Florida Power
CORPORATION

December 3, 1982

Ms. Victoria J. Tschinkel
Secretary
Florida Department of Environmental Regulation
2600 Blair Stone Road
Tallahassee, Florida 32304

Subject: Bartow Units 2 & 3
Coal Conversion

Dear Ms. Tschinkel:

We have reviewed the correspondence from FDER on the subject project and have identified several requests for information which we have not previously addressed. The items to which we have developed responses are as follows:

1. A response to item #1 in C. H. Fancy's letter of May 20, 1982, recommending Best Available Control Technology (BACT) for particulate matter, sulfur dioxide, and nitrogen oxides is in Attachment 1. For sulfur dioxide, an economic and engineering evaluation of burning .7% S coal (1.2 lbs of $SO_2/10^6$ BTU heat input) versus 1.5% S coal (2.75 lbs of $SO_2/10^6$ BTU heat input) as proposed in our application is provided, including a discussion of availability of supplies and any special processing, such as washing, etc. A discussion on why flue gas desulfurization equipment (scrubbers) is not proposed is included.

2. A response to a question in item #3 of C. H. Fancy's letter of May 20, 1982 regarding the NO_x emission rate on 100% coal and the amount of increase of the NO_x emission rate for each unit due to coal conversion is provided in Attachment 2.

3. A response to William Thomas' letter of July 14, 1982, providing the air quality impact analyses required for an application for modification under the PSD regulations is included in Attachment 3. These analyses show that the conversion will not violate the ambient air quality standards nor the PSD increments.

4. Items 1 & 2 in your letter of September 14, 1982, are addressed by the information provided in the above items.

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5. Although not specifically requested in the Department's correspondence, we understand that your staff wanted information on the differences in capacity factors for the units on oil versus coal. This is shown in Attachment 4.

This provides all the information the Department has requested in order to complete the review of our applications. It is our understanding that the Department will work to respond in regards to issuance of the permit in approximately 30 days.

Sincerely,

William S. O'Brien

William S. O'Brien
Director
Environmental & Licensing Affairs

WSO/gr

Attachments

ATTACHMENT 1

1. Response to item #1 in C. H. Fancy's letter of May 20, 1982, recommending Best Available Control Technology (BACT) for particulate matter, sulfur dioxides, and nitrogen oxides:

A. Particulate Matter -
The recommended BACT for particulate matter is an electrostatic precipitator (ESP) that would provide compliance with the 0.1lbs/MBTU emission standard.

Both ESP and fabric filter bag houses were considered and evaluated in the conceptual design for the coal conversion.

The economics were basically a trade-off between the two collection systems.

For maximum fuel flexibility, we are retaining the oil firing capability on the units and will also use supplementary oil firing for flame stabilization at low loads. The ESP was selected becaused fabric filters do not operate effectively when firing heavy oil due to the oil flyash clogging the filters.

Design of the ESP is very conservative by requiring a minimum specific collection area (SCA) of 500. This will allow us to burn a range of different sulfur content coals and still meet the 0.1lbs/MBTU emission limit.

B. Sulfur Dioxide
The recommended BACT for sulfur dioxide is burning a medium sulfur coal with a sulfur dioxide emission rate of 2.75 lbs/MBTU. This will assure compliance of the applicable ambient air quality standards, the prevention of significant deterioration increment and not increase the present emission rate.

By way of comparison, use of a low sulfur coal with a sulfur dioxide emission rate of 1.2 lbs/MBTU would carry certain economic costs and design penalties. There are two major pieces of equipment needed for coal firing that could be affected if low sulfur coal was burned instead of the proposed coal. They are the ESP and the coal pulverizers.

An analysis made by the proposed precipitator manufacturer indicates that the ESP they would supply would be able to operate effectively with any of the four low sulfur coals studied as possible supplies. However, all of the four coals are more corrosive than the proposed design coal. This could increase the maintenance required on the units, but an actual dollar amount cannot presently be determined.

The grindability of the low sulfur coals is worse than the medium sulfur coal and would require an increase in the proposed mill sizes. There would be approximately a $1,000,000 cost increase for the larger coal mills.

B. Sulfur Dioxide (cont.)

Data from recent coal solicitations indicate that the present difference in cost of the low sulfur coal is approximately 15 ($2,600,000) cents/MBTU higher than the cost of medium sulfur coal. This difference will increase each year because of escalating costs for both types of coal.

Utilizing our most recent projections results in the following cost penalty over the first ten years of operation.

Fuel Cost Differential for 1985 - 1994

Unit No. 2	$40,997,000
Unit No. 3	$75,520,000
Total	$116,517,000

C. Nitrogen Oxides

The two units being converted for coal firing at Bartow Plant are both Combustion Engineering tangentially fired units.

In an effort to achieve a minimum NO_x formation on coal firing, it has been decided to redesign and replace the entire burner compartments on both units utilizing state of the art design developed by Combustion Engineering, Inc. and utilizing overfire air for NO_x control. This is the recommended BACT for NO_x control.

Overfire air operation has proven to be the most successful method for controlling NO_x in tangentially fired coal steam generators. Overfire air is introduced into the furnace tangentially through two additional air compartments, termed overfire air ports, designed as vertical extensions of the corner windboxes. These overfire air ports are provided with flow dampers adjusted according to total air and sized to handle 15 percent of the total windbox airflow. The system is also equipped with manual tilt control so that the overfire air compartment nozzles may be tilted independently of the remainder of the windbox nozzles. The position of overfire air dampers and tilt are optimized after initial operation to yield the lowest NO_x emissions consistent with satisfactory furnace performance.

The proven success of overfire air in controlling NO_x formation during coal combustion lies in the fact that this method inhibits formation of NO_x by both atmospheric nitrogen fixation (thermal NO_x) and fuel nitrogen conversion (fuel NO_x). When operating with design levels of overfire air, approximately 15 percent of the windbox airflow is introduced through the overfire air ports, thereby effecting a reduction in total oxygen supply to the primary flame zone. In this reduced oxygen environment, it is hypothesized that the nitrogen in the coal undergoes a recombination reaction forming molecular nitrogen, N_2 rather than nitric oxide, simply

C. Nitrogen Oxides (cont.)

due to insufficient oxygen in this zone and the intense competition with carbon species for the available oxygen. Consequently, the formation of NO through fuel nitrogen conversion is significantly reduced.

Similarly, overfire air operation results in a reduction in thermal NO_x formation through the highly temperature dependent Zeldovich mechanism. Heat release during the initial stages of combustion in the primary flame zone is somewhat reduced and delayed due to the reduced oxygen environment, with combustion readily completed in the vicinity of the overfire air injection ports. The stretching of the heat release over a greater furnace volume results in lower combustion temperatures, thereby reducing thermal NO_x formation.

The overfire NO_x control that will be incorporated into these units will allow the units to operate below the EPA new source performance standard for coal of 0.6 pounds NO_x/MBTU heat input. Combustion Engineering has estimated that the NO_x emission utilizing overfire air systems will be 0.52lbs/MBTU for Unit No. 2 and 0.49lbs/MBTU for Unit No. 3.

2. The decision of not installing scrubbers to control SO_2 emission is economic. The two main incentives for converting these units to coal were to reduce Florida Power's dependence on oil and to affect a fuel savings for our customers. Considering the enormous first cost for installing scrubbers and the continuing operation and maintenance costs, the economic justification for the project would disappear if scrubbers were required.

The following is an economic evaluation covering the initial cost, and the operating and maintenance costs that would be incurred if scrubbers were installed on the units.

These estimates were developed from information presented in Volume I, "Control of Emissions From Coal Fired Power Plants", presented in March 1981, at the EPA Emission Control Symposium.

Initial Equipment and Construction Cost - $156/KW

Unit No. 2 -	(120,000 KW)(156)= (343)	$18,720,000	41,160,000
Unit No. 3 -	(220,000 KW)(156)=	$34,320,000	64,900,000
	295	$55,020,000	106,060,000

1st Year Operating and Maintenance Costs = $10,600,000

Based upon these figures, the ownership costs and operating and maintenance costs are estimated to total more than $225,000,000 during the period 1985-1994.

ATTACHMENT 2

Response to item #3 in C. H. Fancy's letter of May 20, 1982, concerning NO_x emissions resulting from the conversion:

A. As indicated in Attachment 1, item C, the projected NO_x emission rates for Unit 2 and 3 on coal are 0.52lbs/MTU and 0.49lbs/MBTU, respectively.

B. Based on previous calculations of NO_x emission rates on oil and the above projected NO_x emission rates for coal, it is anticipated that the NO_x emission rates for Units 2 and 3 will increase 53% and 17%, respectively.
68% 18%

4. The controls proposed for NO_x emission control are those as outlined in the recommended BACT for NO_x in Attachment 1, Item C.

ATTACHMENT 3

Response to William Thomas' letter of July 14, 1982, providing the air quality impact analyses required under the PSD regulations:

Based on screening modeling results using worst-case meteorological conditions and results using 5 years of hourly meteorological data, the short-term averaging time TSP and SO_2 concentrations are predicted to be lower when Units 2 & 3 are converted from oil to coal. Also, because the impacts from coal firing are less than from oil firing for downwind distances, at least out to 40 km, the proposed conversion will reduce impacts in the PSD Class I area (i.e., Chassahowitzka National Wilderness); the SO_2 non-attainment area in nortwest Pinellas County; and the TSP non-attainment area in Hillsborough County. For all cases, impacts from the coal conversion are less than the applicable National and Florida AAQS and Class II increments.

The predicted maximum annual average concentrations for SO_2, TSP, and NO_x due to emissions from the proposed conversion are less than the applicable National and Florida AAQS and PSD Class II maximum allowable increments. The maximum increases in SO_2, TSP and NO_x concentrations due to the proposed conversion are generally less than the significant level of 1ug/m^3 for these pollutants. As a result, the maximum predicted increase in concentrations do not significantly impact the PSD Class I & II and SO_2, TSP non-attainment areas.

The modeling studies are attached for further review. They were conducted in accordance with the Department's requirements as outlined in meeting and conversations with Mr. Larry George.

ATTACHMENT 4

Response to the question concerning the difference in capacity factors for the units on oil vs. coal.

	BARTOW #2			BARTOW #3		
		Coal			Coal	
Year	Oil	.7%	1.5%	Oil	.7%	1.5%
1982	59	N/A	N/A	34	N/A	N/A
1983	59	N/A	N/A	14	N/A	N/A
1984	56	7	7	15	N/A	N/A
1985	48	80	83	6	82	84
1986	46	77	78	9	79	79
1987	51	77	78	17	78	79
1988	52	78	80	13	80	81
1989	55	77	78	24	78	79
1990	58	79	80	26	80	81
1991	51	77	78	24	79	79
1992	58	78	79	30	79	79
1993	63	78	78	35	79	79
1994	62	77	78	30	79	79

AN AIR QUALITY IMPACT EVALUATION
FOR FPC BARTOW UNITS 2 AND 3
COAL CONVERSION

Prepared for:

FLORIDA POWER CORPORATION
St. Petersburg, Florida

Prepared by:

ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
Gainesville, Florida

November 16, 1982

ESE No. 82-157-100

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1.0 INTRODUCTION

1.1 PURPOSE

Florida Power Corporation (FPC) is an investor-owned company serving the electrical needs in 32 counties located in the west-central portion of the Florida peninsula and the eastern half of the Florida panhandle. To meet the electrical demands in their service area, FPC has 12 generating facilities; 11 of these facilities burn heavy and light oil and natural gas.

During the last 10 years, substantial increases have occurred in the price of fuel oil, with commensurate increases in electricity costs. In response, FPC has changed from burning oil to coal in several generating facilities: Crystal River Units 1 and 2 and Paul L. Bartow Unit 1. FPC, in keeping with efforts to reduce oil consumption, is proposing to install equipment that will allow Bartow Units 2 and 3 to burn coal.

The burning of coal can have potential ambient air quality impacts that are different from those of oil. To evaluate these impacts, FPC contracted ESE to perform state-of-the-art atmospheric dispersion modeling. The purpose of this report is to determine the ambient air quality impacts of burning coal in Bartow Units 2 and 3 and compare the results to promulgated Ambient Air Quality Standards (AAQS) and Prevention of Significant Deterioration (PSD) increments.

1.2 PROJECT DESCRIPTION

The FPC Bartow plant, located in Pinellas County (see Figure 1-1), consists of three fossil steam units with a net winter capability of 437 megawatts (MW); Unit 1 with a capacity of 109 MW, Unit 2 with a capacity of 119 MW, and Unit 3 with a capacity of 209 MW. Currently, Unit 1 burns a mixture of coal and oil. Units 2 and 3 have burned heavy oil and natural gas since their in service dates of August 1961 and July 1963, respectively. A total of four gas turbine peaking units, with a net winter capability of 204 MW, is also located at the Bartow plant.

The steam generators for Units 2 and 3 were designed for coal burning capability. To burn coal in these units, FPC must install coal handling and storage facilities, coal burning equipment (burners), air pollution control equipment, and ash handling and storage facilities.

The coal handling system will consist of receiving facilities, stackout and reclaim facilities, and crushing and silo facilities.

The receiving facilities will consist of the necessary unloading equipment, conveyor, and associated equipment to unload oceangoing barges or ships and convey the coal to the onsite storage area (see Figure 1-2). The system includes a clamshell bucket unloader and conveyor, which will transport coal from the clamshell unloader hopper to the chutework connecting the receiving and stackout and reclaim facilities.

The stackout and reclaim facilities will consist of the necessary conveyors and equipment to place coal into storage and reclaim. The conveyors (2 through 6) will transport and elevate coal from Transfer Point 1 to the radial stacker and from the reclaim hoppers to the coal crusher building. A radial stacker will receive coal from the clamshell unloader hopper through Transfer Point 2 via Conveyor 3 and place the coal into the active storage piles. The rail stacker will be a rail-mounted mast with the capability of rotating 240 degrees. The boom rotation motion will form the pile, while the telescopic chute will be positioned just above the top of the pile to minimize fugitive dust. Coal will be reclaimed from active storage via reclaim hoppers underneath the storage piles and will be conveyed (Conveyors 4 and 5) to magnetic separators for iron removal. The coal will then be conveyed (Conveyor 6) to the crusher building.

The crushing and silo facilities will consist of the necessary crushers, conveyors, and equipment to deliver the properly sized coal at the required feed rate to the plant silos. The crushers will be the ring-type granulator crushers and will have dust-tight frames. Coal will be conveyed from the magnetic separators to the crushers. From the crusher, the coal will then be conveyed to the coal silos either at

Unit 2 or Unit 3. Unit 2 will have three silos, and Unit 3 will have five silos. These silos will provide each unit with a minimum of 8 hours coal supply at maximum load.

A coal sampling and weighing system will be installed to sample and weigh "as received" and "as fired" coal. A sample cutting system is proposed to provide an unbiased representative sample of coal. The "as fired" sample collector will be arranged to index once every 3 hours, at a minimum. The collector will be an automatic rotary collector with eight station arrangements.

The existing oil burners, along with wind box assemblies, will be replaced on both Units 2 and 3. To fire coal, a combination of coal nozzles, oil burners (for flame stabilization), and air registers will be installed. The steam generators for both Units 2 and 3 were manufactured and constructed by Combustion Engineering and are tangentially fired. Unit 2 will have 12 coal nozzles installed, three for each corner of the furnace. A total of 20 coal nozzles will be installed in Unit 3, five for each corner of the furnace. The number of oil burners has not been determined. Burner and air register arrangements have not been designed.

Nitrogen oxides (NO_x) emission control will be incorporated into the design for both Units 2 and 3 as part of their conversion to coal. The design will allow a provision for overfire air, which is considered state-of-the-art for tangentially fired furnaces. The estimated emission rates for these units, 0.52 pound of NO_x per million British thermal units (lb $NO_x/10^6$ Btu) for Unit 2 and 0.49 lb $NO_x/10^6$ Btu for Unit 3, are below the promulgated New Source Performance Standards for new steam electric power plants of 0.6 lb $NO_x/10^6$ Btu (40CFR Part 60 Appendix Da). In this analysis, an NO_x emission limit of 0.6 lb/10^6 Btu was assumed for the proposed coal-fired Units 2 and 3.

Sulfur dioxide (SO_2) emissions will be limited through the sulfur content in the coal. The average sulfur content, as burned, will not exceed 1.58 percent for a heat value of 11,500 British thermal units per pound (Btu/lb).

Particulate emissions will be controlled through the installation of electrostatic precipitators. Tables 1-1 and 1-2 present particulate removal design conditions for Units 2 and 3, respectively. Emission limits of 0.1 lb particulate matter (PM)/10^6 Btu were assumed for this analysis.

The fly ash handling will be accomplished by pneumatically conveying the fly ash collected in the precipitator hoppers to the fly ash storage silo. Fly ash will then either be loaded in trucks for removal from the site to purchasers or placed in a temporary onsite storage area for future sale.

The fly ash storage silo will have sufficient volume to accommodate 92 hours of fly ash production of both units at maximum load while firing the design coal. The silo will be equipped with two telescopic discharge chutes and one rotary unloader. A windbreak enclosure will be installed to prevent the release of fugitive dust from the ash silo unloading area.

A bag filter will be installed on the silo to relieve the silo of the air displaced by incoming ash. The filter will remove fly ash carryover from the air stream exiting the fly ash silo.

A temporary fly ash storage area will be installed to accommodate fly ash generated over a 60-day period while operating at 80-percent load. This area is to be used in the event of a disruption of the offsite fly ash transportation system.

Table 1-1. FPC Bartow Unit 2 Particulate Removal System Design Conditions

Parameter	Value
Flue Gas Flow at System Inlet (Total), acfm	464,000 estimated
Temperature--Normal, °F	320
Temperature--Maximum, °F	750 for 30 minutes
Maximum Particulate at Outlet, lb/10^6 Btu heat input	0.10
Opacity at Chimney Outlet, percent	20
Approximate Total kVA Rating of Transformer-Rectifiers	640
Maximum Gas Velocity through Precipitator at Design Flow Conditions, fps	4.0
Minimum Specific Collecting Area, square feet per 1,000 acfm (based on design flow conditions)	500
Maximum Pressure Drop, inches H_2O	To be supplied precipitator manufacturer
Design Pressure, inches H_2O at 300°F	± 26
Maximum Height of Collecting Surfaces, feet	50
Approximate Aspect Ratio (effective length/effective height)	1.5
Minimum Number of Transformer-Rectifier Sets	10

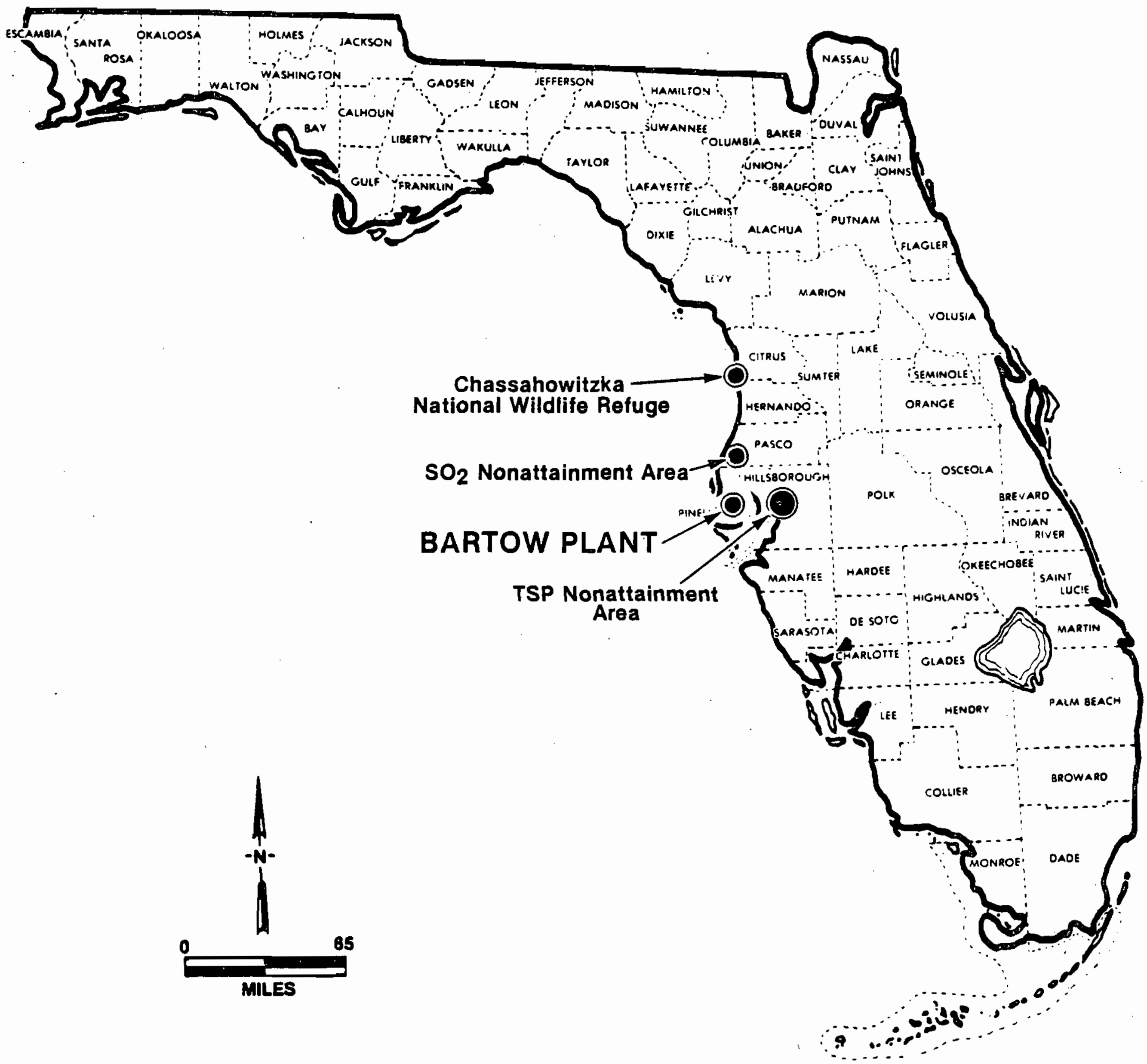
Abbreviations:
acfm = actual cubic feet per minute.
kVA = kilovolt-amperes.
fps = feet per second.

Source: FPC, 1982.

Table 1-2. FPC Bartow Unit 3 Particulate Removal System Design Conditions

Parameter	Value
Flue Gas Flow at System Inlet (Total), acfm	765,000 estimated
Temperature--Normal, °F	320
Temperature--Maximum, °F	750 for 30 minutes
Maximum Particulate at Outlet, lb/10^6 Btu heat input	0.10
Opacity at Chimney Outlet, percent	20
Approximate Total kVA Rating of Transformer-Rectifiers	1,100
Maximum Gas Velocity through Precipitator at Design Flow Conditions, fps	4.0
Minimum Specific Collecting Area, square feet per 1,000 acfm (based on design flow conditions)	500
Maximum Pressure Drop, inches H_2O	To be supplied by precipitator manufacturer
Design Pressure, inches H_2O at 300°F	± 26
Maximum Height of Collecting Surfaces, feet	50
Approximate Aspect Ratio (effective length/effective height)	1.5
Minimum Number of Transformer-Rectifier Sets	15

Source: FPC, 1982.



SOURCE: ESE, 1982.

Figure 1-1
LOCATION MAP OF BARTOW PLANT

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BARTOW PLANT

2.0 METHODS

2.1 DISPERSION MODELS

The models selected for use in this analysis are the U.S. Environmental Protection Agency (EPA) Industrial Source Complex Short-Term (ISCST) and Long-Term (ISCLT) computer codes (EPA, 1979). The ISC model codes, which are approved by EPA and by the Florida Department of Environmental Regulation (DER) are multivariant Gaussian dispersion models used to simulate effluent diffusion at downwind distances from sources or groups of sources. ISCST uses an hour-by-hour computational scheme to estimate maximum 3-hour and 24-hour concentrations. ISCLT uses statistical wind summaries to calculate seasonal or annual ground-level concentrations. The models have a number of options to allow the user to select parameters such as: area, volume, or point sources, coordinate system (polar or cartesian), deposition or concentration, wake effects, stack tip downwash, source separation, terrain effects, and exponential decay.

For this analysis, ISCST was used to assess the particulate matter and SO_2 impacts for the 3-hour and 24-hour averaging times and to estimate 24-hour particulate matter impacts at the plant property line from fugitive emissions. ISCLT was employed to compare annual emissions with long-term (annual) ambient air quality standards for particulate matter, SO_2, and nitrogen dioxide (NO_2).

Throughout this report, the term "maximum concentration" is used to denote highest, second-highest impacts for short-term averaging times. In comparing predicted concentrations with AAQS and PSD increments (see Table 2-1) for such averaging times, EPA and DER recommend using the second-highest predicted impact at each receptor point modeled (EPA, 1978). The highest of these second-highest concentrations over all receptor points is then compared to the standards. This procedure is consistent with the definition of standards and increments, which can be exceeded once per year at each location.

2.2 METEOROLOGICAL DATA

Meteorological data used in the modeling effort were obtained from two sources. Surface data (containing hourly recorded values of wind speed, wind direction, temperature, and cloud cover and ceiling) were obtained from the National Weather Service (NWS) office at the Tampa International Airport. These data were developed to provide a 5-year data base (1970-1974) commensurate with the EPA requirements of a 5-year meteorological data base when offsite meteorological data are used. Upper air data for the same period were obtained from the NWS station located in Ruskin, Florida. These data were used to produce the mixing heights for the short-term modeling portion of the study. Mixing height data for the long-term model (ISCLT) were developed in accordance with guidance in the ISC user's manual using techniques suggested by Holzworth (1972).

2.3 EMISSIONS AND STACK PARAMETERS

The estimated future emissions and stack parameters for Bartow Units 1, 2, and 3 are presented in Table 2-2. These estimates reflect Unit 1 burning a coal-oil mixture and Units 2 and 3 burning coal. Emissions and stack parameters are presented in this table as a function of load. Maximum estimated air quality impacts were estimated using these data.

To compare the proposed changes from oil to coal to the PSD increments, the evaluation requires comparison of predicted future air quality levels with "baseline" air quality concentrations. Baseline concentrations are those due to sources in existence on the baseline date (December 1977) at their baseline emission levels and stack parameters. For the Bartow plant, baseline emissions and stack parameters were determined by DER (George, 1982) to be:

1. The maximum monthly sulfur content of oil in 1977 (to be used in determining the short-term averaging time SO_2 concentrations);
2. The maximum particulate emission rate measured in 1977 [to be used in determining the short-term averaging time total suspended particulates (TSP) baseline concentration]; and

3. The average SO_2, particulate, and NO_x emissions for the years 1976, 1977, 1978, and 1979 (to be used in determining the annual average baseline concentrations).

Table 2-3 presents the baseline emission and stack parameters for Bartow Units 1, 2, and 3. Thse data are based on burning a 2.75 lb $SO_2/10^6$ Btu equivalent sulfur oil and a particulate emission rate of 0.1 lb/10^6 Btu. The table presents the data as a function of load.

As can be observed from a comparison of Tables 2-2 and 2-3, an increase in maximum short-term SO_2 and particulate emissions is not expected from either Unit 1, 2, or 3.

The annual baseline and future emissions for Bartow Units 1, 2, and 3 are presented in Table 2-4. The future emissions are based on the "worst-case" assumption that all units would operate at 100-percent load for an entire year. This assumption is considered conservative, since the average capacity factors for Units 2 and 3 from 1975 through 1981 were 62 percent and 66 percent, respectively.

Annual baseline and future particulate matter and SO_2 emissions for other sources were determined from the DER Air Permit Inventory System (APIS) Report. The criteria for including sources in the analysis were: (1) greater than 100 tons/year and located within 20 kilometers (km), and (2) greater than 200 tons/year and located greater than 20 km but less than 50 km. Listings of the annual baseline and future particulate matter and SO_2 emissions considered in the modeling are presented in Appendix A.

Particulate emissions from coal and fly ash handling and storage are presented in Tables 2-5 and 2-6. Table 2-5 presents emissions from controlled sources, i.e., air that is collected at various transfer and processing points and passed through a bag filter. Fugitive emissions sources are presented in Table 2-6.

2.4 MODEL SCENARIOS

To compare the air quality effects of the proposed Bartow Units 2 and 3 coal conversion to AAQS and PSD increments, eight different modeling scenarios, listed in Table 2-7, were performed.

The proposed maximum SO_2 and particulate emissions for Units 2 and 3 burning coal is the same as that for oil (refer to Table 2-1). As a result, the maximum predicted TSP and SO_2 short-term (3- and 24-hour, as appropriate) concentrations are not expected to be any greater for coal firing than oil firing. In addition, since the greater flow rate for coal firing will increase plume rise and decrease ground-level concentrations, predicted maximum short-term concentrations for coal burning should be lower than that predicted for oil burning. To evaluate this hypothesis, the ISCST model was run to determine ground-level centerline concentrations for six stability classes and up to six wind speeds. A listing of these meteorological conditions is given in Section 3.1. If the results from this analysis demonstrated, for all stabilities, downwind distance, and wind speeds, that there was a predicted decrease in ground-level concentrations by converting Units 2 and 3 from coal to oil, then all short-term impacts using 5 years of meteorological data would be decreased by burning coal.

Also evaluated in the screening analysis was the influence of load on maximum concentrations. Loads of 50 percent, 75 percent, and 100 percent were executed with the ISCST using the screening meteorology.

Comparison with short-term TSP and SO_2 PSD increments was made by subtracting the predicted impacts of Scenario 2 from 3, on a receptor-by-receptor basis. These scenarios were also used to show spatial resolution of maximum short-term impacts. An applicable background concentration was added to the maximum predicted TSP and SO_2 short-term concentrations for making comparisons to AAQS.

A comparison with annual TSP and SO_2 PSD increments was made by subtracting the predicted impacts of Scenario 5 from that predicted in Scenario 4. Predicted maximum annual impacts were compared to AAQS after the addition of a suitable background value.

Baseline and predicted impacts for NO_x were evaluated from the results of Scenarios 6 and 7. A suitable background was added to the model results.

Impacts from coal and fly ash handling were determined from results of Scenario 8. Since the maximum impact for this source category is extremely close to the source of emissions (i.e., within a few hundred meters), then the TSP impacts from these sources will not be coincident with that of the coal units. The maximum predicted concentrations were compared directly to the PSD increments and to AAQS after the addition of a suitable background.

Special receptors were included in both the ISCST and ISCLT model runs to evaluate the air quality impacts to the Hillsborough County TSP nonattainment area, the Pinellas County SO_2 nonattainment area, and the PSD Class I (Chassahowitzka National Wildlife) area. The locations of these areas relative to the Bartow plant are shown in Figure 1-1.

2.5 BACKGROUND AIR QUALITY

To accurately estimate total air quality concentrations, a background concentration must be added to the modeling results. Background is considered to be the air quality concentration not contributed by the sources under evaluation.

For the annual averaging time, background TSP, SO_2, and NO_2 levels were obtained by using the highest mean concentration observed in 1981 for monitors located close to the FPC Bartow plant. This value was added to all annual average model results to obtain maximum air quality level predictions.

A statistical approach was used to determine appropriate short-term (24-hour and 3-hour) background concentrations. Using the maximum measured values at the monitoring stations is not justified for two reasons. First, it is highly unlikely that worst-case meteorological conditions for point source emissions will occur in conjunction with a worst-case background level. Second, the impact of the Bartow plant with SO_2 emissions of 2.75 lb/10^6 Btu is included in the observed data from which a background is selected. A statistically more valid method for determining 24-hour background concentrations is to choose a level that is exceeded 5 percent of the time, or the 95th-percentile concentration. A level that is exceeded 1 percent of the time, or the 99th-percentile concentration, is used for the 3-hour averaging time. A similar approach has been used in previous modeling studies in Florida (ESE, 1979). The probability that these background levels and worst-case point source model predictions will occur simultaneously is less than 1 day in 5 years.

Analysis of many years of ambient data has shown that such data tend to be lognormally distributed. If the lognormal distribution is assumed, the method of Larsen (1971) can be used to estimate the 95th- and 99th-percentile concentration from the annual average concentration. The conversion equation is:

$$C = MgSg^{z}$$

where:
- C = 95th- or 99th-percentile concentration,
- Mg = Geometric mean,
- Sg = Geometric standard deviation,
- z = Number of standard deviations from mean for 95th or 99th percentile (z = 1.64 for the 24-hour averaging time, and z = 2.33 for the 3-hour averaging time).

Table 2-1. Federal and State of Florida AAQS and Allowable PSD Increments (ug/m^3)

Pollutant	Averaging Time	Federal Primary Standard	Federal Secondary Standard	State of Florida	PSD Increment Class I	PSD Increment Class II	PSD Increment Class III
Suspended Particulate Matter	Annual Geometric Mean	75	60	60	5	19	37
	24-Hour Maximum*	260	150	150	10	37	75
Sulfur Dioxide	Annual Arithmetic Mean	80	N/A	60	2	20	40
	24-Hour Maximum*	365	N/A	260	5	91	182
	3-Hour Maximum*	N/A	1,300	1,300	25	512	700
Nitrogen Dioxide	Annual Arithmetic Mean	100	100	100	—	—	—

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

Sources: 40 CFR, Parts 50 and 52.
Ch 17-2, Florida Administrative Code.

Table 2-2. Stack and Operating Data for Short-Term Averaging Periods for the Proposed Coal Conversion

	Unit 1			Unit 2			Unit 3		
Stack Data									
Stack height (feet)		300			300			300	
Stack diameter (feet)		9			9			11	
Operating Data									
Load (percent)	100	75	50	100	75	50	100	75	50
Temperature (°F)	311	311	311	301	301	301	294	294	294
Velocity (fps)	119	89.4	59.6	122	91.2	60.8	134	101	67.1
Emission Data									
SO_2* (lb/hr)	3,355	2,516	1,678	3,277	2,458	1,639	5,451	4,088	2,726
PM† (lb/hr)	122	91.5	61	120	90	60	199	149	99.5

* 2.75 lb SO_2 per 10^6 Btu.
† 0.1 lb PM per 10^6 Btu.

Source: ESE, 1982.

Table 2-3. Stack and Operating Data for Short-Term Averaging Periods for Baseline Conditions

	Unit 1			Unit 2			Unit 3		
Stack Data									
Stack height (feet)		300			300			300	
Stack diameter (feet)		9			9			11	
Operating Data									
Load (percent)	100	75	50	100	75	50	100	75	50
Temperature (°F)	310	275	250	300	275	250	300	275	250
Velocity (fps)	92	69	46	92	69	46	110	82	55
Emission Data									
SO_2* (lb/hr)	3,355	2,516	1,678	3,277	2,458	1,639	5,571	4,178	2,786
PM† (lb/hr)	122	91.5	61	120	90	60	203	152	102

* 2.75 lb SO_2 per 10^6 Btu.
† 0.1 lb PM per 10^6 Btu.

Source: ESE, 1982.

Table 2-4. Emission Data for Annual Averaging Periods for Baseline Conditions and Proposed Coal Conversion

	Emissions (tons per year)			
	Unit 1	Unit 2	Unit 3	
Baseline Conditions				
SO_2*	7,899	4,467	13,480	
PM*	249	135	405	
NO_x†	791	~~1,163~~ 1,155	~~2,921~~ 2,745	
Proposed Coal Conversion				
SO_2	9,600 (based on Dutch?)	14,353	23,876	2.75 lb/MBTU
PM	354	524	871	0.1 lb/MBTU
NO_x	3,206	3,145	5,230	0.6 lb/MBTU

* Average emission rate calculated from fuel burned from 1976 to 1979.
† Average emission rate calculated from fuel burned from 1978 to 1979.

Source: ESE, 1982.

Table 2-5. Coal and Fly Ash Handling Emission Points, FPC Bartow Units 2 and 3 Coal Conversion

Source Name	Process Rate		Estimated Controlled Emissions*			Stack Parameters†	
	Maximum (tons/hr)	Annual (1,000 tons/yr)	Maximum (lb/hr)	Maximum (lb/day)	Annual (tons/yr)	Height (ft)	Flow Rate (scfm)
Clamshell Unloader	1,500	714	8.57	97.2	3.6	46	50,000
Transfer Point 1	1,500	714	1.11	12.7	0.5	46	6,500
Transfer Point 2	1,500	1,428	2.05	49.4	1.7	64	12,000
Reclaim Structure	500	714	0.69	4.56	1.0	54	4,000
Crusher Building	500	714	1.71	11.5	2.5	109	10,000
Transfer Point 3	500	714	2.91	19.4	4.2	144	17,000
Transfer Point 4	500	296	2.91	7.44	1.7	134	17,000
Transfer Point 5	500	418	4.29	17.8	3.6	148	25,000
3 Coal Silos--Unit 2	500	296	2.06	5.28	1.2	110	12,000
3 Coal Silos--Unit 3	500	250.8	2.06	5.28	1.0	155	12,000
2 Coal Silos--Unit 3	500	167.2	1.37	2.28	0.5	155	8,000
2 Fly Ash Vacuum Pumps	40	63	0.86	26.2	2.7	46	5,000
Fly Ash Silo Vent	150	63	3.43	27.6	1.4	46	20,000

* Based on controlled emission rate of 0.02 grain/scf.
† Ambient temperature assumed for each source.

Source: ESE, 1982.

Table 2-6. Coal and Fly Ash Fugitive Emissions, FPC Bartow Units 2 and 3 Coal Conversion

Source Name	Process Rate: Maximum (tons/hr)	Process Rate: Annual (1,000 tons/yr)	Controlled Emission Rates: Maximum (lb/hr)	Controlled Emission Rates: Maximum (lb/day)	Controlled Emission Rates: Annual (tons/yr)	Emission Factor* (kg/tonne)
Radial Stacker†	1,500	714	0.102	1.15	0.024	$0.0009 \frac{\left(\frac{S}{5}\right)\left(\frac{U}{2.2}\right)\left(\frac{H}{3}\right)}{(0.5\ M)^{2}\left(\frac{Y}{416}\right)}$
Active Pile						$0.025 \left(\frac{S}{1.5}\right)\left(\frac{D}{235}\right)\left(\frac{F}{15}\right)\left(\frac{d}{90}\right)$
Wind Erosion						
Low Sulfur	57	500	1.2		5.2	
High Sulfur	24	214	1.2		5.3	
Fly Ash Silo Unloading**	150	62.9	2.25	18.0	0.472	0.15
Conveyors						
Reserve Pile						Emission controls will keep emissions to a minimum
Wind Erosion	Various					
Formation						
Traffic						

* Assumptions: Silt Content (S) = 5 percent.
Mean Wind Speed (U) = 4.4 m/sec.
Height of Release (H) = 3.1 m.
Moisture Content (M) = 7 percent.
Volume of Material Transferred (Y) = 4.6 m^3.
Number of Days that Material is Stored (d) = 8.4 (low sulfur); 19.8 (high sulfur).
Percent of Time that Wind Speed is Greater than 12 mph (F) = 18.8.
Number of Dry Days (D) = 258.

† Emission control efficiency of 75 percent.

** Emission Control Efficiency of 95 percent.

Source: ESE, 1982.

Table 2-7. Modeling Scenarios for FPC Bartow Units 2 and 3 Coal Conversion

Modeling Scenario	Model	Receptor Grid	Meteorology	Pollutant(s)	Source(s)
1. Screening—Maximum 1 Hour	ISCST	0.4–5 km @ 0.2-km spacing 5–10 km @ 0.5-km spacing 10–40 km @ 5-km spacing	6 hourly stability classes and up to 6 wind speeds	TSP* and SO_2	Bartow Units 1, 2, and 3 1) Oil at 2.75 lb $SO_2/10^6$ Btu 2) Coal at 2.75 lb $SO_2/10^6$ Btu (or coal/oil mixture)
2. Baseline Short Term	ISCST	1–5 km @ 1-km spacing 5 at TSP Nonattainment Area 3 at SO_2 Nonattainment Area 2 at Class I Area	5-year Tampa, Hourly (1970–1974)	TSP* and SO_2	Bartow Units 1, 2, and 3 at 2.75 lb $SO_2/10^6$ Btu on oil
3. Projected Short Term	ISCST	1–5 km @ 1-km spacing 5 at TSP Nonattainment Area 3 at SO_2 Nonattainment Area 2 at Class I Area	5-year Tampa, Hourly (1970–1974)	TSP* and SO_2	Bartow Unit 1 on coal/oil mixture; Bartow Units 2 and 3 at 2.75 lb $SO_2/10^6$ Btu and 1.2 lb $SO_2/10^6$ Btu
4. Annual Baseline	ISCLT	1–7.5 km @ 1 km spacing† 3 at SO_2 Nonattainment Area 2 at Class I Area	5-year Tampa, Average (Star 1970–1974)	TSP and SO_2	Bartow Units 1, 2, and 3 at average for 1976–1977; other sources at 1977 actuals
5. Annual Projected	ISCLT	1–7.5 km @ 1 km spacing† 3 at SO_2 Nonattainment Area 2 at Class I Area	5-year Tampa, Average (Star 1970–1974)	TSP and SO_2	Bartow Unit 1 on coal/oil mixture; Units 2 and 3 at 2.75 lb $SO_2/10^6$ Btu; new sources and baseline sources reflect changes, if any, from 1977 baseline
6. Annual Baseline	ISCLT	1–7.5 km @ 1 km spacing	5-year Tampa, Average (Star 1970–1974)	NO_2	Bartow Units 1, 2, and 3 (1978–1979)
7. Annual Projected	ISCLT	1–7.5 km @ 1 km spacing	5-year Tampa, Average (Star 1970–1974)	NO_2	Bartow Units 1, 2, and 3 at 0.6 lb $NO_2/10^6$ Btu
8. Coal and Fly Ash Handling (Fugitive Emissions)	ISCST	34 receptors on FPC's non-water property	5-year Tampa, Hourly (1970–1974)	TSP	Controlled and fugitive emission sources

* Determined through ratio.
† Receptors include TSP nonattainment area.

Source: ESE, 1982.

3.0 RESULTS

3.1 BACKGROUND AIR QUALITY

Ambient air quality for TSP and SO_2 is measured at a monitoring site located 2.2 km west of the FPC Bartow plant (see Figure 1-1). In 1981 the highest and second-highest 24-hour SO_2 concentrations were 152 and 139 micrograms per cubic meter (ug/m^3), respectively. The highest and second-highest observed 3-hour SO_2 concentrations for the same period were 476 and 380 ug/m^3, respectively. Total suspended particulate matter concentrations were measured in 1981 by two co-located monitors at this site. The highest and second-highest observed TSP concentrations, for both monitors, were 92 and 79 ug/m^3, respectively. Data from this monitoring site were used to develop background concentrations for TSP and SO_2.

NO_2 is measured in Pinellas County at a site located 16 km southwest of the Bartow plant. The NO_2 background concentration was determined to be the 1981 annual average for this site.

Table 3-1 presents the background concentrations developed for TSP, SO_2, and NO_2. These concentrations were added to the predicted impacts with Bartow units firing coal; the total was used for comparison with AAQS.

3.2 SCREENING ANALYSIS

The results of the screening analysis are presented in Tables 3-2 and 3-3. As shown in Table 3-2, for all stabilities and wind speeds evaluated, maximum predicted centerline ground-level SO_2 concentrations with the Bartow plant burning coal were reduced from the predicted concentrations while burning oil. Reductions in SO_2 concentrations from 46 percent to 4.5 percent were calculated. The calculated SO_2 reductions in ground-level concentrations would also be the same for TSP.

The maximum predicted centerline SO_2 concentrations from Bartow Units 2 and 3 burning coal as a function of load is shown in Table 3-3. With the exception of the most unstable meteorological conditions, all maximum SO_2 concentrations were highest at 100-percent load.

The screening analysis has shown that: (1) a refined short-term impact analysis using a 5-year meteorological data base is not necessary since all TSP and SO_2 concentrations are predicted to be lower for coal firing than oil firing, and (2) a 100-percent load condition will produce maximum ground-level concentrations.

3.3 MODELING RESULTS

3.3.1 SO_2 Concentrations

Class II Impacts--A summary of the maximum 3- and 24-hour average SO_2 concentrations that were predicted over a 5-year period due to the emissions from the Bartow plant for baseline conditions and proposed coal conversion is presented in Table 3-4. The predicted concentrations assume that Units 1, 2, and 3 operate at maximum capacity (i.e., 100-percent load) for both the baseline conditions and for the proposed coal conversion.

For the proposed coal conversion, SO_2 emission limits from Units 2 and 3 of 2.75 and 1.2 lb/10^6 Btu were considered in the modeling. Background concentrations for the 3- and 24-hour averaging periods were estimated as 121 and 62 ug/m^3, respectively. The background concentrations were added to the predicted plant impacts to provide an estimate of the total air quality impacts. From the results presented in Section 3.2, the impacts from proposed coal-fired units generally will be lower than those for the oil-fired units for all meteorological conditions and downwind distances. As shown in Table 3-4, the maximum concentrations over the 5-year period for both the 3- and 24-hour averaging periods are lower when Units 2 and 3 are converted from oil- to coal-fired units. The spatial distributions of the maximum 3- and

24-hour average concentrations due to proposed coal conversion assuming maximum emissions (i.e., 2.75 lb/10^6 Btu) are presented in Figures 3-1 and 3-2, respectively. In addition, the spatial distributions of the difference between the maximum 3- and 24-hour average concentrations of baseline conditions and proposed coal conversion assuming maximum emissions for Units 2 and 3 are displayed in Figures 3-3 and 3-4, respectively.

For the 3-hour averaging period, the maximum predicted concentrations for the proposed coal conversion, assuming emission limits of 2.75 and 1.2 lb/10^6 Btu, are 607 and 428 ug/m^3, respectively. These concentrations are well below the national and Florida AAQS of 1,300 ug/m^3. Similar to the screening modeling results, the difference in predicted concentrations between the baseline conditions and proposed coal conversion over the 5-year period shows a net decrease for both emission limits. As shown in Figure 3-3, the net decrease in concentrations between baseline conditions and proposed coal conversion, assuming maximum emissions, occurs at all downwind distances. Because these concentrations due to the proposed coal conversion are lower than the baseline concentrations, none of the 3-hour PSD increment would be consumed.

The maximum predicted 24-hour average concentrations for the proposed coal conversion, assuming emission limits of 2.75 and 1.2 lb/10^6 Btu, are 173 and 131 ug/m^3, respectively. These concentrations are well below the Florida AAQS of 260 ug/m^3. Again, the impacts for the proposed coal conversion are predicted to be lower than those for the oil-fired units over the 5 years of meteorological data are at all downwind distances (see Figure 3-4). As a result, none of the 24-hour PSD allowable increment would be consumed.

A summary of the annual average concentrations due to baseline emissions and the proposed coal conversion at the Bartow plant is presented in Table 3-5. The predicted concentrations for baseline conditions include the impacts from sources that were estimated to be operating as of the baseline date (i.e., 1977). The predicted concentrations for the proposed coal conversion (i.e., projected case) include changes in emissions from existing sources that have occurred since the baseline date and emissions from new sources. A more detailed description of the methods used in developing these emission inventories is presented in Section 2.0.

The predicted source concentrations were then added to a background concentration of 25 ug/m^3 to produce a total air quality impact. These total impacts are conservative because the background concentration has been estimated from monitoring data, which would have included impacts from the sources that were modeled. As seen in Table 3-5, the total impacts for the projected case are lower than baseline conditions, indicating that there have been significant emission reductions from the sources considered in the modeling since the baseline date. Because of these emission reductions, total air quality impacts have been reduced, resulting in an expansion of the available PSD increments. All of the total predicted air quality impacts are less than the national and Florida AAQS of 80 ug/m^3. The impacts from Units 1, 2, and 3 alone show that the increase in annual average concentrations due to the coal conversion is about 1.6 ug/m^3 with Units 2 and 3 operating at 2.75 $lb/10^6$ Btu.

Class I and Nonattainment Area--A summary of the predicted 3-hour, 24-hour, and annual average concentrations for the baseline emissions and proposed coal conversion in the Class I and SO_2 nonattainment areas is presented in Table 3-6. For the short-term averaging periods, only the impacts due to the emissions from the Bartow plant are presented. Baseline and projected concentrations for the annual average include impacts from other major sources but not a background concentration. These results show that a net decrease occurs in predicted concentrations in the Class I and nonattainment areas over the 5-year period when Units 2 and 3 are converted to coal-fired units.

For the annual averaging period, the total air quality impacts in the Class I area due to the projected emissions from all sources shows a net decrease in concentrations from impacts associated with the baseline conditions. Predicted annual average concentrations in the nonattainment area show an increase in concentrations from the baseline condition. The increase in impacts due to the proposed coal conversion at the Bartow plant is not significant (i.e., less than 1 ug/m^3), even assuming an emission limit of 2.75 $lb/10^6$ Btu at 100-percent load.

3.3.2 TSP Concentrations

Class II Impacts--A summary of the maximum 24-hour average TSP concentrations due to the emissions from the Bartow plant for baseline conditions and proposed coal conversion is presented in Table 3-7. The predicted concentrations assume that Units 1, 2, and 3 operate at maximum capacity (i.e., 100-percent load) for both baseline conditions (i.e., oil-fired) and for the proposed coal conversion. The background concentration for the 24-hour averaging period was estimated to be 92 ug/m^3. The background concentration was added to the predicted plant impacts to provide an estimate of the total air quality impacts. From the results presented in Section 3.1, the impacts from the proposed coal-fired units generally will be lower than those for the oil-fired units for all downwind distances and meteorological conditions.

As shown in Table 3-7, the maximum 24-hour concentration over the 5-year period is lower when Units 2 and 3 are converted from oil- to coal-fired units. The maximum concentration of 96.0 ug/m^3 due to the proposed coal conversion is less than the national and Florida AAQS of 150 ug/m^3. Similar to the screening model results, the difference in predicted concentrations between the baseline emissions and proposed coal conversion over the 5-year period shows a net decrease. Because these concentrations due to the proposed coal conversion are lower than the baseline concentrations, none of the PSD increment would be consumed.

A summary of the annual average concentrations due to the baseline emissions and the proposed coal conversion at the Bartow plant is presented in Table 3-8. The predicted concentrations for baseline conditions include the impacts from sources that were estimated to be operating as of the baseline in 1977. The predicted concentrations for the proposed coal conversion (i.e., projected case) include changes in emissions from existing sources that have occurred since the baseline date and emissions from new sources. A more detailed description of the methods used in developing these emission inventories is presented in Section 2.0. The predicted source concentrations were added to a background concentration of 46 ug/m^3. These total impacts are conservative because the background concentration has been estimated from monitoring data, which would have included impacts from the sources that were modeled. It should be noted that the arithmetic averages calculated for the plant impacts were adjusted to geometric means based on the statistics from the monitoring data. As seen in Table 3-7, the total impacts for the projected case are lower than the baseline conditions, indicating that there has been a reduction in emissions from the sources considered in the modeling since the baseline date. Because of these emission reductions, total air quality impacts have been reduced, resulting in an expansion of the available PSD increment. All of the total air quality predicted impacts are less than the national and Florida AAQS of 60 ug/m^3. The increase in annual average concentrations due to the proposed coal conversion at Units 2 and 3 is less than 1.0 ug/m^3 and, therefore, is not significant.

<u>Class I and Nonattainment Areas</u>--A summary of the predicted 24-hour and annual average concentrations for the baseline emissions and proposed coal conversion in the Class I and PM nonattainment areas is presented in Table 3-9. For the 24-hour average, only the impacts due to the emissions from the Bartow plant are presented. These results show that

a net decrease occurs in predicted concentrations in the Class I and nonattainment area over the 5-year period when Units 2 and 3 are converted to coal-fired units.

For the annual averaging period, the total air quality impacts in the Class I and nonattainment areas remain essentially the same for both the baseline conditions and when Units 2 and 3 are converted to coal-fired units. A background concentration was not added to these results. Also, the impacts due only to the Bartow plant before and after coal conversion are less than 1 ug/m^3 and, therefore, not significant.

Impacts of Fugitive Emissions--Maximum 24-hour and annual average particulate matter concentrations were predicted for the emissions emanating from the proposed coal and fly ash handling systems for Units 2 and 3. In this analysis, concentrations were predicted using 5 years of meteorological data at 34 receptor locations that are the closest distances to public access around the plant. Based on the modeling results, the maximum 24-hour average concentration of 26 ug/m^3 was predicted to occur about 700 m to the southeast of the plant. Because the fugitive emissions are essentially released at ground level, their impacts are not expected to be coincident with the maximum predicted concentrations due to the stack emissions from Units 1, 2, and 3. Also, the maximum concentrations due to the fugitive emissions generally will occur closest to the source of emissions and decrease with increasing downwind distances. Therefore, the maximum concentration due to the highest fugitive emissions would consume less than 75 percent of the 24-hour PSD increment of 37 ug/m^3. When combined with the ambient background concentration of 92 ug/m^3, the total predicted concentration of 118 ug/m^3 is less than the national and Florida AAQS of 150 ug/m^3.

As a conservative estimate of the annual average concentrations, the maximum short-term emissions from the fugitive sources were used in the modeling analyses. The maximum annual average concentration over the

5 years of data was 3.3 ug/m^3, which is less than 20 percent of the annual average PSD increment of 19 ug/m^3. When combined with the ambient background concentration of 46 ug/m^3, the total predicted concentration of 49.3 ug/m^3 is less than the national and Florida AAQS of 60 ug/m^3. Again, the predicted annual average concentrations are conservative because all the coal and fly ash handling activities will not be occurring for all 24-hour periods in the year, as assumed in the modeling analyses.

3.3.3 NO_x Concentrations

A summary of the highest annual average concentrations due to the baseline emissions and the proposed coal conversion at the Bartow plant is presented in Table 3-10. The predicted concentrations for baseline and projected conditions are due only to the emissions from the Bartow plant and a background annual average concentration of 26 ug/m^3. As seen in Table 3-10, the total impacts for the projected case are slightly higher than the baseline case. For both cases, the total concentrations are less than national and Florida AAQS of 100 ug/m^3.

Table 3-1. Background Concentrations for SO_2, TSP, and NO_2

Pollutant	Site Number	Number of Observations	Geometric Mean (ug/m^3)	Geometric Standard Deviation (ug/m^3)	Background (ug/m^3) Annual Average		
					Annual Average	24-Hour	3-Hour
SO_2	3980-023-G02*	7446	24.5	1.89	25	62	121
TSP	3980-023-G02*	52	49 (arithmetic mean)	1.39	46†	92	NA
NO_2	3980-018-G01**	6857	21	2.13	~~26~~ 23	NA	NA

*10100 San Martin Road, St. Petersburg, (NAMS).
†Geometric Mean.
**7200 22nd Avenue, N. St. Petersburg (SLAMS).
NA = Not applicable.

Source: Florida Department of Environmental Regulation, 1982.
ESE, 1982.

Table 3-2. Comparison of Maximum Hourly Centerline Concentrations Due to the Existing Oil-Fired and Proposed Coal-Fired Units*

Meteorological Conditions			Hourly Concentrations (ug/m^3)		Downwind Distance (km)	Percent Reduction in Concentration from Existing Oil-Fired to Proposed Coal-Fired Units
Stability Class	Stability	Wind Speed (m/s)	Existing Units	Proposed Units		
1	Very Unstable	1.0	1,652	890	1.4	46
		3.0	1,265	1,055	0.8	17
2	Unstable	1.0	535	510	5.5	4.5
			540	503	5.0	6.8
		3.0	672	564	2.2	16
			691	560	2.0	19
		5.0	736	629	1.6	15
			750	610	1.4	19
3	Slightly Unstable	1.0	291	278	15.0	4.5
			325	272	10.0	16
		3.0	530	434	4.0	18
			538	424	3.6	21
		5.0	594	498	2.8	16
			600	492	2.6	18
		7.0	593	513	2.4	13
			604	511	2.2	15
		10.0	566	501	2.0	12
			575	497	1.8	14
4	Neutral	1.0	68	40	40.0	41
		3.0	202	155	15.0	23
		5.0	255	208	9.5	19
			258	205	8.5	21
		7.0	274	228	7.0	17
			276	226	6.5	18
		10.0	274	235	5.5	14
			275	232	5.0	16
		15.0	251	223	4.4	11
			252	222	4.2	12
5	Slightly Stable	1.0	355	303	30.0	15
			357	298	25.0	17
		3.0	225	199	20.0	12
		5.0	167	151	20.0	10
			171	150	15.0	12
6	Stable	1.0	91	65	40.0	29
		3.0	89	73	40.0	18

* Existing case with Units 1, 2, and 3 firing oil; proposed case with Unit 1 firing coal-oil mixture, Units 2 and 3 firing coal.

Source: ESE, 1982.

Table 3-3. Comparison of Maximum Hourly Centerline Concentrations Due to the Proposed Coal-Fired Units 2 and 3 Operating at 100-, 75-, and 50-Percent Loads

Meteorological Conditions			100-Percent Load		75-Percent Load		50-Percent Load	
Stability Class	Stability	Wind Speed (m/s)	Concentration (ug/m^3)	Distance (km)	Concentration (ug/m^3)	Distance (km)	Concentration (ug/m^3)	Distance (km)
1	Very Unstable	1.0	443	1.4	885	1.4	615	1.4
		3.0	709	0.8	668	0.8	556	0.8
2	Unstable	1.0	366	5.5	286	5.0	229	3.8
		3.0	381	2.2	364	2.0	331	1.6
		5.0	428	1.6	395	1.4	341	1.2
3	Slightly Unstable	1.0	199	15	170	10.0	161	7.5
		3.0	291	4.2	282	3.6	262	3.0
		5.0	338	3.0	317	2.6	277	2.2
		7.0	352	2.4	320	2.2	268	2.0
		10.0	347	2.0	305	1.8	245	1.6
4	Neutral	1.0	23	40	34	40	43	40
		3.0	101	15	105	15	106	10
		5.0	139	10	136	8.5	125	7.0
		7.0	155	7.5	145	6.5	127	5.5
		10.0	161	6.0	146	5.0	120	4.4
		15.0	155	4.6	134	4.2	105	3.8
5	Slightly Stable	1.0	206	30	187	25	161	20
		3.0	138	20	119	20	95	15
		5.0	106	20	90	15	72	15
6	Stable	1.0	41	40	46	40	50	40
		3.0	49	40	46	40	41	40

Source: ESE, 1982.

Table 3-4. Summary of Predicted Maximum 3- and 24-Hour SO_2 Concentrations due to Baseline Conditions and Proposed Coal Conversion*

Averaging Period	Baseline Conditions		Proposed Coal Conversion 2.75 lb/10^6 Btu		Proposed Coal Conversion 1.2 lb/10^6 Btu		Minimum Difference Between Baseline and Proposed Coal Conversion 2.75 lb/10^6 Btu	Minimum Difference Between Baseline and Proposed Coal Conversion 1.2 lb/10^6 Btu
	Plant	Total	Plant	Total	Plant	Total		
3-Hour								
Concentration (ug/m^3)	601	722	486	607	307	428	-3.8	-31.2
Year	1971		1971		1971		1970	1974
Period (Julian day/hour ending)	178/12		178/12		178/12		NA	NA
Location [Direction (°), Distance (km)]	90-2.0		90-2.0		90-2.0		190-5.0	140-1.0
24-Hour								
Concentration (ug/m^3)	133	195	111	173	69	131	-1.1	-4.3
Year	1971		1974		1974		1972	1972
Period (Julian day)	220		286		286		NA	NA
Location [Direction (°), Distance (km)]	90, 2.0		240, 3.0		240, 3.0		160, 1.0	160, 1.0

* Based on 100-percent load conditions using 5 years of meteorological data.
† 3-hour background estimated as 121 ug/m^3; 24-hour background estimated as 62 ug/m^3.
NA = Not applicable.

Source: ESE, 1982.

Table 3-5. Annual Average SO_2 Concentrations Due to Baseline Conditions and Proposed Coal Conversion

Case	Sources	Concentration* (ug/m^3) Sources	Concentration* (ug/m^3) Total	Location UTM Coordinates (km) East, North
Baseline	All	49	74	350, 3083
	Bartow Units 1, 2, 3	7.3	NA	345, 3083
Projected	All with Units 2 and 3			
	@ 2.75 $lb/10^6$ Btu	24.2	49.2	346, 3083
	@ 1.2 $lb/10^6$ Btu	20.8	45.8	346, 3083
	Bartow Units 1, 2, and 3 with Units 2 and 3			
	@ 2.75 $lb/10^6$ Btu	8.9	NA	346, 3083
	@ 1.2 $lb/10^6$ Btu	5.5	NA	346, 3083

* Background concentration is estimated as 25 ug/m^3.

NA = Not applicable.

Source: ESE, 1982.

Table 3-6. Predicted 3-, 24-Hour, and Annual Average SO_2 Concentrations at the PSD Class I and Nonattainment Areas due to the Baseline Conditions and Proposed Coal Conversion at the Bartow Plant*

Area	Source	Proposed Emission Limits for Units 2 and 3 ($lb/10^6$ Btu)	Concentrations (ug/m^3)† 3-Hour Bartow Plant	24-Hour Bartow Plant	Annual All Sources	Annual Bartow Plant
PSD Class I	Baseline		61.4	10.9	13.6	0.8
	Proposed Coal Conversion	2.75	52.3	10.0	3.9	1.4
		1.2	32.1	6.0	3.7	1.2
Nonattainment	Baseline		125	34	5.5	0.4
	Proposed Coal Conversion	2.75	116	31	9.0	0.6
		1.2	69.9	18.7	8.4	0.2

* Composite maximum concentrations assuming maximum plant operation using 5 years of meteorological data.

† Highest second-highest concentration for Class I area; highest concentration for nonattainment area.

Source: ESE, 1982.

Table 3-7. Summary of Predicted Maximum 24-Hour TSP Concentrations due to Baseline Conditions and Proposed Coal Conversion*

Averaging Period	Baseline Conditions		Proposed Coal Conversion		Minimum Difference Between Baseline and Proposed Coal Conversion
	Plant	Total†	Plant	Total†	
24-Hour					
Concentration (ug/m^3)	4.8	96.8	4.0	96.0	-0.04
Year	1971		1974		1972
Period (Julian day)	220		286		NA
Location [Direction (°), Distance (km)]	90, 2.0		240, 3.0		160, 1.0

* Based on 100-percent load conditions using 5 years of meteorological data.
† Background concentration estimated as 92 ug/m^3.
NA = Not applicable.

Source: ESE, 1982.

Table 3-8. Annual Average TSP Concentrations Due to Baseline Conditions and Proposed Coal Conversion

Case	Sources	Concentration* (ug/m^3)		Location UTM Coordinates (km)
		Sources	Total	East, North
Baseline	All	13.9	59.9	347, 3083
	Bartow Units 1, 2, 3	0.2	NA	345, 3083
Projected	All	13.4	59.4	347, 3083
	Bartow Units 1, 2, 3	0.3	NA	346, 3083

*Background concentration is estimated as 46 ug/m^3.

NA = Not applicable.

Source: ESE, 1982.

Table 3-9. Predicted 24-Hour and Annual Average TSP Concentrations at the PSD Class I and Nonattainment Areas due to the Baseline Conditions and Proposed Coal Conversion at the Bartow Plant*

		Concentrations (ug/m^3)		
		24-Hour	Annual	
Area	Source	Bartow Plant†	All Sources	Bartow Plant
PSD Class I	Baseline	0.4	0.42	0.01
	Proposed Coal Conversion	0.4	0.47	0.02
Nonattainment	Baseline	2.5	5.9	0.03
	Proposed Coal Conversion	2.2	6.1	0.10

* Composite maximum concentrations assuming maximum plant operation using 5 years of meteorological data.

† Highest second-highest concentration for Class I area; highest concentration for nonattainment area.

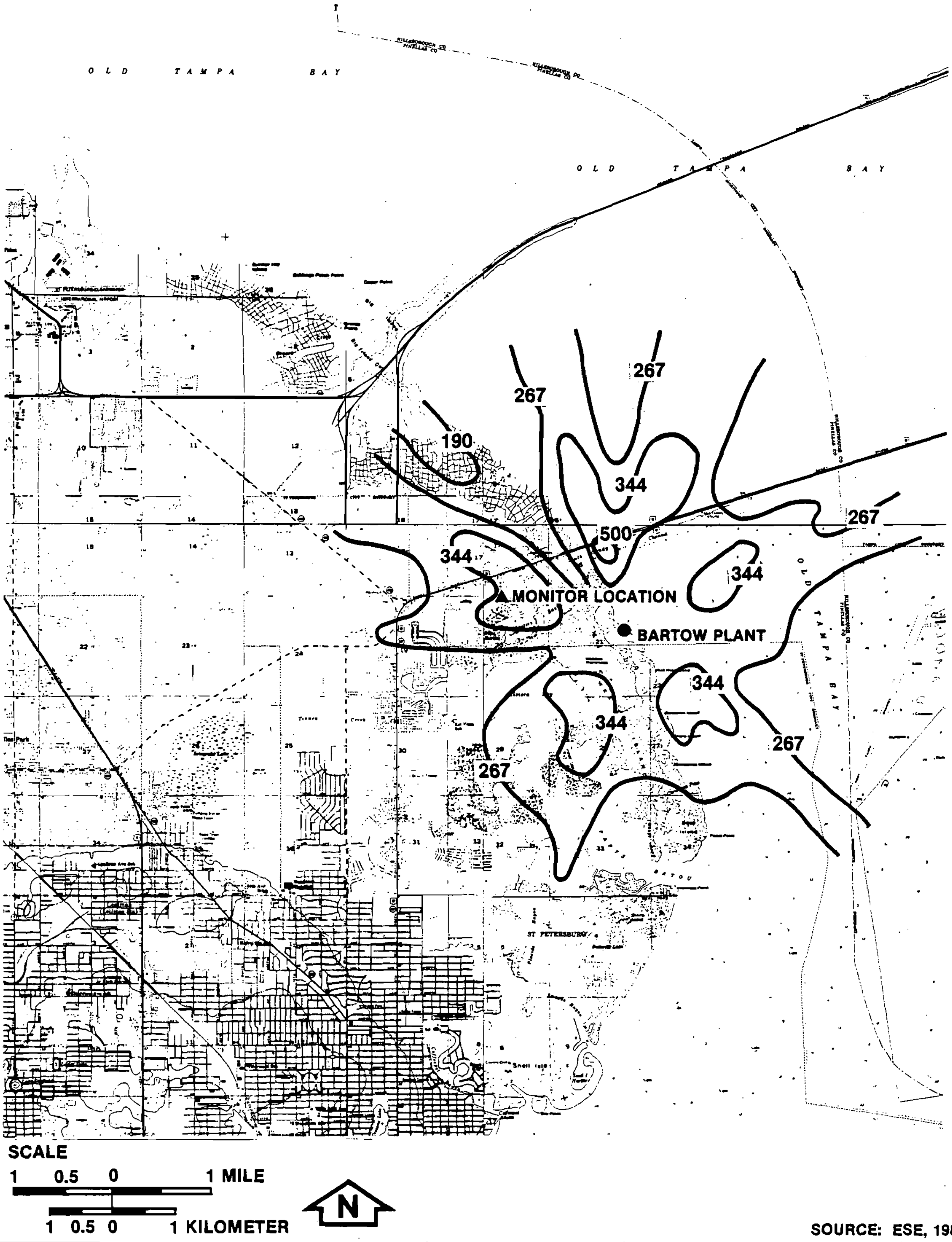
Source: ESE, 1982.

Table 3-10. Predicted Annual Average NO_2 Concentrations Due to Baseline Conditions and Proposed Coal Conversion

	Baseline Conditions		Proposed Coal Conversion	
	Plant*	Total†	Plant*	Total†
Concentration (ug/m^3)	1.3	27.3	2.0	28
Location UTM Coordinates (km) East, North	345, 3083		346, 3083	

* Bartow Units 1, 2, and 3 only.
† Background concentration is estimated as 26 ug/m^3.

Source: ESE, 1982.



SOURCE: ESE, 1982.

Figure 3-1
FIVE-YEAR COMPOSITE OF MAXIMUM 3-HOUR AVERAGE SO_2 CONCENTRATIONS (ug/m3) DUE TO THE PROPOSED COAL CONVERSION

Florida Power CORPORATION

BARTOW PLANT

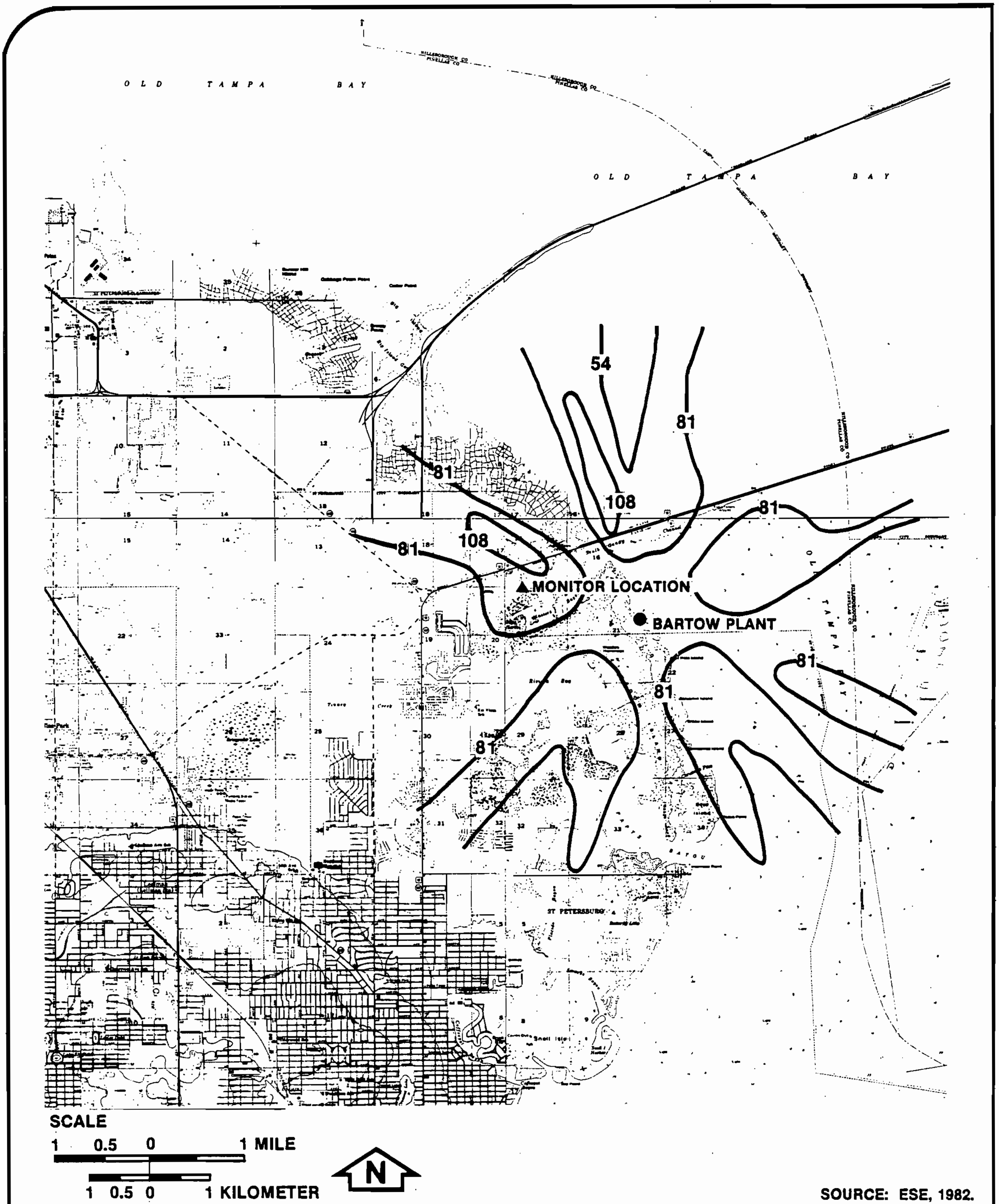
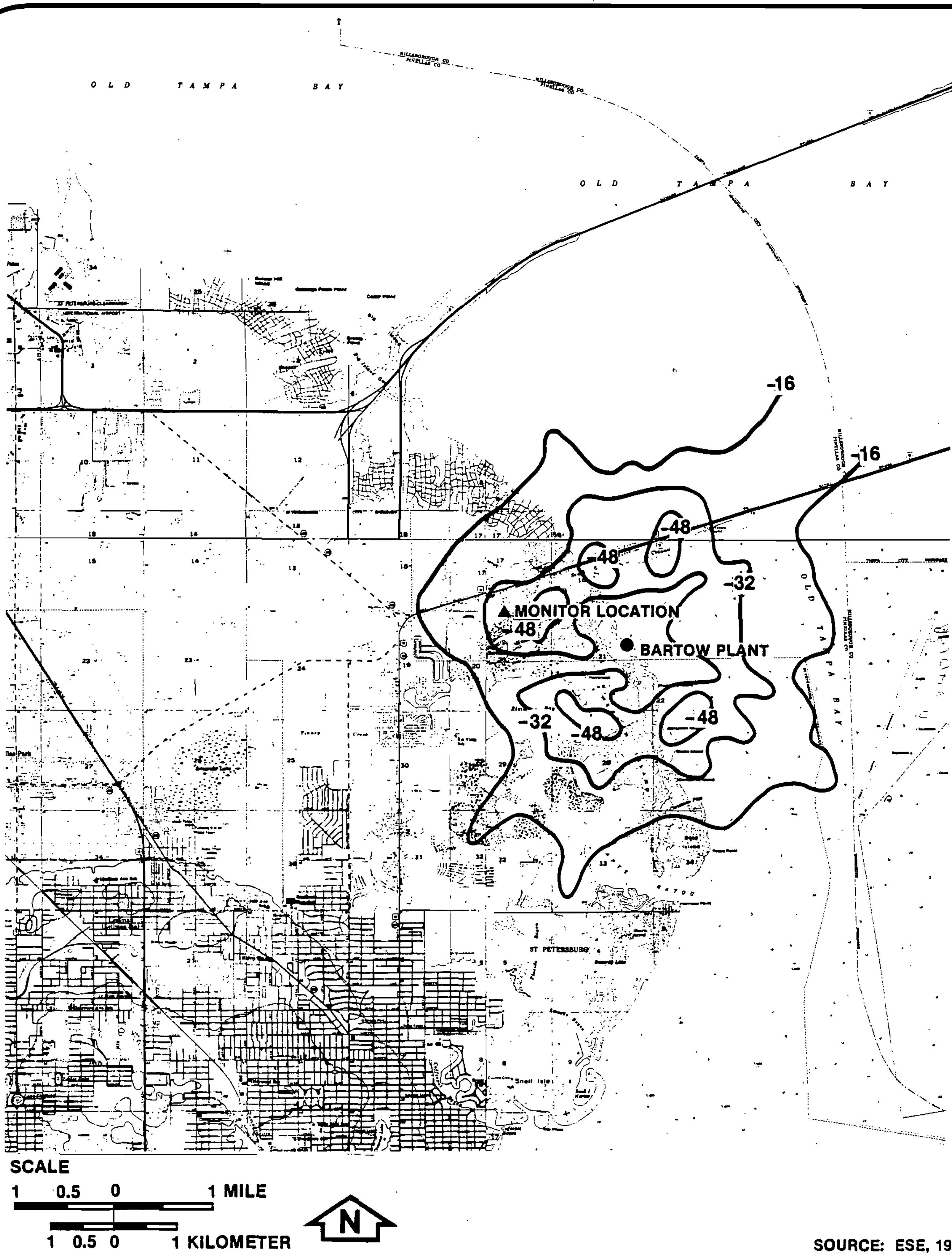


Figure 3-2
FIVE-YEAR COMPOSITE OF MAXIMUM 24-HOUR AVERAGE SO_2 CONCENTRATIONS (ug/m^3) DUE TO THE PROPOSED COAL CONVERSION

Florida Power CORPORATION
BARTOW PLANT

BEST AVAILABLE COPY

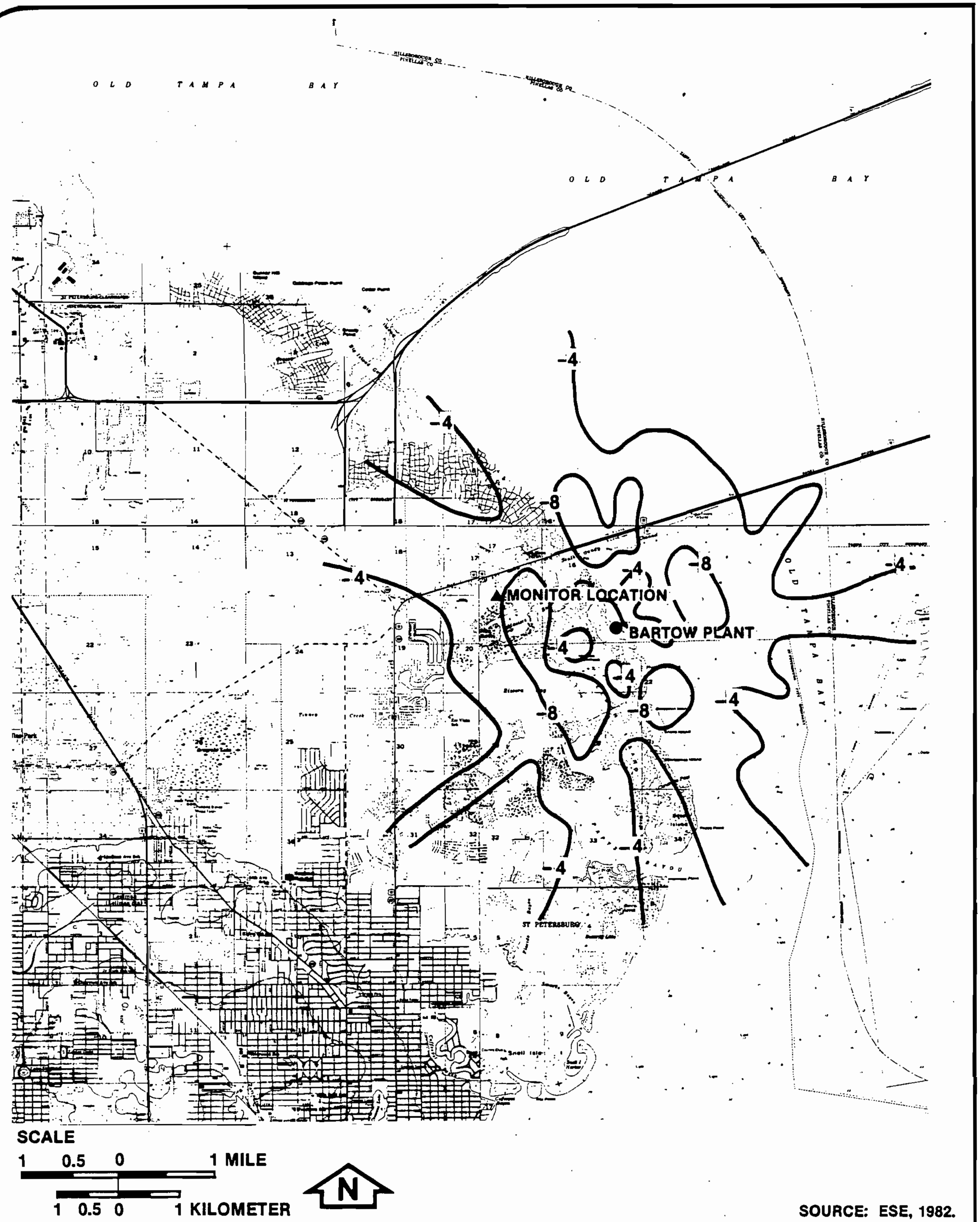


SOURCE: ESE, 1982.

Figure 3-3
FIVE-YEAR COMPOSITE OF DIFFERENCE BETWEEN MAXIMUM 3-HOUR AVERAGE SO_2 CONCENTRATIONS (ug/m^3) OF BASELINE CONDITIONS AND PROPOSED COAL CONVERSION

Florida Power CORPORATION
BARTOW PLANT

BEST AVAILABLE COPY



SOURCE: ESE, 1982.

Figure 3-4
FIVE-YEAR COMPOSITE OF DIFFERENCE BETWEEN MAXIMUM 24-HOUR AVERAGE SO_2 CONCENTRATIONS (ug/m^3) OF BASELINE CONDITIONS AND PROPOSED COAL CONVERSION

Florida Power CORPORATION
BARTOW PLANT

4.0 CONCLUSIONS

The proposed coal conversion at FPC's Bartow plant Units 2 and 3 will have different potential ambient air quality impacts than those produced with the existing oil-fired units. Based on screening modeling results using worst-case meteorological conditions and results using 5 years of hourly meteorological data, the short-term average TSP and SO_2 concentrations are predicted to be lower when Units 2 and 3 are converted from oil- to coal-fired units. Based on the proposed emission limits of 2.75 lb $SO_2/10^6$ Btu and 0.10 lb $PM/10^6$ Btu, the maximum TSP and SO_2 emissions for Units 2 and 3 are the same as those for oil. Because the coal-fired units will have greater flow rates than the oil-fired units, the plume rise will be higher for the coal-fired units, resulting in the potential for lower ground-level concentrations than those for the oil-fired units. As a result, the maximum ground-level concentrations for the 3- and 24-hour average SO_2 and 24-hour TSP concentrations due to the proposed coal-fired units are predicted to be lower than the applicable national and Florida AAQS and PSD Class II maximum allowable increments. In addition, because the impacts for the coal-fired units are less than the impacts for the oil-fired units, the proposed coal conversion at Units 2 and 3 will reduce impacts in the PSD Class I area (i.e., Chassahowitzka National Wildlife Refuge) and the SO_2 and TSP nonattainment areas. When the fugitive emissions from the coal and fly ash handling systems are considered in the modeling, their impacts are also predicted to be less than the applicable TSP standards.

The predicted maximum annual average SO_2, TSP, and NO_2 concentrations due to emissions from the proposed coal-fired units are less than the applicable national and Florida AAQS and PSD Class II maximum allowable increments. The maximum increases in SO_2, TSP, and NO_2 concentrations due to the proposed coal conversion are generally less than the significant level of 1 ug/m^3 for these pollutants. As a result, the maximum predicted increases in concentrations due to the proposed coal conversion do not significantly impact the PSD Class I and II areas and SO_2 and TSP nonattainment areas.

REFERENCES

Environmental Science and Engineering, Inc. 1979. Analysis of the Air Quality Impact Resulting from a Particulate Emission Rule Change for Fossil-Fuel Steam Generators in Florida. ESE Report No. 79-123-09. Prepared for the Florida Electric Power Coordinating Group. Gainesville, Florida.

George, L. 1982. Personal Communication. Florida Department of Environmental Regulation. Tallahassee, Florida.

Holzworth, G.C. 1972. Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution throughout the Contiguous United States. Publication No. AP-101. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina.

Larsen, R.I. 1971. A Mathematical Model for Relating Air Quality Measurements to Air Quality Standards. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina.

U.S. Environmental Protection Agency. 1978. Guideline on Air Quality Models. EPA-450/2-78-027.

U.S. Environmental Protection Agency. 1979. Industrial Source Complex (ISC) Dispersion Model User's Guide. Volume I. EPA-450/4-79-030.

APPENDIX A
EMISSIONS INVENTORIES

Table A-1. Baseline Sulfur Dioxide Emissions

NO.	SOURCE DESCRIPTION	SOURCE NO.	DISP.	TYPE	QFLG (G/SEC)	X (M)	Y (M)	HEIGHT (M)	ELEV. (M)	TEMP. (K)	VEL. (M/SEC)	DIAM. (M)
1	FPC MANATEE 10-01,02	1	0	0	1078	367400.00	3055100.00	121.90	0.00	416.00	14.90	7.90
2	FPC HIGGINS 12-01,02,03	2	0	0	569	336500.00	3098300.00	53.00	0.00	419.00	12.80	3.80
3	FPC HIGGINS 12-04,05,06,07	3	0	0	119.7	336500.00	3098300.00	16.80	0.00	727.00	61.00	4.60
4	FPC BAYBORO 13-01,02	4	0	0	8.97	338700.00	3071200.00	61.90	0.00	450.00	5.70	3.80
5	FPC BAYBORO 13-03,04,05,06	5	0	0	150.2	338700.00	3071200.00	12.20	0.00	755.00	61.00	2.80
6	FPC ANCLOTE	6	0	0	725.6	324400.00	3118700.00	152.10	0.00	408.00	12.50	7.30
7	GARDINIER 8-01	7	0	0	31.5	363200.00	3082400.00	24.40	0.00	363.00	6.00	1.40
8	GARDINIER 8-02	8	0	0	56.2	363200.00	3082400.00	22.60	0.00	360.00	7.40	1.60
9	GARDINIER 8-03	9	0	0	74.9	363200.00	3082400.00	21.90	0.00	360.00	9.10	1.80
10	GARDINIER 8-04	10	0	0	175.4	363200.00	3082400.00	28.00	0.00	351.00	6.20	2.90
11	GARDINIER 8-05	11	0	0	185.9	363200.00	3082400.00	29.30	0.00	352.00	7.10	3.30
12	GARDINIER 8-06	12	0	0	52.5	363200.00	3082400.00	45.70	0.00	355.00	11.10	2.70
13	GARDINIER 8-07	13	0	0	6.62	363200.00	3082400.00	26.80	0.00	340.00	7.70	0.40
14	GARDINIER 8-32	14	0	0	7.67	362900.00	3082500.00	23.80	0.00	346.00	3.30	1.80
15	GARDINIER 8-36	15	0	0	2.45	362900.00	3082500.00	20.70	0.00	317.00	10.00	1.10
16	GARDINIER 8-38	16	0	0	2.53	362900.00	3082500.00	20.70	0.00	310.00	14.80	1.10
17	GARDINIER 8-42	17	0	0	3.74	362900.00	3082500.00	18.30	0.00	589.00	6.90	2.50
18	TAMPA WATER	18	0	0	11.5	359300.00	3100200.00	38.10	0.00	394.00	1.30	1.50
19	GEN. PORTLAND 18-01,02,03	19	0	0	22.1	357900.00	3090600.00	53.30	0.00	400.00	11.60	3.00
20	GEN. PORTLAND 18-05	20	0	0	6.42	357900.00	3090600.00	36.00	0.00	464.00	15.20	2.70

Table A-1. Baseline Sulfur Dioxide Emissions (Continued, Page 2 of 2)

21	GEN. PORTLAND 18-06	21	0	0	76.7	357900.003090600.00	44.20	0.00	472.00	11.40	4.70
22	NITRAM 29-03	22	0	0	6.40	363100.003089000.00	27.40	0.00	477.00	24.20	0.90
23	NITRAM 29-04	23	0	0	5.00	363100.003089000.00	27.40	0.00	505.00	24.20	0.90
24	TPA INCIN. 42-01,02,03	24	0	0	6.30	360300.003092300.00	27.40	0.00	344.00	9.00	2.10
25	GULF COAST 57-01	25	0	0	10.3	363900.003093800.00	29.60	0.00	344.00	30.40	0.60
26	CHLORIDES 59-01	26	0	0	20.4	361800.003088300.00	29.90	0.00	366.00	22.60	0.60
27	TECO BB 39-01	27	0	0	1796	361600.003075000.00	149.30	0.00	423.00	19.30	7.30
28	TECO BB 39-02	28	0	0	1698	361600.003075000.00	149.30	0.00	423.00	18.40	7.30
29	TECO BB 39-03	29	0	0	1666	361600.003075000.00	149.30	0.00	418.00	8.60	7.60
30	GANNON 40-01	30	0	0	174.0	360000.003087500.00	61.00	0.00	427.00	8.30	4.30
31	GANNON 40-02	31	0	0	174.0	360000.003087500.00	76.20	0.00	427.00	17.10	3.00
32	GANNON 40-03	32	0	0	221.0	360000.003087500.00	76.20	0.00	403.00	14.80	3.20
33	GANNONE 40-04	33	0	0	259.0	360000.003087500.00	71.60	0.00	414.00	29.30	2.90
34	GANNON 40-05	34	0	0	689.0	360000.003087500.00	70.10	0.00	415.00	14.30	4.50
35	GANNON 40-06	35	0	0	1146	360000.003087500.00	93.30	0.00	417.00	16.00	5.40
36	HOOKER'S PT 01,02	36	0	0	194.3	358000.003091000.00	45.70	0.00	400.00	1.60	3.70
37	HOOKER'S PT 03,04	37	0	0	198.5	358000.003091000.00	45.70	0.00	397.00	3.40	4.00
38	HOOKER'S PT 05	38	0	0	97.2	358000.003091000.00	52.70	0.00	414.00	4.90	3.70
39	HOOKER'S PT 06	39	0	0	167.9	358000.003091000.00	52.70	0.00	436.00	5.90	3.90
40	BARTOW UNIT 1	40	0	0	227.2	342380.003082720.00	91.40	0.00	405.00	19.60	2.70
41	BARTOW UNIT 2	41	0	0	129.0	342380.003082720.00	91.40	0.00	405.00	19.60	2.70
42	BARTOW UNIT 3	42	0	0	387.8	342380.003082720.00	91.40	0.00	405.00	23.50	3.40

Table A-2. Projected Sulfur Dioxide Emissions

NO.	SOURCE DESCRIPTION	SOURCE NO.	DISP.	TYPE	QFLG	X (M)	Y (M)	HEIGHT (M)	ELEV. (M)	TEMP. (K)	VEL. (M/SEC)	DIAM. (M)
1	FPC MANATEE 10-01,02	1	0	0	1078	367400.00	3055100.00	121.90	0.00	416.00	14.90	7.90
2	FPC HIGGINS 12-01,02,03	2	0	0	589	336500.00	3098300.00	53.00	0.00	419.00	12.80	3.80
3	FPC HIGGINS 12-04,05,06,07	3	0	0	119.7	336500.00	3098300.00	16.80	0.00	727.00	61.00	4.60
4	FPC BAYBORO 13-01,02	4	0	0	0.97	338700.00	3071200.00	61.90	0.00	450.00	5.70	3.80
5	FPC BAYBORO 13-03,04,05,06	5	0	0	150.2	338700.00	3071200.00	12.20	0.00	755.00	61.00	2.80
6	FPC ANCLOTE	6	0	0	724.5	324400.00	3118700.00	152.10	0.00	422.00	32.90	7.30
7	GARDINIER 8-04	7	0	0	15.3	363200.00	3082400.00	45.70	0.00	363.00	9.10	2.30
8	GARDINIER 8-05	8	0	0	32.6	363200.00	3082400.00	45.70	0.00	363.00	8.20	2.40
9	GARDINIER 8-06	9	0	0	34.7	363200.00	3082400.00	45.70	0.00	363.00	12.40	2.70
10	GARDINIER 8-07	10	0	0	6.50	363200.00	3082400.00	38.40	0.00	325.00	10.80	2.40
11	GARDINIER 8-32	11	0	0	1.72	362900.00	3082500.00	23.80	0.00	349.00	5.50	1.80
12	GARDINIER 8-36	12	0	0	2.45	362900.00	3082500.00	20.70	0.00	317.00	10.00	1.10
13	GARDINIER 8-38	13	0	0	0.78	362900.00	3082500.00	20.70	0.00	314.00	15.30	1.10
14	GARDINIER 8-42	14	0	0	4.50	362900.00	3082500.00	18.30	0.00	589.00	3.70	2.50
15	TAMPA WATER	15	0	0	11.5	359300.00	3100200.00	38.10	0.00	394.00	1.30	1.50
16	GEN. PORTLAND 18-05	16	0	0	81.0	357900.00	3090600.00	36.00	0.00	505.00	17.70	2.70
17	GEN. PORTLAND 18-06	17	0	0	10.3	357900.00	3090600.00	36.00	0.00	454.00	8.80	2.70
18	NITRAM 29-03	18	0	0	6.4	363100.00	3089000.00	27.40	0.00	477.00	24.20	0.90
19	NITRAM 29-04	19	0	0	5.0	363100.00	3089000.00	27.40	0.00	505.00	24.20	0.90
20	TPA INCIN. 42-01,02,03	20	0	0	6.3	360300.00	3092300.00	27.40	0.00	344.00	9.00	2.10

Table A-2. Projected Sulfur Dioxide Emissions (Continued, Page 2 of 2)

21	GULF COAST	21	0	0	10.8	363900.003093800.00	29.60	0.00	344.00	30.40	0.60
22	CHLORIDES 50-01	22	0	0	13.0	361800.003088300.00	30.20	0.00	398.00	22.90	0.60
23	TECO BB 39-01	23	0	0	1654	361600.003075000.00	149.30	0.00	422.00	28.60	7.30
24	TECO BB 39-02	24	0	0	1638	361600.003075000.00	149.30	0.00	422.00	28.60	7.30
25	TECO BB 39-03	25	0	0	1685	361600.003075000.00	149.30	0.00	417.00	14.43	7.30
26	TECO BB 4	26	0	0	465	361600.003075000.00	149.30	0.00	342.00	19.97	7.30
27	GANNON 40-01	27	0	0	174	360000.003087500.00	93.30	0.00	438.00	32.30	3.05
28	GANNON 40-02	28	0	0	174	360000.003087500.00	93.30	0.00	438.00	32.30	3.05
29	GANNON 40-03	29	0	0	221	360000.003087500.00	93.30	0.00	427.00	35.40	3.23
30	GANNON 40-04	30	0	0	259	360000.003087500.00	93.30	0.00	443.00	24.60	2.93
31	GANNON 40-05	31	0	0	689	360000.003087500.00	93.30	0.00	416.00	20.70	4.45
32	GANNON 40-06	32	0	0	1146	360000.003087500.00	93.30	0.00	439.00	23.40	5.36
33	HOOKER'S PT 01,02	33	0	0	111.8	358000.003091000.00	85.30	0.00	403.00	18.20	3.41
34	HOOKER'S PT 03,04	34	0	0	113.6	358000.003091000.00	85.30	0.00	403.00	11.50	3.44
35	HOOKER'S PT 05	35	0	0	55.7	358000.003091000.00	85.30	0.00	403.00	18.20	3.40
36	HOOKER'S PT 06	36	0	0	107.1	358000.003091000.00	85.30	0.00	436.00	17.90	2.90
37	PINELLAS RESOURCE RECOVERY	37	0	0	31.1	335000.003083500.00	49.10	0.00	522.00	38.20	2.74
38	EXXON	38	0	0	0.78	362200.003087200.00	9.40	0.00	340.00	11.00	3.00
39	BARTOW UNIT 1	39	0	0	422.7	342380.003082720.00	91.40	0.00	428.00	36.33	2.70
40	BARTOW UNIT 2	40	0	0	412.9	342380.003082720.00	91.40	0.00	423.00	37.06	2.70
41	BARTOW UNIT 3	41	0	0	606.8	342380.003082720.00	91.40	0.00	419.00	40.90	3.40
42	BARTOW UNIT 2 (1.2)	42	0	0	160.8	342380.003082720.00	91.40	0.00	423.00	37.06	2.70
43	BARTOW UNIT 3 (1.2)	43	0	0	300.9	342380.003082720.00	91.40	0.00	419.00	40.90	3.40

3083000.000	0.179871	0.221657	0.203543	0.180249	0.160463	0.144368	0.131136
3082000.000	0.045656	0.118921	0.141397	0.140705	0.133599	0.125093	0.116696
3081000.000	0.039379	0.051800	0.056481	0.067991	0.080873	0.085521	0.086071
3080000.000	0.047786	0.050262	0.052889	0.053159	0.051990	0.050711	0.058096
3079000.000	0.051822	0.051135	0.052238	0.051780	0.050421	0.048571	0.046444
3078000.000	0.053479	0.051142	0.050930	0.051174	0.049644	0.047695	0.045600
3077000.000	0.053662	0.050306	0.049510	0.049206	0.048969	0.047084	0.044980
3076000.000	0.053017	0.049215	0.047883	0.047303	0.046855	0.046375	0.044408
3075000.000	0.051903	0.048292	0.046088	0.045403	0.044855	0.044298	0.043590

** ANNUAL GROUND LEVEL CONCENTRATION (MICROGRAMS PER CUBIC METER) (CONT.) FROM COMBINED SOURCES 56, -58,

0 - DISCRETE RECEPTORS -

X DISTANCE (METERS)	Y DISTANCE (METERS)	CONCENTRATION	X DISTANCE (METERS)	Y DISTANCE (METERS)	CONCENTRATION	X DISTANCE (METERS)	Y DISTANCE (METERS)	CONCENTRATION
325000.0	3112000.0	0.024513	327000.0	3112000.0	0.024931	329000.0	3112000.0	0.025319
341000.0	3165000.0	0.010788	342500.0	3174000.0	0.009749			

1

** END OF ISCLT PROGRAM, 58 SOURCES PROCESSED **

1

NO.	SOURCE DESCRIPTION	SOURCE NO.	DISP.	TYPE	QFLG (G/SEC)	X (M)	Y (M)	HEIGHT (M)	ELEV. (M)	TEMP. (K)	VEL. (M/SEC)	DIAM. (M)
1	BORDEN 2-04	1	0	0	1.98	348500.00	3057300.00	38.10	0.00	295.00	19.30	0.60
2	BORDEN 2-05	2	0	0	3.40	348500.00	3057300.00	10.70	0.00	300.00	22.30	1.10
3	BORDEN 2-06,07	3	0	0	3.40	348500.00	3057300.00	61.00	0.00	311.00	20.50	2.10
4	BORDEN 2-08	4	0	0	0.20	348500.00	3057300.00	22.90	0.00	303.00	14.70	0.30
5	BORDEN 2-09	5	0	0	2.50	348500.00	3057300.00	37.50	0.00	317.00	21.00	0.80
6	BORDEN 2-10	6	0	0	0.75	348500.00	3057300.00	9.80	0.00	305.00	23.80	1.00
7	BORDEN 2-11	7	0	0	0.83	348500.00	3057300.00	12.50	0.00	299.00	10.00	1.40
8	FPC MANATEE 10-01,02	8	0	0	134.4	367400.00	3055100.00	121.90	0.00	416.00	14.90	7.90
9	FPC HIGGINS 12-01,02,03	9	0	0	5.67	336500.00	3098300.00	53.00	0.00	419.00	12.80	3.80

Table A-3. Baseline PM Emissions (Continued, Page 2 of 3)

10	FPC HIGGINS 12-04,05,06,07	10	0	0	0.42	336500.003098300.00	16.80	0.00	727.00	61.00	4.60
11	FPC BAYBORO 13-03,04,05,06	11	0	0	1.98	338700.003071200.00	12.20	0.00	755.00	61.00	2.80
12	FPC ANCLOTE	12	0	0	2.91	324400.003118700.00	152.10	0.00	408.00	12.50	7.30
13	GARDINIER 8-02	13	0	0	0.66	363200.003082400.00	22.60	0.00	360.00	7.40	1.60
14	GARDINIER 8-03	14	0	0	1.06	363200.003082400.00	21.90	0.00	360.00	9.10	1.80
15	GARDINIER 8-04	15	0	0	2.02	363200.003082400.00	28.00	0.00	351.00	6.20	2.90
16	GARDINIER 8-05	16	0	0	2.53	363200.003082400.00	29.30	0.00	352.00	7.10	3.30
17	GARDINIER 8-06	17	0	0	1.98	363200.003082400.00	45.70	0.00	355.00	11.10	2.70
18	GARDINIER 8-07	18	0	0	4.20	363200.003082400.00	26.80	0.00	340.00	7.70	0.40
19	GARDINIER 8-32	19	0	0	2.84	362900.003082500.00	23.80	0.00	346.00	3.30	1.80
20	GARDINIER 8-36	20	0	0	3.65	362900.003082500.00	20.70	0.00	317.00	10.00	1.10
21	GARDINIER 8-38	21	0	0	2.90	362900.003082500.00	20.70	0.00	310.00	14.80	1.10
22	GARDINIER 8-42	22	0	0	2.79	362900.003082500.00	18.30	0.00	589.00	6.90	2.50
23	GARDINIER 8-31,33-35,37,39-41,43	23	0	0	10.3	362900.003082500.00	25.00	0.00	330.00	15.00	1.00
24	GEN. PORTLAND 18-01,02,03	24	0	0	2.94	357900.003090600.00	53.30	0.00	400.00	11.80	3.00
25	GEN PORTLAND 18-04	25	0	0	2.22	357900.003090600.00	45.00	0.00	391.00	3.10	3.80
26	GEN. PORTLAND 18-05	26	0	0	2.73	357900.003090600.00	36.00	0.00	464.00	15.20	2.70
27	GEN. PORTLAND 18-06	27	0	0	3.30	357900.003090600.00	44.20	0.00	472.00	11.40	4.70
28	GEN. PORTLAND 18-07,08,09,10,11,12	28	0	0	13.7	357900.003090600.00	12.20	0.00	377.00	24.90	1.20
29	IMC TERM 24-01	29	0	0	4.66	360100.003087500.00	10.70	0.00	344.00	9.20	3.00
30	IMC TERM 24-02	30	0	0	1.41	360100.003087500.00	12.20	0.00	297.00	19.20	1.80
31	IMC TERM 24-03	31	0	0	3.28	360100.003087500.00	13.70	0.00	306.00	49.40	0.40
32	NAT. GYP. 28-01	32	0	0	3.34	347400.003082500.00	27.10	0.00	435.00	18.60	0.80
33	NAT. GYP. 28-03	33	0	0	3.71	347400.003082500.00	16.80	0.00	339.00	39.30	0.30
34	NAT. GYP 28-05	34	0	0	4.40	347400.003082500.00	19.50	0.00	349.00	10.20	1.10
35	NAT. GYP 28-07	35	0	0	1.47	347400.003082500.00	9.80	0.00	302.00	23.00	0.40
36	NAT. GYP. 28-09	36	0	0	3.31	347400.003082500.00	19.80	0.00	325.00	18.00	0.20
37	NAT. GYP. 28-14	37	0	0	3.69	347400.003082500.00	23.50	0.00	477.00	24.20	0.40

Table A-3. Baseline PM Emissions (Continued, Page 3 of 3)

38	NITRAM 29-01	38	0	0	2.61	363100.003089000.00	61.00	0.00	305.00	1.90	6.90
39	NITRAM 29-03	39	0	0	0.55	363100.003089000.00	27.40	0.00	477.00	24.20	0.90
40	NITRAM 29-04	40	0	0	0.48	363100.003089000.00	27.40	0.00	505.00	24.20	0.90
41	TPA INCIN. 42-01,02,03	41	0	0	22.0	360300.003092300.00	27.40	0.00	344.00	9.00	2.10
42	SCHILTZ 160-01	42	0	0	13.1	362000.003103200.00	12.20	0.00	639.00	7.40	1.50
43	TECO BB 39-01	43	0	0	34.1	361600.003075000.00	149.30	0.00	423.00	19.30	7.30
44	TECO BB 39-02	44	0	0	32.2	361600.003075000.00	149.30	0.00	423.00	18.40	7.30
45	TECO BB 39-03	45	0	0	31.6	361600.003075000.00	149.30	0.00	418.00	8.60	7.60
46	GANNON 40-01	46	0	0	15.8	360000.003087500.00	61.00	0.00	427.00	8.30	4.30
47	GANNON 40-02	47	0	0	15.8	360000.003087500.00	76.20	0.00	427.00	17.10	3.00
48	GANNON 40-03	48	0	0	24.0	360000.003087500.00	76.20	0.00	403.00	14.80	3.20
49	GANNONE 40-04	49	0	0	23.5	360000.003087500.00	71.60	0.00	414.00	29.30	2.90
50	GANNON 40-05	50	0	0	20.7	360000.003087500.00	70.10	0.00	415.00	14.30	4.50
51	GANNON 40-06	51	0	0	47.0	360000.003087500.00	93.30	0.00	417.00	16.00	5.40
52	HOOKER'S PT 01,02	52	0	0	10.8	358000.003091000.00	45.70	0.00	400.00	1.60	3.70
53	HOOKER'S PT 03,04	53	0	0	10.3	358000.003091000.00	45.70	0.00	397.00	3.40	4.00
54	HOOKER'S PT 05	54	0	0	5.10	358000.003091000.00	52.70	0.00	414.00	4.90	3.70
55	HOOKER'S PT 06	55	0	0	9.80	358000.003091000.00	52.70	0.00	436.00	5.90	3.90
56	BARTOW UNIT 1	56	0	0	7.18	342380.003082720.00	91.40	0.00	405.00	19.60	2.70
57	BARTOW UNIT 2	57	0	0	3.60	342380.003082720.00	91.40	0.00	405.00	19.60	2.70
58	BARTOW UNIT 3	58	0	0	11.6	342380.003082720.00	91.40	0.00	405.00	23.50	3.40

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Table A-4. Projected PM Emissions

NO.	SOURCE DESCRIPTION	SOURCE NO.	DISP.	TYPE	QFLG (G/SEC)	X (M)	Y (M)	HEIGHT (M)	ELEV. (M)	TEMP. (K)	VEL. (M/SEC)	DIAM. (M)
1	BORDEN 2-04	1	0	0	1.98	348500.00	3057300.00	38.10	0.00	295.00	19.30	0.60
2	BORDEN 2-05	2	0	0	3.40	348500.00	3057300.00	10.70	0.00	300.00	22.30	1.10
3	BORDEN 2-06,07	3	0	0	3.40	348500.00	3057300.00	61.00	0.00	311.00	20.50	2.10
4	BORDEN 2-08	4	0	0	0.20	348500.00	3057300.00	22.90	0.00	303.00	14.70	0.30
5	BORDEN 2-09	5	0	0	2.50	348500.00	3057300.00	37.50	0.00	317.00	21.00	0.80
6	BORDEN 2-10	6	0	0	0.75	348500.00	3057300.00	9.80	0.00	305.00	23.80	1.00
7	BORDEN 2-11	7	0	0	0.83	348500.00	3057300.00	12.50	0.00	299.00	10.00	1.40
8	FPC MANATEE 10-01,02	8	0	0	13.44	367400.00	3055100.00	121.90	0.00	416.00	14.90	7.90
9	FPC HIGGINS 12-01,02,03	9	0	0	5.67	336500.00	3098300.00	53.00	0.00	419.00	12.80	3.80
10	FPC HIGGINS 12-04,05,06,07	10	0	0	0.42	336500.00	3098300.00	16.80	0.00	727.00	61.00	4.60
11	FPC BAYBORO 13-03,04,05,06	11	0	0	1.98	338700.00	3071200.00	12.20	0.00	755.00	61.00	2.80
12	FPC ANCLOTE	12	0	0	2.90	324400.00	3118700.00	152.10	0.00	422.00	32.90	7.30
13	GARDINIER 8-36	13	0	0	3.65	362900.00	3082500.00	20.70	0.00	317.00	10.00	1.10
14	GARDINIER 8-31,33-35,37,39-41,43	14	0	0	10.3	362900.00	3082500.00	25.00	0.00	330.00	15.00	1.00
15	GEN PORTLAND 18-04	15	0	0	8.33	357900.00	3090600.00	36.00	0.00	505.00	17.70	2.70
16	GEN. PORTLAND 18-05	16	0	0	10.82	357900.00	3090600.00	36.00	0.00	454.00	8.80	2.70
17	IMC TERM 24-01	17	0	0	4.68	360100.00	3087500.00	10.70	0.00	344.00	9.20	3.00
18	IMC TERM 24-02	18	0	0	1.41	360100.00	3087500.00	12.20	0.00	297.00	19.20	1.80
19	IMC TERM 24-03	19	0	0	3.28	360100.00	3087500.00	13.70	0.00	306.00	49.40	0.40
20	NAT. GYP. 28-01	20	0	0	3.38	347400.00	3082500.00	27.10	0.00	435.00	18.60	0.80
21	NAT. GYP. 28-03	21	0	0	3.78	347400.00	3082500.00	16.80	0.00	339.00	39.30	0.30
22	NAT. GYP 28-05	22	0	0	4.40	347400.00	3082500.00	19.50	0.00	349.00	10.20	1.10
23	NAT. GYP 28-07	23	0	0	1.47	347400.00	3082500.00	9.80	0.00	302.00	23.00	0.40
24	NAT. GYP. 28-09	24	0	0	3.31	347400.00	3082500.00	19.80	0.00	325.00	18.00	0.20

Table A-4. Projected PM Emissions (Continued, Page 2 of 2)

25	NAT. GYP. 28-14	25	0	0	3.69	347400.003082500.00	23.50	0.00	477.00	24.20	0.40
26	NITRAM 29-01	26	0	0	2.61	363100.003089000.00	61.00	0.00	305.00	1.90	6.90
27	NITRAM 29-03	27	0	0	0.55	363100.003089000.00	27.40	0.00	477.00	24.20	0.90
28	NITRAM 29-04	28	0	0	0.43	363100.003089000.00	27.40	0.00	505.00	24.20	0.90
29	TPA INCIN. 42-01,02,03	29	0	0	22.0	360300.003092300.00	27.40	0.00	344.00	9.00	2.10
30	SCHILTZ 160-01	30	0	0	13.1	362000.003103200.00	12.20	0.00	639.00	7.40	1.50
31	TECO BB 39-01	31	0	0	50.8	361600.003075000.00	149.30	0.00	422.00	28.60	7.30
32	TECO BB 39-02	32	0	0	50.4	361600.003075000.00	149.30	0.00	422.00	28.60	7.30
33	TECO BB 39-03	33	0	0	51.9	361600.003075000.00	149.30	0.00	417.00	14.43	7.30
34	TECO BB	34	0	0	17.8	361600.003075000.00	149.30	0.00	342.00	19.97	7.30
35	GANNON 40-01	35	0	0	15.8	360000.003087500.00	93.30	0.00	438.00	32.30	3.05
36	GANNON 40-02	36	0	0	15.8	360000.003087500.00	93.30	0.00	438.00	32.30	3.05
37	GANNON 40-03	37	0	0	20.1	360000.003087500.00	93.30	0.00	427.00	35.40	3.23
38	GANNONE 40-04	38	0	0	23.6	360000.003087500.00	93.30	0.00	443.00	24.60	2.93
39	GANNON 40-05	39	0	0	28.8	360000.003087500.00	93.30	0.00	416.00	20.70	4.45
40	GANNON 40-06	40	0	0	47.8	360000.003087500.00	93.30	0.00	439.00	23.40	5.36
41	HOOKER'S PT 01,02	41	0	0	10.1	358000.003091000.00	85.30	0.00	403.00	18.20	3.41
42	HOOKER'S PT 03,04	42	0	0	10.3	358000.003091000.00	85.30	0.00	403.00	11.50	3.44
43	HOOKER'S PT 05	43	0	0	5.00	358000.003091000.00	85.30	0.00	403.00	18.20	3.40
44	HOOKER'S PT 06	44	0	0	9.80	358000.003091000.00	85.30	0.00	436.00	17.90	2.90
45	PINELLAS RESOURCE RECOVERY	45	0	0	10.8	335000.003083500.00	49.10	0.00	522.00	38.20	2.74
46	BARTOW UNIT 1	46	0	0	15.4	342380.003082720.00	91.40	0.00	428.00	36.33	2.70
47	BARTOW UNIT 2	47	0	0	15.6	342380.003082720.00	91.40	0.00	423.00	37.06	2.70
48	BARTOW UNIT 3	48	0	0	25.1	342380.003082720.00	91.40	0.00	419.00	40.90	3.40

APPENDIX B

DESCRIPTION OF THE ISC MODEL

APPENDIX B
ISC MODEL DESCRIPTION

The Industrial Source Complex (ISC) Dispersion Model is a Gaussian plume model which can be used to assess the air quality impact of various sources associated with an industrial complex located in either flat or complex terrain. In addition to predicting ambient concentrations, the model can be used to calculate dry deposition resulting from significant particulate gravitational settling velocities. ISC also specifies, upon request, the meteorological period during which the maximum calculated concentrations or depositions occurred.

The ISC short-term model (ISCST), an extended version of the Single Source (CRSTER) model, calculates impacts for each hour of meteorological input data from emission data and stack parameters. The hourly meteorological data include wind direction, wind speed, atmospheric stability, temperature, and mixing heights which have been processed from surface and upper air data recorded at a representation National Weather Service (NWS) station. Various averaging times are available through program options such as specifying a 1- through 24-hour average and an average over the total number of days per year of meteorological input data. Twenty-four-hour averages are calculated from midnight to midnight of each day; shorter-term averages are calculated for nonoverlapping, consecutive time periods.

The ISC long-term model (ISCLT) extends and combines basic features of the Air Quality Display Model (AQDM) and the Climatological Dispersion Model (CDM). The ISCLT model uses the same equations as ISCST model except that the seasonal or annual frequencies of combinations of 16 wind directions, 6 wind speeds, and 6 stability categories are applied to concentration calculations. Also, the horizontal distribution of the plume width is described by sector-averaging concentrations over a

22.5-degree sector that defines the wind direction. The concentration distribution within a sector is modified to account for discontinuities in concentrations that may occur at the boundaries of adjacent sectors.

The ISC programs accept the following source types: stack, volume, and area. The volume source option is also used to simulate line sources. The contributions to ambient ground-level concentrations from each emission point are computed by means of a modified version of the Gaussian plume equation (e.g., Turner, 1970). The modifications include the following: (1) trapping of the plume between the top of the mixing layer and the ground surface, (2) uniform vertical mixing of the plume in the mixing layer beyond a critical distance, and (3) neglect of any ground-level effects from plumes released above the mixing layer.

Trapping is simulated by the method of multiple images (e.g., Turner, 1970), which results in a convergent infinite series of terms representing reflection from the upper and lower boundaries of the trapping layer. Beyond a certain distance, the trapping effects result in a nearly uniform vertical distribution. The computational procedure is simplified by approximating this distance and introducing an appropriate simplification for calculations at more distant points. The modified Gaussian plume equation for the concentration from a single stack is:

$$X\,(x,y) = \frac{Q\,R}{\sigma y\,u} \exp\left[-\frac{1}{2}\left(\frac{y}{\sigma y}\right)\right]^2$$

Where: $R = 0$, for $H > L$;

$$R = \frac{1}{2.5066L}, \text{ for } H \leq L \text{ and } \frac{\sigma z}{L} \geq 1.6;$$

$$R = \frac{1}{\pi \sigma_z(x)} \left\{ \exp\left[-\frac{1}{2}\left(\frac{H}{\sigma_z}\right)^2\right] + \sum_{i=1}^{\infty}\left[\exp\left[-\frac{1}{2}\left(\frac{2iL - H}{\sigma_z}\right)^2\right] + \exp\left[-\frac{1}{2}\left(\frac{2iL + H}{\sigma_z}\right)^2\right]\right]\right\} \text{for } H \leq L \text{ and } \frac{\sigma_z}{L} < 1.6$$

$X(x,y)$ = Concentration at location x,y (g/m^3);
x = Distance downwind from plant (m);
y = Distance crosswind from plant (m);
Q = Pollutant emission rate (g/sec);
u = Wind speed (m/sec);
σ_y = Horizontal diffusion parameter (m);
σ_z = Vertical diffusion parameter (m);
H = Effective plume height above terrain (m); and
L = Height of the top of the mixing layer (m).

Concentrations computed for each stack are summed to determine a single concentration from all the plant at a receptor.

The area source equation in the ISC model programs is based on the equation for a continuous and finite crosswind Gaussian line source.

The generalized Briggs (1971 and 1975) plume-rise equations, including 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 on plume dispersion of aerodynamic wakes and eddies formed by buildings and other structures.

The plume rise equation for non-stable stability classes [i.e., very unstable, unstable, slightly unstable, and neutral (categories corresponding to Classes A, B, C, and D, respectively)] is given in the following equation. To determine if downwash is expected to occur, the plume rise due solely to momentum is calculated at a downwind distance equal to two building heights (2Hb) downwind. The equation would then simplify to the first term, since F would equal zero for nonbuoyant plumes.

$$\Delta h = \left[\frac{3\ Fm\ x'}{\beta_j^{\,2}\ u^2} + \frac{3Fx'^2}{2\beta_1^{\,2}\ u^3} \right]^{1/3}$$

Where: F = Buoyancy flux, $F = g\ \frac{Vsd^2}{4} \left(1 - \frac{Ta}{Ts}\right)$

F_m = Momentum flux, $F_m = \frac{(Ta/Ts)\ Vs^2 d^2}{4}$

β_j = Jet entrainment coefficient, $\beta_j = \left(\frac{1}{3} + \frac{u}{Vs}\right)$

T_a = Ambient temperature (°K)

T_s = Stack gas temperature (°K)

V_s = Exit velocity (m/s)

d = Stack inside diameter (m)

x' is defined as follows:

Let $\alpha = \frac{4d\ (Vs + 3u)^2}{Vs\ u}$

$$x' = \begin{cases} x\ , & \text{if } x < 3.5x^* \text{ and } F > 0 \\ 3.5\ x^*, & \text{if } x \geq 3.5x^* \text{ and } F > 0 \\ x\ , & \text{if } x < \alpha \text{ and } F = 0 \\ \alpha\ , & \text{if } x \geq \alpha \text{ and } F = 0 \end{cases}$$

Where: $x^* = 14\ F^{5/8},\ F \leq 55\ m^4/s^3$

$34\ F^{2/5},\ F > 55\ m^4/s^3$

For stable stability classes (i.e., slightly stable and stable categories corresponding to Classes E and F, respectively), the Briggs (1975) plume rise equation is:

$$h = \left[\frac{3Fm}{\beta_j^{\,2} u\ S^{1/2}} \sin\left(S^{1/2}\ \frac{x'}{u}\right) + \frac{3F}{\beta_2^{\,2} u\ S} \left[1 - \cos\left(S^{1/2}\ \frac{x'}{u}\right)\right] \right]^{1/3}$$

Where: S = Stability parameter, $S = \frac{g}{Ta} \frac{d\theta}{dz}$

$\frac{d\theta}{dz}$ = Potential temperature gradient (0.020 for Class E and 0.035 for Class F)

β_2 = Adiabatic entrainment coefficient, equals 0.6 (Briggs, 1975)

x' = Defined as follows

g = Acceleration due to gravity, 9.8 m/s^2

u = Wind speed at stack height (m/s)

β_1 = Adiabatic entrainment coefficient, equals 0.6 (Briggs, 1975)

x' = Downwind distance, or in the determination of building downwash influence x' is equal to $2H_b$.

For applications when building downwash effects are not considered, the momentum flux term in equation (1) is negligible when compared to the buoyancy flux term. In general, for $B_1 = 0.6$,

$$\Delta h = \frac{1.6\ F^{1/3}\ x'^{2/3}}{u}$$

which is identical to the plume rise formula used in CRSTER for unstable plume rise.

Let $C = \pi u S^{-1/2}$

$$x' = \begin{cases} x, & \text{if } x < C \text{ and } F > 0 \\ C, & \text{if } x \geq C \text{ and } F > 0 \\ x, & \text{if } x < C/2 \text{ and } F = 0 \\ C/2, & \text{if } x \geq C/2 \text{ and } F = 0 \end{cases}$$

If $F = 0$ and the plume rise, Δh, is greater than $(3V_s d)/u$ then the ISC model sets Δh to $(3V_s d)/u$.

If $F > 0$ and final plume rise is specified (i.e., $x' = C$) in the model application,

$$\Delta h = 2.6 \left(\frac{F}{u\ s} \right)^{1/3}$$

which is identical to the plume rise formula used in CRSTER for stable plume rise.

The effective plume height used in the calculation of concentration is then:

$$H = h + \Delta h$$

Where: h = Stack height (m).

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. The wind profile exponents used in this analysis were 0.1, 0.15, 0.2, 0.25, 0.3, and 0.3 for stability Categories A, B, C, D, E, and F, respectively.

The ISC model is used to account for variations in terrain height over the receptor grid. The Pasquill-Gifford curves (Turner, 1970) are used to calculate horizontal (σy) and vertical (σz) plume spread. The ISC model has one rural and two urban dispersion mode options. In the rural mode, rural mixing heights and the σy and σz values for the indicated stability category are used in the calculations. In one urban mode, the stable E and F categories are redefined as neutral stability. In the other urban mode, the E and F stability categories are combined and the σy and σz values for the stability category [one step less stable than the indicated stability category (except A)] are used in the calculations. Urban mixing heights are used in both urban models.

Various output options can be selected for the ISC models. Tables of the highest and second-highest concentrations or depositions can be requested for each averaging time. A table of the annual arithmetic averages is also available. In addition, the ISC models can provide the user with tables of the 50 maximum concentrations or depositions, or an average over the period of meteorological input data. Receptor grids of polar, cartesian, or discrete receptor grids can be specified.