VIRGIN ISLANDS AIR POLLUTANT EMISSION INVENTORY

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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PREFACE

This report, which presents the emission inventory for the Virgin Islands Area, is another in a series of surveys outlining the sources and emissions of air pollutants for major metropolitan areas in the country. These surveys provide estimates of the present levels of air pollutant emissions and status of their control. They are conducted by the National Inventory of Air Pollutant Emissions and Control Branch of the National Air Pollution Control Administration. The pollutants, which include sulfur oxides, particulates, carbon monoxide, hydrocarbons and nitrogen oxides, are delineated with respect to source type, season of the year and geographical distribution within the area. The general procedure for the surveys is based upon the rapid survey technique for estimating air pollutant emissions.[1] These reports are intended to serve as aids in the proposing of boundaries of Air Quality Control Regions, as directed by the Air Quality Act of 1967.

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INTRODUCTION

This report summarizes the Virgin Islands area air pollutant emission inventory conducted in January 1970. The data and emission estimates presented are for 1968 and indicate the conditions during that year.

The Study Area is based on population distribution and air pollutant sources. It comprises the three major islands in the grouping, namely St. Thomas, St. Croix, and St. John. This area covers approximately 137 square miles and had a 1968 population of 60,400.

A grid coordinate system was used to show the geographical distribution of emissions within islands. The Study Area was subdivided into 31 grid zones of 25 square kilometers.

All sources of emissions were classified into five categories--transportation, stationary fuel combustion, solid-waste disposal, industrial processes and evaporative losses. Each of these source categories was divided into two subgroups--point sources and area sources. Facilities emitting large quantities of air pollutants were considered point sources. The many remaining contributors such as motor vehicles, residential fuel users, small commercial and industrial facilities and on-site refuse burning equipment, were considered collectively as area sources. For this report individual sources having emissions greater than zero tons per average annual day for any pollutant were classified as point sources.

Emissions were estimated by using various indicators such as fuel consumption, refuse burning rates, vehicle-miles, production data, and control efficiencies and emission factors relating these indicators to emission rates.[2] These factors represent average emission rates for a particular source category. Since individual sources have inherent differences that cannot always be taken into consideration, discrepancies between the actual and estimated emissions

are more likely in individual sources than in the total emissions for a source category.

As in all emission surveys, the data presented are estimates and should not be interpreted as absolute values. The estimates are, in some cases, partial totals due to the lack of emission factors and production or consumption data. Despite these limitations, the estimates are of sufficient accuracy and validity in defining the extent and distribution of air pollutant emissions within the Study Area.

SUMMARY OF RESULTS

The estimated annual emissions of the five surveyed pollutants in the Virgin Islands are presented in Table 1. The following is a brief summary of pollutant emissions and sources.

Sulfur Oxides — The predominant sources of the 19,800 tons of sulfur oxides emitted annually are the combustion of fuels (89 percent) and industrial process losses (10 percent).

Particulate Matter — The annual emissions of 4,330 tons are distributed between the various source types. The largest source is industrial processes with stationary fuel combustion being the second largest.

Carbon Monoxide — Motor vehicles contribute only 10 percent of 283,600 tons of carbon monoxide emitted within the Study Area in 1968. This is due to a large industrial process source which accounts for almost 89 percent of the total.

Hydrocarbons — The two largest sources of the yearly 11,450 tons of hydrocarbons are industrial processes and motor vehicles. They contribute 53 and 29 percent respectively.

Oxides of Nitrogen — Stationary fuel combustion and transportation are the important sources of the 8,450 tons of oxides of nitrogen. The four large fuel burning sources alone account for 64 percent of the total emitted.

TABLE 1 SUMMARY OF AIR POLLUTANT EMISSIONS IN THE VIRGIN ISLANDS STUDY AREA, 1968 (Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation	60	300	29,310	3,330	1,370
Motor Vehicles	50	70			
Gasoline	50	70	18,760	1,340	750
Diesel	N	N	N	N	N
Aircraft	N	220	10,540	1,970	590
Vessels	10	10	10	20	30
Stationary Fuel Combustion	17,600	1,300	110	150	5,360
Fuel Oil	17,600	1,280	110	150	5,120
Natural Gas	N	20	N	N	240
Solid Waste Disposal	40	610	3,240	1,140	420
Industrial Processes	2,100	2,120	251,000	6,000	1,300
Evaporative Losses	--	--	--	830	--
TOTAL	19,800	4,330	283,660	11,450	8,450

N = Negligible

TABLE 1A SUMMARY OF AIR POLLUTANT EMISSIONS IN THE VIRGIN ISLANDS STUDY AREA, 1968 (10^3 Kg/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation	50	270	26,590	3,020	1,250
Motor Vehicles					
Gasoline	40	60	17,020	1,210	680
Diesel	N	N	N	N	N
Aircraft	N	220	9,560	1,790	540
Vessels	10	10	10	20	30
Stationary Fuel Combustion	15,970	1,180	100	140	4,860
Fuel Oil	15,970	1,160	100	140	4,640
Natural Gas	N	20	N	N	220
Solid Waste Disposal	40	550	2,940	1,030	380
Industrial Processes	1,910	1,920	227,700	5,440	1,180
Evaporative Losses	--	--	--	750	--
TOTAL	17,970	3,920	257,330	10,380	7,670

N = Negligible

STUDY AREA

The Study Area for the report consists of the three major islands--St. Thomas, St. John and St. Croix . Figure 1 presents the Study Area in relation to North America.

The approximate 1968 population for the Study Area was 60,400 which covers an area of 137 square miles. Table 2, which gives population by county and Figure 3, which shows the population density, indicate that most of the population is in the urbanized portions of St. Thomas and St. Croix. The population in this area has increased at a quicker pace than the nation as a whole. Between 1960 and 1968, the nation's population increased over 11 percent while the Virgin Islands increased 88 percent.

The climate is tropical with warm winters. The summer temperature is only a few degrees higher than the winter on the average. There are no heating degree days. The average low temperature throughout the year is around 70 degrees. The average high temperature in the summer is around 88 degrees.

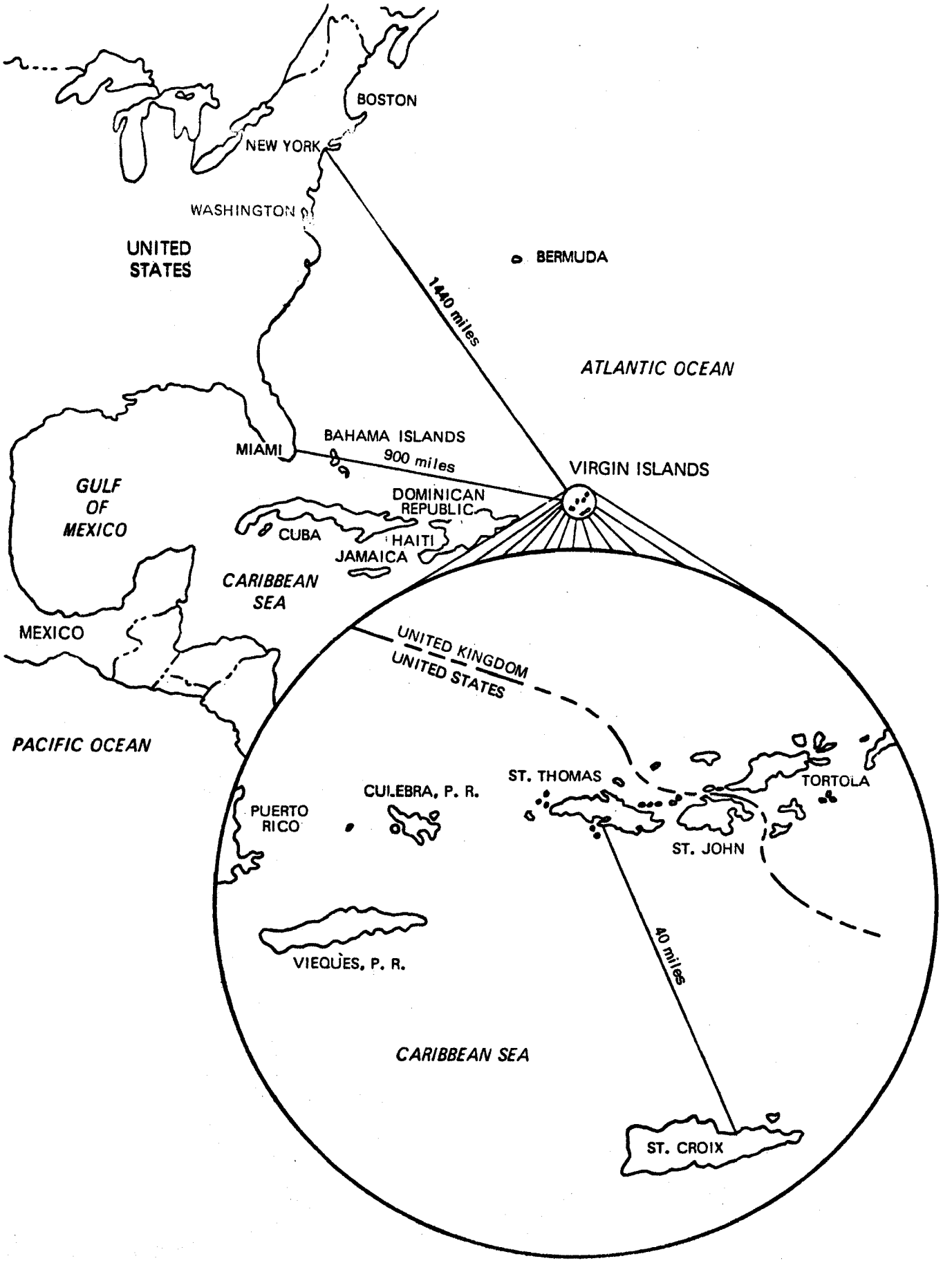

Figure 1. Virgin Islands in relation to the United States.

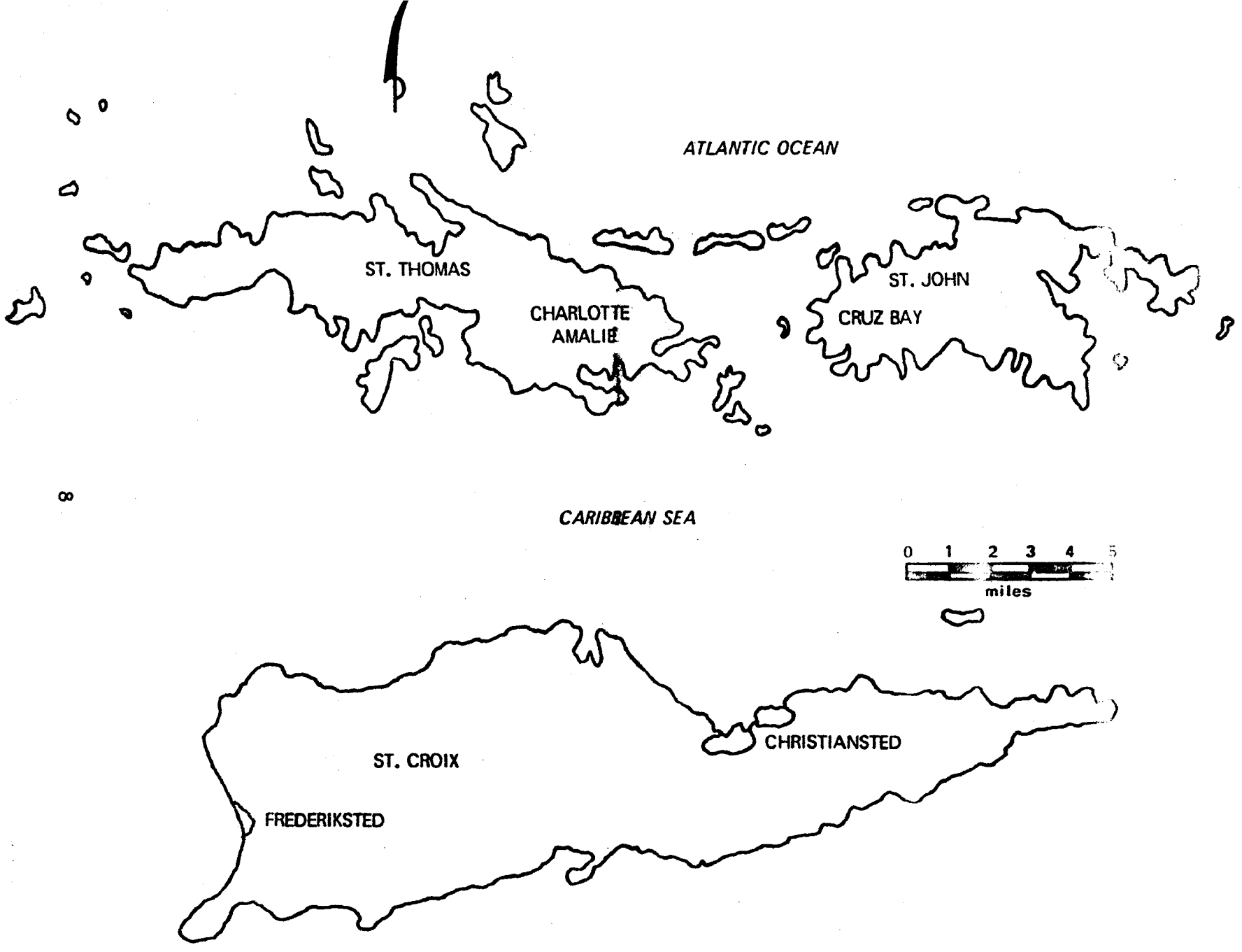

Figure 2. Virgin Islands study area.

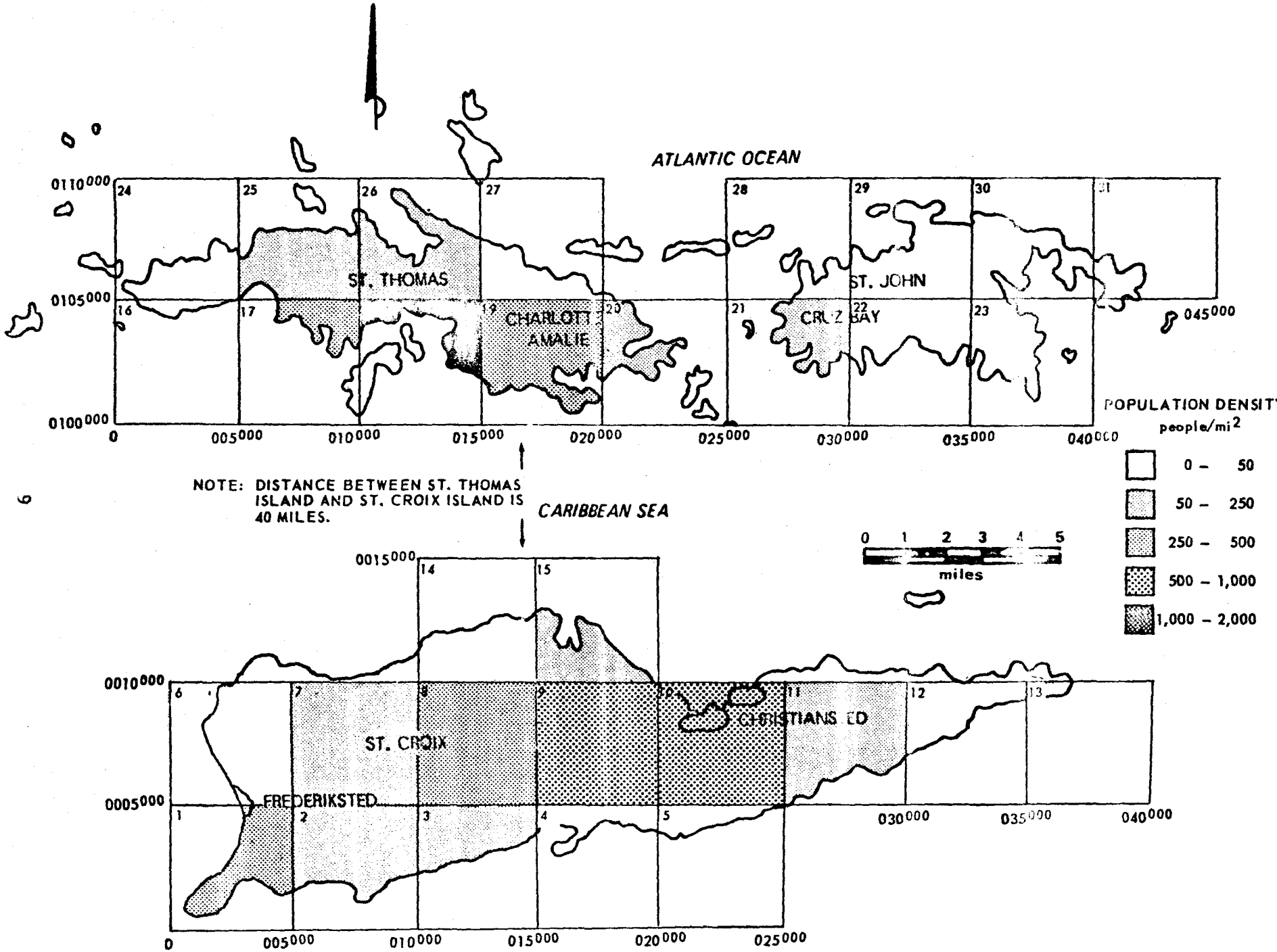

Figure 3. Population density for the Virgin Islands.

TABLE 2 POPULATION AND AREA CHARACTERISTICS OF THE VIRGIN ISLANDS STUDY AREA, 1968

Jurisdiction	1968 Population	Area, Mi^2	Population Density People/mi^2, 1968
St. Croix	27,700	87	318
St. John	1,600	18	89
St. Thomas	31,100	32	971
TOTAL	60,400	137	440

GRID COORDINATE SYSTEM

A grid coordinate system was used in the Virgin Islands Area to indicate the geographical distribution of emissions. A map showing the grid coordinate system is presented in Figure 4.

The grid system used was based upon the metric system. Each north-south and east-west grid line , as illustrated in Figure 4, is identified by a coordinate number expressed in meters. Each point source and grid, using its geographical center, is identified by a horizontal and vertical coordinate to the nearest 100 meters.

Grid zones of different sizes are usually used in the grid coordinate system to allow a satisfactory definition of the geographical gradation of emissions and to limit the number of grid zones. The majority of the emissions is usually concentrated in the populated and industrialized portions of a Study Area. Smaller grids are placed over these areas to allow the grid coordinate system to reflect the changes of emissions over short distances. Grid zones smaller than the 25 kilometer grid zones used in this report are not usually warranted because of the inherent inaccuracies in the data. Larger grid zones are usually used in the rural portions, because a smaller percentage of the total emissions usually occurs in lightly populated areas. Because the Virgin Islands have a relatively small area compared to other studies of this type, only one size grid was used (25 Km^2).

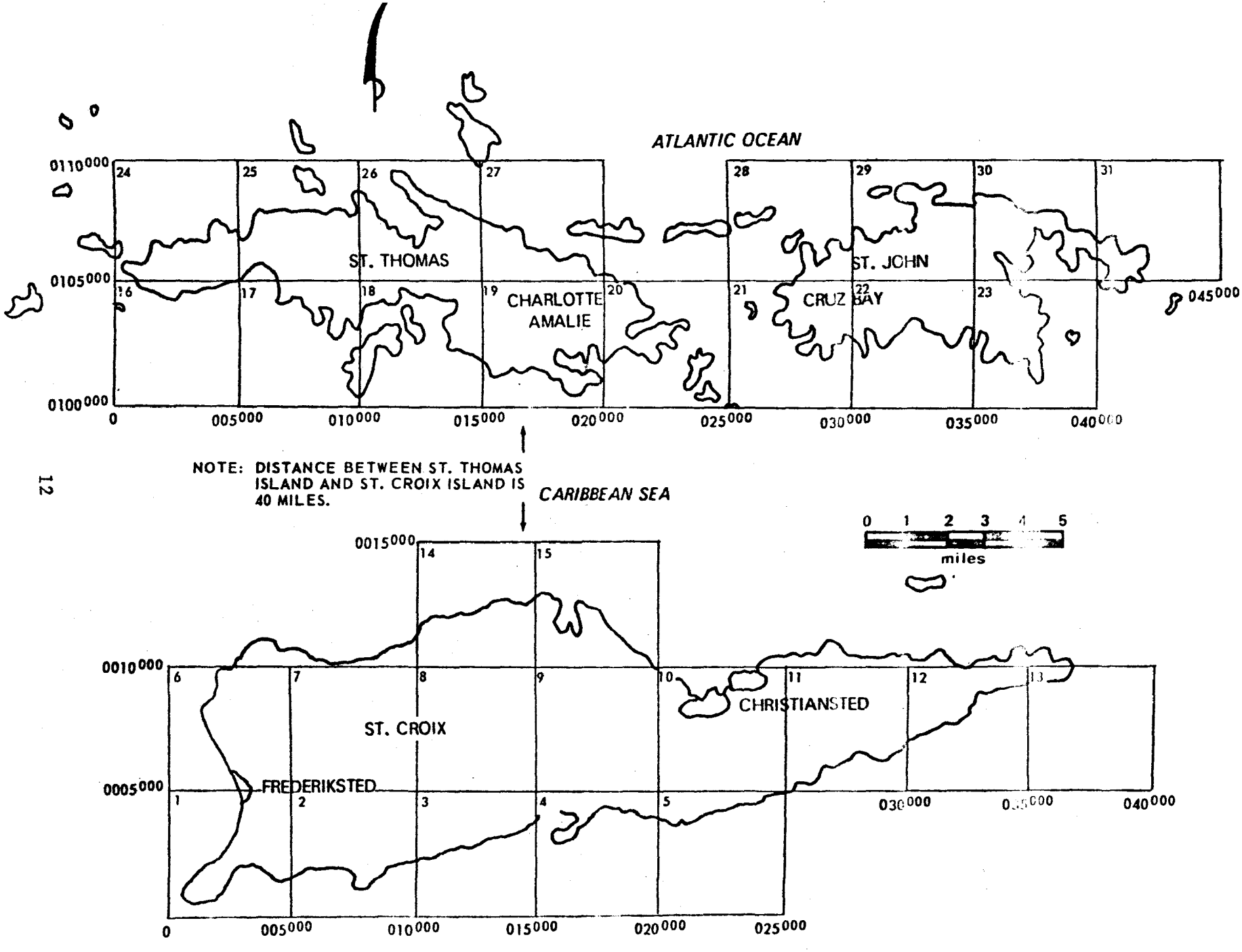

Figure 4. Virgin Islands grid coordinate system.

EMISSIONS BY CATEGORY

TRANSPORTATION

Transportation is the source category concerned with mobile source of air pollutants. The sources in this category include: road vehicles (both gasoline and diesel powered), aircraft, vessels, and railroads. With the exception of aircraft, all the sources are presented as area sources. Since most of the aircraft emissions are attributable to the immediate vicinity of the airports, aircraft are presented as point sources.

Road Vehicles

METHODOLOGY: Vehicle miles of travel were obtained from gasoline consumption. Total vehicle miles of travel for 1968 were obtained by using an average factor of fuel consumed per vehicle mile.[3]

The vehicle miles of travel which included only gasoline vehicle was apportionned onto the grid system by locating major arterials and secondary roads.

Approximately 1.5 to 2.0 percent of gasoline is lost through evaporation from gasoline tanks and the carburetor. (This is exclusive of hydrocarbon losses from exhaust.) It was assumed that no diesel fuel was lost by evaporation. Since 1963 most new automobiles were equipped with positive crankcase ventilation (PCV) valves that reduce hydrocarbon emissions from the crankcase by about 90 percent. Due to a lag time in the automobile replacement rate, it was assumed that 80 percent of the automobiles were equipped with PCV valves.

RESULTS: More than 177 million miles were traveled by motor vehicles in 1968. In the process, 14.2 million gallons of gasoline was consumed for highway purposes. Table 3 indicates that about 97 percent of all motor vehicle travel occurs in St. Thomas and St. Croix.

TABLE 3 VEHICLE MILES OF TRAVEL AND GASOLINE CONSUMPTION FOR THE STUDY AREA, 1968

Jurisdiction	Vehicle Miles (10^3/Day)	Gasoline (10^6/Year)
St. Croix	236.3	6.90
St. John	237.3	6.93
St. Thomas	12.0	0.35
TOTAL	485.6	14.18

The resulting emissions from motor vehicles are shown in Table 1. Motor vehicles are by far the most significant transportation source, accounting for 65 percent of the carbon monoxide and 41 percent of the hydrocarbons.

Aircraft

METHODOLOGY: The total number of flights by type was obtained from the Federal Aviation Administration. A flight is defined as the combination of a take-off and landing. Estimates were made as to the kind and number of engines in each type category. Table 5 presents the results of these estimates at Harry S. Truman Field and Alexander Hamilton Airport.

Emissions were obtained by applying the appropriate emission factors to the total number of flights in each engine and type category.

RESULTS: Table 4 presents the resulting air pollutant emissions from the two airports in the Study Area. As can be seen, the piston engines are the largest source of emissions among aircraft, accounting for 97 percent of the carbon monoxide and 96 percent of the hydrocarbons.

Vessels

METHODOLOGY: The number of vessels entering St. Thomas was obtained from the Virgin Islands Port Authority-Marine Division. This total included both cruise and cargo ships. An average consumption of fuel while in port was used to determine the quantity of fuel consumed by this source category.

RESULTS: Air pollutant emissions from vessels are shown in Table 1. It is apparent from this table that the percent contribution from this source category to total transportation emissions is negligible.

FUEL COMBUSTION IN STATIONARY SOURCES

Only fuel oil and to some extent natural gas are consumed within the Study Area. In 1968, fuel oil accounted for 21.3×10^{12} BTU of

TABLE 4 SUMMARY OF AIR POLLUTANT EMISSIONS FROM AIRCRAFT FOR THE STUDY AREA, 1968 (Tons/Year)

Source Category	Sulfur Oxides	Partic-ulates	Carbon Monoxide	Hydro-carbons	Nitrogen Oxides
Jet Engine	N	170	120	30	100
Piston Engine	N	50	10,420	1,940	490
Total	N	220	10,540	1,970	590

TABLE 5 SUMMARY OF AIRCRAFT FLIGHTS BY AIRPORT, 1968

Airport	Number of Engines	
	2 Engine	3 Engine
H. S. Truman	55,300	6,000
A. Hamilton	25,700	5,000
Total	81,000	11,000

TABLE 6 FUELS USED IN STATIONARY SOURCES FOR THE STUDY AREA, 1968

Jurisdiction	Residual Fuel Oil 10^6 Gal.	Distillate Fuel Oil 10^6 Gal.	Natural Gas 10^6 Ft.^{3}
St. Croix			
Industry	88.2	19.3	2,200
Power Plant	6	3	0.5
St. John	0	0	0
St. Thomas			
Industry	0	0	0
Power Plant	14	1	0
TOTAL	108.2	23.3	2,200

SULFUR CONTENTS OF FUEL

Distillate Fuel Oil	0.2 - 1.0%
Residual Fuel Oil	2.0%

energy or 91 percent of the total. As shown in Table 6, 2.2 billion cubic feet of natural gas and 132 million gallons of fuel oils were burned within the Study Area.

Industry is the largest consumer of both fuels. Since there are no heating requirements, and all power is supplied by the two power plants, no fuel is consumed by all residential and commercial sources and most industrial plants.

METHODOLOGY: All fuel consumption was obtained from the Virgin Island Health Department.

RESULTS: The resulting emissions are shown in Table 7. The combustion of oil accounts for the majority of emissions from fuel combustion in stationary sources.

SOLID WASTE

METHODOLOGY: The total solid waste generated within the Study Area was found by applying the national average per capita generation rates of refuse per day to the total Study Area resident population.[4] This generation rate includes both collected and uncollected waste. On the average 5.5 lb/day of waste is collected by municipalities for disposal. This figure includes household, commercial and industrial refuse. Since there is a large number of non-residents, especially tourists, on the islands during the year, it was assumed they contributed about 1.5 lb/day per resident. The disposal method for the three islands is open burning dumps. The emissions from these dumps were calculated individually and located within the Study Area.

RESULTS: Table 8, which is a solid waste balance for the Study Area, shows the results of the above methodology. Table 1 presents the emissions from solid waste disposal practices.

INDUSTRIAL PROCESSES

The major industry in the Study Area is tourism. However, there are two large industries on St. Croix-- an oil refinery and an alumina plant. In addition, there are several small asphalt and concrete

TABLE 7 EMISSIONS FROM STATIONARY FUEL COMBUSTION IN THE STUDY AREA, 1968 (Tons/Year)

Source Category	Sulfur Oxides	Partic-ulates	Carbon Monoxide	Hydro-carbons	Nitrogen Oxides
Industry	3,460	120	N	40	1,250
Power Plants	14,140	1,180	110	110	4,110
TOTAL	17,600	1,300	110	150	5,360

batching plants on St. Croix and St. Thomas. There are no industrial establishments on St. John.

METHODOLOGY: Data for the two large industrial plants were collected in cooperation with the local air pollution agency. The alumina plant is a source of particulates only. However, the two rotary kilns are both equipped with electrostatic precipitators. The bauxite ore is wet during handling and processing. Thus emissions from this plant are small. Data on the oil refinery has not been supplied by the company at this time. However, using published data on refinery capacity emission estimates were made based on this information and other data supplied by the Virgin Islands Department of Health.

RESULTS: Total emissions from industrial processes are shown in Table 1. As can be seen, this category is the major source of carbon monoxide and an important source of sulfur oxides and particulates.

TABLE 8 SOLID WASTE DISPOSAL PRACTICES FOR THE VIRGIN ISLANDS STUDY AREA, 1968 (Tons/Year)

Jurisdiction	Total Generated	Open Burning Dumps
St. Croix	35,400	35,400
St. John	1,830	1,830
St. Thomas	39,100	39,100
TOTAL	66,330	66,330

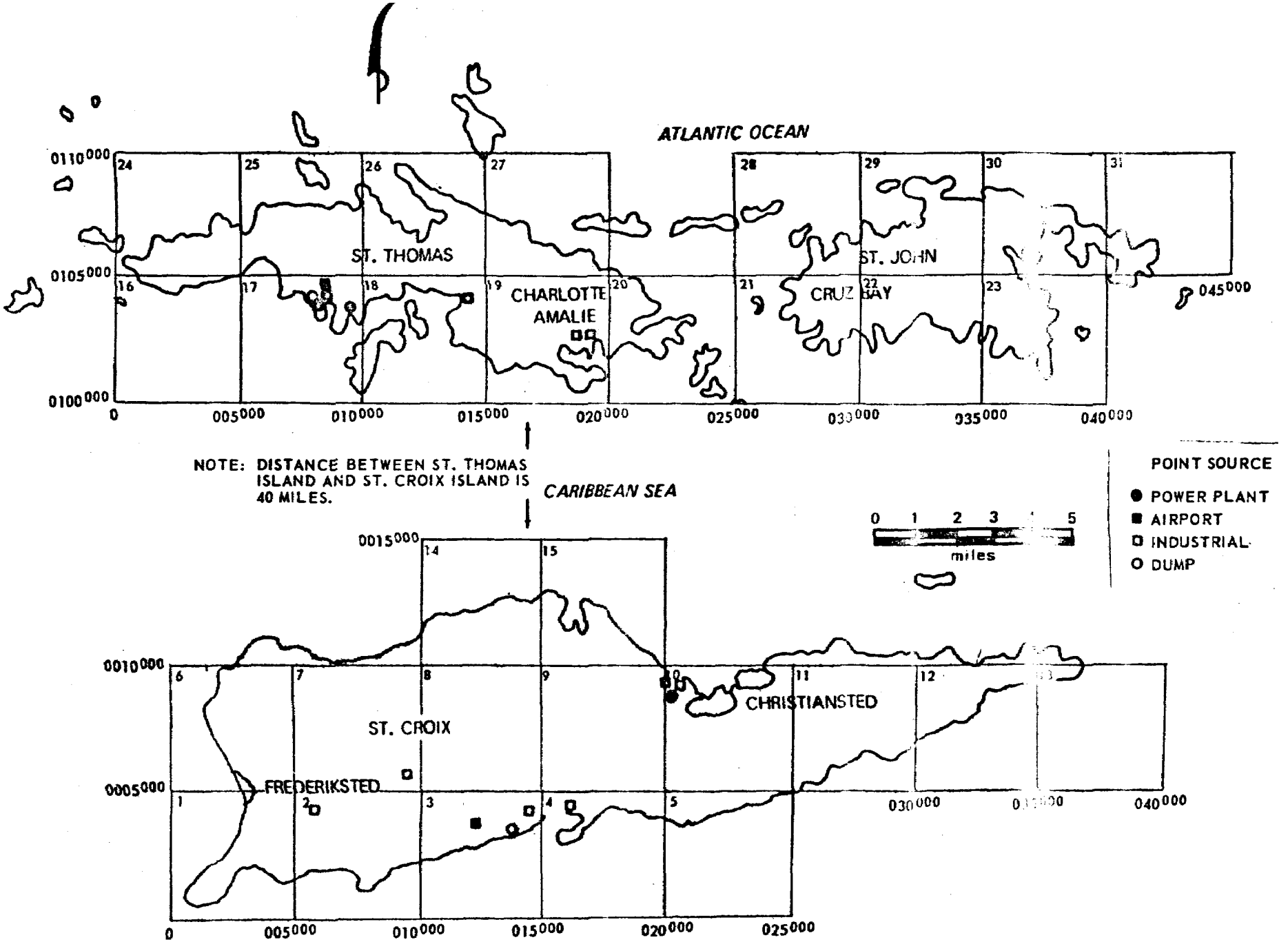

Figure 5. Location of point sources in the Virgin Islands.

EMISSIONS BY JURISDICTION

The previous section of this report presents emissions primarily by source category. The emissions by island and source are summarized here in Tables 9 through 11.

TABLE 9 SUMMARY OF AIR POLLUTANT EMISSIONS IN ST. JOHN ISLAND
1968 (Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation	N	N	440	30	20
Road Vehicles	N	N	440	30	20
Other	N	N	N	N	N
Stationary Fuel Combustion	0	0	0	0	0
Industry	0	0	0	0	0
Power Plants	0	0	0	0	0
Solid Waste	N	10	80	30	10
Industrial Processes	0	0	0	0	0
Evaporative Losses	--	--	--	20	--
TOTAL	N	10	520	80	30

N = Negligible

TABLE 10 SUMMARY OF AIR POLLUTANT EMISSIONS IN ST. CROIX ISLAND
1968 (Tons/Year)

Source Category	Sulfur Oxides	Partic-ulates	Carbon Monoxide	Hydro-carbons	Nitrogen Oxides
Transportation	30	130	10,970	1,190	580
Road Vehicles	30	30	7,710	570	370
Other	N	100	3,260	620	210
Stationary Fuel Combustion	15,300	1,220	110	120	4,570
Industry	14,100	1,170	110	110	4,100
Power Plants	1,200	50	N	10	470
Solid Waste Disposal	20	280	1,500	530	190
Industrial Processes	2,100	1,190	251,000	6,000	1,300
Evaporative Losses	--	--	--	420	--
TOTAL	17,450	2,820	263,580	8,260	6,640

TABLE 11 SUMMARY OF AIR POLLUTANT EMISSIONS IN ST. THOMAS ISLAND, 1968 (Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation	30	170	17,900	2,110	770
Road Vehicles	30	40	10,610	740	370
Other	N	130	7,290	1,370	400
Stationary Fuel Combustion	2,300	80	N	30	790
Industry	0	0	0	0	0
Power Plants	2,300	80	N	30	790
Solid Waste Disposal	20	320	1,660	580	220
Industrial Processes	0	930	0	0	0
TOTAL	2,350	1,500	19,560	3,110	1,780

EMISSIONS BY GRID

For the purpose of defining the geographical variation of air pollutant emissions in the Study Area, the resulting emissions were apportioned on the grid coordinate system. The emissions were divided into two source groups--point and area sources. Nineteen point sources are identified individually with respect to location and emissions. Each of these point sources emit more than 0 tons per day of any pollutant.

Figure 5 shows the location of the point sources in the area. Collectively the 19 point sources account for 99.9 percent of the sulfur oxides, 97 percent of particulates, 93 percent of carbon monoxide, 77 percent of hydrocarbons and 90 percent of nitrogen oxides. The percent contribution to nitrogen oxide emissions is low because motor vehicles, which are area sources account for 10 percent of the total nitrogen oxide emissions. Similarly, the contribution to total hydrocarbon emissions is low since two groups of area sources, motor vehicles and evaporative losses are major contributors. Table 12 presents the emissions of point sources. It has been assumed that seasonal variations in point sources are negligible.

Area sources are sources of emissions that are insignificant by themselves, but as a group emit a significant amount. Examples are motor vehicles, residential houses, light commercial and industrial establishments and backyard burning. The emissions from area sources have been added to that for point sources to obtain total emissions by grid as given in Table 13.

The emissions are presented for an annual average day, an average winter day (December, January, February), and an average summer day (June, July, August). The annual average daily emission rates were obtained by dividing yearly totals by 365. Seasonal averages in most areas are calculated by the use of space heating variations in fuel consumption and variations in motor vehicle traffic activity. This method is described in detail in the appendix. Other sources are assumed to be constant throughout the year.

TABLE 12 SUMMARY OF AIR POLLUTANT EMISSIONS FROM POINT SOURCES
TONS/DAY

				SOx			PART			CO			HC			NOX		
ID	GR	HC	VC	S	W	A	S	W	A	S	W	A	S	W	A	S	W	A
2	2	60	042	0.0	0.0	0.0	0.20	0.20	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	3	145	040	15.7	15.7	15.7	2.19	2.19	2.19	0.39	0.39	0.39	0.20	0.20	0.20	3.63	3.63	3.63
2	3	130	035	0.0	0.0	0.0	0.20	0.20	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	3	142	032	0.0	0.0	0.0	0.66	0.66	0.66	3.52	3.52	3.52	1.24	1.24	1.24	0.45	0.45	0.45
7	3	130	030	0.0	0.0	0.0	0.25	0.25	0.25	8.92	8.92	8.92	1.68	1.68	1.68	0.54	0.54	0.54
2	4	16	045	29.1	29.1	29.1	2.14	2.14	2.14	690.49	690.49	690.49	16.70	16.70	16.70	11.24	11.24	11.24
2	7	90	060	0.0	0.0	0.0	0.41	0.41	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	10	201	092	0.0	0.0	0.0	1.03	1.03	1.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	10	210	090	0.0	0.0	0.0	0.41	0.41	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	10	208	088	3.3	3.3	3.2	0.12	0.12	0.12	0.00	0.00	0.00	0.03	0.03	0.03	1.29	1.29	1.28
2	17	75	1042	0.0	0.0	0.0	0.41	0.41	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	17	83	1042	0.0	0.0	0.0	0.41	0.41	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	17	92	1033	6.4	6.4	6.3	0.20	0.20	0.20	0.00	0.00	0.00	0.06	0.06	0.06	2.15	2.15	2.15
5	17	78	1035	0.0	0.0	0.0	0.85	0.85	0.85	4.55	4.55	4.55	1.00	1.00	1.00	0.38	0.38	0.38
7	17	75	1045	0.0	0.0	0.0	0.33	0.33	0.33	10.95	10.95	10.95	3.74	3.74	3.74	1.07	1.07	1.07
2	18	140	1037	0.0	0.0	0.0	0.91	0.91	0.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	19	190	1032	0.0	0.0	0.0	0.41	0.41	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	19	194	1029	0.0	0.0	0.0	0.41	0.41	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	20	37	1060	0.0	0.0	0.0	0.04	0.04	0.04	0.21	0.21	0.21	0.07	0.07	0.07	0.02	0.02	0.02

TABLE 13 SUMMARY OF AIR POLLUTANT EMISSIONS FROM ALL SOURCES, 1969

TONS/DAY

GRID	AREA	SOX			PART			CO			HC			NOX		
		S	W	A	S	W	A	S	W	A	S	W	A	S	W	A
1	9.6	0.0	0.0	0.0	0.0	0.0	0.0	3.3	3.9	3.5	0.5	0.5	0.5	0.2	0.2	0.2
2	9.6	0.0	0.0	0.0	0.2	0.2	0.2	1.1	1.3	1.2	0.1	0.2	0.1	0.1	0.1	0.1
3	9.6	15.8	15.8	15.8	3.3	3.3	3.3	13.8	13.9	13.8	3.2	3.3	3.3	4.7	4.7	4.7
4	9.6	29.2	29.2	29.2	2.1	2.1	2.1	691.4	691.6	691.5	16.8	16.8	16.8	11.3	11.3	11.3
5	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.5	0.1	0.1	0.1	0.0	0.0	0.0
7	9.6	0.0	0.0	0.0	0.4	0.4	0.4	1.3	1.5	1.4	0.2	0.2	0.2	0.1	0.1	0.1
8	9.6	0.0	0.0	0.0	0.0	0.0	0.0	1.3	1.5	1.4	0.2	0.2	0.2	0.1	0.1	0.1
9	9.6	0.0	0.0	0.0	0.0	0.0	0.0	4.3	5.0	4.5	0.5	0.6	0.6	0.2	0.3	0.2
10	9.6	3.3	3.3	3.3	1.6	1.6	1.6	4.7	5.5	5.0	0.7	0.7	0.7	1.5	1.5	1.5
11	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.7	0.6	0.1	0.1	0.1	0.0	0.0	0.0
12	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.4	0.0	0.1	0.0	0.0	0.0	0.0
15	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.7	0.6	0.1	0.1	0.1	0.0	0.0	0.0
16	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
17	9.6	6.5	6.5	6.4	2.2	2.2	2.2	28.7	28.7	28.4	5.8	5.9	5.8	4.1	4.0	3.9
18	9.6	0.0	0.1	0.0	1.0	1.0	1.0	16.9	19.6	17.8	1.8	2.1	1.9	0.6	0.7	0.6
19	9.6	0.0	0.0	0.0	0.9	0.8	0.8	3.9	4.5	4.1	0.4	0.5	0.5	0.1	0.2	0.1
20	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.6	0.5	0.1	0.1	0.1	0.0	0.0	0.0
21	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.7	0.6	0.1	0.1	0.1	0.0	0.0	0.0
22	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
23	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
24	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0
25	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.0	0.9	0.1	0.1	0.1	0.0	0.0	0.0

TABLE 13 (cont.)

26	9.6	0.0	0.0	0.0	0.0	0.0	0.0	1.3	1.5	1.3	0.1	0.2	0.2	0.1	0.1	0.1
27	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0
28	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
29	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
30	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.1	0.1	0.1	0.0	0.0	0.0
31	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0

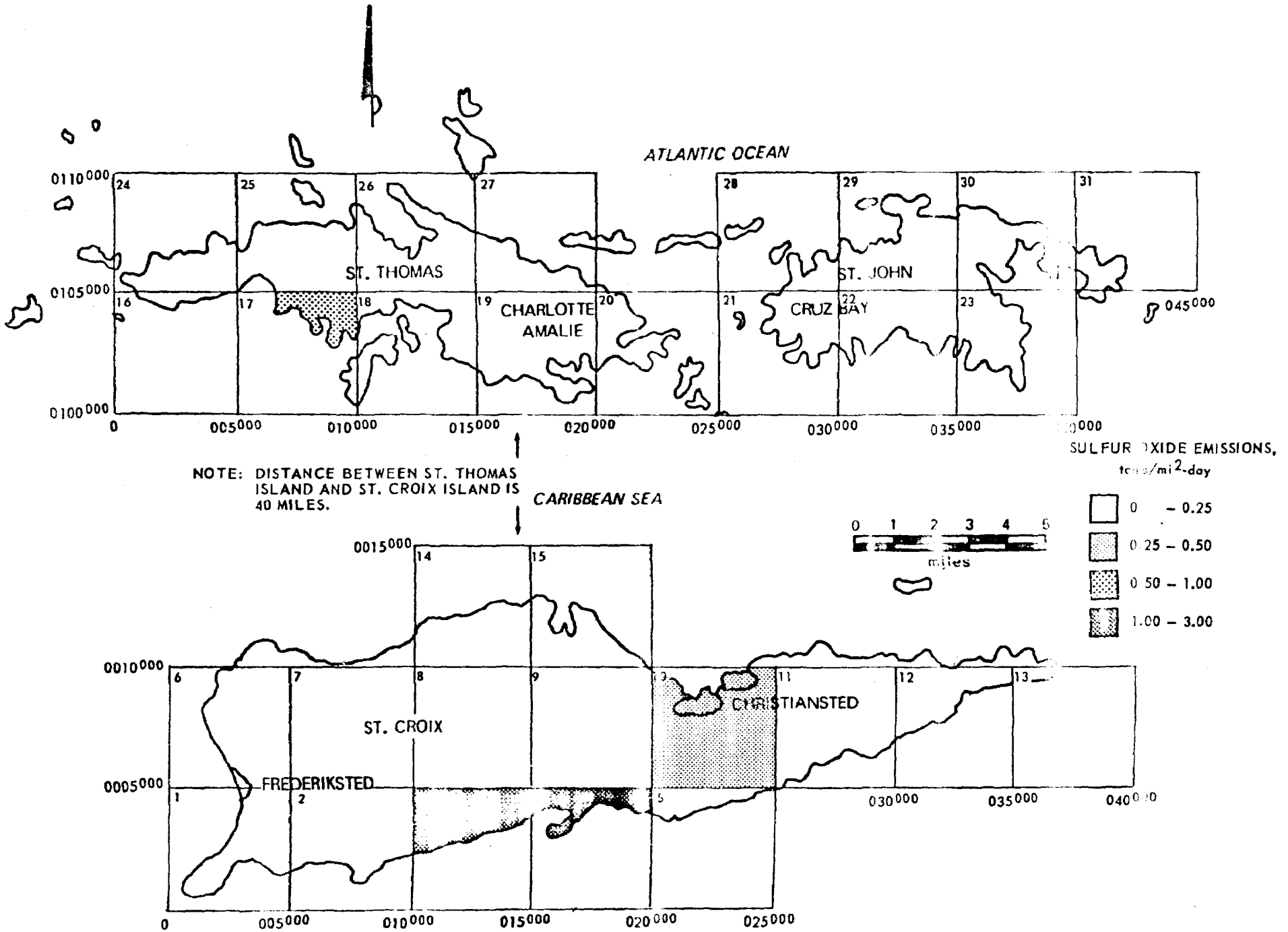

Figure 6. Sulfur oxide emission density for the Virgin Islands.

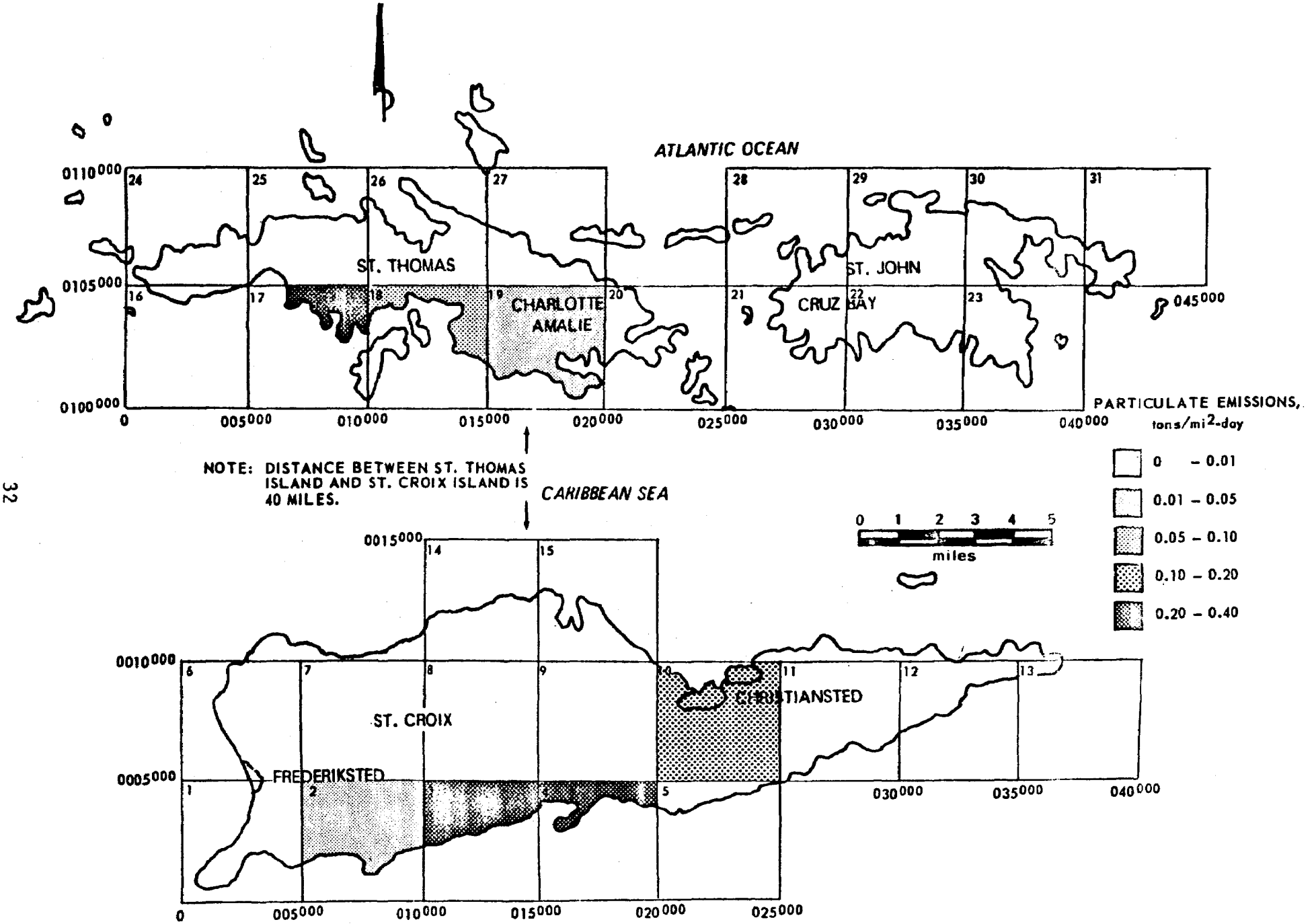

Figure 7. Particulate emission density for the Virgin Islands.

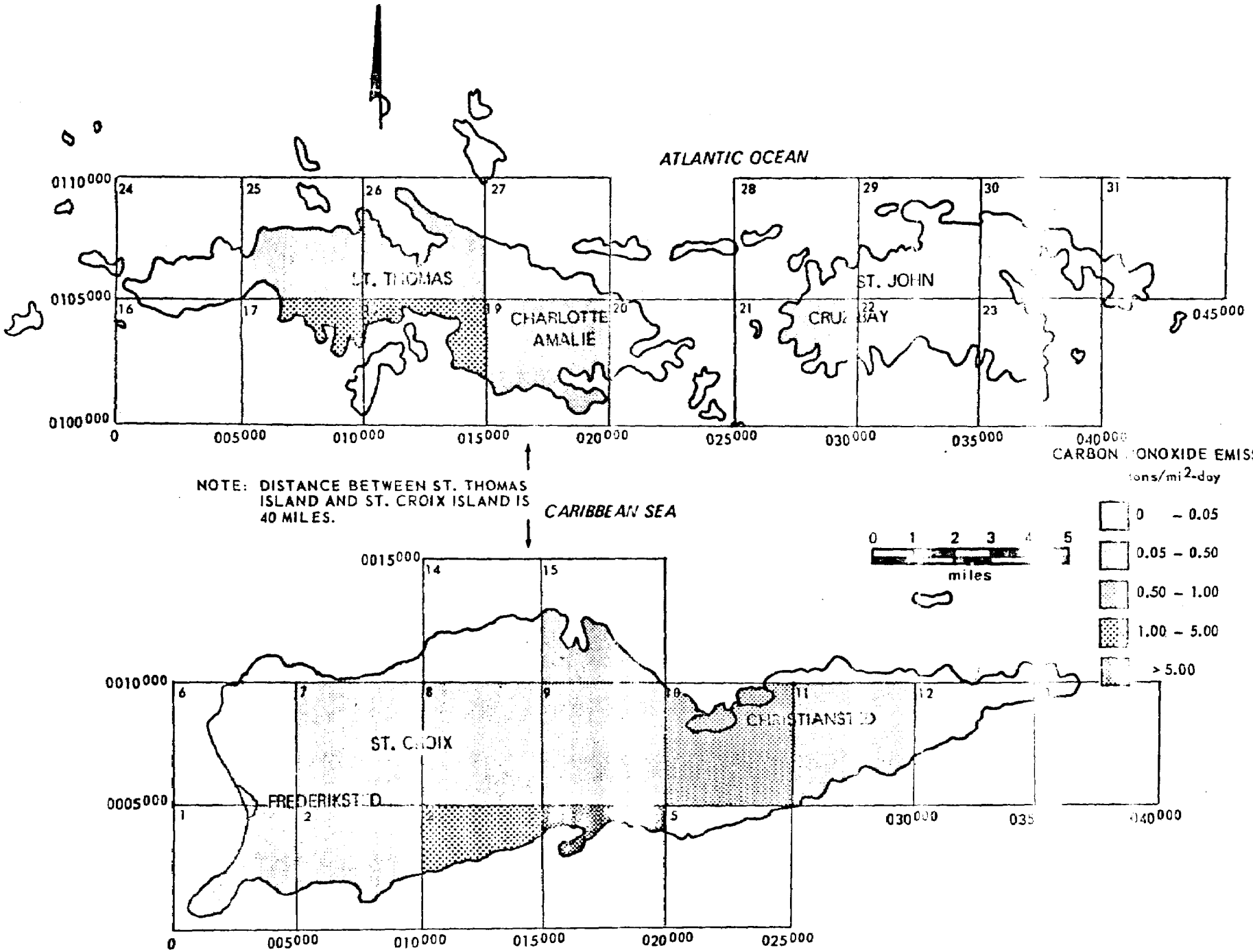

Figure 8. Carbon monoxide emission density for the Virgin Islands.

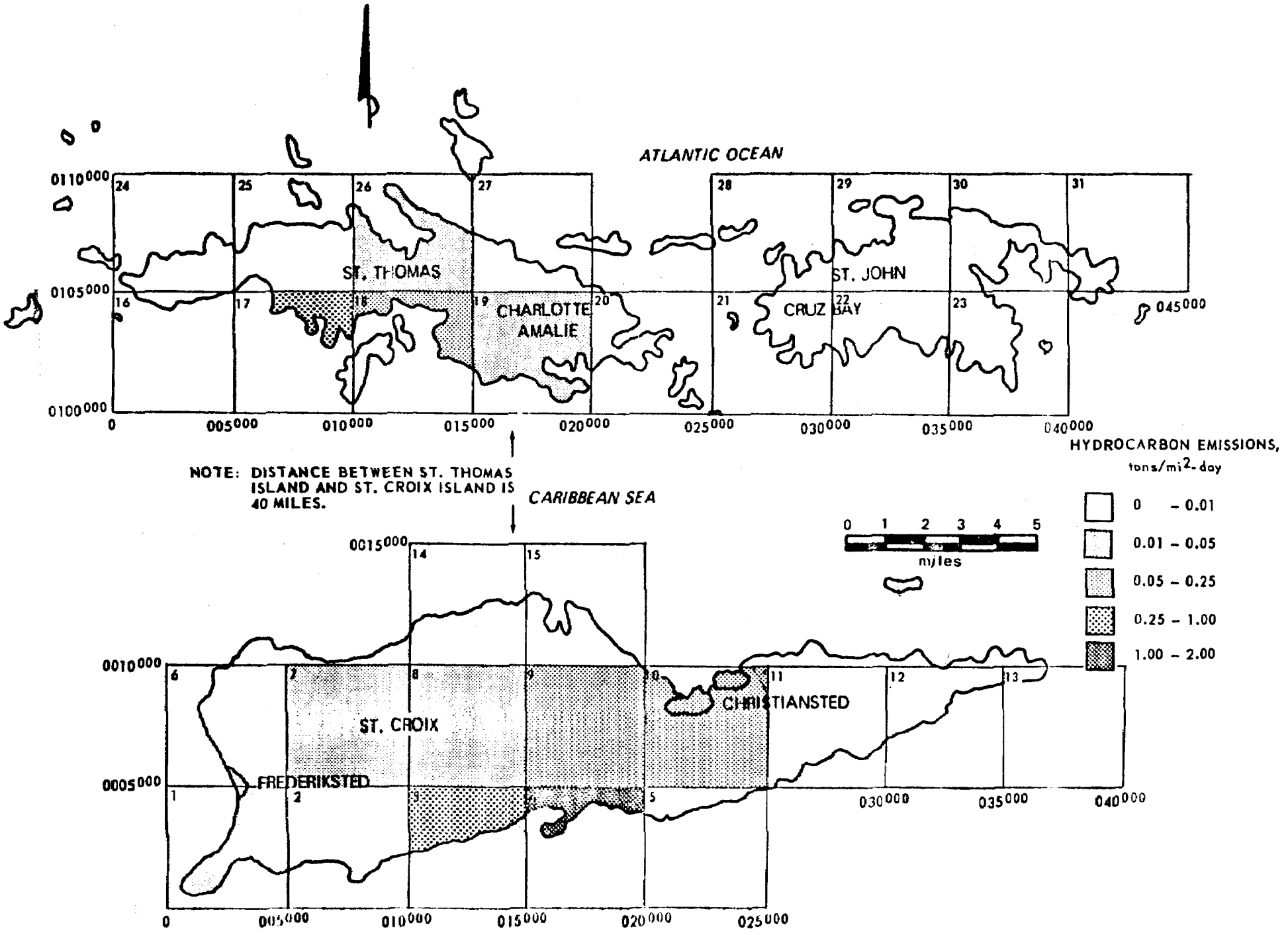

Figure 9. Hydrocarbon emission density for the Virgin Islands.

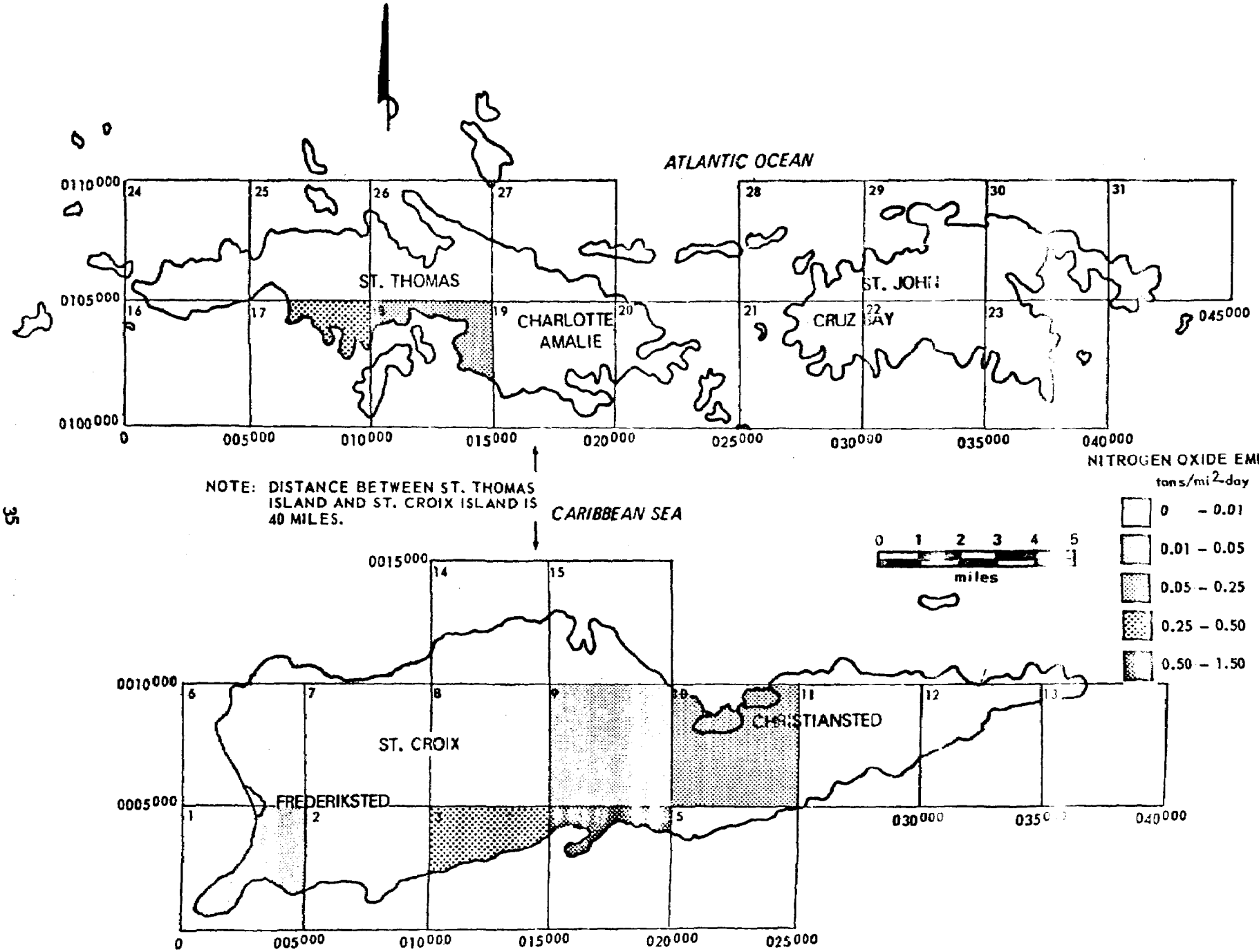

Figure 10. Nitrogen oxide emission density for the Virgin Islands.

EMISSION DENSITIES

In order to provide a visual representation of the emissions of pollutants by grid, emission density maps have been provided. Figures 6 through 10 show variation in emission densities for the respective grids throughout the Study Area. As expected the emissions generally follow the pattern and degree of urbanization. Emission densities are higher in grids with high populations and correspondingly high vehicular and industrial activity.

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