49	60	66

Table 2 Experiments at MSW Incinerator in Umeå.

Experiments	No of experiments	Temp ^{o}C mean	Temp ^{o}C range
Fall 1984			
Normal conditions	3	803	736-846
Normal conditions with wooden chips	2	764	737-790
Normal conditions with oil burner	2	827	811-842
Low temperature	3	539	484-580
Low temperature with oil burner	3	625	602-658
Start-up procedure	1	-	20-790
start-up procedure with oil burner	1	-	20-816
Spring 1985			
Normal conditions	3	784	700-850

Table 3. Levels of PCDD and PCDF from MSW incineration, Umeå. (ng/Nm^3 dg 10% CO$_2$)

Experiment	normal	normal chips	normal oil	low temp	low temp oil	start	start oil	normal
season	fall	fall	fall	fall	fall	fall	fall	spring
no of exp.	3	2	2	3	3	1	1	3
2378-TCDF	2.5	2.3	2.4	2.6	2.1	9.5	2.3	0.85
Tot. TCDF	86	75	68	87	75	260	80	19
2378-TCDD	0.5	0.6	0.7	0.4	0.3	1.3	0.7	<0.1
Tot. TCDD	43	45	52	54	47	100	49	<10
12378/ 12348-PeCDF	9.0	8.3	9.8	8.3	7.1	52	9.0	2.5
23478-PeCDF	6.1	7.3	7.8	7.4	6.5	40	9.0	3.9
Tot. PeCDF	97	100	120	110	87	520	120	43
12378-PeCDD	2.5	3.6	3.6	3.2	3.6	14	3.9	2.4
Tot. PeCDD	53	70	76	80	70	280	90	49
123478/ 123479-HxCDF	3.6	4.6	5.6	5.2	3.6	48	5.7	4.5
123678-HxCDF	3.7	4.6	5.5	5.0	3.4	40	5.7	4.6
123789-HxCDF	0.8	0.8	1.2	1.2	1.4	52	2.3	3.6
234678-HxCDF	2.6	4.4	4.3	5.1	4.2	36	5.4	4.3
Tot. HxCDF	33	46	51	50	37	380	54	43
123478-HxCDD	1.6	2.9	3.5	5.1	3.1	31	4.4	2.3
123678-HxCDD	3.7	5.6	6.5	9.5	6.6	56	7.9	5.8
123789-HxCDD	1.3	2.4	3.0	3.8	2.6	20	3.5	2.0
Tot. HxCDD	32	53	72	82	57	400	70	55
Tot. HpCDF	34	73	94	67	40	380	51	49
Tot. HpCDD	18	29	37	54	36	380	38	56
OCDF	10	52	50	23	25	180	41	33
OCDD	12	19	31	14	20	130	27	53
TCDD-Equ.	9.1	10	11	11	10	53	12	5.6

Table 4. Distrubution of spike in sample train.

	13C-TCDF	13C- OCDD
Filter	0.1 ng	0.5 ng
Condensate	0.45 ng	0.5 ng
Adsorbent	1.45 ng	1.0 ng

(ng/Nm^3 dg 10% CO_2)

Place	Type	Mean value
Umeå 1	MSW cross-grate	10
Umeå 2	MSW cross-grate	5.6
Avesta 1	MSW cross-grate	80
Avesta 2	MSW cross-grate	2.0
Borås	MSW cross-grate	38
Mid Sweden	MSW fluidized bed	1.8
Rönnskär	Indust. Copper melt.	11
Mid.Sweden	Indust. Steel mill	0.8 ng/g dust

Table 6. Results from peat incineration and laboratory pyrolysis.

Experiment	Peat inciner. pg/Nm^3	Smoke generator ng/g	SARAN pyrolysis ng/g	OCDD & F pyrolysis ug/g
2.3.7.8-TCDF	0.4	0.075	0.06	16
Tot. TCDF's	13	1.5	0.46	240
2.3.7.8-TCDD	<2	NA	NA	NA
TOT. TCDD'S	<20	NA	NA	NA
1.2.3.4.8-/				
1.2.3.7.8-PnCDF	<0.2	0.4	0.1	110
2.3.4.7.8-PnCDF	1	0.2	0.2	4.6
Tot. PnCDF's	10	4.4	2.2	240
1.2.3.7.8-PnCDD	<0.6	<0.04	<0.06	<3
Tot. PnCDD's	<6	<0.4	<0.6	22
1.2.3.4.7.9-/				
1.2.3.4.7.8-HxCDF	0.4	1.1	0.7	ND*
1.2.3.6.7.8-HxCDF	0.4	1.0	0.6	ND*
1.2.3.7.8.9-HxCDF	0.2	0.4	0.6	ND*
2.3.4.6.7.8-HxCDF	0.4	0.3	0.5	ND*
Tot. HxCDF's	10	8.0	6.6	ND*
1.2.3.4.7.8-HxCDD	<1	<0.04	<0.06	ND*
1.2.3.6.7.8-HxCDD	<1	<0.04	<0.06	ND*
1.2.3.7.8.9-HxCDD	<1	<0.04	<0.06	ND*
Tot. HxCDD's	<6	<0.3	<0.5	ND*
Tot. HpCDF's	20	8.6	46	ND*
Tot. HpCDD's	20	<0.6	0.5	ND*
OCDF	<20	6.0	24	ND*
OCDD	70	<1	1	ND*

NA = Not Analyzed
ND* = Not Detected due to overload of unreacted material.

Table 7. Exposure of TCDD-equvivalents for a 55 kg person or 5 kg baby.

Exposure		pg/kg bw, day	Ref.
Inhalation	(20 m^3/day)	0.02	This study
Milk	(1 l/day)	0.5 - 5	16
Salmon	(100g/week)	20	17
Breast milk	(850ml/day) 5 kg baby	20 - 200	5

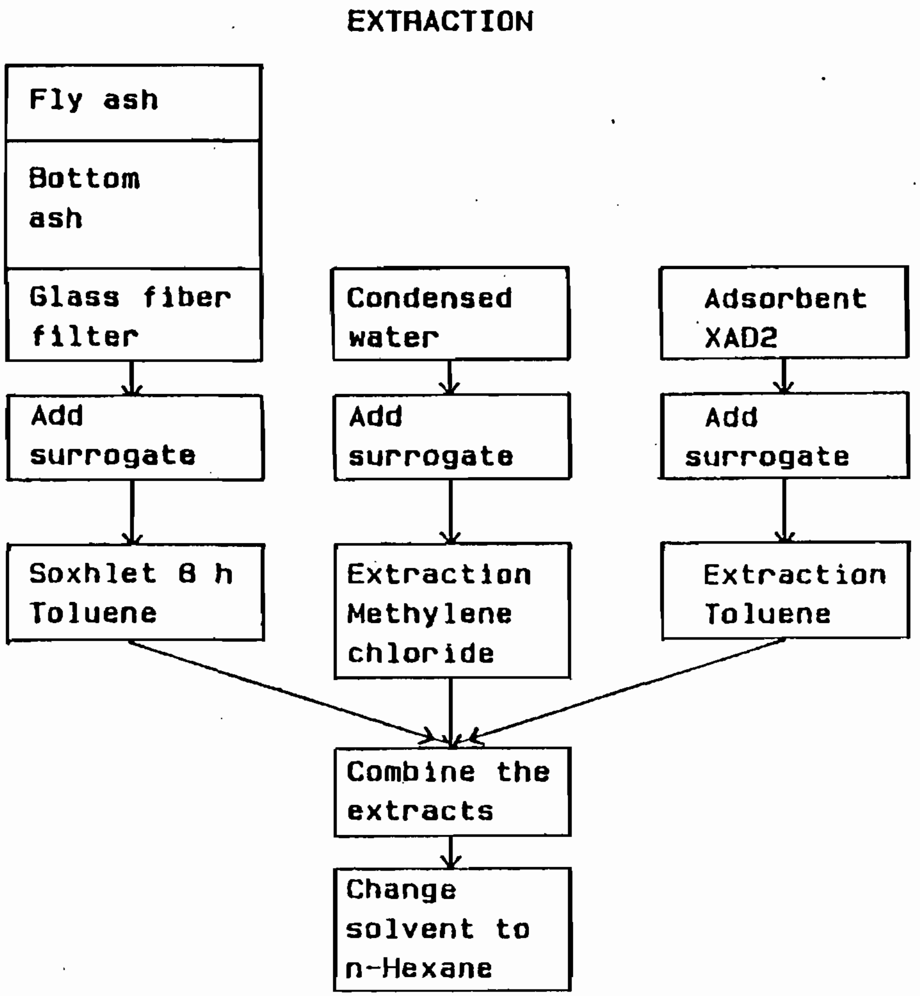


Figure 1. Extraction procedure for incineration samples.

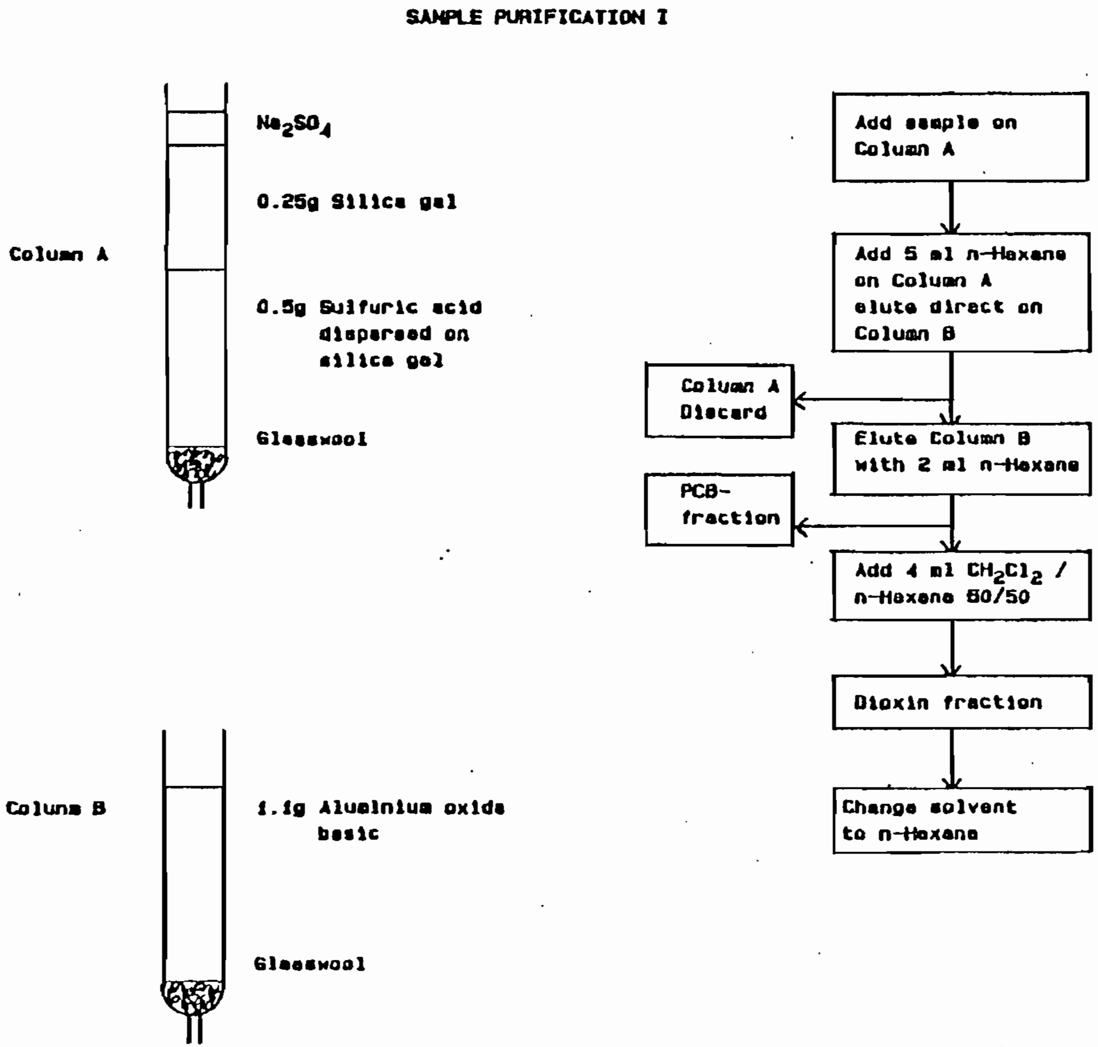


Figure 2. Clean-up for incineration samples. Part I.

SAMPLE PURIFICATION II (EPRI 613)

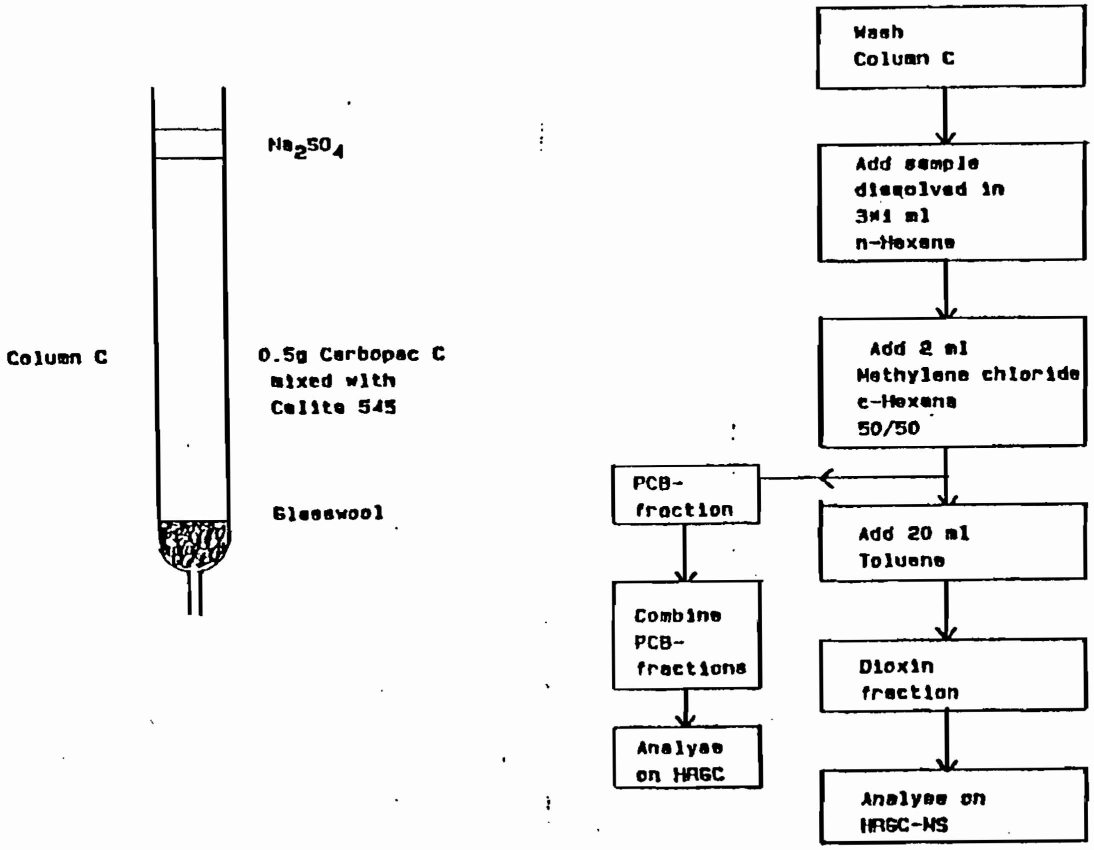
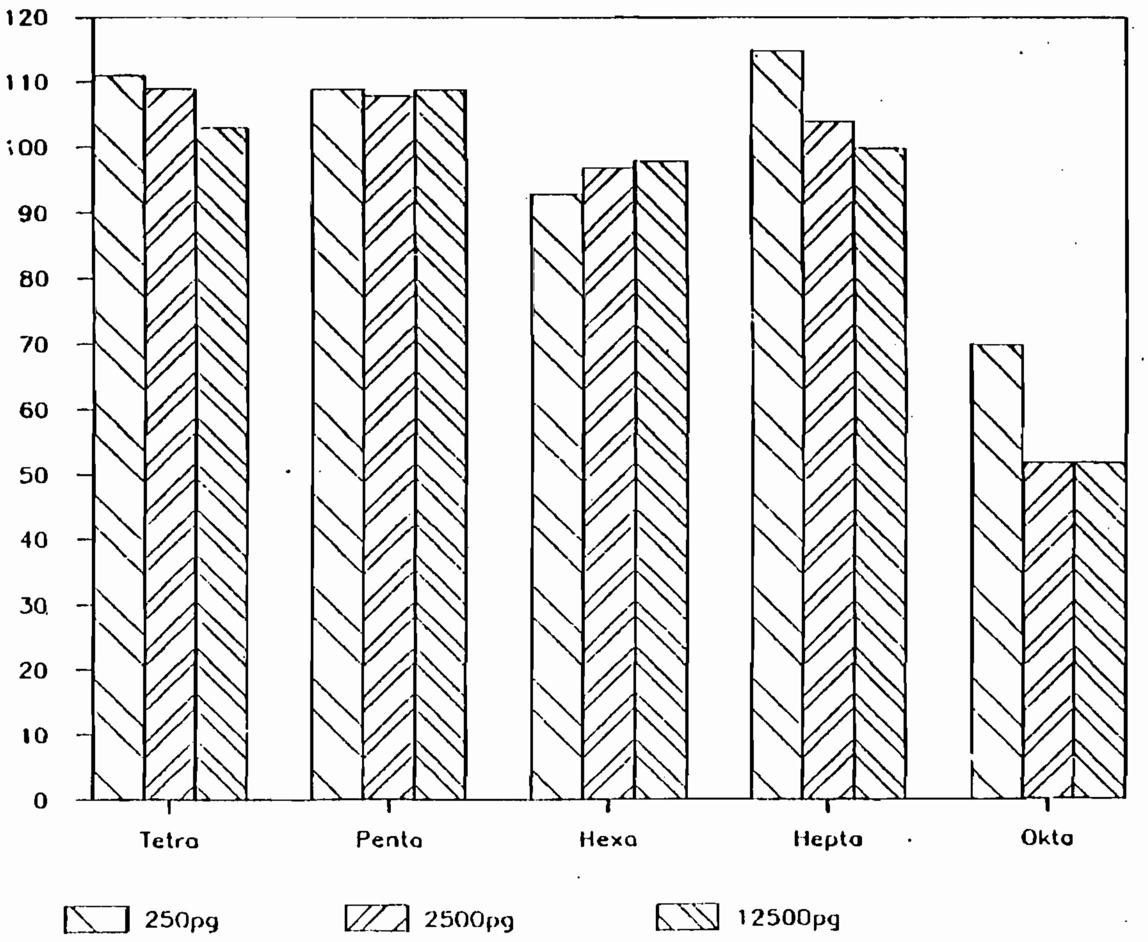


Figure 3. Clean-up for incineration samples. Part II.

Figure 4. Recovery from the Carbopack C column.



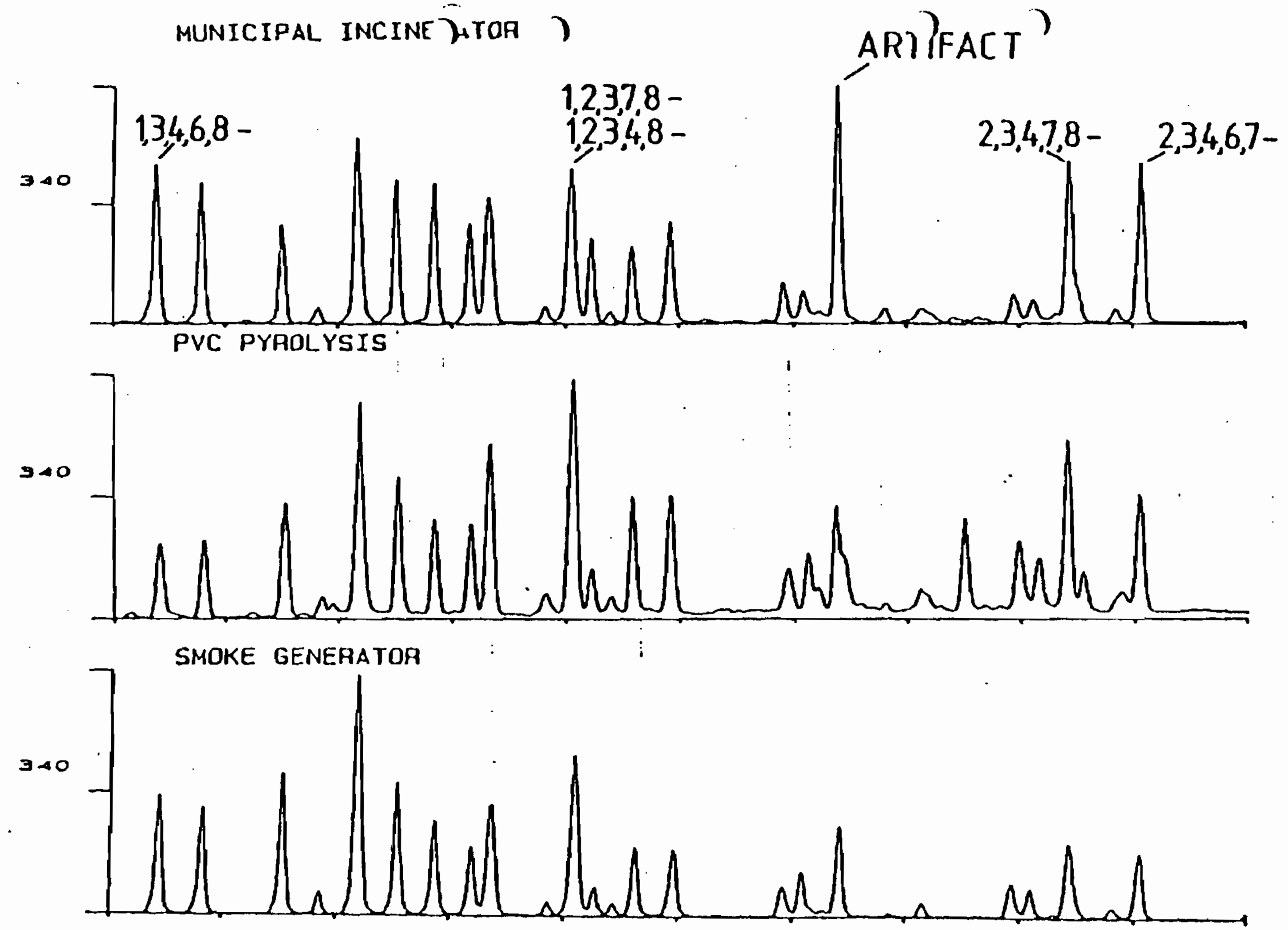


Figure 5. Penta-CDFs found in samples from a MSW incinerator, from PVC pyrolysis and from a military smoke generator.

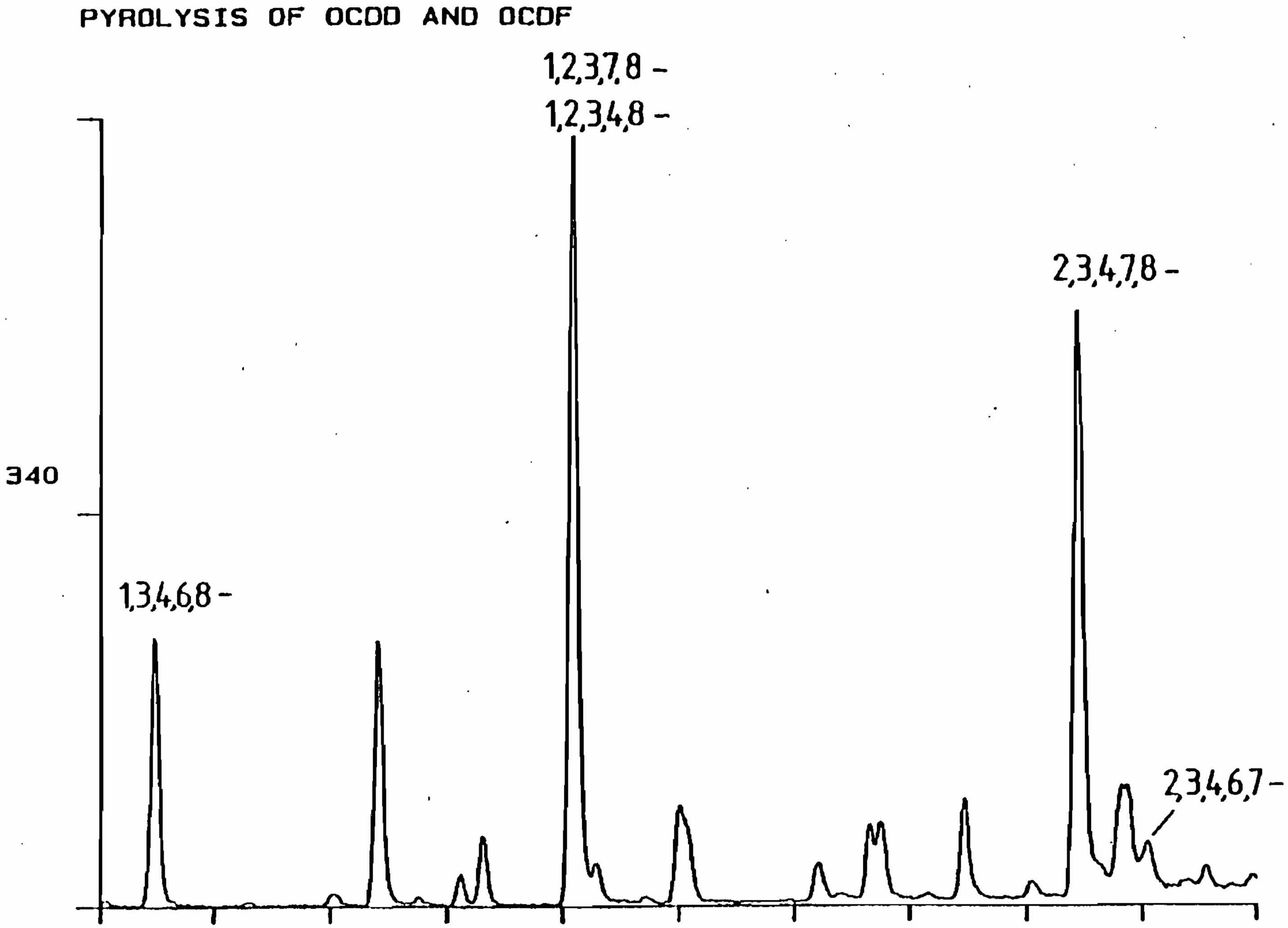


Figure 6. Penta-CDFs from pyrolysis of octa-CDF.

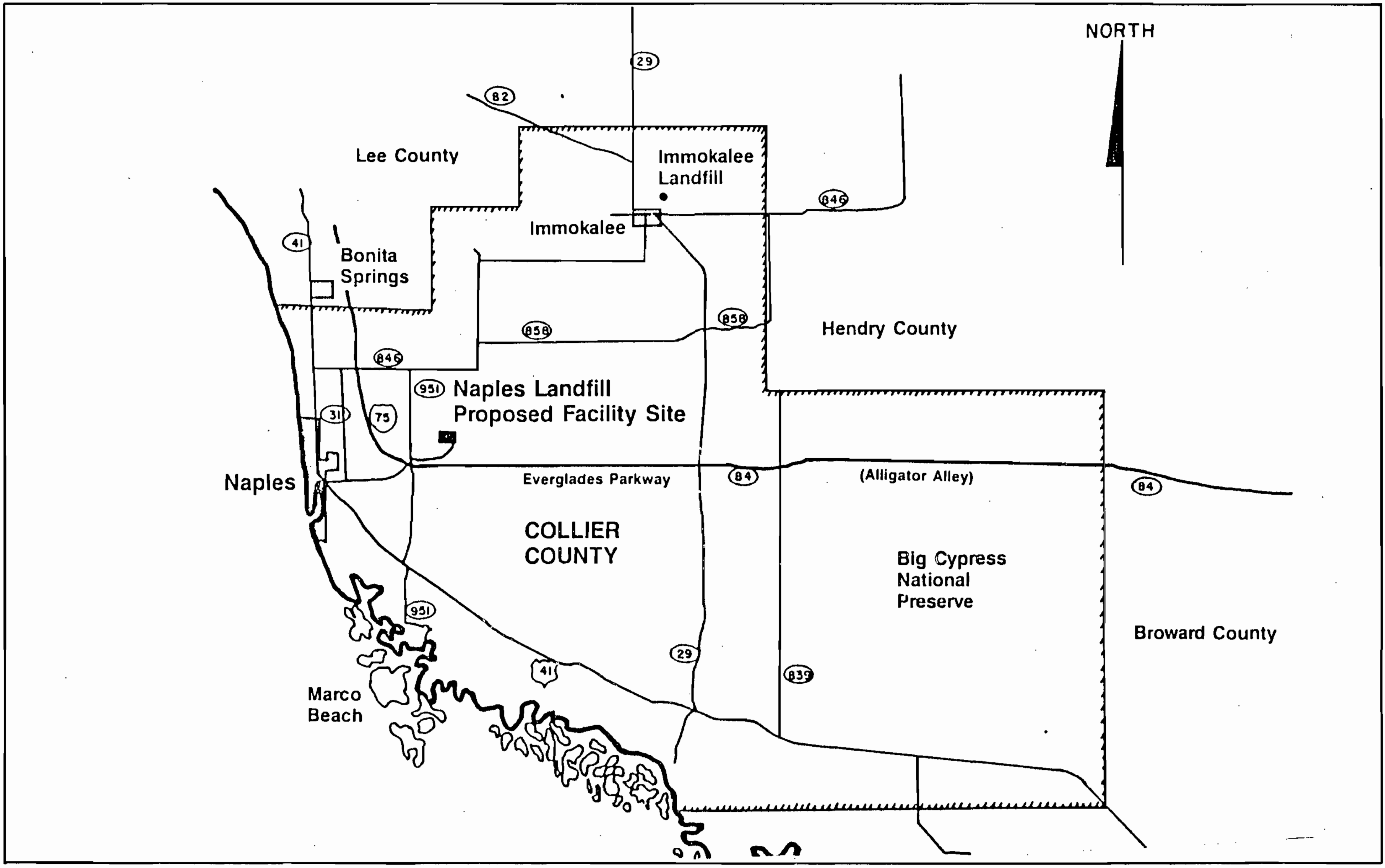
APPENDIX VIII

MAPS AND DRAWINGS

APPENDIX VIII

COLLIER COUNTY WASTE TO ENERGY PLANT

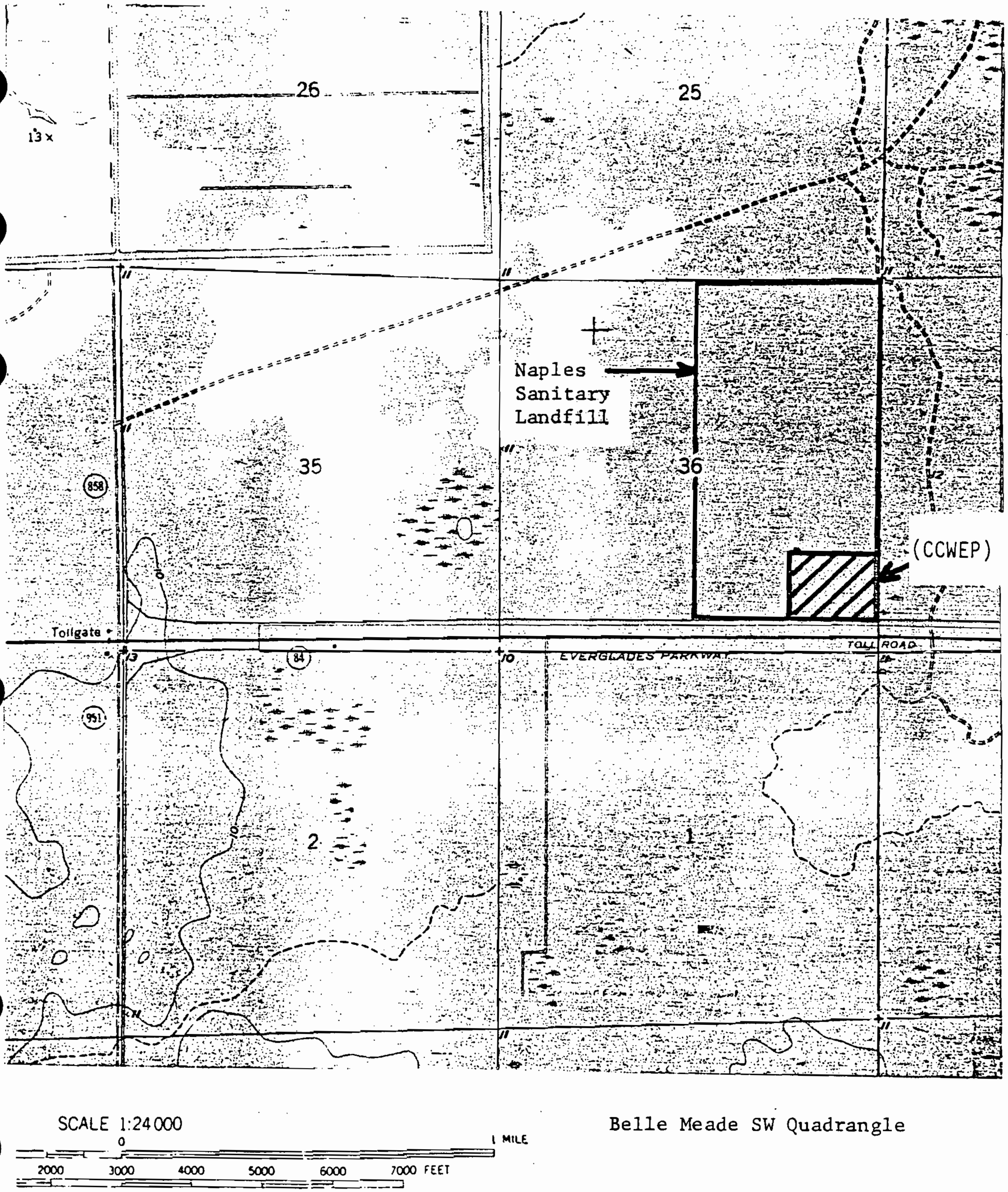
LIST OF MAPS/DRAWINGS



PROPOSED COLLIER COUNTY WASTE-TO-ENERGY PLANT
SURROUNDING VICINITY MAP

Source: Henningson, Durham & Richardson, 1985a

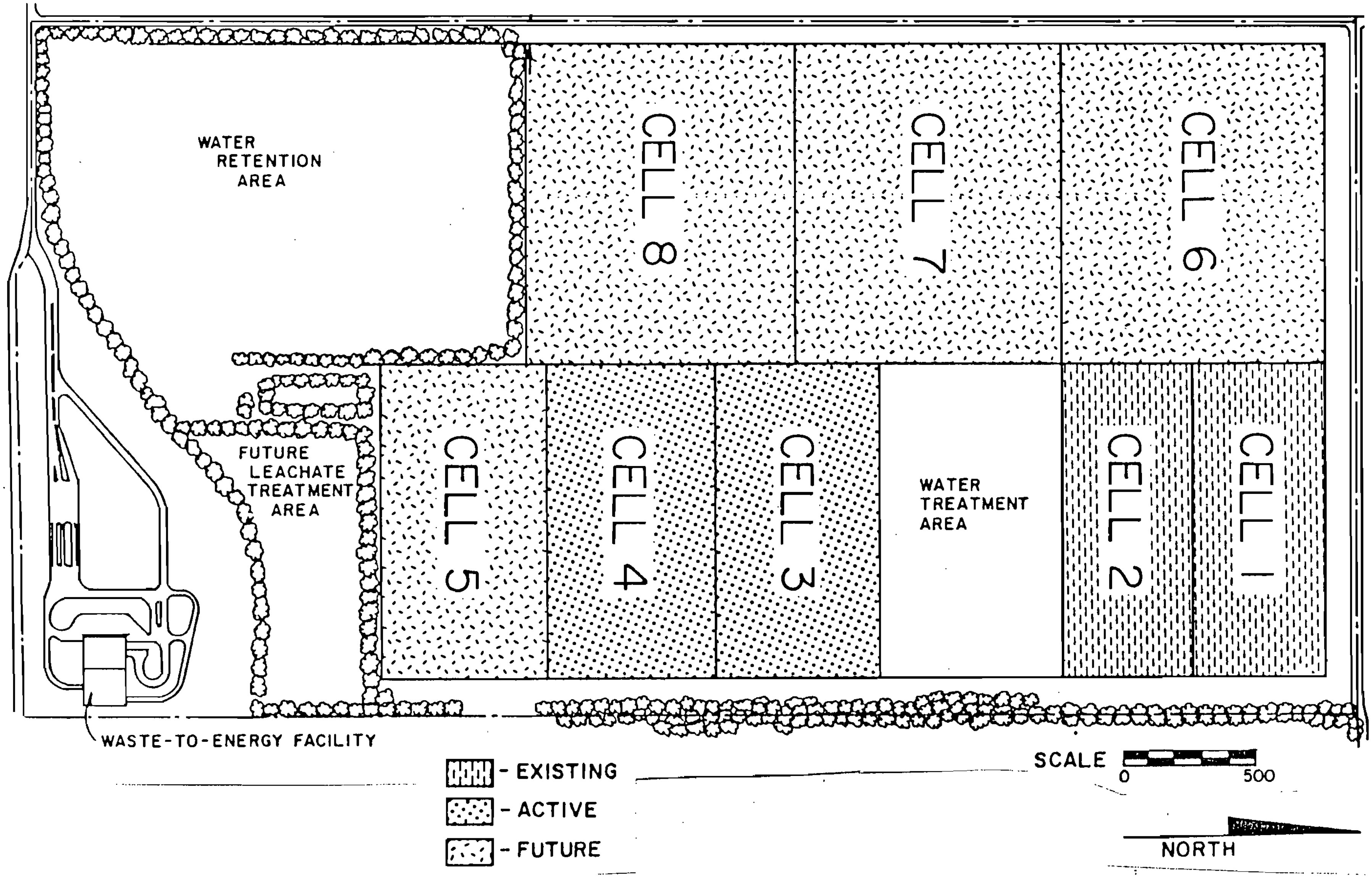
Best Available Copy



LOCATION OF PROPOSED COLLIER COUNTY WASTE-TO-ENERGY PLANT
(CCWEP)

Source: U.S. Geological Survey, 1973

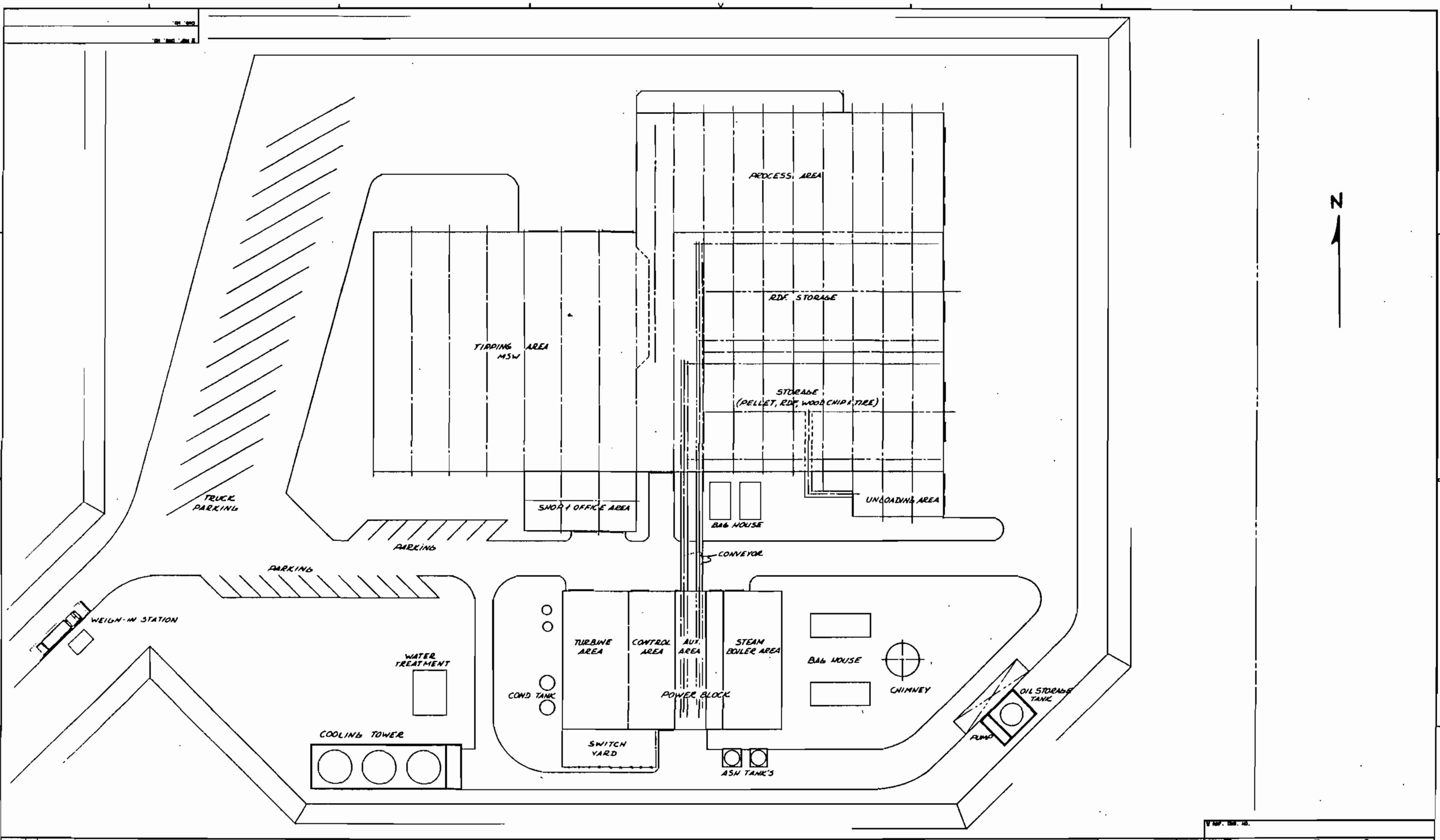
KBN



NAPLES SANITARY LANDFILL SITE PLAN

Source: Henningson, Durham & Richardson, 1985a

KBN



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WESTINGHOUSE PROPRIETARY DATA

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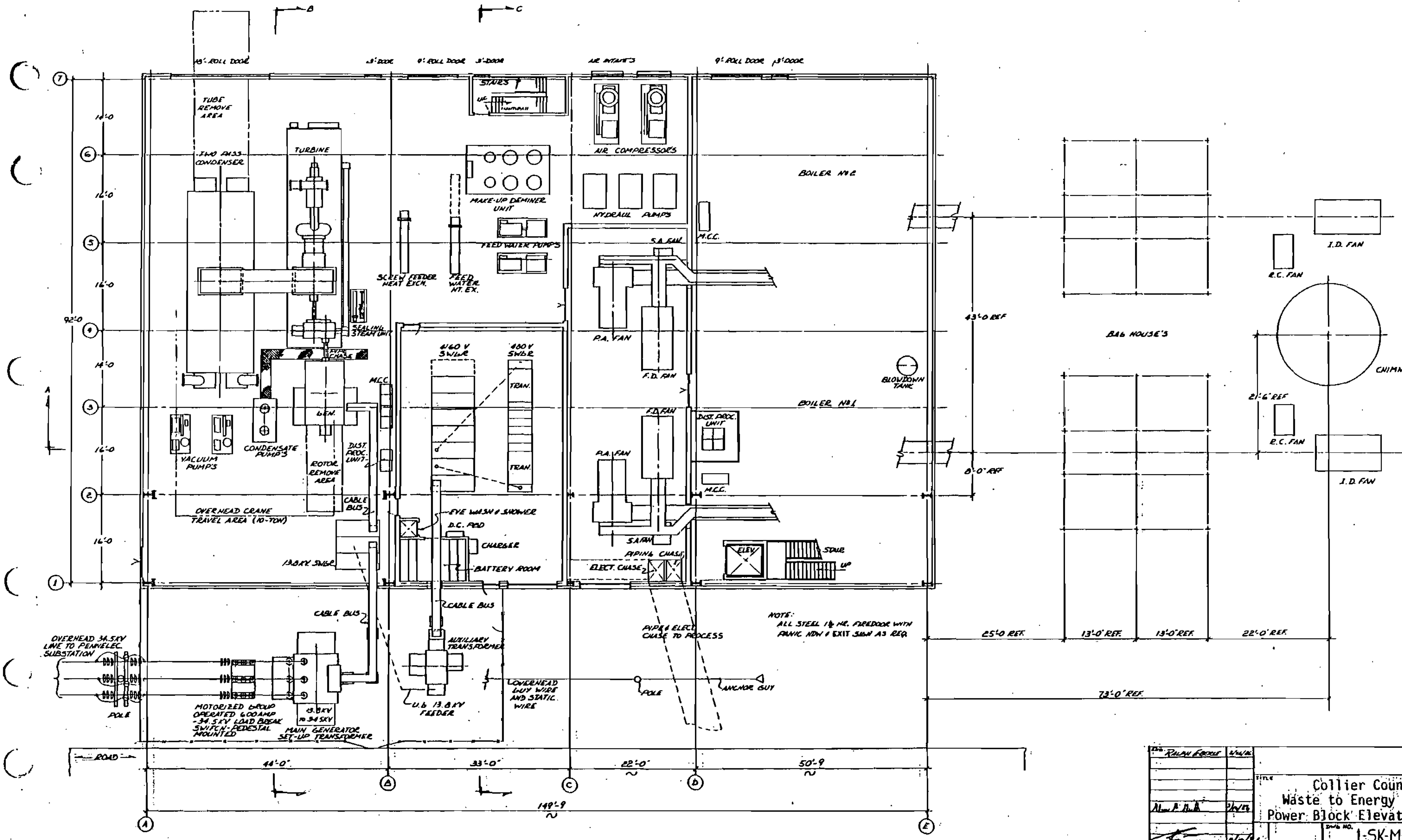
DFTM		
CHKR		
	Ram F. Eberle	4/21/86
	J.P. Bennett	4/25/86
ENG		

Westinghouse Electric Corporation
PLANT ENGINEERING DIVISION - PITTSBURGH, PA

TITLE
RESOURCE RECOVERY OF COLLIER, INC.
COLLIER MUNICIPAL WASTE-TO-ENERGY PLANT
COLLIER SITE
PLOT PLAN

SIZE D DWG. NO. 2A-OS 000D01/A REV. A
SCALE 1" = 30'-0



NOTE:
ALL STEEL 1½ HR. FIREDOOR WITH PANIC HDW & EXIT SIGN AS REQ.

DR. Ralph Froese 4/4/86

TITLE
Collier County
Waste to Energy Plant
Power Block Elevation 0'-0"

DWG NO. 1-SK-M-D025/A