ENVIRONMENTAL IMPACT STATEMENT
APPENDIX K: Air Emission Inventory and Assessment

SAVANNAH HARBOR EXPANSION PROJECT

Chatham County, Georgia and Jasper County, South Carolina

January 2012

(Revised July 2012)

US Army Corps of Engineers
Savannah District
South Atlantic Division

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Air Emission Inventory & Assessment

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AIR EMISSION INVENTORY & ASSESSMENT
FOR THE
PORT OF SAVANNAH

1.0 INTRODUCTION

The Port of Savannah (see Figure 1) is a complex junction in the transportation of goods within the US and internationally. The port includes both public and privately-owned terminals and services a wide variety of vessel types and cargoes.

The publicly-owned Georgia Ports Authority (GPA) provides two modern, deepwater terminals: Garden City Terminal and Ocean Terminal. The Garden City Terminal (GCT) is the largest single-terminal container facility of its kind on the U.S. East and Gulf coasts. It encompasses more than 1,200 acres and moves millions of tons of containerized cargo annually. Ocean Terminal (OT) is GPA's dedicated breakbulk and Roll-on / Roll-off facility (RORO), covering 208 acres and providing customers with more than 1.3 million square feet of covered, versatile storage.

In addition to the GCT and OT, there are 20 privately-owned terminals in the Port of Savannah as shown below.

Table 1-1
Privately-Owned Terminals in the Port of Savannah

EL Paso Energy/Southern LNG	City Front	Citgo Asphalt Refining Company	SEPCO - Georgia Power Plant Kraft
Valero	Colonial 1	Georgia Kaolin Terminals	Newport Terminals
Conoco-Phillips	Colonial 2	Southern Bulk Industries	East Coast Terminal
Georgia Pacific Gypsum	Colonial 3	National Gypsum	Savannah Steel
Wood Chip Exporting Corp	Global Ship Systems	Vopak	Savannah Sugar Refinery

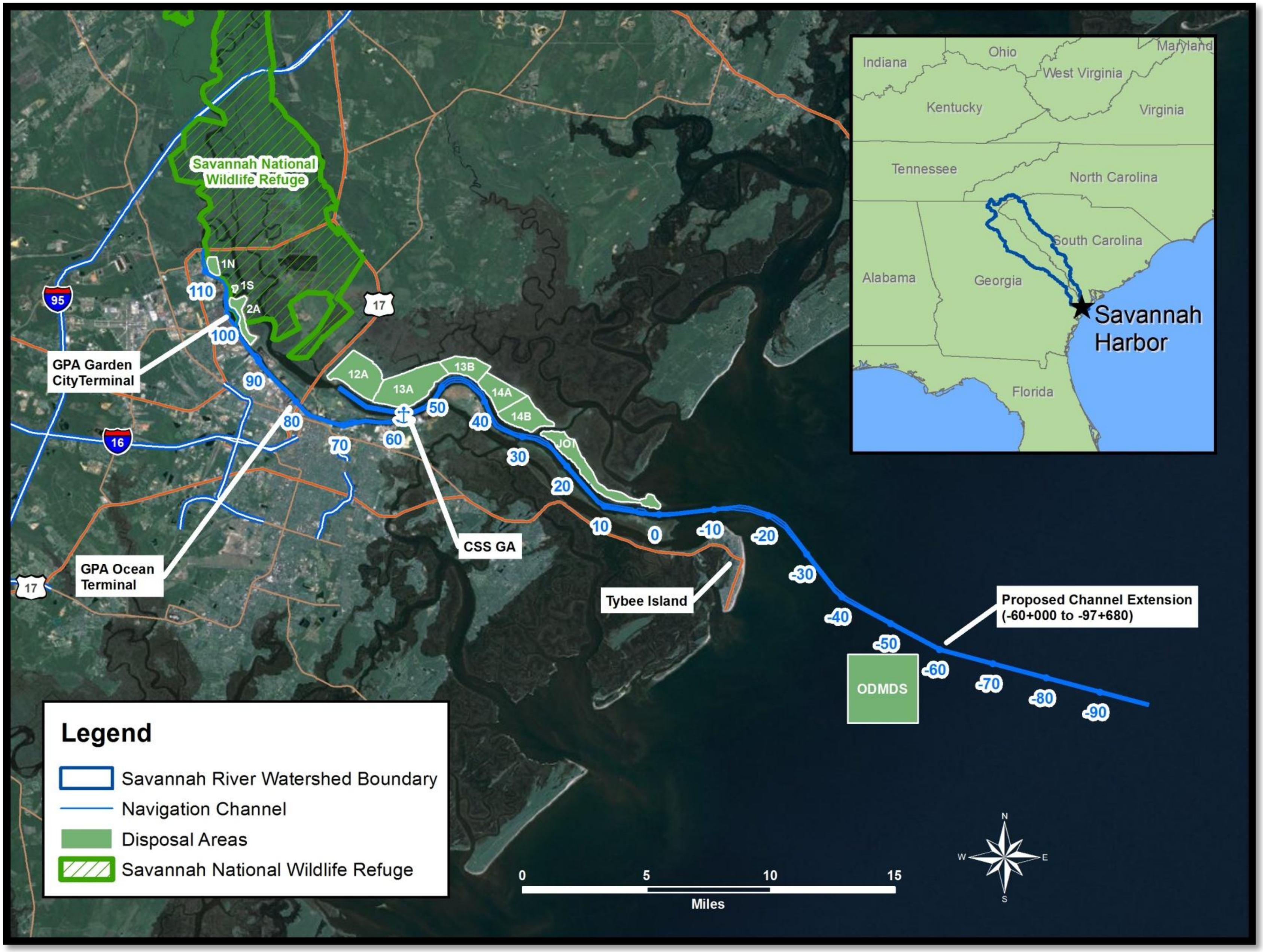

Figure 1-1. Current Savannah Harbor navigation project.

Economic projections indicate that containerized shipping is expected to increase throughout the world, along the US East Coast and in the Port of Savannah. In response to this growth in container volume, the shipping industry is expected to continue its trend toward larger container vessels. The planned deepening of the Panama Canal will aid in the use of these larger vessels on routes serving the eastern US. A more detailed description of the expected changes to the world fleet and the one calling at Savannah can be found in the Economic Appendix, in the GRR.

The characteristics and physical specifications of the container vessels that presently call at Savannah are shown below.

Table 1-2
Container Vessel Characteristics / Physical Specifications

Ship Class	Overall Length (feet)	Beam (feet)	Draft (feet)	TEU Capacity
Post-Panamax	1044.0	140.0	46	>=6,000
Panamax	951.0	106.0	42	4,000
Sub-Panamax	716.3	100.0	38	2,500
Handy Size	610.7	85.1	32	1,600

The Savannah Harbor navigation channel is currently authorized at a depth of 42 feet MLW. The GPA indicates that 70% percent of the container vessels that called on the port in 2006 were operationally constrained by the channel depth. As the newer, larger container vessels increase their calls at the port, that percentage will increase. The 1999 Water Resources Development Act authorized deepening the channel to a maximum depth of 48 feet to allow the Port to accommodate the larger classes of container vessels that are now being constructed. That authorization was subject to several conditions, including an evaluation of incremental amounts of harbor deepening, development of mitigation plans, and approval of the project by the Departments of the Army, Interior, Commerce and the US Environmental Protection Agency.

Under both the without and with project conditions, the Corps expects the Garden City Terminal to reach its build-out capacity in 2030 when the total number of TEUs processed through the terminal reaches 6.5 million. That capacity is the maximum number of containers that could reasonably be processed through the Garden City Terminal in a year. That determination includes factors such as the size of the terminal, the number of gates that provide access to the property, the number and size of the berths, the number and size of the container cranes, the number of jockey trucks that move the containers within the terminal, how the containers are stacked within the terminal, and the number of railroads that service the terminal and the frequency of their trains. It is anticipated that without deepening, more vessels will be required to transport the cargo that is expected to move through the port. With deepening, the total number of vessels decreases as vessels will be able to load more deeply under the improved conditions.

No increases in cargo are expected to occur as a result of the proposed harbor deepening. As a result, the project would not affect the number of containers that move through the areas that surround the port. The economic benefits of the project would result from the use of larger, more cost-effective container ships, not an increase in the number of containers.

In 2006, the Corps' Mobile District prepared a report entitled "Air Quality Analysis, Savannah Harbor Expansion Project". That report is available from Savannah District. The analyses documented in the report described the air emissions associated with container vessels calling on the Georgia Ports Authority (GPA) Garden City and Ocean Terminals in Savannah Harbor. Emission estimates for those operations are presented in the report for the period 2004 through 2050, both with and without implementation of the proposed harbor deepening project.

In response to EPA Region 4's request, the Corps prepared an Air Emission Inventory for the Port of Savannah (an earlier version of this Appendix K). The Corps provided the report to the US Environmental Protection Agency (EPA) Region 4 office for review and comment. As a result of their review, EPA requested the analysis be expanded to include (1) the emissions from landside equipment that service these vessels, (2) the air toxics emitted by both the vessels and the landside equipment, and (3) similar analyses associated with the privately-owned terminals in the harbor. EPA recognized that the emissions associated from vessels calling at the privately-owned terminals were not likely to be affected by the proposed harbor deepening, but they desired the comprehensive air quality assessment of the harbor to be able to more accurately place any expected increase in emissions resulting from the proposed harbor deepening in its proper context. After their review of the DEIS, EPA submitted additional comments on January 28, 2011 concerning Appendix K; in response, the Corps has further revised this appendix to address those additional comments.

2.0 OBJECTIVE

The objective of this work is to expand the Corps' 2006 air quality analysis to the entire harbor to more completely assess air quality impacts from the proposed harbor deepening. This more detailed assessment will evaluate the air emissions (including air toxics) from all cargo-carrying vessels and landside cargo handling equipment at both the GPA and privately-operated terminals at the port. It will also compare these emissions for both the "With" (i.e., -44, -45, -46, and -47/48 foot depths) and "Without Project" (No Action) alternatives (i.e., -42 foot depth existing depth) for years 2016, 2020, 2025, 2030, and 2066. The assessment does not include a detailed dispersion modeling assessment of these emissions or a risk-based assessment of the health effects associated with the proposed project. The primary focus of this work is a comparative assessment of the air emissions associated with the operation of the port before and after project implementation, in conjunction with consideration of the current status of air quality in the Savannah area.

For the purposes of this assessment, the area defined for vessel emissions is consistent with the area considered in the 2006 Corps report and the US Environmental Protection Agency's (EPA's) "**Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories, Final Report, dated April 2009**. For vessels, the area began in the ocean in the outer half of the entrance channel where the harbor pilots join the vessel to accompany it on its inland transit, and extends to wherever the vessel is docked to load or discharge its cargo. On land, the area includes the equipment used to load and unload the vessels, and then move that cargo around within the terminal. For container cargo, the landside area includes the location/time trucks wait to enter the GPA terminal to drop off or pick up its load, as well as the location/time for the outgoing trucks to clear the immediate vicinity of the port and the city limits. The updated air emission inventory and assessment includes the following sources: Equipment used to transport containers away from the port, tugs which assist vessels moving through and docking in the harbor, Coast Guard vessels employed during the movement of LNG vessels, the shuttle boats and paddle-wheel boats which transport tourists, vessel shifts between docks within the port, and the other 20 non-GPA terminals in the port.

This emission inventory and assessment is based on information provided by GPA, the Savannah Pilots Association, the Savannah Maritime Association, EPA, other ports, and company websites. The Commodity Forecast (in Section 5.0) and Fleet Forecasts (see Economic Appendix) discussed in the GRR were also used to develop vessel calls at the port and cargo handled by the terminals. It was supplemented by dredging records maintained by Savannah District, as well as projections developed by the Corps during the Economic Analysis for the Savannah Harbor Expansion Project. The GPA staff conducted much of the local "leg work" for this analysis, contacting various equipment owners and operators to obtain information that the District needed. Without their assistance, this analysis would not contain such detailed information, and therefore would not be as accurate. Staff from the Corps' Wilmington District coordinated with EPA and other ports to obtain air inventories which have been conducted, and they performed much of the technical work.

3.0 METHODOLOGY FOR DETERMINING AIR EMISSIONS

The US Environmental Protection Agency's (EPA's) "**Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories, Final Report, dated April 2009** provided the framework to determine all air emissions. The expanded analysis followed a Mid-Tier approach described as Figure 2-3 in EPA's guidance document (located on page 2-20) and shown in the following flow chart taken from that report:

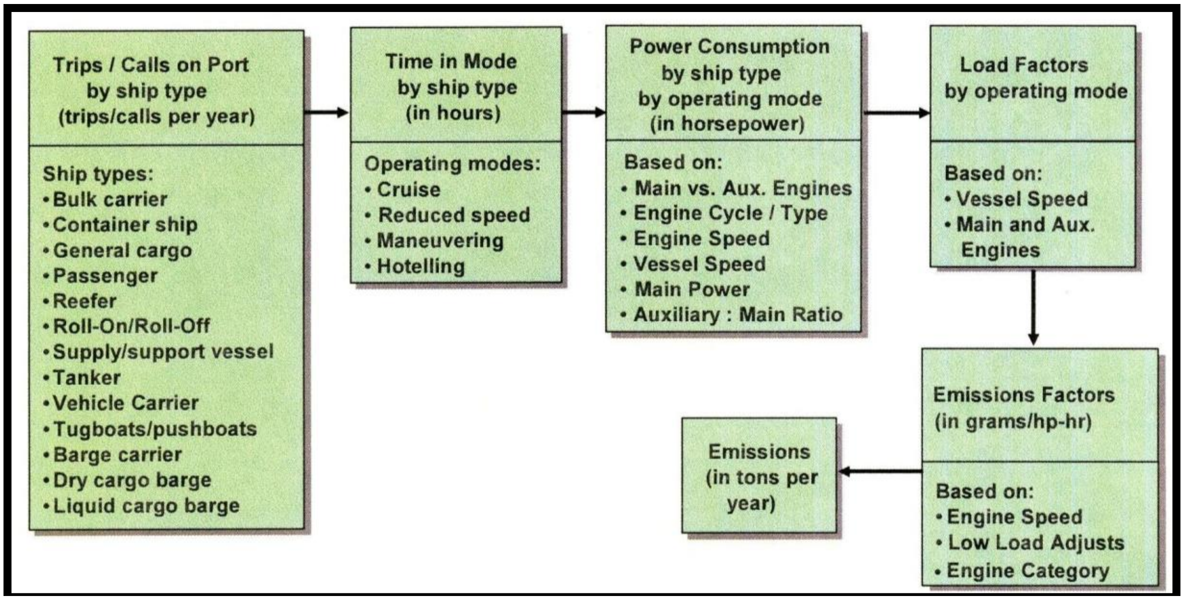

Figure 3-1. US EPA flow chart for mid-tier air emission inventory preparation (USEPA 2009).

The analysis followed EPA's overall evaluation process. In general, air emissions are calculated by determining the size of the engine, the amount of time the engine is used, the load upon the engine, and the emission rate for that type of pollutant. There are many details which can affect the final calculated value, including age of the engine and the type of fuel that it burns.

The first step to develop an air emission inventory using EPA's Mid-Tier approach (in Figure 3-1) is to determine the vessel types and calls per year at the port. The Commodity and Fleet Forecasts (see Table 4-3 and Attachment A) developed by the Mobile District, USACE, GPA, and the Harbor Pilots provided the number and types of vessels calling at the port for the No Action Alternative or baseline depth (i.e., -42 foot depth) and alternative depths (i.e., -44, -45, -46, -47 and -48 foot) for the years 2016 to 2066. Detailed descriptions of how these forecasts were developed are found in Section 5.0 and in the Economic Appendix both in the GRR.

The Fleet Forecast provided the numbers and types (Post-Panamax, Panamax, Sub-Panamax, and Handy size) of vessels calling at the port for different depths for the years 2016 to 2066. The air emissions for each different vessel engine size (includes both main and auxiliary engines working under various loads at different times with different fuels) for all depths and years were then calculated using EPA's Mid-Tier Approach (USEPA 2009). Harbor craft (tugs, tourist vessels, etc.), harbor shifts (vessel movements from one terminal to another), and dredging operations (includes both maintenance and deepening work) emissions were also calculated (USEPA 2009).

The air emissions for all land based operations (Cargo Handling Equipment, trucks going into and out of the terminals, terminal jockey trucks, trains, cranes, top lifts, etc.) using different fuels for all 22 terminals were also calculated using the formula's and methods discussed in US Environmental Protection Agency's (EPA's) "**Current Methodologies in Preparing Mobile**

Source Port-Related Emission Inventories, Final Report, dated April 2009. GPA provided equipment data and usage for its land-based operations at both Garden City and Ocean Terminals.

Once all vessel and land-based emissions for the 22 terminals at the Port of Savannah were calculated (see table 5-78) for all depths and years, then the Corps calculated the amount of air toxics emitted for these depths and years (see Tables 5-63 to 5-76). Air Toxics are generally determined as a ratio of criteria pollutants discharged. The emission rates are a proportion of other parameters such as VOC, PM10, gallons or miles. The Corps obtained information from the NMIM "SCC Toxics" database table provided by EPA, Region 5 concerning the ratios of specific air toxics to other physical parameters. These ratios are displayed in Tables 5-63 and 5-64.

In summary, the District calculated air emissions from 13 different sources that are directly associated with operations of the harbor. This includes emissions from both GPA (Garden City and Ocean Terminals) and the 20 private terminals in the Port. It also includes the vessels which call at the port, the tugs which assist those vessels, the landside equipment that moves the cargo on the terminals, ancillary vessels which operate in the harbor (dredges and tourist boats), and equipment used to move containers out of the harbor area.

This expanded air emission assessment builds upon the 2006 Air Emissions Analysis. Information was obtained on vessels which call at the non-GPA terminals. That information consisted of the number and type of vessels which call at each of the private terminals in the harbor. Details were obtained for the landside equipment associated with cargoes moving through the GPA terminals. Those details include not only the number and type of equipment, but also the specific model number, its engine size, fuel type, age, and annual use rate. The analysis used detailed information when it was accessible, but more general information when detailed data was not available. That approach follows the EPA Best Practices guidance. In this application, this approach results in the analysis being more accurate in those components which could be affected by the proposed harbor deepening.

4.0 BASELINE AND ESTIMATED FLEET FORECAST FOR THE PORT OF SAVANNAH

The Georgia Ports Authority and USACE, Mobile District developed the following table, which serves as the baseline for the emission inventory and assessment. All information within this table was developed by interviewing the harbor pilots and their traffic logs. For 2008, that information is as follows:

Table 4-1
Baseline Existing 42 Foot Depth Garden City Terminal (One-way Vessel Calls)

	Post Panamax	Panamax	Sub-Panamax	Handy-size	Total
Total	32	1,261	213	15	1,521

Table 4-2
Baseline Existing 42-Foot Depth
Ocean Terminal and Non-GPA Terminals
2008 LNG AND General Cargo
(One-Way Vessel Calls)

General Cargo	**1,083**
LNG	**120**

Currently at the Port of Savannah, the existing navigation channel has an authorized depth of -42 feet. For this air emission analysis, the Corps used 2008 as the baseline. The Corps then assumed that the project would be deepened to -48 feet in 2016 (base year), the modifications to the Panama Canal are completed in 2015, and that the end of the 50-year project life was 2066. At 2030, the capacity of the port would be reached. This means that between 2030 and 2066, no additional growth occurs in commodities or annual vessel numbers. No additional vessels could load/off-load at the port each year between 2030 and 2066. Tables 4-3 and 4-4 below show the Corps' estimated fleet forecast each year of in-bound vessels (one way only), at the various depths (i.e., 42 (Baseline), 44, 45, 46, 47, and 48 feet), and arriving at the Port of Savannah in 2016, 2020, 2025, 2030, and 2066. From Table 4-3, it is apparent that the number of vessels calling on the Port of Savannah decreases as the depth of the Federal channel increases.

Table 4-3
Summary of Vessel Calls (One-way) Calling at Garden City Terminal

2016	**Post Panamax**	**Panamax**	**Sub-Panamax**	**Handy-size**	**Total**
-42 feet Baseline	617	1,171	448	57	2,293
-44 feet	560	1,116	448	57	2,181
-45 feet	558	1,094	448	57	2,157
-46 feet	557	1,084	448	57	2,145
-47 feet	**557**	**1,079**	**448**	**57**	**2,141**
-48-feet	557	1,079	448	57	2,141

2020	**Post-Panamax**	**Panamax**	**Sub-Panamax**	**Handy-Size**	**Total**
-42 feet Baseline	1,137	778	528	65	2,509
-44 feet	1,011	700	528	65	2,304
-45 feet	1,001	671	528	65	2,265
-46 feet	995	658	528	65	2,247
-47 feet	**995**	**649**	**528**	**65**	**2,238**
-48-feet	995	649	528	65	2,238

2025	**Post-Panamax**	**Panamax**	**Sub-Panamax**	**Handy-Size**	**Total**
-42 feet Baseline	1,388	1,122	670	87	3,267
-44 feet	1,232	992	670	87	2,982
-45 feet	1,220	952	670	87	2,930
-46 feet	1,214	932	670	87	2,903
-47 feet	**1,211**	**924**	**670**	**87**	**2,892**
-48-feet	1,211	924	670	87	2,892

2030	**Post-Panamax**	**Panamax**	**Sub-Panamax**	**Handy-Size**	**Total**
-42 feet Baseline	1,948	1,196	836	111	4,092
-44 feet	1,707	1,067	836	111	3,720
-45 feet	1,693	1,007	836	111	3,647
-46 feet	1,683	982	836	111	3,613
-47 feet	**1,679**	**975**	**836**	**111**	**3,601**
-48-feet	1,679	975	836	111	3,601

2066	**Post-Panamax**	**Panamax**	**Sub-Panamax**	**Handy-Size**	**Total**
-42 feet Baseline	1,948	1,196	836	111	4,092
-44 feet	1,707	1,067	836	111	3,720
-45 feet	1,693	1,007	836	111	3,647
-46 feet	1,683	982	836	111	3,613
-47 feet	**1,679**	**975**	**836**	**111**	**3,601**
-48-feet	1,679	975	836	111	3,601

Table 4-4 shows the estimated number of General Cargo (Breakbulk, RORO, bulk, and tanker) and LNG vessels arriving at the Ocean Terminal and the other 20 non-GPA terminals in the Port of Savannah for all depths (i.e., -42, -44, -45, -46, -47, and -48 feet) and all years:

Table 4-4
Number of General Cargo Vessel Calls (One Way)
Arriving at the Ocean Terminal and 20 non-GPA Terminals

Vessels	2016	2020	2025	2030	2066
General Cargo	1,733	2,068	2,468	2,946	2,946
LNG	120	136	151	167	167
TOTAL	1,853	2,204	2,619	3,113	3,113

The vessel numbers and types taken from the Fleet Forecast (see Attachment A in Appendix K and the Economic Appendix in the GRR) found within the above tables (Tables 4-1, 4-2, 4-3, and 4-4) were used through-out this emission inventory.

5.0 CALCULATIONS OF AIR EMISSIONS

This report summarizes the analyses that the Corps performed. The intent is for the report to (1) summarize the information that was obtained and used in the analyses, and (2) provide sufficient information to understand the analyses that were conducted.

5.1 Harbor Fleet

Detailed information was collected on the fleet of deep-draft vessels which call at the Port of Savannah. GPA reviewed the logs of the Harbor Pilots for various years through 2008 and provided the Corps with this information. The Corps used this information in both the economic evaluation and this air quality evaluation.

For this air quality evaluation, the Corps took the Harbor Pilots information and calculated the number and types of vessels that call at the different terminals. This information is summarized below.

Table 5-1
2008 Vessel Calls by Type and Location

	Total Harbor	Elba Island LNG Terminal	Garden City Terminal	Ocean Terminal	Non-GPA Terminals
Container	1,521		1,521	---	---
Bulk	170		---	12	158
Breakbulk	362		---	240	122
Tanker	406		---	---	406
RO/RO	145		---	145	---
LNG *	120	120			
Total	2,724	120	1,521	397	686

NOTE 1: A small number of other vessels called at Savannah in 2008. They were excluded from the analysis due to their small number and unpredictability of their calls.

5.2 Transit Time

After consulting with the Harbor Pilots, GPA provided the Corps with information on the time it takes to move vessels in the harbor. The Pilots separated the typical transit into time spent in three different modes of operations: Reduced Speed (9-12 knots), Maneuvering (5-8 knots), and Docking. The Corps used this information to calculate average transit times to the various terminals.

The following table summarizes the typical transit times:

Table 5-2
2008 Transit Time by Vessel Type (Minutes)

	Reduced Speed Zone (9-12 knots)	Maneuvering (5-8 knots)	Docking
Tanker	90	44	30
Container	90	60	30
Bulk	90	56	30
Breakbulk	90	48	30
RO/RO	90	30	30

The durations reflect the time the Harbor Pilots spent on the vessels. This covers the time between the dock and when they meet/leave the vessel on the outer half of the entrance channel.

5.3 Shifts

GPA obtained information from the Harbor Pilots on the number and timing of vessel shifts which occurred within the harbor in 2008. Some vessels call at multiple berths, while others are moved while they are serviced or wait for some other reason. The time it took to move from one terminal to another was also identified. The information was provided by GPA after consultation with the Harbor Pilots. The District used this information to calculate average movement times and develop summaries of vessel shifts by vessel types.

The following tables summarize the important information collected concerning vessel shifts:

Table 5-3
Number of Vessel Shifts in 2008

Bulk	Breakbulk	Container	Tanker	Total
45	61	2	68	176

Table 5-4
Time for Vessel Shifts in 2008 (Minutes)

	Reduced Speed Zone (9-12 knots)	Maneuvering (5-8 knots)	Docking
Average Vessel	30	35	30

5.4 Container Vessels at Garden City Terminal – Georgia Ports Authority

Using the information above, one can begin to calculate air emissions from various sources within the harbor. The first category to be discussed is the Container vessels that call at the GPA terminals. In general, the Corps followed the same procedures as were followed by Mobile District in their 2006 Draft Air Quality Analysis. That procedure also follows the methodology described in EPA's 2009 Best Practices Report.

In summary, air emissions are calculated by determining the size of the engine, the amount of time the engine is used, the load upon the engine, and the emission rate for that type of pollutant. This procedure is shown below:

EMISSIONS PER TRANSIT = ENGINE KW X LOAD FACTOR X TRAVEL TIME X EMISSION RATE

For the first type of information needed – **"Engine kW"** – the Corps started with information described earlier on the fleet of vessels that call at Savannah. Using that information, EPA's 2009 Best Practices Report can be consulted to obtain information on the typical sizes for the propulsion and auxiliary engines. The following information was obtained from that EPA report:

Table 5-5
Engine Size by Vessel Type

Vessel Type	Propulsion Engine (Kw)	Total Auxiliary Engine (Kw)
Bulk	8,000	1,775
Container	30,900	6,800
Cruise	39,600	10,998
General Cargo	9,300	1,775
RO/RO	11,000	2,851
Reefer	9,600	3,900
Tanker	9,400	1,985

So for Container vessels, the following Engine kW values were used:

Vessel Type	Propulsion Engine (Kw)	Total Auxiliary Engine (Kw)
Container	30,900	6,800

The next type of information needed is the **"Load Factor"**. The load factor accounts for how hard the engine is working at that time. Therefore, the emission calculations use the durations for the various modes of operation that were discussed earlier in this document. An additional category was used called "Hotelling" to capture the emissions that occur while a vessel is docked and loading or unloading cargo.

The load factors vary by the size of the Container vessel being considered. This required separate calculations to be performed for four sizes of containerships that call at the port: Post-Panamax, Panamax, Sub-Panamax, and Handy Size. This load factor values which were used were taken from EPA's Best Practices Report dated 2009.

The main engine load factors used are as follows:

Table 5-6
Main Engine Load Factors

	Post-Panamax	Panamax	Sub-Panamax	Handy Size
Reduced Speed Zone	10 %	12 %	16 %	20 %
Maneuvering	2 %	3 %	4 %	5 %
Slow / Dead Slow	2%	3%	5%	5%
Docking	2 %	3 %	4 %	5 %
Hotelling	0 %	0 %	0 %	0 %

Different load factors are used for the auxiliary engines used on these vessels. The main engine load factors used for the auxiliary engines are as follows:

Table 5-7
Auxiliary Engine Load Factors

	Auxiliary Engines
Reduced Speed Zone	25 %
Maneuvering	50 %
Slow / Dead Slow	50%
Docking	50 %
Hotelling	17 %

The third type of information needed is called the **"Travel Time"**. The travel time for Container vessels were taken from Mobile's 2006 Draft Air Quality Analysis. That information was obtained from the Harbor Pilots and is shown below.

Table 5-8 Travel Time

Mode	**Location**	**Time (Hours)**
Full Maneuvering (Reduced Speed Zone)	Pilots' Station to US Coast Guard Dock	1.40
Slow / Dead Slow	10 minutes past Fort Pulaski	0.17
Full Maneuvering (Reduced Speed Zone)	To LNG facility	0.33
Slow / Dead Slow	Past LNG facility/Elba Island	0.25
Full Maneuvering (Reduced Speed Zone)	To terminals at City	0.17
Slow / Dead Slow	To Garden City Terminal	1.50
Docking (Maneuvering)	Dock	0.50
Hotelling	Dock	16.0

The fourth type of information needed is called the **"Emission Rate"**. An emission rate is the rate at which a particular pollutant is discharged by a given engine. The emission rates used in this analysis for vessel engines were taken from EPA's Best Practices Report dated 2009. For main propulsion engines, we selected emission rates for Slow Speed Diesel engines using Marine Diesel Oil (MDO) fuel. The Savannah Harbor Pilots stated that all Ocean Going Vessels calling at the port use MDO and not Residual Oil (RO) fuel. For the Auxiliary Engines, we used the emission rates for engines using MDO.

Those selected emission rates found in Table 2-9: Emission Factors for OGV Main Engines, g/kWh (USEPA 2009) on page 2-14 and Table 2-16, Auxiliary Engine Emission Factors, g/kWh (USEPA 2009) on page 2-19 are as follows:

Table 5-9
Engine Emission Factors for MDO Fuel (Grams/kW-Hour)

	NOx	CO	HC	PM10	PM2.5	SO2	CO2
Main Propulsion Engine	17.00	1.40	0.60	0.45	0.42	3.62	588.79
Auxiliary Engines	13.90	1.10	0.40	0.49	0.45	4.24	690.71

Using those emission rates and information described previously for the other three required inputs (Engine power (Kw), Load Factor, and Travel Time), one can calculate the Emissions Per Vessel.

To allow separation of air emissions while vessels are docked (hotelling), the District performed separate calculations for inbound transits, Hotelling, and Outbound transits.

The results from these calculations are shown in the following tables:

Table 5-10
Main Engine Emissions In-Bound Transits (Tons Per Transit)

	NOx	CO	HC	PM10	PM2.5	SO2	CO2
Post-Panamax	0.5102	0.0785	0.0595	0.0185	0.0168	0.0942	15.0838
Panamax	0.2921	0.0429	0.0233	0.0117	0.0106	0.0594	9.1650
Sub-Panamax	0.2051	0.0267	0.0152	0.0064	0.0058	0.0429	5.6915
Handy Size	0.1469	0.0170	0.0091	0.0044	0.0039	0.0310	3.6099

Table 5-11
Auxiliary Engine Emissions In-Bound Transits
(Tons Per Transit)

	NOx	CO	HC	PM10	PM2.5	SO2	CO2
Post-Panamax	0.3173	0.0251	0.0091	0.0112	0.0103	0.0968	15.7695
Panamax	0.1928	0.0153	0.0055	0.0068	0.0062	0.0588	9.5816
Sub-Panamax	0.1197	0.0095	0.0034	0.0042	0.0039	0.0365	5.9502
Handy Size	0.0759	0.0060	0.0022	0.0027	0.0025	0.0232	3.7740

Since concerns have been expressed about emissions from Containerships while they are docked, the Corps performed separate calculations for emissions that occur from the auxiliary engines during that period. This allows one to evaluate the potential value of cold-ironing of Container vessels in this harbor. Those calculations are summarized as follows:

Table 5-12
Hotelling Emissions Auxiliary Engine Emissions Only (Tons Per Vessel)

	NOx	CO	HC	PM10	PM2.5	SO2	CO2
Post-Panamax	0.5128	0.0406	0.0148	0.0181	0.0166	0.1564	25.4810
Panamax	0.3116	0.0247	0.0090	0.0110	0.0101	0.0950	15.4823
Sub-Panamax	0.1935	0.0153	0.0056	0.0068	0.0063	0.0590	9.6146
Handy Size	0.1227	0.0097	0.0035	0.0043	0.0040	0.0374	6.0983

Using this information and the 2008 vessel fleet shown on the next page, the total emissions from Container vessels at the Garden City Terminal while docked were calculated and are summarized as follows:

Table 5-13
Total Emissions of Container Vessels
(In and Out Bound) includes Hotelling (Tons per vessel)

	NOx	CO	HC	PM10	PM2.5	SO2	CO2
Post-Panamax	2.1679	0.2478	0.1520	0.0775	0.0707	0.5383	87.1876
Panamax	1.2815	0.1409	0.0667	0.0480	0.0438	0.3314	52.9754
Sub-Panamax	0.8432	0.0878	0.0429	0.0280	0.0256	0.2179	32.8980
Handy Size	0.5685	0.0558	0.0260	0.0184	0.0168	0.1458	20.8662

The District multiplied those emissions by the number and size of Container vessels that call at the port. The number of vessels was obtained from the Economic Analysis. For 2008, that information is as follows:

Table 5-14
2008 Container Vessel Transits by Vessel Type and Service

Service	Post Panamax	Panamax	Sub-Panamax	Handy-size	Total
Total	32	1,261	213	15	**1,521**

For 2008, 1,521 Container vessels called at Savannah, resulting in 3,042 transits through the harbor. All of these called at the Garden City Terminal.

Using those 2008 vessel numbers, the Corps calculated the air emissions of the Containerships that call at the Garden City Terminal over their entire vessel transit (In-bound, Hotelling, Out-bound for Main and Auxiliary Engines) as follows:

Table 5-15
Summary of Container Vessel Emissions Calling at GCT for 2008
at the -42 foot depth (Total Tons)

	NOx	CO	HC	PM10	PM2.5	SO2	CO2
TOTAL	1,873.40	205.11	98.48	69.30	63.20	483.73	76,912.27

5.5 Tugs

Tugs are used to assist each vessel that moves through the harbor. They are used to dock/undock the vessels, as well as to help move them between terminals within the port (called shifts). On 28 May 2009, representatives from GPA and the Corps obtained information and discussed usage with the two companies that own and operate tugs in the Port of Savannah. Both Moran Towing and Crescent Towing each own five tugs with the following characteristics:

Table 5-16
Tug Characteristics

	Main Engine (HP)	# of Auxiliary Engines	Auxiliary Engine (HP)
Moran Towing			
1	6500	2	100
1	5100	2	100
2	3300	2	100
1	3000	2	100
Crescent Towing			
1	6500	2	100
4	4000	2	100

During this discussion with the tug owners, Moran and Crescent indicated that all ten tugs are Category 2 marine engines, their main engines displacement is 11.6 liters per cylinder, and the age of their engines are less than 3 years old (Tier 2, 2004 to 2007). In 2009, all ten tugs use ULSD fuel or 15ppm sulfur fuel. Before 2016, all tugs will be "cold ironed" at their respective docks.

Both Moran and Crescent stated that it takes 2 tugs to dock and undock vessels, as well as "shift" vessels from one terminal to another. On average, the time required to dock a vessel is about 4 hours (includes 1 hour warm up of main and auxiliary engines), undocking is about 3.5 hours (includes 1 hour warm-up of main and auxiliary engines), and shifting vessels is about 4 hours (includes 1 hour warm-up of main and auxiliary engines).

The Corps assumed that all ten tugs are used to dock/undock and shift vessels equally throughout the year. The USEPA formula that was used to calculate tug emissions for all ten tugs is found on page 3-12 in Section 3.7 entitled Emission Determination (USEPA Guidelines dated April 2009). This emission formula included both main and auxiliary engines, load factors, activity use (hours), and the criteria pollutant factor. The formula is described below:

Emissions pollutant,H/C = N H/C x {(<EF pollutant,H/C,main> x N Eng H/C,main x LFH/C.main x ActivityHC,main x HP H/C,main)
+ (<EFpollutant,H/C,aux> x N Eng H/C,aux x LF H/C,aux x Activity H/C,aux x HP H/C,aux)}

The fuel emission factors were taken from Table 3-8 (page 3-10) USEPA Current Methodologies in Preparing Mobile Source Port Related Emission Inventories, Final Report, April 2009. The emission factors were also fuel corrected for ULSD (15 ppm sulfur) Table 3-9 (page 3-10) in USEPA 2009. The following table shows the emission factors used for all ten tugs:

Table 5-17
Tug Emission factors

Pollutant	Tug Main Engine Emission Factor (g/kW-hr)	Tug Auxiliary Engine Emission Factor (g/kW-hr)
NOx	9.8000	9.8000
CO	5.0000	5.0000
VOC	0.5	0.5
PM_{10}	0.6192	0.6192
$PM_{2.5}$	0.6006	0.6006
SO_2	0.0065	0.0065
CO_2	690.0000	690.0000

The horsepower rating for each tug for both main and auxiliary engines were converted to kW (see table below). The load factors were taken from Table 3-3 (USEPA 2009).

Table 5-18
Load Factors for Tugs

COMBINED TUGS FROM MORAN AND CRESCENT*						
# of Tugs	**ME HP of Tugs**	**kW**	**Load Factor**	**# of Aux Engines**	**kW of Aux**	**Load Factor**
2	6500	4847.0492	0.85	2	74.56998714	0.56
1	5100	3803.0693	0.85	2	74.56998714	0.56
4	4000	2982.7995	0.85	2	74.56998714	0.56
2	3300	2460.8096	0.85	2	74.56998714	0.56
1	3000	2237.0996	0.85	2	74.56998714	0.56
10 Total						

Load factors are taken from table 3-3 USEPA Load Factors for Harbor Craft on page 3-6 (Final Report April 2009)

On average it takes 7.5 hours (i.e., 4 hours to dock and 3.5 hours to undock) for two tugs to dock/undock each vessel at GCT. In 2008 there were 1521 container vessels that docked/undocked. This means that 1,521 vessels times 7.5 hours or 11,407.5 hours in 2008 were used by the ten tugs to dock/undock. In 2008, each tug worked **on average** about 1141 hours. The Corps used the 1141 hours per tug for the activity of use in 2008.

Table 5-19
Docking/Undocking Emissions for all Ten Tugs at GCT (2008)

TUGS	Total NO_x Emissions (ton/call)	Total CO Emissions (ton/call)	Total HC Emissions (ton/call)	Total PM_{10} Emissions (ton/call)	Total $PM_{2.5}$ Emissions (ton/call)	Total SO_2 Emissions (ton/call)	Total CO_2 Emissions (ton/call)
6500 HP	0.103601	0.052858	0.005259	0.006546	0.006349	0.000069	7.294339
5100 HP	0.040865	0.020850	0.002075	0.002582	0.002505	0.000027	2.877233
4000 HP	0.129092	0.065863	0.006554	0.008157	0.007912	0.000086	9.089132
3300 HP	0.053611	0.027352	0.002722	0.003387	0.003286	0.000036	3.774629
3000 HP	0.024462	0.012481	0.001242	0.001546	0.001499	0.000016	1.722328
TOTAL	0.351631	0.179403	0.017851	0.022217	0.021551	0.000233	24.757661

For docking and undocking at the GPA Ocean Terminal (OT) and non-GPA terminals, the Corps assumed that all ten tugs were equally used throughout the year. In 2008, there were 1083 vessels docked/undocked times 7.5 hours per vessel or about 8122.5 hours of activity for all ten tugs. Each tug was used 812.25 hours at OT and non-GPA terminals.
The following table represents the emissions for all ten tugs at OT and non-GPA terminals:

Table 5-20
OT/non-GPA Terminal Emissions for all Ten Tugs (2008)

TOTAL Tugs	Total NO_x Emissions (ton/call)	Total CO Emissions (ton/call)	Total HC Emissions (ton/call)	Total PM_{10} Emissions (ton/call)	Total $PM_{2.5}$ Emissions (ton/call)	Total SO_2 Emissions (ton/call)	Total CO_2 Emissions (ton/call)
6500 HP	0.073767	0.037636	0.003745	0.004661	0.004521	4.89E-05	5.1937994
5100 HP	0.029097	0.014846	0.001477	0.001838	0.001783	1.93E-05	2.0486807
4000 HP	0.091918	0.046897	0.004666	0.005808	0.005633	6.1E-05	6.4717486
3300 HP	0.038172	0.019476	0.001938	0.002412	0.00234	2.53E-05	2.6876553
3000 HP	0.017418	0.008887	0.000884	0.001101	0.001068	1.16E-05	1.2263521
TOTAL	0.250372	0.127741	0.012711	0.015819	0.015345	0.000166	17.628236

For shifting vessels from one terminal to another, the Corps assumed that all ten tugs were equally used. In 2008, there were about 176 vessels shifted times 4 hours for two tugs to shift each vessel. Therefore, the total hours used to shift vessels in 2008 was 704 hours (176 times 4 = 704) and each tug was used 70.4 hours (704 divided by 10 =70.4). The following table represents the emissions for all ten tugs used to shift in 2008:

Table 5-21 Emissions for all Ten Tugs for Vessel Shifts (2008)

TOTAL Tugs	Total NO_x Emissions (ton/call)	Total CO Emissions (ton/call)	Total HC Emissions (ton/call)	Total PM_{10} Emissions (ton/call)	Total $PM_{2.5}$ Emissions (ton/call)	Total SO_2 Emissions (ton/call)	Total CO_2 Emissions (ton/call)
6500 HP	0.006394	0.003262	0.000325	0.000404	0.000392	4.24E-06	0.450161
5100 HP	0.002522	0.001287	0.000128	0.000159	0.000155	1.67E-06	0.177565
4000 HP	0.007967	0.004065	0.000404	0.000503	0.000488	5.28E-06	0.560925
3300 HP	0.003309	0.001688	0.000168	0.000209	0.000203	2.19E-06	0.232947
3000 HP	0.00151	0.00077	7.66E-05	9.54E-05	9.25E-05	1E-06	0.106291
TOTAL	0.021700	0.011072	0.001102	0.001371	0.001330	0.000014	1.527889

5.6 Other Deep-Draft Vessel Types

The distribution of vessel calls in 2008 by type is summarized as follows:

	Total Harbor
Container	1,521
Bulk	170
Breakbulk	362
Tanker	406
RO/RO	145
LNG *	120
Total	2,724

Those totals do not include some vessels which called at the port in 2008 because they appeared to be infrequent calls (one call per vessel type in that year) or were barges.

Although Container vessels dominate the Savannah Harbor fleet (1521 of 2,724 vessels in 2008), numerous other types of vessels also call at the port. Those include Bulk, Breakbulk, Tanker, and RO/RO vessels. The Corps performed separate calculations of emissions from those vessels because they generally have different engine configurations than Container vessels. The emission calculation process followed the same procedure as stated for Containerships:

EMISSIONS PER TRANSIT = ENGINE HORSEPOWER X LOAD FACTOR X TRAVEL TIME X EMISSION RATE

The typical engine horsepower for the various types of vessels was taken from Table 2-4 on page 2-7 of EPA's 2009 Best Practices Report and is shown below:

Table from EPA's 2009 Best Practices Report

Vessel Type	Propulsion Engine (Kw)	Auxiliary Engine (Kw)	Auxiliary Engine (#)	Total Auxiliary Power (Kw)
Bulk*	8,000	612	2.9	1,775
Container	30,900	1,889	3.6	6,800
Cruise	39,600	2,340	4.7	10,998
General Cargo	9,300	612	2.9	1,775
RORO	11,000	983	2.9	2,851
Reefer	9,600	975	4	3,900
Tanker	9,400	735	2.7	1,985

* Since EPA's description of Bulk and Breakbulk vessels are so similar and information could not be readily found for emissions from main engines of Breakbulk vessels, the Corps used the emission rates for Bulk vessels. Since the engine size and emissions are different for the Main Propulsion Engine and Auxiliary Engines, the Corps performed separate calculations for both of those engine types.

The Load Factor for main propulsion engines OGV were obtained from the Table 2-15 on page 2-18 of the USEPA 2009 report.

Table 5-22
Main Engine Load Factors
(From USEPA 2009 report)

Pollutant	RSZ (12% Low Load Factor)	MANEUVERING (3% Low Load Factor)	DOCKING (3% Low Load Factor)	HOTELLING (Main Engine Shut Down)
NOx	1.14	2.92	2.92	0.00
CO	1.64	6.46	6.46	0.00
HC	1.76	11.68	11.68	0.00
PM10	1.24	4.33	4.33	0.00
PM2.5	1.20	4.20	4.20	0.00
SO2	1.18	2.49	2.49	0.00
CO2	1.17	2.44	2.44	0.00

Load Factors for auxiliary engines were obtained from EPA's 2009 Best Practices Report (page 2-12).

Table 5-23
Auxiliary Engine Load Factors

Ship Type	Cruise	RSZ	Maneuver	Hotel
Auto Carrier	0.15	0.30	0.45	0.26
Bulk Carrier *	0.17	0.27	0.45	0.10
Container Ship	0.13	0.25	0.48	0.19
Cruise Ship	0.80	0.80	0.80	0.64
General Cargo	0.17	0.27	0.45	0.22
Miscellaneous	0.17	0.27	0.45	0.22
OG Tug	0.17	0.27	0.45	0.22
RORO	0.15	0.30	0.45	0.26
Reefer	0.20	0.34	0.67	0.32
Tanker	0.24	0.28	0.33	0.26

* Since EPA's description of Bulk and Breakbulk vessels are so similar and information could not be readily found for emissions from main engines of Breakbulk vessels, we used the emission rates for Bulk vessels.

Travel time was based on information provided by GPA from discussions with the Harbor Pilots. Differences in time between the vessel types are primarily the result of the different destinations (docking location). That information is summarized as follows:

Table 5-24
Travel Time (minutes)

Vessel Type	Reduced Speed Zone	Maneuvering	Docking
Container	90	60	30
Bulk	90	56	30
Breakbulk	90	48	30
Tanker	90	44	30
RO/RO	90	30	30

The emission rates were obtained from the USEPA 2009 report. Those rates are shown below.

Table 5-25
Main Engine Emission Factors

Pollutant	Main Engine Emission Factor (g/kW-hr)	Auxiliary Engine Emission Factor (g/kW-hr)
NO_X	17.00	13.90
CO	1.40	1.10
HC	0.60	0.40
PM_{10}	0.45	0.49
$PM_{2.5}$	0.42	0.45
SO_2	3.62	4.24
CO_2	588.79	690.71

Combining this information, one can calculate the emissions per transit for each of the vessel types (including Tugs). The results of those calculations are as follows:

Table 5-26
2008 Summary for Emissions of Vessels at Ocean and Non-GPA Terminals

	NOx (Tons/year)	CO (Tons/year)	CO (Tons/year)	PM_{10} (Tons/year)	$PM_{2.5}$ (Tons/tear)	SO_2 (Tons/year)	CO_2 (Tons/year)
170 Bulk Vessels in 2008	166.82	25.97	17.98	6.03	5.98	33.95	5447.00
362 Break Bulk Vessels in 2008	359.53	61.40	41.55	14.71	13.34	86.20	8587.74
406 Tanker Vessels in 2008	467.77	68.44	45.63	16.73	15.19	100.46	16156.18
145 RoRo Vessels in 2008	183.61	25.53	16.41	6.49	5.90	40.91	6589.75
TUGS **	0.25	0.13	0.01	0.02	0.02	0.00	17.63
TOTAL	1177.98	181.48	121.57	43.97	40.43	261.52	36798.30

* According to the Port of Portland Spreadsheets, VOC= 1.005* HC.
** Two Tugs used to dock/undock a total of 1083 vessels (170+362+406+145=1083)
Emissions taken from the GCT Sheet TUG2 Table 2

5.7 Intra-Harbor Shifts

Some vessels shift location once in the harbor; they move from one terminal to another. This may be to receive fuel or take on food, or to wait to take on other cargo. The air emission analysis included these vessel movements.

GPA consulted the records of the Harbor Pilots and obtained information on the number of shifts that had occurred in 2008 as well as the origin and destination of each of those vessel movements. The Harbor Pilots provided information on the length of time it took to move from one terminal to another. This information is summarized as follows:

Table 5-27
2008 Shifts by Vessel Type

	Total Harbor
Container	2
Bulk	45
General Cargo / Breakbulk	61
Tanker	68
RO/RO	0
Total	176

These numbers do not include two vessels (yachts) that were moved within the port in 2007 because they appeared to be infrequent calls by vessels that may have been receiving repairs.

The amount of time it took to shift vessels from one terminal to another was found to be independent of vessel type. Therefore, average values were calculated to shift vessels within the harbor. These are shown below.

Table 5-28
Time to Shift Vessels (minutes)

Docking	Maneuvering	Docking
30	35	30

Calculations can then be performed for the emissions for these vessel movements. The Corps used the values for Engine Horsepower, Load Factor, and Emission Rate that were used and described in the previous section titled “Emissions From Other Vessel Types”. That information applies to these emissions because they are the same types of vessels. Since the values are the same, they will not be repeated here.

Combining this information, the Corps calculated the air emissions from the inner harbor shifts of non-container vessels to be as shown below. The emissions from the tugs that assist these vessels are also shown. The summary of those calculations is as follows:

Table 5-29
2008 Summary Emissions (tons/year) for all Harbor Shifts

	NOx	CO	HC	PM10	PM2.5	SO2	CO2
TOTAL	144.77	26.02	20.11	5.67	5.13	27.29	4,218.29

5.8 Maintenance Dredging

Dredges commonly operate in the harbor to maintain suitable depths for deep-draft vessels in both the navigation channel and the berths. The Corps of Engineers maintains the navigation channel, while the berth owners are responsible for maintaining depths at the berths. The berth maintenance operations are of a smaller scale than those to maintain the navigation channel. The berth owners may use a crane with a clamshell bucket, a tug dragging apparatus to perform agitation dredging, or a small dredge. This analysis includes only emissions from the Corps dredges because those operations use larger equipment and are conducted for longer periods of time than are the berth maintenance operations. Therefore, they are expected to result in more air emissions than those used to maintain the berths.

The Corps reviewed its records of recent dredging contracts to obtain information on the dredging it conducted. The most recent dredging records (2008) were used to identify the typical dredge and supporting equipment for the inner harbor dredging. This information revealed the following:

Table 5-30
Equipment Used Inner Harbor Channel Dredging 2008

	Engine Size (Horsepower)	Days of Use	Hours of Use
Dredge	5,200	308	3,878
Booster	2,000	308	2,145

The Corps assumed that one Tug Tender Boat was used to support the operations. Based on the 2003 Port of Houston report, we assumed that support boat had a 1,100 HP engine. We also assumed it operated for 18 hours per day.

The Corps selected an average dredge engine Load Factor of 75 percent. This value was averaged from two sources reported in the Port of Houston's 2003 report titled "Improvement to the Commercial Marine Vessel Inventory in the Vicinity of Houston, Texas". Engine Load factors for dredge tug tender were averaged from values obtained from EPA's Best Practices Report for an Assist Tugboat and a Dredge Tender. Because the District's data showed information on the amount of time that a booster pump was used, we used a 100 percent Load Factor over that entire duration.

Emission rates for NOx, VOC and CO were taken from 2003 Port of Houston report for the dredge, tug support, and booster pump engines. These rates were higher for those parameters than values contained in EPA's 2009 Best Practices report. Emission rates for other parameters (HC, PM10 and SO2), some of which were not reported for Houston, were taken from that EPA report. Information on engine load factors was obtained from EPA's Best Practices Report.

The District also reviewed the record of the dredge used to maintain the Savannah Harbor entrance channel in early 2007. Those records reveal that the dredge "Glenn Edwards" worked on that channel for 24 days. There were 504 hours of effective operating time and 72 hours of non-effective time. Using the company's website for the sizes of various types of equipment on board, we calculated that the horsepower likely in use totaled 5,457 HP. This matches fairly well with the size of typical hopper dredge (6,400 HP) reported in the 2003 Port of Houston report. We used engine emission rates reported in EPA's 2009 Best Practices report.

The District combined the hours of use with the engine size, load factor and the emission rates to produce emission totals by pollutant type for the four different types of equipment. The calculations followed a variation of the standard procedure:

EMISSIONS FROM EACH EQUIPMENT TYPE	=	ENGINE HORSEPOWER	X	LOAD FACTOR	X	TIME OF USE	X	EMISSION RATE

The summary of those calculations is as follows:

Table 5-31
Summary Table for Maintenance Dredge Emissions (Ton/year)

	Total HC Emissions (ton/year)	Total VOC Emissions (ton/year)	Total CO Emissions (ton/year)	Total NO_x Emissions (ton/year)	Total PM_{10} Emissions (ton/year)	Total $PM_{2.5}$ Emissions (ton/year)	Total SO_2 Emissions (ton/year)
Pipeline dredge	3.3571	3.3739	31.0840	161.6367	3.7301	3.6182	7.8332
Booster	0.9536	0.9584	8.8301	45.9163	1.0596	1.0278	2.2252
Tug Tender	0.6767	0.6801	6.2661	32.5835	0.7519	0.7294	1.5790
Hopper Dredge**	0.0187	0.0188	0.4668	2.5149	0.0602	0.0546	0.7379
TOTAL	5.0062	5.0312	46.6469	242.6515	5.6018	5.4300	12.3753

**Port of New York/New Jersey Marine Vessel Emission Inventory, dated April 2003.
Table 7-10 on page 86 provided the following:

Hopper Dredge Emissions (gm/Kw-hr)

NOx	CO	HC***	PM10	PM2.5	SO2	VOC
13.36	2.48	0.0995024	0.32	0.29	3.92	0.10

5.9 Dredging During Harbor Deepening

If the harbor is deepened, dredges will be the primary equipment used to excavate the channel and relocate the sediments out of the channel. The Corps reviewed the information developed as part of the cost estimating efforts. The dredges and supporting equipment expected to be used consist of the following:

Table 5-32
Dredges Expected To Be Used

	Number	Engine Size (Horsepower)
30-inch Pipeline Dredge	1	8,700
Dredge Support Tug	2	600
Dredge Support Survey Boat	2	100
Dredge Support Derrick	2	200
30-inch Booster Pump	1	5,200
Hopper Dredge & Support	1	5,200

The same equipment would be needed to construct all depth alternatives. It is the duration of use that would vary by depth. Those estimated durations are as shown below. These durations do not include the time necessary to deepen the entrance channel extension, which is believed will take from 5.6 to 11 months, depending on depth alternative

Table 5-33
Approximate Dredging Duration By Channel Depth (Months)

	44-Feet	45-Feet	46-Feet	47-Feet	48-Feet
Pipeline	22.4	31.1	29.1	26.9	25.1
Hopper	14.1	6.2	8.8	11.8	14.9

To calculate the air emissions from this equipment, information is needed on the emission rates and load factors. The Corps obtained emission rates for NOx, VOC and CO from the 2003 Port of Houston report for the dredge, tug support, and booster pump engines. These rates were higher for those parameters than values contained in EPA's 2009 Best Practices report. Emission rates for other parameters (HC, PM10 and SO2), some of which were not reported for Houston, were taken from that EPA report.

The District combined the days of use with the engine size, effective working time, and the emission rates to produce emission totals by pollutant type for the four different types of equipment. The calculations followed a slight variation of the standard procedure:

EMISSIONS FROM EACH TYPE OF DREDGING = ENGINE HORSEPOWER X LOAD FACTOR X DURATION OF USE X EMISSION RATE

The summary of those calculations is as follows:

Table 5-34
Summary of New Work Dredging Emissions (Tons)

	HC	VOC	CO	NOx	PM10	PM2.5	SO2
44-Foot Depth Alternative							
Pipeline Dredging	26.42	26.56	244.67	1272.27	29.36	26.42	61.66
Hopper Dredging	0.06	0.06	1.42	7.66	0.18	0.17	2.25
45-Foot Depth Alternative							
Pipeline Dredging	29.81	29.96	276.03	1435.33	33.12	32.13	69.56
Hopper Dredging	0.06	0.06	1.42	7.66	0.18	0.17	2.24
46-Foot Depth Alternative							
Pipeline Dredging	30.94	31.10	286.49	1489.76	34.38	33.35	72.20
Hopper Dredging	0.06	0.06	1.42	7.66	0.18	0.17	2.25
47-Foot Depth* Alternative							
Pipeline Dredging	65	65	582	3015	74	65	150
Hopper Dredging	0.7	0.7	17.1	92.0	2.2	2.2	27
48-Foot Depth Alternative							
Pipeline Dredging	68.8	69.14	636.8	3311.6	76.4	74.87	160.5
Hopper Dredging	3.68	3.7	20.6	178.2	0.37	0.33	4.48

* Estimated not calculated.

This new work dredging would be performed one time, when the harbor is deepened. The work would take different lengths of time, depending on the channel depth selected.

The amount of dredging being conducted will vary during those periods of time. In some months, three pipeline dredges may be working in the inner harbor, while in others there may be only two, and in a few months only one dredge may operate. The variability is primarily the result of the availability of funding and environmental dredging windows in the upper harbor. The three pipeline dredges would operate in different parts of the harbor. As a result, their emissions would not be concentrated, but instead would be distributed along the roughly 21 miles of inner harbor navigation channel.

These emission totals do not include work that would be performed to construct the various mitigation features. The mitigation work consists of several features, including plugging a small tidal channel, deepening two other channels, constructing a flow diversion weir, removing a concrete structure, and constructing a submerged weir. This work would primarily require different and much smaller equipment, than what was evaluated above. The equipment would be similar to construction equipment which is commonly used throughout the area on a regular basis. This equipment would include backhoes, small bulldozers, small cranes, etc. Much of the mitigation work would be performed upriver of the new work dredging, primarily in the vicinity of the area of the Savannah National Wildlife Refuge. Air emissions from this work would, therefore, be somewhat dispersed from the channel dredging work.

5.10 Tourist Boats

The Corps evaluated air emissions from the vessels which operate daily in the harbor to transport tourists. This includes the boats operated by the Chatham Transit Authority to shuttle passengers between River Street and Hutchinson Island. It also includes the paddle wheel boats which people use to tour the harbor from the river. The basic information was provided by the Savannah Maritime Association, who obtained it through coordination with the two organizations that operate those vessels.

The following table is a summary of the vessel information:

Table 5-35
Chatham County's Tourist Shuttle Boats

	Engine Size (Horsepower)	Daily Use	Type of Use
Juliette Gordon Low	115	18 hr/day	20 min @ 90% capacity 40 min @ 30% capacity
Susie King Taylor	115	10 hr/day	20 min @ 90% capacity 40 min @ 30% capacity

Table 5-36
Paddle Wheel Tourist Boats

	Engine Size (Horsepower)	Daily Use	Weekly Use	Type of Use
River Boat #1	800	4 hr/day	7 days/wk	1 hr @ 80% capacity 3 hr @ 50% capacity
River Boat #2	600	3 hr/day	7 days/wk	1 hr @ 80% capacity 2 hr @ 50% capacity

The use rates for these sources are summarized as follows:

Table 5-37
Engine Use Rates

Vessel	Use Rate (HP-hr/yr)
Juliette Gordon Low	376,740
Susie King Taylor	209,300
River Boat #1	728,000
River Boat #2	436,800

The Corps selected emission rates for the vessel engines from those given in EPA's Best Practice Report. The rates selected for the County's shuttle boats were those reported for Category 1 Harbor Craft with 100 HP engines. The rates are slightly smaller for larger engine sizes. The rates selected for the Paddle Wheel boats were those reported for Category 1 Harbor Craft with 750 and 600 HP engines.

These engine use rates were combined with the emission rates to produce emission totals by pollutant type. The summary of those calculations is as follows:

Table 5-38
Summary Table for Tourist Boat Emissions

	Total HC Emissions (ton/year)	Total VOC* Emissions (ton/year)	Total CO Emissions (ton/year)	Total NOx Emissions (ton/year)	Total PM10 Emissions (ton/year)	Total PM2.5 Emissions (ton/year)	Total SO2 Emissions (ton/year)	Total CO2 Emissions (ton/year)
Chatham County Tourist Schuttle Boats	0.13	0.13	0.82	4.82	0.19	0.19	0.30	332.39
Paddle-Wheel Tourist Boats	0.26	0.26	1.44	9.57	0.29	0.28	0.60	660.65
TOTAL	0.39	0.39	2.26	14.39	0.48	0.47	0.91	983.03

5.11 Landside Equipment at Non-GPA Terminals

The Corps analyzed emissions from equipment used on the land to load and unload cargoes at the non-GPA terminals in the harbor. Detailed information was not readily available for the equipment used at the various private terminals. The Corps reviewed the air inventories that had been prepared for other harbors to identify a harbor which most reflected the types of vessels and cargoes which are handled at the Port of Savannah. The ports of Seattle and Tacoma were identified as being most similar to Savannah. In 2002, the total tonnage handled by the ports was as follows:

Table 5-39
2002 Total Tonnage

Seattle	19.6 million
Tacoma	20.6 million
Savannah	20.7 million

As in Savannah, both Seattle and Tacoma possess container, bulk, breakbulk, RO/RO, and tanker terminals.

The Corps took information on these two ports from the April 2007 report titled "Puget Sound Maritime Air Emissions Inventory". That report describes air emissions from various sources, including landside equipment, for several terminals in Puget Sound. The number of vessel movements by vessel type was obtained for the two Puget Sound ports, as was the emission quantity by source (CHE, fleet vehicles, etc) and pollutant.

The District calculated an average emission rate per vessel for each pollutant type for each port. We blended those values to produce an average emission rate per vessel for each pollutant type for use at the Port of Savannah. For CO and SO2, we decided to use emission rates closer to those from the Port of Seattle because 30 percent of the vessels calling at the Port of Tacoma are auto carriers or RO/RO. Such vessels make only limited calls at Savannah, so the values from Seattle should be more representative of the fleet in Savannah.

Using the Puget Sound report, the following information summarizes the emissions from the two ports for three categories of air emission sources -- Cargo Handling Equipment, Heavy Duty Vehicles, and Fleet Vehicles. These types of equipment comprise that which load, unload, and move cargoes on a terminal.

Table 5-40
Summary of Landside Emissions (2005 Data)

	NOx	VOC	CO	SO2	PM10	PM2.5	CO2
	------------------------------- Tons per Year -------------------------------------						
Seattle	718	78	806	71	40	38	66,553
Tacoma	638	45	277	8	35	34	66,899
	---------------------------- Pounds per Vessel --------------------------------						
Seattle	612.6	66.6	687.7	60.6	34.1	32.4	56,786
Tacoma	609.7	43	264.7	7.6	33.4	32.5	63,926
Blended Average	611.1	54.8	581	50	33.8	32.5	60,356

To use this information, one must then know the number of vessels that call at Savannah. That information was presented previously, but is repeated here:

Table 5-41
2008 Vessel Calls by Type and Location

	Total Harbor	Elba Island LNG Terminal	Garden City Terminal	Ocean Terminal	Non-GPA Terminals
Container	1,521		1,521	---	---
Bulk	170		---	12	158
Breakbulk	362		---	240	122
Tanker	406		---	---	406
RO/RO	145		---	145	---
LNG *	120	120			
Total	2,724	120	1,521	397	686

The table shows that there were 686 vessels, other than LNG vessels, that called at non-GPA terminals in 2008.

Using those vessels numbers and the emission rates, one can quantify the 2008 air emissions by pollutant source from the landside equipment used at non-GPA terminals in Savannah. Again, that equipment is comprised of Cargo Handling Equipment, Heavy Duty Vehicles, and Fleet Vehicles. The summary of those calculations is as follows:

Table 5-42
Summary Table for Non-GPA Landside Cargo Handling Equipment and Ocean Terminal

SUMMARY TABLE FOR NON-GPA LANDSIDE CHE AND OCEAN TERMINAL

	Total HC* Emissions (ton/year)	Total VOC Emissions (ton/year)	Total CO Emissions (ton/year)	Total NO_x Emissions (ton/year)	Total PM_{10} Emissions (ton/year)	Total $PM_{2.5}$ Emissions (ton/year)	Total SO_2 Emissions (ton/year)	Total CO2
TOTAL	18.69493	18.788405	199.283	209.620883	11.589027	11.132487	17.15	20702.15

5.12 Liquefied Natural Gas Vessel Operations

The Corps evaluated air emissions from the operations to handle the Liquefied Natural Gas (LNG) vessels which call at the Port of Savannah. The basic information was obtained from the FERC's August 2007 Final EIS on the Elba III Project. That report provided information on air emissions by pollutant type for various components of the operation, including the following: LNG vessel transit, LNG vessel offloading, LNG vessel hotelling, tug assist vessel berthing/unberthing, tug assist vessel standby, and Coast Guard escort vessels. The list covered all aspects of the vessel handling operations. A summary of those emissions are as follows:

Table 5-43
Emissions Summary (Tons per Year)

	VOC	CO	NOx	PM	SO2
Calculated Total	34.7	530	492	58.1	527.4

The Corps used this information to calculate average emission rates per vessel call. The report also provided vessel transit numbers for the recent past and expectations for the near future (at capacity after completion of the Elba III Project). FERC's EIS stated that the expected the facility to handle its full capacity of 126 vessels after February 2006 (after completion of the Elba II Project) and handle 221 vessels after completion of the Elba III Project (now under construction). Using those values, one can calculate the present emissions and those expected in the future. The summary of those calculations is as follows:

Table 5-44
Summary of LNG Emissions

TOTAL	Total HC* Emissions (ton/year)	Total VOC Emissions (ton/year)	Total CO Emissions (ton/year)	Total NO_x Emissions (ton/year)	Total PM_{10} Emissions (ton/year)	Total $PM_{2.5}$ ** Emissions (ton/year)	Total SO_2 Emissions (ton/year)
126 LNG After Feb 2006	19.68	19.78	302.17	279.93	33.12	32.13	300.68
120 LNG Vessels 2016	18.74	18.84	287.78	266.60	31.54	30.60	286.37
136 LNG Vessels 2020	21.24	21.35	326.15	302.15	35.75	34.68	324.55
151 LNG Vessels 2025	23.59	23.70	362.12	335.47	39.69	38.50	360.35
167 LNG Vessels 2030	26.09	26.22	400.49	371.02	43.90	42.58	398.53
167 LNG Vessels 2066	26.09	26.22	400.49	371.02	43.90	42.58	398.53
TOTAL	**135.45**	**136.13**	**2079.23**	**1926.23**	**227.93**	**221.09**	**2069.03**

Since the values presented by FERC for the LNG facility after the Elba III Project is completed are for operation of that facility at full capacity, the Corps chose to use that value for emissions from operations associated with this overall facility in all future years. We are assuming that the facility will not expand beyond the size for which the owners obtained approval in 2007. The FERC EIS did not indicate that the owners may want to expand the facility more in the future.

5.13 GPA Cargo Handling Equipment

Since detailed information could be obtained on the Cargo Handling Equipment (CHE) used to load/unload vessels at GPA's Garden City and Ocean Terminals and transport the cargo within the terminal, The District conducted a detailed analysis of their air emissions. The Cargo Handling Equipment included in this analysis consists of Container Cranes, Rubber Tire Gantry Cranes (RTG's), Toplifts, and Jockey Trucks (or Yard Hustlers).

The information on equipment type, numbers, and amount of use was provided by GPA. Most of the information is from GPA's records, but some they provided after coordination with other companies from which they lease the equipment. The Corps obtained some equipment horsepower information from manufacturer's websites.

Seventeen of nineteen container cranes at the Garden City Terminal are electric. They were not included in this analysis. The following tables are summaries of important information in this worksheet:

Table 5-45
Summary of GPA Cargo Handling Equipment

	Engine HP	Number	Average Use (Hours/Year)
---------------------------- GARDEN CITY TERMINAL ---------------------------------			
Rubber Tired Gantry Cranes	750	47	93,021
Container Cranes (GCT)	1,200	2	2,274
Toplifts	600	42 – FY 05	3.403
	600	43 – FY06	3,975
	600	54 – FY07	3,280
Empty Container Handlers	175	4 – FY05	3,419
	175	14 – FY06	1,201
	175	19 – FY07	2,672
Jockey Trucks	165	220	1,500
----------------------------------- OCEAN TERMINAL -----------------------------------			
Container Cranes	1,200	6	1,642
Toplifts	335	3 – FY05	474
	335	2 – FY06	254
	335	2 – FY07	111
Jockey Trucks	165	25	1,500
	200	5	1,500

The air emission rates for the various types of equipment were provided by EPA Region 5 and are from the NONROAD2005 model for the 2007 calendar year. The NONROAD2005 model for 2007 used diesel fuel with 1339 ppm Sulfur. The rates are dependent upon the horsepower of the engine.

The air emissions are calculated by equipment and pollutant type. The emission rates are multiplied by the usage rates to produce the pollutant quantity for that year. Separate calculations were made for the Garden City Terminal and Ocean Terminal.

The emissions calculated (with 1339 ppm Sulfur fuel) by equipment type are as follows:

Table 5-46 Summary of GPA CHE Emissions Tons Per Year – 2008

	HC	VOC	CO	NOx	PM10	PM2.5	SO2	CO2
GARDEN CITY TERMINAL								
Rubber Tired Gantry Cranes	13.09	13.79	116.86	231.46	15.37	14.91	15.67	22448.96
Container Cranes	0.58	0.61	2.17	8.34	0.41	0.40	0.43	611.22
Toplifts FY07	21.55	22.71	177.04	465.00	25.31	24.55	42.30	60596.45
Empty Container Handlers FY07	1.50	1.58	6.35	18.02	1.41	1.37	1.68	2398.82
Jockey Trucks	11.55	12.16	48.84	139.67	10.89	10.56	12.89	18456.24
Total	**48.27**	**50.84**	**351.26**	**862.49**	**53.39**	**51.79**	**72.96**	**104511.69**

Table 5-47 Summary of GPA CHE Emissions Tons Per Year – 2008

	HC	VOC	CO	NOx	PM10	PM2.5	SO2	CO2
OCEAN TERMINAL								
Container Cranes	0.4192	0.4415	1.5665	6.0272	0.2947	0.2859	0.3084	441.8825
Toplifts FY07	0.0945	0.0995	0.7760	2.0382	0.1109	0.1076	0.1854	265.6034
Jockey Trucks	1.6538	1.7411	7.0031	20.3768	1.5383	1.4918	1.9103	2735.9359
Total	**2.1674**	**2.2822**	**9.3456**	**28.4421**	**1.9439**	**1.8852**	**2.4041**	**3443.4218**

Prior to 2016, when the Federal navigation channel is deepened, the CHE for the Garden City and Ocean Terminals will be using the ULSD fuel with 15 ppm Sulfur. The emission rates for the CHE for these terminals were calculated using methods reviewed by EPA Region 5 and are from the NONROAD2008 model for the 2010 calendar year.

The emissions calculated for the CHE in both terminals using the ULSD fuel (15 ppm Sulfur) is:

Table 5-48 Summary of GPA CHE Emissions Tons Per Year – 2010

	HC	VOC	CO	NOx	PM10	PM2.5	SO2	CO2
GARDEN CITY TERMINAL								
Rubber Tired Gantry Cranes	10.16	10.70	103.79	196.08	11.72	11.37	0.20	22,458.46
Container Cranes	0.48	0.50	1.80	7.45	0.30	0.29	0.01	611.55
Toplifts	22.10	23.27	173.80	398.34	25.76	24.98	0.60	64,496.20
Empty Container Handlers	1.77	1.86	10.32	22.58	2.38	2.31	0.04	3,881.79
Jockey Trucks	8.58	9.04	49.53	109.56	11.37	11.02	0.17	18,465.03
Total	**43.08**	**45.37**	**339.24**	**734.01**	**51.52**	**49.97**	**1.01**	**109,913.04**

Table 5-49 Summary of GPA CHE Emissions Tons Per Year – 2010

	HC	VOC	CO	NOx	PM10	PM2.5	SO2	CO2
OCEAN TERMINAL								
Container Cranes	0.34	0.36	1.3	5.38	0.22	0.21	0.004	442.12
Toplifts	0.09	0.09	0.72	1.66	0.10	0.10	0.002	267.84
Jockey Trucks	1.24	1.30	7.11	16.02	1.57	1.52	0025	2,737.18
Total	1.67	1.76	9.13	23.07	1.89	1.83	0.03	3,447.14

5.14 Trucks Calling at Garden City Terminal

Trucks which transport containers to/from the port also emit pollutants into the air. The District included these emissions in its analysis. GPA provided information on the trucks calling at the Garden City Terminal. This data includes the number of trucks by month, separated into Receiving and Delivering, and the average amount of time spent at the GPA terminal by each truck. This information was provided in 2008 and is shown below:

Table 5-50
Trucks Calling at Garden City Terminal
July 2006-June 2007

	Receive	**Deliver**
JAN	57,601	57,227
FEB	54,950	54,449
MAR	62,984	59,698
APR	53,743	53,602
MAY	61,170	60,555
JUN	59,945	59,572
JUL	57,361	56,413
AUG	64,823	64,398
SEP	60,218	59,097
OCT	67,442	65,699
NOV	62,297	60,766
DEC	59,546	57,001
TOTAL	722,080	708,477

GPA also provided the following information on the average truck dwell time:

Table 5-51
Truck Dwell Time

	Distribution	**Time on the Terminal**
Single Transaction	21 %	43 minutes
Multi-Transaction	79 %	56 minutes

Based on this information, trucks spent a total of about 640,190 hours in the Garden City Terminal (GCT) in 2006/2007. The Corps then used the 2006/2007 number of truck hours spent in the Garden City Terminal for the 2008 Truck Emissions at GCT.

The Corps included 15 minutes each way for each truck to account for the time it travels in the vicinity of the port, but not on the terminal. This additional 30 minutes of engine time accounts for time spent traveling between the Interstate highway system and the Garden City Terminal. The Corps added the additional 0.5 hour per truck and added that number to 640,190 hours. Therefore, the total truck hours in 2006/2007 were about 1,001,228.8 hours.

Ultra-low sulfur diesel (ULSD) fuel was proposed by EPA as a new standard for the sulfur content in on-road diesel fuel sold in the United States since October 15, 2006, except for rural Alaska. California has required it since September 1, 2006, and rural Alaska will transition all diesel to ULSD in 2010. This new regulation applies to all diesel fuel, diesel fuel additives and distillate fuels blended with diesel for on-road use, such as kerosene. By December 1, 2010, all highway diesel fuel will be ULSD. As of September 2007, most on-highway diesel fuel sold at retail locations in the United States is ULSD. For the purpose of this analysis ULSD was used in subsequent calculations for trucks in 2008 at the Garden City Terminal (the base year) because: (1) ULSD has been used since 2006; and (2) Conversation with US EPA indicated that the majority of trucks in 2008 use the ULSD fuel.

Moreover, the Georgia Port Authority (GPA) is in the process of converting all its truck fleet to the ULSD diesel fuel (15 ppm Sulfur) prior to the 2010 deadline.

Emission rates for the truck engines (from EPA's 1997 report numbered "EPA 420-F-97-014") are shown below:

Table 5-52
Emission Rates for Heavy Duty Trucks/Buses - 2008 (Grams/BHP-Hour)

YEAR	HC	CO	NOX	PM
1990	1.30	15.50	6.00	0.60
1991-1993	1.30	15.50	5.00	0.25
1994-1997	1.30	15.50	5.00	0.10
1998-2003	1.30	15.50	4.00	0.10
2004		15.50		0.10
2007			0.20	0.01

US EPA, Region 5 provided the Corps with spreadsheets that used the MOBILE 6 model to calculate in-use truck emission rates (by vehicle class, model year and calendar year) for a set of calendar years. MOBILE 6 spreadsheets were used with the following assumptions:

By Model Year Runs:

Calendar Years :	**1980,1990,2000,2005,2010,2020 (July Evaluation)**
Summer Temperatures:	**72 to 92 degrees Fahrenheit , min/max**
Pollutants:	**Criteria Pollutants and PM2.5 (exhaust PM only)**
Fuels:	**Default for gasoline sulfur**
	and 15 ppm for diesel sulfur
Other inputs:	**Default**

The workbook consists of 21 worksheets, one for each of seven calendar years and one of three gasoline and diesel fuel types.

A description of each one of them follows:

Worksheet name	Calendar Year	Sulfur content of Fuel in ppm	
		Gasoline	**Diesel**
bymy1	1980	default	15
bymy2	1990	default	15
bymy3	1995	default	15
bymy4	2000	default	15
bymy5	2005	default	15
bymy6	2010	default	15

Each of the above worksheets contain data on grams per mile for 28 vehicle classes , for ages 0 to24, for VOC,CO, NOX and total exhaust PM2.5

Also included are data on miles per day, travel fraction and age fraction.

Georgia Port Authority (GPA) provided us with the number of trucks arriving/departing at the Garden City Terminal but did not provide model year, weight, or average speed at the terminal. However, GPA did provide us with the average time for each truck at the port. The Corps increased this truck time (provided by GPA) at the terminal to cover any stand-by time at the entrance/exit gates as well as time required to enter/leave the Savannah Metro Area. The Corps then made the following assumptions: assume each truck was 33,000 lb (HDDV8A) and that **average** speed in the terminal is 27.6 miles/hr.

Below is a sample calculation for CO, where we used the MOBILE 6 spreadsheets (provided by US EPA Region 5):

Multiple gm/mile by 27.6 miles/hour equals gm/hr of criteria pollutant;

Then multiple gm/hr by travel fraction to get national average default for all model years. Sum each column to get grams of criteria pollutant and multiple by 1,001,228.8 hours/year and 0.00000110231131 to get tons/year. Therefore, the total tons of CO per year for all trucks at Garden City Terminal is 53.7 tons (see last number on the far right column, below).

age	model year	etype	grams per mile	etype desc	vtype short desc	vtype description	travel fraction	miles/day	age fraction			
0	2010	2	0.244077321	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.0862	240.63	0.0388		**0.580689237**	
1	2009	2	0.244077321	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.15251	227.527	0.0726		**1.027388811**	
2	2008	2	0.244077321	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.1271	202.749	0.0679		**0.85621348**	
3	2007	2	0.244077321	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.10592	180.67	0.0635		**0.713533689**	
4	2006	2	2.413255222	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.08829	160.996	0.0594		**5.880629979**	
5	2005	2	2.458118365	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.07364	143.462	0.0556		**4.996037085**	
6	2004	2	2.498070106	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.06138	127.839	0.052		**4.231950589**	
7	2003	2	2.533685991	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.05112	113.917	0.0486		**3.574807969**	
8	2002	2	2.565428383	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.04264	101.511	0.0455		**3.019160309**	
9	2001	2	2.593715762	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.03549	90.457	0.0425		**2.540606838**	
10	2000	2	2.618912811	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.02962	80.6053	0.0398		**2.14099265**	
11	1999	2	2.641382553	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.02467	71.8277	0.0372		**1.798496249**	
12	1998	2	2.661363535	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.02056	64.0064	0.0348		**1.510206706**	
13	1997	2	2.679197886	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.01717	57.0358	0.0326		**1.269650445**	
14	1996	2	2.695119211	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.01426	50.8243	0.0304		**1.060734239**	
15	1995	2	2.726160213	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.01192	45.2895	0.0285		**0.896884901**	
16	1994	2	2.75569306	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.00991	40.3575	0.0266		**0.753726143**	
17	1993	2	4.190999567	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.00827	35.9625	0.0249		**0.956604033**	
18	1992	2	4.281027481	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.00689	32.0457	0.0233		**0.81409731**	
19	1991	2	4.319158347	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.00575	28.5563	0.0218		**0.68545043**	
20	1990	2	4.602806131	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.00479	25.4464	0.0204		**0.608509382**	
21	1989	2	4.120198723	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.004	22.6749	0.0191		**0.454869939**	
22	1988	2	15.78387938	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.00332	20.2061	0.0178		**1.446308436**	
23	1987	2	16.83255045	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.00278	18.0059	0.0167		**1.291527931**	
24	1986	2	17.16458257	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.01179	16.0441	0.0796		**5.585423827**	
											48.69450061	
											48754336.41	
											53.742456	**Total CO**
												Tons/year

The Corps then calculated the following pollutants (HC, VOC, NOx, PM_{10}, and $PM_{2.5}$) for trucks at the Garden City Terminal. Please note, that the MOBILE 6 spreadsheets did not have a VOC category for heavy duty trucks (HDDV8A). However, after reviewing the Port of Portland Air Inventory Spreadsheets, they determined that VOC= 1.005* HC. Therefore, we used this formula to calculate the VOC of heavy duty trucks (HDDV8A) at the Garden City Terminal.

Using those emission rates, the time spent by trucks on the terminal and additional time spent in the vicinity of the terminal, the emissions for each pollutant type can be calculated. The emissions for the truck fleet assumed that the ULSD (15 ppm Sulfur) was used and the following calculations were discussed with USEPA Region 5. The summary for those calculations are as follows:

Table 5-53
Summary of 2008 Truck Emissions at GCT Using ULSD (Tons)

HC	VOC	CO	NOx	PM10	PM2.5
12.2	12.3	53.7	218.4	4.78	4.64

5.15 Locomotives

GPA uses trains to move containers to and from their Garden City Terminal. The trains are powered by locomotives, some of which are Line Haul engines, while others are Switching engines that are used to combine the individual cars into long trains. The locomotives are owned by Norfolk Southern and the Savannah Port Terminal Railroad. The basic information on this equipment was provided by GPA, who obtained it from discussions with these two companies. GPA owns the Mason Intermodal Container Transfer Facility (ICTF), which is served by Norfolk Southern. The locomotive use information is summarized as follows in Table 5-54:

Table 5-54
Locomotives

	Engine Type	Number of Engines	Amount of Use	Type of Use
Norfolk Southern	GEC40	11	11 round trips per week	Line Haul
Garden City Terminal (CSX)	EMD-SW1200	3	21 hours per day	Switching
Golden Isles (CSX)	EMD-SW1500	1	6 hours per day	Switching

For the Norfolk Southern trains calling at the Mason ICTF, engine use durations were identified through further discussions with GPA. Those discussions resulted in the following summary of engine working time:

Table 5-55
Engine Work Time

	Amount of Use	Duration of Use
Mason ICTF	11 trips per week	Arrival - 20 minutes Loading – 2 1/3 hours Departure – 20 minutes

Based on the above information and further discussions with GPA, the following use rates were calculated:

Table 5-56
Amount of Engine Use

Type Of Engine	Use (Hours/Week)	Use (Hours/Year)
Line Haul	33	1,716
Switching	69	3,588
Total	102	5,304

GPA provided the following information on the **average** hours of locomotive operation:

1. Norfolk Southern used 11 locomotives for an average of 11 trips per week to and from the port. GPA stated that the line-haul locomotives only remain at the port (an **average** 3 hours see Table 5-55). Therefore, the estimated average weekly and yearly line-haul locomotive hours of operation at the port are: 33 hours per week (11 locomotives/week times 3 hours/locomotive = 33 hours) and for the year is 1,716 hours (33 times 52 weeks = 1,716).

2. CSX used a total of 4 switch locomotives an **average** of 3 times per week for a total of 21 hours per day plus 1 time per week for about 6 hours per day. Or on average about 69 hours per week (3 times 21 hours per day plus 6 hours per day = 69 hours). On average the switch locomotives were used 69 hours per week times 52 weeks in a year equals about 3,588 hours of operation in a year. Please note, both the hours of use for the line-haul and switch locomotives are **average estimates**. Cargo operations (goods being hauled in/out and switched to/from the port by train) are not carried out continuously 24 hour per day 7 day a week.

The hours provided for both line-haul and switch locomotives in Table 5-56 include idling. However, GPA did not know the exact percentage of idling versus in-operation. The NONROAD model assumes that the idling air emission rate is lower than the in-operation rate. The District assumed the same in-operation air emission rate for locomotives, whether idling or in-operation. **Therefore the locomotive air emission estimates (shown in Tables 5-57, 5-58, 5-59, and 5-60, below) are greater (more conservative) than if idling had been factored into the equation.** The District used category SCC 2285002015 for locomotives as the air emission rate NONROAD2005 model for the 2007 calendar year (using 1139 ppm Sulfur diesel fuel see Tables 5-57 and 5-58, below) and NONROAD2008 model for the 2010 calendar year (using 15 ppm Sulfur diesel fuel see Tables 5-59 and 5-60, below).

The Corps selected emission rates for the locomotive engines from information provided EPA, Region 5. We used emission rates for 2,000 HP engines, since the engine size presently in use averages 1,633 HP.

Table 5-57
Emission Rates for Diesel Railway Locomotives (Pounds/Hour-Unit)

HC	VOC	CO	NOx	PM10	PM2.5	SO2	CO2
1.0153	1.0691	4.5034	6.4649	0.6874	0.6668	0.3284	470.51

The engine horsepower is multiplied by the emission rate and the duration of use. The product is the air emission quantity by pollutant type. The total emissions from locomotives in 2008 (using 1139 ppm Sulfur diesel fuel) are summarized as follows:

Table 5-58
Summary of 2008 Locomotive Emissions (Tons)

HC	VOC	CO	NOx	PM10	PM2.5	SO2	CO2
2.69	2.84	11.94	17.15	1.82	1.77	0.87	1,248

EPA Region 5, (by email dated 6 February 2009) provided the **following emission standards for locomotives using ULSD (15 ppm Sulfur):**

In 2009, SCC 2285002015, Diesel Railway Maintenance HP 2000 (HP Ave is 1633). All Units are in lbs./hr/unit.

Table 5-59 Emission Rates for Diesel Railway Locomotives Using ULSD (15ppm) (Pounds/Hour-Unit)

HC	VOC	CO	NOx	PM10	PM2.5	SO2	CO2
0.8709	0.917	3.8745	6.0419	0.5498	0.5333	0.0043	470.9581

The following table provides the total emissions for locomotives using ULSD (15 ppm Sulfur):

Table 5-60 Summary of Locomotive Emissions Using ULSD (15 ppm) (Tons)

HC	VOC	CO	NOx	PM10	PM2.5	SO2	CO2
2.3	2.4	10.3	16.0	1.45	1.41	0.01	1249.0

GPA moved 18 percent of the containers with trains in 2006. Their 2016 future facility plan calls for that to increase to 25 percent. GPA has constructed a second rail yard facility that was completed in 2008. This facility is used by CSX, which until that time did not have a dedicated on-site facility from which to support movements GPA's operations. The expected increased use of trains would be accompanied by a corresponding decrease in the use of trucks. Trains are generally viewed as being more efficient in moving containers from the perspectives of traffic and air quality. This air quality analysis does not include these future changes, so the analysis overstates the total future air emissions.

5.16 GPA Fleet Vehicles

GPA also operates a fleet of vehicles at its Garden City and Ocean Terminals. These vehicles include the automobiles and small trucks used on those two GPA facilities. GPA provided the basic information on their vehicle fleet, which includes 197 vehicles with license tags. The information was voluminous and included the type of vehicle, age, fuel type, and number of miles driven per year. The Corps summarized this information by vehicle category (Light Duty Gas Vehicles, Light Duty Diesel Trucks, etc), as shown in Table 5-61, below:

Table 5-61 GPA Vehicle Fleet (July 2006-June 2007)

EPA Classification	Typical Vehicles	Total Mileage
Light Duty Gas Vehicles	Cars, Pickups, Vans	484,069
Light Duty Gas Trucks	Heavy Duty Pickups, etc.	973,266
Light Duty Diesel Trucks		30,312

US EPA, Region 5 provided the Corps with spreadsheets that used the MOBILE 6 model to calculate in-use vehicle emission rates (by vehicle class, model year and calendar year) for a set of calendar years. The Corps used the emissions for the following vehicle categories:

LDGV	Light-Duty Gasoline Vehicles (Passenger Cars)
LDGT1	Light-Duty Gasoline Trucks 1 (0-6,000 lbs. GVWR, 0-3750 lbs. LVW)
LDDT12	Light-Duty Diesel Trucks 1 and 2 (0-6,000 lbs. GVWR)

The product is the air emission quantity by pollutant type, as summarized in Table 5-62, below:

Table 5-62 Summary of 2006/2007 GPA Vehicle Fleet Emissions (Tons)

	HC	VOC	CO	NOx	PM10	PM2.5
Light Duty Gas Vehicles (LDGV)	**.40**	**0.4**	**4.20**	**0.31**	**0.002**	**0.002**
Light Duty Gas Trucks (LDGT1)	0.83	0.83	9.75	0.81	0.005	0.004
Light Duty Diesel Trucks (LDDT12)	0.01	0.01	0.03	0.03	0.002	0.002
Total	1.24	1.24	13.98	1.15	0.009	0.008

5.17 Air Toxics

In addition to the criteria pollutants that are traditionally evaluated when one discusses air emissions, there are also numerous other compounds which are emitted. Some of those are classified as “air toxics”. In its review of the Corps’ 2006 draft Air Quality Analysis, EPA Region 4 requested that air toxics also be considered.

Air Toxics are generally determined as a ratio of criteria pollutants discharged. The emission rates are a proportion of other parameters such as VOC, PM10, gallons or miles. The Corps obtained information from the NMIM "SCC Toxics" database table provided by EPA, Region 5 concerning the ratios of specific air toxics to other physical parameters. These ratios are displayed in Tables 5-63A, 5-63B, and 5-64, below and were also used but not displayed in Tables 5-65 to 5-76.

The 28 toxics which have been identified in the highest quantity in emission inventories prepared for other ports -- and their relationship to other calculated pollutants -- are shown in Tables 5-63A and 5-63B, below.

The Corps calculated emissions of air toxics at the Port of Savannah (includes all 22 terminals, land based operations, dredging, tourist boats, shifts, OGVs, etc.) for the 28 air toxics in the 2008 base year by quantity and compared them to the reported 2002 Chatham County EPA NEI air toxic emission. To calculate Ethyl Benzene, the Corps multiplied the total VOC emissions in 2008 for the -42 foot depth (see Table 5-78), which is 352.54 tons times 0.0031 equals about 1.09 tons. The total PM10 emissions in 2008 for the -42 foot depth (see Table 5-78) are about 229.76 tons. Additionally, the Corps calculated the percent of the 2008 air toxics emissions to the 2002 EPA NEI Chatham County data. All of these quantities are shown below in Table 5-63A, below.

Table 5-63A Summary of Air Toxic Emissions for the Port of Savannah – 2008 Compared to 2002 EPA Chatham County NEI (Tons Per Year)

	AIR TOXIC PARAMETER		AIR TOXIC RATIOS TAKEN FROM NMIM "SCC TOXICS" DATABASE"	AIR TOXICS For Port In 2008 (TONS / YEAR)	2002 EPA NEI DATA CHATHAM COUNTY (TONS/YEAR)	PERCENT OF 2008 PORT BASE YEAR TO 2002 EPA NEI COUNTY DATA
1	Ethyl Benzene	VOC	0.0031001	1.092907	56.028	1.95%
2	Styrene	VOC	0.00059448	0.209578	10.74	1.95%
3	1,3-Butadiene	VOC	0.0018616	0.656287	33.64	1.95%
4	Acrolein	VOC	0.00303165	1.068776	54.79	1.95%
5	Toluene	VOC	0.014967	5.276454	270.50	1.95%
6	Hexane	VOC	0.0015913	0.560996	28.76	1.95%
7	Anthracene	PM10	0.00000043	0.000099	0.00279	3.54%
8	Propionaldehyde	VOC	0.0118	4.159963	213.26	1.95%
9	Pyrene	PM10	0.0000029	0.000666	0.0188	3.54%
10	Xylene	VOC	0.010582	3.730570	191.25	1.95%
11	Benzo(g,h,i)perylene	PM10	0.00000019	0.000044	0.00123	3.54%
12	Indeno(1,2,3,c,d)pyrene	PM10	0.000000079	0.000018	0.0005	3.54%
13	Benzo(b)fluoranthene	PM10	0.00000049	0.000113	0.0032	3.54%
14	Fluoranthene	PM10	0.000017	0.003906	0.110	3.54%
15	Benzo(k)fluoranthene	PM10	0.00000035	0.000080	0.00227	3.54%
16	Acenaphthylene	PM10	0.000084	0.019300	0.55	3.54%
17	Chrysene	PM10	0.0000019	0.000437	0.0123	3.54%
18	Formaldehyde	VOC	0.118155	41.654271	2135.42	1.95%
19	Benzo(a)pyrene	PM10	0.00000035	0.000080	0.00227	3.54%
20	Dibenzo(a,h)anthracene	PM10	2.9E-09	0.000001	0.188181	3.54%
21	2,2,4-Trimethylpentane	VOC	0.00066	0.232676	11.93	1.95%
22	Benz(a)anthracene	PM10	0.00000071	0.000163	0.0046	3.54%
23	Benzene	VOC	0.020344	7.172058	367.68	1.95%
24	Acetaldehyde	VOC	0.05308	18.712781	959.31	1.95%
25	Acenaphthene	PM10	0.0001	0.022976	0.649	3.54%
26	Phenanthrene	PM10	0.00026	0.059738	1.69	3.54%
27	Fluorene	PM10	0.0001	0.022976	0.65	3.54%
28	Naphthalene	PM10	0.00046	0.105691	2.98	3.54%

The Corps also calculated emissions of air toxics at the Port of Savannah (includes all 22 terminals, land based operations, dredging, tourist boats, shifts, OGVs, etc.) for the 28 air toxics in the 2008 base year by quantity and compared them to the reported 2005 EPA NEI air toxic emissions. As indicated in Section 6 entitled "Comparison of Emissions at Port with Emissions in Chatham County", the 2005 USEPA NEI Data **does not include** 2280003100 Marine Vessels, Commercial, Residual, Port emissions or 2280003200 Marine Vessels, Commercial, Residual, Underway emissions. This means that the percent 2008 Port Emissions compared to the 2005 NEI data may be slightly higher than in Table 5-63A. All of these calculated quantities are shown below in Table 5-63B below.

Table 5-63B Summary of Air Toxic Emissions – 2008
Compared to the 2005 EPA Chatham County NEI (Tons Per Year)

	AIR TOXIC PARAMETER		AIR TOXIC RATIOS TAKEN FROM NMIM "SCC TOXICS" DATABASE"	AIR TOXICS For Port In 2008 (TONS / YEAR)	2005 EPA NEI DATA CHATHAM COUNTY (TONS/YEAR)	PERCENT OF 2008 PORT BASE YEAR TO 2005 EPA NEI COUNTY DATA
1	Ethyl Benzene	VOC	0.0031001	1.09290682	54.0502	2.02%
2	Styrene	VOC	0.00059448	0.20957751	10.3648	2.02%
3	1,3-Butadiene	VOC	0.0018616	0.65628700	32.4570	2.02%
4	Acrolein	VOC	0.00303165	1.06877551	52.8568	2.02%
5	Toluene	VOC	0.014967	5.27645442	260.9496	2.02%
6	Hexane	VOC	0.0015913	0.56099565	27.7443	2.02%
7	Anthracene	PM10	0.00000043	0.00009880	0.0031	3.20%
8	Propionaldehyde	VOC	0.0118	4.15996273	205.7330	2.02%
9	Pyrene	PM10	0.0000029	0.00066631	0.0208	3.20%
10	Xylene	VOC	0.010582	3.73056997	184.4972	2.02%
11	Benzo(g,h,i)perylene	PM10	0.00000019	0.00004365	0.0014	3.20%
12	Indeno(1,2,3,c,d)pyrene	PM10	0.000000079	0.00001815	0.0006	3.20%
13	Benzo(b)fluoranthene	PM10	0.00000049	0.00011258	0.0035	3.20%
14	Fluoranthene	PM10	0.000017	0.00390596	0.1220	3.20%
15	Benzo(k)fluoranthene	PM10	0.00000035	0.00008042	0.0025	3.20%
16	Acenaphthylene	PM10	0.000084	0.01930003	0.6027	3.20%
17	Chrysene	PM10	0.0000019	0.00043655	0.0136	3.20%
18	Formaldehyde	VOC	0.118155	41.65427087	2060.0324	2.02%
19	Benzo(a)pyrene	PM10	0.00000035	0.00008042	0.0025	3.20%
20	Dibenzo(a,h)anthracene	PM10	2.9E-09	0.00000067	0.0000	3.20%
21	2,2,4-Trimethylpentane	VOC	0.00066	0.23267588	11.5071	2.02%
22	Benz(a)anthracene	PM10	0.00000071	0.00016313	0.0051	3.20%
23	Benzene	VOC	0.020344	7.17205778	354.6976	2.02%
24	Acetaldehyde	VOC	0.05308	18.71278150	925.4498	2.02%
25	Acenaphthene	PM10	0.0001	0.02297622	0.7175	3.20%
26	Phenanthrene	PM10	0.00026	0.05973818	1.8655	3.20%
27	Fluorene	PM10	0.0001	0.02297622	0.7175	3.20%
28	Naphthalene	PM10	0.00046	0.10569062	3.3005	3.20%

At the request of EPA, the Corps calculated emissions of air toxics for the Garden City Terminal. Table 5-64 below shows the emissions calculated for 2008, while the following Tables 5-65, 5-66, and 5-67 show the emissions expected in future years (i.e., 2016, 2025, and 2030) for the No Action Alternative or -42 foot depth. The numbers for the future years are based on the cargo tonnages expected in the project's economic analysis. The emissions would not increase after 2030 because that terminal is expected to reach its maximum operating capacity then and would not be able to receive additional cargoes.

Table 5-64 Summary of Air Toxic Emissions Garden City Terminal Existing -42 foot depth 2008 (Tons Per Year)

	AIR TOXIC PARAMETER	AIR TOXIC RATIOS TAKEN FROM NMIM "SCC TOXICS" DATABASE	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	0.0031001	0.306821	0.208215	0.00005562	0.515092
2	Styrene	0.00059448	0.058836	0.039928	0.00001067	0.098775
3	1,3-Butadiene	0.0018616	0.184245	0.125033	0.00003340	0.309311
4	Acrolein	0.00303165	0.300047	0.203618	0.00005439	0.503719
5	Toluene	0.014967	1.481304	1.005245	0.00026851	2.486818
6	Hexane	0.0015913	0.157493	0.106878	0.00002855	0.264400
7	Anthracene	0.00000043	0.000030	0.000026	0.00000001	0.000056
8	Propionaldehyde	0.0118	1.167862	0.792536	0.00021170	1.960610
9	Pyrene	0.0000029	0.000201	0.000174	0.00000006	0.000375
10	Xylene	0.010582	1.047315	0.710730	0.00018984	1.758235
11	Benzo(g,h,i)perylene	0.00000019	0.000013	0.000011	0.00000000	0.000025
12	Indeno(1,2,3,c,d)pyrene	0.000000079	0.000005	0.000005	0.00000000	0.000010
13	Benzo(b)fluoranthene	0.00000049	0.000034	0.000029	0.00000001	0.000063
14	Fluoranthene	0.000017	0.001178	0.001020	0.00000038	0.002198
15	Benzo(k)fluoranthene	0.00000035	0.000024	0.000021	0.00000001	0.000045
16	Acenaphthylene	0.000084	0.005821	0.005040	0.00000187	0.010863
17	Chrysene	0.0000019	0.000132	0.000114	0.00000004	0.000246
18	Formaldehyde	0.118155	11.693960	7.935773	0.00211974	19.631853
19	Benzo(a)pyrene	0.00000035	0.000024	0.000021	0.00000001	0.000045
20	Dibenzo(a,h)anthracene	2.9E-09	0.000000	0.000000	0.00000000	0.000000
21	2,2,4-Trimethylpentane	0.00066	0.065321	0.044328	0.00001184	0.109661
22	Benz(a)anthracene	0.00000071	0.000049	0.000043	0.00000002	0.000092
23	Benzene	0.020344	2.013473	1.366386	0.00036498	3.380224
24	Acetaldehyde	0.05308	5.253400	3.565070	0.00095227	8.819422
25	Acenaphthene	0.0001	0.006930	0.006000	0.00000222	0.012932
26	Phenanthrene	0.00026	0.018017	0.015601	0.00000578	0.033624
27	Fluorene	0.0001	0.006930	0.006000	0.00000222	0.012932
28	Naphthalene	0.00046	0.031877	0.027602	0.00001022	0.059488

Table 5-65 Summary of Air Toxic Emissions Garden City Terminal Without Project -42 foot depth -- 2016 (Tons Per Year)

	AIR TOXIC PARAMETER	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	0.600036	0.250814	0.00008385	0.850942
2	Styrene	0.115064	0.048096	0.00001608	0.163178
3	1,3-Butadiene	0.360320	0.150613	0.00005035	0.510988
4	Acrolein	0.586788	0.245276	0.00008199	0.832153
5	Toluene	2.896921	1.210907	0.00040480	4.108271
6	Hexane	0.308002	0.128744	0.00004304	0.436794
7	Anthracene	0.000020	0.000033	0.00000001	0.000053
8	Propionaldehyde	2.283935	0.954681	0.00031914	3.238965
9	Pyrene	0.000134	0.000221	0.00000010	0.000355
10	Xylene	2.048187	0.856138	0.00028620	2.904638
11	Benzo(g,h,i)perylene	0.000009	0.000014	0.00000001	0.000023
12	Indeno(1,2,3,c,d)pyrene	0.000004	0.000006	0.00000000	0.000010
13	Benzo(b)fluoranthene	0.000023	0.000037	0.00000002	0.000060
14	Fluoranthene	0.000787	0.001296	0.00000057	0.002084
15	Benzo(k)fluoranthene	0.000016	0.000027	0.00000001	0.000043
16	Acenaphthylene	0.003888	0.006406	0.00000281	0.010297
17	Chrysene	0.000088	0.000145	0.00000006	0.000233
18	Formaldehyde	22.869356	9.559347	0.00319564	32.432199
19	Benzo(a)pyrene	0.000016	0.000027	0.00000001	0.000043
20	Dibenzo(a,h)anthracene	0.000000	0.000000	0.00000000	0.000000
21	2,2,4-Trimethylpentane	0.127746	0.053397	0.00001785	0.181162
22	Benz(a)anthracene	0.000033	0.000054	0.00000002	0.000087
23	Benzene	3.937660	1.645934	0.00055023	5.584196
24	Acetaldehyde	10.273839	4.294445	0.00143561	14.569854
25	Acenaphthene	0.004629	0.007626	0.00000335	0.012258
26	Phenanthrene	0.012035	0.019827	0.00000871	0.031871
27	Fluorene	0.004629	0.007626	0.00000335	0.012258
28	Naphthalene	0.021293	0.035078	0.00001541	0.056388

Table 5-66 Summary of Air Toxic Emissions Garden City Terminal Without Project -42 foot depth -- 2025 (Tons Per Year)

	AIR TOXIC PARAMETER	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	0.987080	0.349133	0.00011946	1.336332
2	Styrene	0.189284	0.066950	0.00002291	0.256257
3	1,3-Butadiene	0.592738	0.209653	0.00007174	0.802463
4	Acrolein	0.965285	0.341424	0.00011682	1.306826
5	Toluene	4.765530	1.685583	0.00057675	6.451690
6	Hexane	0.506674	0.179212	0.00006132	0.685947
7	Anthracene	0.000031	0.000046	0.00000002	0.000076
8	Propionaldehyde	3.757149	1.328915	0.00045471	5.086520
9	Pyrene	0.000207	0.000308	0.00000014	0.000515
10	Xylene	3.369335	1.191744	0.00040777	4.561487
11	Benzo(g,h,i)perylene	0.000014	0.000020	0.00000001	0.000034
12	Indeno(1,2,3,c,d)pyrene	0.000006	0.000008	0.00000000	0.000014
13	Benzo(b)fluoranthene	0.000035	0.000052	0.00000002	0.000087
14	Fluoranthene	0.001216	0.001805	0.00000081	0.003021
15	Benzo(k)fluoranthene	0.000025	0.000037	0.00000002	0.000062
16	Acenaphthylene	0.006009	0.008917	0.00000401	0.014930
17	Chrysene	0.000136	0.000202	0.00000009	0.000338
18	Formaldehyde	37.620846	13.306610	0.00455305	50.932010
19	Benzo(a)pyrene	0.000025	0.000037	0.00000002	0.000062
20	Dibenzo(a,h)anthracene	0.000000	0.000000	0.00000000	0.000001
21	2,2,4-Trimethylpentane	0.210146	0.074329	0.00002543	0.284500
22	Benz(a)anthracene	0.000051	0.000075	0.00000003	0.000126
23	Benzene	6.477580	2.291140	0.00078395	8.769505
24	Acetaldehyde	16.900804	5.977867	0.00204541	22.880717
25	Acenaphthene	0.007154	0.010615	0.00000477	0.017773
26	Phenanthrene	0.018599	0.027599	0.00001241	0.046211
27	Fluorene	0.007154	0.010615	0.00000477	0.017773
28	Naphthalene	0.032907	0.048829	0.00002195	0.081757

Table 5-67 Summary of Air Toxic Emissions Garden City Terminal Without Project -42 foot depth -- 2030+ (Tons Per Year)

	AIR TOXIC PARAMETER	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	1.291789	0.418960	0.00014963	1.710898
2	Styrene	0.247715	0.080340	0.00002869	0.328085
3	1,3-Butadiene	0.775715	0.251584	0.00008985	1.027389
4	Acrolein	1.263266	0.409709	0.00014632	1.673122
5	Toluene	6.236640	2.022699	0.00072239	8.260061
6	Hexane	0.663083	0.215055	0.00007680	0.878214
7	Anthracene	0.000040	0.000055	0.00000003	0.000094
8	Propionaldehyde	4.916974	1.594699	0.00056953	6.512242
9	Pyrene	0.000267	0.000369	0.00000017	0.000636
10	Xylene	4.409442	1.430093	0.00051075	5.840046
11	Benzo(g,h,i)perylene	0.000017	0.000024	0.00000001	0.000042
12	Indeno(1,2,3,c,d)pyrene	0.000007	0.000010	0.00000000	0.000017
13	Benzo(b)fluoranthene	0.000045	0.000062	0.00000003	0.000108
14	Fluoranthene	0.001564	0.002165	0.00000102	0.003731
15	Benzo(k)fluoranthene	0.000032	0.000045	0.00000002	0.000077
16	Acenaphthylene	0.007729	0.010700	0.00000502	0.018434
17	Chrysene	0.000175	0.000242	0.00000011	0.000417
18	Formaldehyde	49.234326	15.967933	0.00570281	65.207961
19	Benzo(a)pyrene	0.000032	0.000045	0.00000002	0.000077
20	Dibenzo(a,h)anthracene	0.000000	0.000000	0.00000000	0.000001
21	2,2,4-Trimethylpentane	0.275017	0.089195	0.00003186	0.364244
22	Benz(a)anthracene	0.000065	0.000090	0.00000004	0.000156
23	Benzene	8.477196	2.749368	0.00098191	11.227547
24	Acetaldehyde	22.118048	7.173440	0.00256193	29.294051
25	Acenaphthene	0.009201	0.012738	0.00000598	0.021945
26	Phenanthrene	0.023924	0.033119	0.00001554	0.057058
27	Fluorene	0.009201	0.012738	0.00000598	0.021945
28	Naphthalene	0.042326	0.058594	0.00002750	0.100948

Similarly, the Corps calculated emissions of air toxics for the Garden City Terminal if the harbor is deepened. The following tables (Tables 5-68 to 5-76) show the emissions expected under those conditions. Again, the emissions would not increase after 2030 because that terminal is expected to reach its maximum operating capacity then and would not be able to receive additional cargoes. The emissions are the same for both the 47- and 48-foot alternatives because the vessel fleet is not expected to change between those alternatives (see Table 4-3 Fleet Forecast). Therefore, the same number and size of vessels would be used in those alternatives, so their air emissions would be the same.

Table 5-68 Summary of Air Toxic Emissions Garden City Terminal With 44-Foot Project – 2016 (Tons Per Year)

	AIR TOXIC PARAMETER	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	0.570728	0.250814	0.000080	0.821622
2	Styrene	0.109444	0.048096	0.000015	0.157555
3	1,3-Butadiene	0.342720	0.150613	0.000048	0.493381
4	Acrolein	0.558126	0.245276	0.000078	0.803480
5	Toluene	2.755422	1.210907	0.000385	3.966715
6	Hexane	0.292958	0.128744	0.000041	0.421743
7	Anthracene	0.000019	0.000033	0.000000	0.000052
8	Propionaldehyde	2.172378	0.954681	0.000304	3.127362
9	Pyrene	0.000128	0.000221	0.000000	0.000349
10	Xylene	1.948145	0.856138	0.000272	2.804555
11	Benzo(g,h,i)perylene	0.000008	0.000014	0.000000	0.000023
12	Indeno(1,2,3,c,d)pyrene	0.000003	0.000006	0.000000	0.000010
13	Benzo(b)fluoranthene	0.000022	0.000037	0.000000	0.000059
14	Fluoranthene	0.000748	0.001296	0.000001	0.002045
15	Benzo(k)fluoranthene	0.000015	0.000027	0.000000	0.000042
16	Acenaphthylene	0.003698	0.006406	0.000003	0.010107
17	Chrysene	0.000084	0.000145	0.000000	0.000229
18	Formaldehyde	21.752318	9.559347	0.003040	31.314704
19	Benzo(a)pyrene	0.000015	0.000027	0.000000	0.000042
20	Dibenzo(a,h)anthracene	0.000000	0.000000	0.000000	0.000000
21	2,2,4-Trimethylpentane	0.121506	0.053397	0.000017	0.174920
22	Benz(a)anthracene	0.000031	0.000054	0.000000	0.000085
23	Benzene	3.745327	1.645934	0.000523	5.391785
24	Acetaldehyde	9.772020	4.294445	0.001365	14.067830
25	Acenaphthene	0.004403	0.007626	0.000003	0.012032
26	Phenanthrene	0.011447	0.019827	0.000008	0.031282
27	Fluorene	0.004403	0.007626	0.000003	0.012032
28	Naphthalene	0.020253	0.035078	0.000015	0.055345

Table 5-69 Summary of Air Toxic Emissions Garden City Terminal With 46-Foot Project – 2016 (Tons Per Year)

	AIR TOXIC PARAMETER	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	0.561307	0.250814	0.000078	0.812200
2	Styrene	0.107637	0.048096	0.000015	0.155749
3	1,3-Butadiene	0.337063	0.150613	0.000047	0.487723
4	Acrolein	0.548914	0.245276	0.000077	0.794267
5	Toluene	2.709941	1.210907	0.000379	3.921227
6	Hexane	0.288122	0.128744	0.000040	0.416907
7	Anthracene	0.000019	0.000033	0.000000	0.000051
8	Propionaldehyde	2.136521	0.954681	0.000299	3.091500
9	Pyrene	0.000126	0.000221	0.000000	0.000347
10	Xylene	1.915988	0.856138	0.000268	2.772394
11	Benzo(g,h,i)perylene	0.000008	0.000014	0.000000	0.000023
12	Indeno(1,2,3,c,d)pyrene	0.000003	0.000006	0.000000	0.000009
13	Benzo(b)fluoranthene	0.000021	0.000037	0.000000	0.000059
14	Fluoranthene	0.000736	0.001296	0.000001	0.002033
15	Benzo(k)fluoranthene	0.000015	0.000027	0.000000	0.000042
16	Acenaphthylene	0.003637	0.006406	0.000003	0.010045
17	Chrysene	0.000082	0.000145	0.000000	0.000227
18	Formaldehyde	21.393270	9.559347	0.002989	30.955606
19	Benzo(a)pyrene	0.000015	0.000027	0.000000	0.000042
20	Dibenzo(a,h)anthracene	0.000000	0.000000	0.000000	0.000000
21	2,2,4-Trimethylpentane	0.119500	0.053397	0.000017	0.172914
22	Benz(a)anthracene	0.000031	0.000054	0.000000	0.000085
23	Benzene	3.683506	1.645934	0.000515	5.329955
24	Acetaldehyde	9.610721	4.294445	0.001343	13.906509
25	Acenaphthene	0.004330	0.007626	0.000003	0.011959
26	Phenanthrene	0.011258	0.019827	0.000008	0.031093
27	Fluorene	0.004330	0.007626	0.000003	0.011959
28	Naphthalene	0.019919	0.035078	0.000014	0.055011

Table 5-70 Summary of Air Toxic Emissions Garden City Terminal With 47/48-Foot Project -- 2016 (Tons Per Year)

	AIR TOXIC PARAMETER	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	0.552503	0.250814	0.000078	0.803396
2	Styrene	0.105949	0.048096	0.000015	0.154060
3	1,3-Butadiene	0.331777	0.150613	0.000047	0.482437
4	Acrolein	0.540304	0.245276	0.000077	0.785657
5	Toluene	2.667436	1.210907	0.000378	3.878721
6	Hexane	0.283603	0.128744	0.000040	0.412388
7	Anthracene	0.000018	0.000033	0.000000	0.000051
8	Propionaldehyde	2.103010	0.954681	0.000298	3.057988
9	Pyrene	0.000124	0.000221	0.000000	0.000345
10	Xylene	1.885936	0.856138	0.000267	2.742342
11	Benzo(g,h,i)perylene	0.000008	0.000014	0.000000	0.000023
12	Indeno(1,2,3,c,d)pyrene	0.000003	0.000006	0.000000	0.000009
13	Benzo(b)fluoranthene	0.000021	0.000037	0.000000	0.000058
14	Fluoranthene	0.000726	0.001296	0.000001	0.002023
15	Benzo(k)fluoranthene	0.000015	0.000027	0.000000	0.000042
16	Acenaphthylene	0.003588	0.006406	0.000003	0.009997
17	Chrysene	0.000081	0.000145	0.000000	0.000226
18	Formaldehyde	21.057723	9.559347	0.002984	30.620053
19	Benzo(a)pyrene	0.000015	0.000027	0.000000	0.000042
20	Dibenzo(a,h)anthracene	0.000000	0.000000	0.000000	0.000000
21	2,2,4-Trimethylpentane	0.117626	0.053397	0.000017	0.171040
22	Benz(a)anthracene	0.000030	0.000054	0.000000	0.000084
23	Benzene	3.625732	1.645934	0.000514	5.272179
24	Acetaldehyde	9.459980	4.294445	0.001340	13.755765
25	Acenaphthene	0.004272	0.007626	0.000003	0.011901
26	Phenanthrene	0.011107	0.019827	0.000008	0.030942
27	Fluorene	0.004272	0.007626	0.000003	0.011901
28	Naphthalene	0.019651	0.035078	0.000014	0.054744

Table 5-71 Summary of Air Toxic Emissions Garden City Terminal With 44-Foot Project -- 2025 (Tons Per Year)

	AIR TOXIC PARAMETER	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	0.900971	0.349133	0.000109	1.250213
2	Styrene	0.172772	0.066950	0.000021	0.239743
3	1,3-Butadiene	0.541030	0.209653	0.000065	0.750749
4	Acrolein	0.881077	0.341424	0.000107	1.222608
5	Toluene	4.349804	1.685583	0.000526	6.035914
6	Hexane	0.462474	0.179212	0.000056	0.641742
7	Anthracene	0.000028	0.000046	0.000000	0.000074
8	Propionaldehyde	3.429391	1.328915	0.000415	4.758721
9	Pyrene	0.000189	0.000308	0.000000	0.000497
10	Xylene	3.075408	1.191744	0.000372	4.267524
11	Benzo(g,h,i)perylene	0.000012	0.000020	0.000000	0.000033
12	Indeno(1,2,3,c,d)pyrene	0.000005	0.000008	0.000000	0.000014
13	Benzo(b)fluoranthene	0.000032	0.000052	0.000000	0.000084
14	Fluoranthene	0.001110	0.001805	0.000001	0.002915
15	Benzo(k)fluoranthene	0.000023	0.000037	0.000000	0.000060
16	Acenaphthylene	0.005485	0.008917	0.000004	0.014405
17	Chrysene	0.000124	0.000202	0.000000	0.000326
18	Formaldehyde	34.338954	13.306610	0.004156	47.649721
19	Benzo(a)pyrene	0.000023	0.000037	0.000000	0.000060
20	Dibenzo(a,h)anthracene	0.000000	0.000000	0.000000	0.000000
21	2,2,4-Trimethylpentane	0.191813	0.074329	0.000023	0.266166
22	Benz(a)anthracene	0.000046	0.000075	0.000000	0.000122
23	Benzene	5.912502	2.291140	0.000716	8.204358
24	Acetaldehyde	15.426446	5.977867	0.001867	21.406180
25	Acenaphthene	0.006530	0.010615	0.000004	0.017149
26	Phenanthrene	0.016977	0.027599	0.000011	0.044587
27	Fluorene	0.006530	0.010615	0.000004	0.017149
28	Naphthalene	0.030036	0.048829	0.000020	0.078885

Table 5-72 Summary of Air Toxic Emissions Garden City Terminal With 46-Foot Project -- 2025 (Tons Per Year)

	AIR TOXIC PARAMETER	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	0.877102	0.349133	0.000106	1.226341
2	Styrene	0.168194	0.066950	0.000020	0.235165
3	1,3-Butadiene	0.526697	0.209653	0.000064	0.736414
4	Acrolein	0.857736	0.341424	0.000104	1.199264
5	Toluene	4.234568	1.685583	0.000512	5.920663
6	Hexane	0.450222	0.179212	0.000054	0.629488
7	Anthracene	0.000027	0.000046	0.000000	0.000073
8	Propionaldehyde	3.338538	1.328915	0.000404	4.667858
9	Pyrene	0.000184	0.000308	0.000000	0.000492
10	Xylene	2.993933	1.191744	0.000362	4.186040
11	Benzo(g,h,i)perylene	0.000012	0.000020	0.000000	0.000032
12	Indeno(1,2,3,c,d)pyrene	0.000005	0.000008	0.000000	0.000013
13	Benzo(b)fluoranthene	0.000031	0.000052	0.000000	0.000083
14	Fluoranthene	0.001081	0.001805	0.000001	0.002886
15	Benzo(k)fluoranthene	0.000022	0.000037	0.000000	0.000059
16	Acenaphthylene	0.005340	0.008917	0.000004	0.014260
17	Chrysene	0.000121	0.000202	0.000000	0.000323
18	Formaldehyde	33.429237	13.306610	0.004046	46.739893
19	Benzo(a)pyrene	0.000022	0.000037	0.000000	0.000059
20	Dibenzo(a,h)anthracene	0.000000	0.000000	0.000000	0.000000
21	2,2,4-Trimethylpentane	0.186732	0.074329	0.000023	0.261084
22	Benz(a)anthracene	0.000045	0.000075	0.000000	0.000121
23	Benzene	5.755866	2.291140	0.000697	8.047703
24	Acetaldehyde	15.017764	5.977867	0.001818	20.997449
25	Acenaphthene	0.006357	0.010615	0.000004	0.016976
26	Phenanthrene	0.016527	0.027599	0.000011	0.044137
27	Fluorene	0.006357	0.010615	0.000004	0.016976
28	Naphthalene	0.029240	0.048829	0.000020	0.078088

Table 5-73 Summary of Air Toxic Emissions Garden City Terminal With 47/48-Foot Project -- 2025 (Tons Per Year)

	AIR TOXIC PARAMETER	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	0.862111	0.349133	0.000106	1.211350
2	Styrene	0.165320	0.066950	0.000020	0.232290
3	1,3-Butadiene	0.517695	0.209653	0.000064	0.727412
4	Acrolein	0.843076	0.341424	0.000103	1.184603
5	Toluene	4.162193	1.685583	0.000511	5.848286
6	Hexane	0.442527	0.179212	0.000054	0.621793
7	Anthracene	0.000027	0.000046	0.000000	0.000072
8	Propionaldehyde	3.281478	1.328915	0.000403	4.610796
9	Pyrene	0.000181	0.000308	0.000000	0.000489
10	Xylene	2.942763	1.191744	0.000361	4.134868
11	Benzo(g,h,i)perylene	0.000012	0.000020	0.000000	0.000032
12	Indeno(1,2,3,c,d)pyrene	0.000005	0.000008	0.000000	0.000013
13	Benzo(b)fluoranthene	0.000031	0.000052	0.000000	0.000083
14	Fluoranthene	0.001061	0.001805	0.000001	0.002866
15	Benzo(k)fluoranthene	0.000022	0.000037	0.000000	0.000059
16	Acenaphthylene	0.005241	0.008917	0.000004	0.014161
17	Chrysene	0.000119	0.000202	0.000000	0.000320
18	Formaldehyde	32.857882	13.306610	0.004030	46.168523
19	Benzo(a)pyrene	0.000022	0.000037	0.000000	0.000059
20	Dibenzo(a,h)anthracene	0.000000	0.000000	0.000000	0.000000
21	2,2,4-Trimethylpentane	0.183540	0.074329	0.000023	0.257892
22	Benz(a)anthracene	0.000044	0.000075	0.000000	0.000120
23	Benzene	5.657490	2.291140	0.000694	7.949324
24	Acetaldehyde	14.761088	5.977867	0.001811	20.740766
25	Acenaphthene	0.006240	0.010615	0.000004	0.016859
26	Phenanthrene	0.016223	0.027599	0.000011	0.043833
27	Fluorene	0.006240	0.010615	0.000004	0.016859
28	Naphthalene	0.028702	0.048829	0.000019	0.077550

Table 5-74 Summary of Air Toxic Emissions Garden City Terminal With 44-Foot Project – 2030+ (Tons Per Year)

	AIR TOXIC PARAMETER	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	1.174354	0.418960	0.000136	1.593449
2	Styrene	0.225196	0.080340	0.000026	0.305562
3	1,3-Butadiene	0.705196	0.251584	0.000082	0.956861
4	Acrolein	1.148424	0.409709	0.000133	1.558266
5	Toluene	5.669672	2.022699	0.000657	7.693028
6	Hexane	0.602803	0.215055	0.000070	0.817927
7	Anthracene	0.000036	0.000055	0.000000	0.000091
8	Propionaldehyde	4.469976	1.594699	0.000518	6.065192
9	Pyrene	0.000243	0.000369	0.000000	0.000612
10	Xylene	4.008584	1.430093	0.000464	5.439141
11	Benzo(g,h,i)perylene	0.000016	0.000024	0.000000	0.000040
12	Indeno(1,2,3,c,d)pyrene	0.000007	0.000010	0.000000	0.000017
13	Benzo(b)fluoranthene	0.000041	0.000062	0.000000	0.000103
14	Fluoranthene	0.001422	0.002165	0.000001	0.003588
15	Benzo(k)fluoranthene	0.000029	0.000045	0.000000	0.000074
16	Acenaphthylene	0.007026	0.010700	0.000005	0.017731
17	Chrysene	0.000159	0.000242	0.000000	0.000401
18	Formaldehyde	44.758478	15.967933	0.005184	60.731595
19	Benzo(a)pyrene	0.000029	0.000045	0.000000	0.000074
20	Dibenzo(a,h)anthracene	0.000000	0.000000	0.000000	0.000001
21	2,2,4-Trimethylpentane	0.250016	0.089195	0.000029	0.339240
22	Benz(a)anthracene	0.000059	0.000090	0.000000	0.000150
23	Benzene	7.706542	2.749368	0.000893	10.456803
24	Acetaldehyde	20.107317	7.173440	0.002329	27.283086
25	Acenaphthene	0.008365	0.012738	0.000005	0.021108
26	Phenanthrene	0.021749	0.033119	0.000014	0.054881
27	Fluorene	0.008365	0.012738	0.000005	0.021108
28	Naphthalene	0.038478	0.058594	0.000025	0.097098

Table 5-75 Summary of Air Toxic Emissions Garden City Terminal With 46-Foot Project – 2030+ (Tons Per Year)

	AIR TOXIC PARAMETER	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	1.140575	0.418960	0.000132	1.559667
2	Styrene	0.218718	0.080340	0.000025	0.299084
3	1,3-Butadiene	0.684912	0.251584	0.000079	0.936575
4	Acrolein	1.115391	0.409709	0.000129	1.525230
5	Toluene	5.506593	2.022699	0.000638	7.529930
6	Hexane	0.585464	0.215055	0.000068	0.800586
7	Anthracene	0.000035	0.000055	0.000000	0.000090
8	Propionaldehyde	4.341404	1.594699	0.000503	5.936606
9	Pyrene	0.000236	0.000369	0.000000	0.000605
10	Xylene	3.893283	1.430093	0.000451	5.323827
11	Benzo(g,h,i)perylene	0.000015	0.000024	0.000000	0.000040
12	Indeno(1,2,3,c,d)pyrene	0.000006	0.000010	0.000000	0.000016
13	Benzo(b)fluoranthene	0.000040	0.000062	0.000000	0.000102
14	Fluoranthene	0.001381	0.002165	0.000001	0.003547
15	Benzo(k)fluoranthene	0.000028	0.000045	0.000000	0.000073
16	Acenaphthylene	0.006824	0.010700	0.000004	0.017529
17	Chrysene	0.000154	0.000242	0.000000	0.000396
18	Formaldehyde	43.471070	15.967933	0.005035	59.444038
19	Benzo(a)pyrene	0.000028	0.000045	0.000000	0.000073
20	Dibenzo(a,h)anthracene	0.000000	0.000000	0.000000	0.000001
21	2,2,4-Trimethylpentane	0.242824	0.089195	0.000028	0.332047
22	Benz(a)anthracene	0.000058	0.000090	0.000000	0.000148
23	Benzene	7.484875	2.749368	0.000867	10.235111
24	Acetaldehyde	19.528961	7.173440	0.002262	26.704664
25	Acenaphthene	0.008124	0.012738	0.000005	0.020867
26	Phenanthrene	0.021123	0.033119	0.000014	0.054255
27	Fluorene	0.008124	0.012738	0.000005	0.020867
28	Naphthalene	0.037372	0.058594	0.000024	0.095990

Table 5-76 Summary of Air Toxic Emissions Garden City Terminal Wit 47/48-Foot Project -- 2030+ (Tons Per Year)

	AIR TOXIC PARAMETER	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	1.118472	0.418960	0.000132	1.537564
2	Styrene	0.214480	0.080340	0.000025	0.294846
3	1,3-Butadiene	0.671639	0.251584	0.000079	0.923302
4	Acrolein	1.093776	0.409709	0.000129	1.503614
5	Toluene	5.399882	2.022699	0.000636	7.423217
6	Hexane	0.574119	0.215055	0.000068	0.789241
7	Anthracene	0.000034	0.000055	0.000000	0.000089
8	Propionaldehyde	4.257273	1.594699	0.000501	5.852473
9	Pyrene	0.000231	0.000369	0.000000	0.000600
10	Xylene	3.817836	1.430093	0.000449	5.248379
11	Benzo(g,h,i)perylene	0.000015	0.000024	0.000000	0.000039
12	Indeno(1,2,3,c,d)pyrene	0.000006	0.000010	0.000000	0.000016
13	Benzo(b)fluoranthene	0.000039	0.000062	0.000000	0.000101
14	Fluoranthene	0.001354	0.002165	0.000001	0.003520
15	Benzo(k)fluoranthene	0.000028	0.000045	0.000000	0.000072
16	Acenaphthylene	0.006689	0.010700	0.000004	0.017393
17	Chrysene	0.000151	0.000242	0.000000	0.000393
18	Formaldehyde	42.628653	15.967933	0.005019	58.601604
19	Benzo(a)pyrene	0.000028	0.000045	0.000000	0.000072
20	Dibenzo(a,h)anthracene	0.000000	0.000000	0.000000	0.000001
21	2,2,4-Trimethylpentane	0.238119	0.089195	0.000028	0.327342
22	Benz(a)anthracene	0.000057	0.000090	0.000000	0.000147
23	Benzene	7.339827	2.749368	0.000864	10.090060
24	Acetaldehyde	19.150513	7.173440	0.002255	26.326208
25	Acenaphthene	0.007963	0.012738	0.000005	0.020706
26	Phenanthrene	0.020704	0.033119	0.000014	0.053837
27	Fluorene	0.007963	0.012738	0.000005	0.020706
28	Naphthalene	0.036631	0.058594	0.000024	0.095249

5.18 Greenhouse Gases (GHGs)

Green house gases are discussed within the US Environmental Protection Agency, Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories, Final Report, April 2009. The following information was taken from this document (USEPA 2009):

> *Carbon dioxide (CO2), the primary greenhouse gas associated with combustion of diesel (and other fossil fuels), accounted for about 96 percent of the transportation sector's global warming potential-weighted GHG emissions for 2003. Methane (CH4) and nitrous oxide (N2O) together account for about 2 percent of the transportation total GHG emissions in 2003. Both of these gases are released during diesel fuel consumption (although in much smaller quantities than CO2) and are also affected by vehicle emissions control technologies.*

In addition to the GHGs, another climate forcing pollutant of concern is elemental carbon.

On Page 2-16 of EPA 2009, the following information is found for marine diesel engines in OGVs: To estimate CO2 equivalents, CH4 emissions should be multiplied by 21 and N2O emissions should be multiplied by 310. Therefore, to estimate CH4 and N20, CO2 should be divided by 21 and 310, respectively. Since C02 =CH4 X 21 and CO2=N20 X 310. **CH4=CO2 / 21 and N20 = CO2 / 310.**

On Page 3-11 of EPA 2009, the following information is found for diesel commercial marine vessels: In addition to the greenhouse gas emission factors discussed above, it is possible to estimate elemental carbon emission factors from EPA's SPECIATE4 model for emissions of PM2.5. For diesel harbor craft, the diesel commercial marine vessel (SCC 2280002000) sector is appropriate. That sector is assigned an emission fraction of 77.12% elemental carbon. That is: EFEC = 77.12% x 97% x EFPM10 after adjusting the PM10 emission factor for fuel sulfur. **Elemental Carbon equals .7712 X 0.97 X PM10 implies that Carbon = 0.7712 * 0.97 * PM10**

The Corps estimated the GHGs for all marine diesel vessels within the 22 terminals in the Port of Savannah for all depths. Marine diesel vessels include OGVs, LNGs, tourist boats, tugs, shifts, pipeline and hopper dredges, etc. **The reason CO2 emissions are greater in 2016 compared to 2020 is because the harbor deepening is a one-time action and is completed in 2016.** Table 5-77 provides this GHGs information.

Table 5-77
Estimated Greenhouse Gases for All Vessels and All Depths

42-Foot Depth					
Year	**# of Vessels**	**CO_2**	**N_20**	**CH_4**	**Carbon**
2008	**2,724**	131993.04	425.78	6285.38	130.42
2016	**4,146**	200896.90	648.05	9566.52	198.50
2020	**4,713**	228371.23	736.68	10874.82	225.65
2025	**5,886**	285209.64	920.03	13581.41	281.81
2030	**7,205**	349122.57	1126.20	16624.88	344.96
2066	**7,205**	349122.57	1126.20	16624.88	344.96

44-Foot Depth					
Year	**# of Vessels**	**CO_2**	**N_20**	**CH_4**	**Carbon**
2008	**NA**	NA	NA	NA	NA
2016	**4,034**	268274.58	865.40	12774.98	107.61
2020	**4,508**	243821.57	786.52	11610.55	102.16
2025	**5,601**	300310.63	968.74	14300.51	122.02
2030	**6,833**	371372.78	1197.98	17684.42	146.23
2066	**6,833**	371372.78	1197.98	17684.42	146.23

45-Foot Depth					
Year	**# of Vessels**	**CO_2**	**N_20**	**CH_4**	**Carbon**
2008	**NA**	NA	NA	NA	NA
2016	**4,010**	266678.50	860.25	12698.98	106.97
2020	**4,469**	241712.20	779.72	11510.10	101.27
2025	**5,549**	297522.53	959.75	14167.74	120.89
2030	**6,760**	367405.24	1185.18	17495.49	144.67
2066	**6,760**	367405.24	1185.18	17495.49	144.67

46-Foot Depth					
Year	**# of Vessels**	**CO_2**	**N_20**	**CH_4**	**Carbon**
2008	**NA**	NA	NA	NA	NA
2016	**3,998**	265880.46	857.68	12660.97	106.65
2020	**4,451**	240738.65	776.58	11463.75	100.87
2025	**5,522**	296074.86	955.08	14098.80	120.30
2030	**6,726**	365557.34	1179.22	17407.49	143.94
2066	**6,726**	365557.34	1179.22	17407.49	143.94

47-Foot Depth					
Year	**# of Vessels**	**CO_2**	**N_20**	**CH_4**	**Carbon**
2008	NA	NA	NA	NA	NA
2016	3,994	265614.45	856.82	12648.31	106.54
2020	4,442	240251.87	775.01	11440.57	100.66
2025	5,511	295485.07	953.18	14070.72	120.06
2030	6,714	364905.15	1177.11	17376.44	143.68
2066	6,714	364905.15	1177.11	17376.44	143.68

48-Foot Depth					
Year	**# of Vessels**	**CO_2**	**N_20**	**CH_4**	**Carbon**
2008	NA	NA	NA	NA	NA
2016	3,994	265614.45	856.82	12648.31	106.54
2020	4,442	240251.87	775.01	11440.57	100.66
2025	5,511	295485.07	953.18	14070.72	120.06
2030	6,714	364905.15	1177.11	17376.44	143.68
2066	6,714	364905.15	1177.11	17376.44	143.68

5.19 Total Port Emissions

The District calculated air emissions from 13 different sources that are directly associated with operations of the harbor. This includes emissions from both GPA and private terminals in the Port. It also includes the vessels which call at the port, the tugs which assist those vessels, the landside equipment that moves the cargo on the terminals, ancillary vessels which operate in the harbor (dredges and tourist boats), and equipment used to move containers out of the harbor area.

The Economic Analysis predicts continued growth in the volume of containerized cargoes moving through the Port of Savannah in the future until the Garden City Terminal reaches is build-out capacity. The growth projections vary by year, trade route, and whether the cargo is an import or export. Based on those projections, the Corps expects a larger number of container vessels to call at Savannah in the future without a harbor deepening. This growth would be caused primarily by market forces outside the influence of the port itself, so growth would occur independent of a harbor deepening. These projections are described in detail in the GRR-Economic Appendix. As a general summary, the Corps expects a long term growth of roughly 3 percent per year in cargoes that are transported through the port as containers. No additional cargoes would move through the Garden City Terminal once the site reaches its build-out capacity. Based on the detailed growth rates, the Economic Analysis predicts different container fleets in the future years. Those fleets are summarized and found in Section 4.0 of this document.

Under both the Without- and With-Project conditions, the District expects the Garden City Terminal to reach its build-out capacity in 2030 when the total number of TEUs processed reaches 6.5 million. No increase in cargo is expected to occur as a result of the proposed harbor deepening. The project’s economic benefits accrue from the use of larger, more cost-effective container ships, not an increase in the number of containers.

The Corps calculated air emissions for the expected future fleets of vessels expected to call at the Port and their associated landside equipment. The District used a conservative assumption that the landside equipment would grow at the same rate as the cargo volume. This assumption is conservative for this air emission inventory because it does not take into account any improvements in cargo handling efficiency that may occur in the future. Growth in such efficiency has been commonly observed in the past and is expected to continue to occur at Savannah, but the ability to predict its amount and timing are quite difficult.

Container traffic has dominated the movement of ocean cargo over the past 20 years. There is nothing to indicate that such dominance is likely to change in the foreseeable future. The Corps believes that movement of other cargoes through Savannah would also continue to grow in volume in the future. The District calculated air emissions for non-containerized cargoes assuming a 1 percent annual growth rate in those commodities. That same growth rate was applied to the associated landside equipment. The Corps included a 1 percent annual growth rate for the use of Tourist Boats in the harbor, and their resulting air emissions. The number of vessel shifts is also projected to increase by 1 percent per year. Using those projections, Table 5-78 on the following page shows the air emissions calculated for all vessels arriving/departing at the Georgia Ports Authority (Garden City and Ocean Terminals) and the 20 non-GPA terminals for the baseline (2008), 2016, 2020, 2025, 2030 and 2066. The number of OGVs calls (found in column 2 of Table 5-78) were doubled since each vessel included in-bound, docking, hotelling, undocking and out-bound emissions. Moreover, the emissions are the same for all depths from 2030 to the end of the project life in 2066. The reason is that the port reaches its capacity near 2030 of 6.5 million TEUs. The fleet forecast in Table 4-3 and in Attachment A, reflects this matter. The emissions would be the same for both the 47- and 48-foot depth alternatives because the vessel fleets are expected to be the same for both of those alternatives. With the same number and size of vessels, their air emissions would be the same. The bottom of the table 5-78 provides summaries of the air emissions in 2008, 2016, Total Without Project (50 years), Total With 48-foot Project (50 years), and during construction of a 48-foot deepening project.

Table 5-78
Summary Of All Pollutants (Tons/Year) For All 22 Terminals
Includes All Vessels And All Land-Based Emissions

BASELINE: Depth -42 feet									
Year	**# of Vessels**	**HC**	**VOC**	**CO**	**NOx**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**CO_2**
2008	**2,724**	348.34	352.54	1,394.06	5,042.24	229.76	216.14	1,177.49	258,153.99
2016	**4,146**	566.82	578.86	2,041.34	7,500.77	235.87	223.90	503.08	446,818.70
2020	**4,713**	663.09	670.16	2,130.17	6,238.08	247.18	233.98	509.67	461,222.15
2025	**5,886**	806.26	814.83	2,517.67	6,202.50	295.26	279.18	584.43	561,166.22
2030	**7,205**	991.74	1,002.19	2,988.15	6,396.84	353.36	333.77	671.22	684,375.12
2066	**7,205**	991.74	1,002.19	2,988.15	6,396.84	353.36	333.77	671.22	684,375.12

Depth -44 feet									
Year	**# of Vessels**	**HC**	**VOC**	**CO**	**NOx**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**CO_2**
2008	**NA**	NA	NA	NA	NA	NA	NA	NA	NA
2016	**4,034**	553.48	565.30	1,995.12	7,307.59	229.64	218.01	499.05	432,777.09
2020	**4,508**	634.79	641.41	2,036.09	5,914.58	234.59	222.06	501.57	432,816.48
2025	**5,601**	768.34	776.33	2,393.41	5,844.31	278.64	263.47	573.32	523,452.89
2030	**6,833**	941.26	950.95	2,827.68	5,995.87	331.97	313.55	656.38	635,509.88
2066	**6,833**	941.26	950.95	2,827.68	5,995.87	331.97	313.55	656.38	635,509.88

Depth -45 feet									
Year	**# of Vessels**	**HC**	**VOC**	**CO**	**NOx**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**CO_2**
2008	**NA**	NA	NA	NA	NA	NA	NA	NA	NA
2016	**4,010**	550.62	562.40	1,985.22	7,266.19	228.31	216.75	498.18	429,768.18
2020	**4,469**	629.40	635.94	2,018.19	5,853.03	232.20	219.79	500.03	427,412.47
2025	**5,549**	761.42	769.30	2,370.74	5,778.96	275.61	260.60	571.30	516,571.86
2030	**6,760**	931.35	940.90	2,796.19	5,917.19	327.77	309.58	653.47	625,920.74
2066	**6,760**	931.35	940.90	2,796.19	5,917.19	327.77	309.58	653.47	625,920.74

Depth -46 feet									
Year	**# of Vessels**	**HC**	**VOC**	**CO**	**NOx**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**CO_2**
2008	**NA**	NA	NA	NA	NA	NA	NA	NA	NA
2016	**3,998**	549.20	560.95	1,980.27	7,245.50	227.64	216.12	497.75	428,263.72
2020	**4,451**	626.92	633.42	2,009.93	5,824.63	231.09	218.75	499.32	424,918.31
2025	**5,522**	757.83	765.65	2,358.97	5,745.02	274.04	259.11	570.25	512,999.02
2030	**6,726**	926.74	936.21	2,781.52	5,880.54	325.82	307.74	652.11	621,454.56
2066	**6,726**	926.74	936.21	2,781.52	5,880.54	325.82	307.74	652.11	621,454.56

Depth -47 feet									
Year	**# of Vessels**	**HC**	**VOC**	**CO**	**NOx**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**CO_2**
2008	**NA**	NA	NA	NA	NA	NA	NA	NA	NA
2016	**3,994**	548.72	560.46	1,978.62	7,238.60	227.42	215.90	497.60	427,762.23
2020	**4,442**	625.68	632.16	2,005.80	5,810.42	230.54	218.22	498.97	423,671.23
2025	**5,511**	756.36	764.17	2,354.17	5,731.20	273.40	258.50	569.82	511,543.41
2030	**6,714**	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26
2066	**6,714**	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26

Depth -48 feet									
Year	**# of Vessels**	**HC**	**VOC**	**CO**	**NOx**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**CO_2**
2008	**NA**	NA	NA	NA	NA	NA	NA	NA	NA
2016	**3,994**	548.72	560.46	1,978.62	7,238.60	227.42	215.90	497.60	427,762.23
2020	**4,442**	625.68	632.16	2,005.80	5,810.42	230.54	218.22	498.97	423,671.23
2025	**5,511**	756.36	764.17	2,354.17	5,731.20	273.40	258.50	569.82	511,543.41
2030	**6,714**	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26
2066	**6,714**	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26

SUMMARY								
Year	**HC**	**VOC**	**CO**	**NOx**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**CO_2**
2008	348.34	352.54	1,394.06	5,042.24	229.76	216.14	1,177.49	258,153.99
2016	566.82	578.86	2,041.34	7,500.77	235.87	223.90	503.08	446,818.70
Without Project (50-Year Period of Analysis)	21,100	21,321	65,964	165,322	7,647	7,234	15,208	14,308,936
With 47/48-foot Project (50-Year Period of Analysis)	20,269	20,477	63,209	157,894	7,277	6,884	14,984	13,480,470
Harbor Deepening	70	70	671	3,495	81	78	214	181,442

The calculated emissions for 2030 and 2066 are likely to represent "worst case" conditions, because they do not include factors which are expected to reduce air emissions in the future. Those factors include (1) shifts to cleaner fuels, as mandated by EPA, (2) shifts to more containers being moved by rail, rather than by truck, (3) shifts to gas and electric power for landside equipment at the terminal, and (4) increases in cargo handling efficiency at the port.

Since the Corps' expectation is that a change in harbor depth in Savannah of up to 6 feet would not provide sufficient rationale for vessel lines to alter their trade routes, the amount of cargo entering the port With and Without the proposed harbor deepening would remain the same. Therefore, no changes in air emissions at the port would be expected to occur as a result of any of the proposed deepening alternatives. A growth in cargo movements and accompanying air emissions is expected in the future over time in Savannah, but those increases would be the result of increasing demand for the goods which move through the port and not a result of a harbor deepening.

6.0 ANALYSIS

The objective of this Air Inventory and Assessment was to more thoroughly evaluate the air impacts expected from the proposed harbor deepening. Additional sources were included that provided a better understanding of the air emissions resulting from normal operations within the port. A total of 13 sources of emissions were evaluated, consisting of the following:

Containerships	GPA Cargo Handling Equipment	Tourist Boats	Maintenance Dredging
Non-Container Vessels	Landside Equipment at Non-GPA Terminals	Liquefied Natural Gas Vessel Operations	Dredging During Deepening
Tugs	GPA Fleet Vehicles	Locomotives	Tractor Trailers
Intra-Harbor Shifts			

The inventory identified the air emissions from those various sources. The calculated emission tonnages were shown in the previous section (Total Port Emissions). The various contributions from the different sources are discussed in the remainder of this section. The figure below shows that the largest sources of air pollutants in 2008 were the operations that directly support the deep-draft vessels that call at the port (Figure 6-1). Included in those categories are emissions from the vessels and the land-side operations required to handle their cargoes. The category of "Other Terminals" includes GPA's Ocean Terminal and the 20 privately-owned terminals located along the river. The Liquefied Natural Gas vessels and their supporting operations comprise the third largest source of air emissions in the port. The air emissions expected for 2016, the base year of the project are also shown. Figure 6-2 illustrates total port emissions in 2016 with the existing channel depth. Figure 6-3 shows total port emissions in 2016 with a 47/48-foot channel deepening. The effects of harbor deepening on air emissions are generally not readily apparent. The effects of the construction to deepen the harbor are shown in the figure to show their relationship to emissions from other sources at that time. As stated previously, since no increase in the number of container ships that call on the port are expected to occur as a result of a harbor deepening, air emissions in the Port are also not expected to increase on a long term basis as a result of a harbor deepening project.

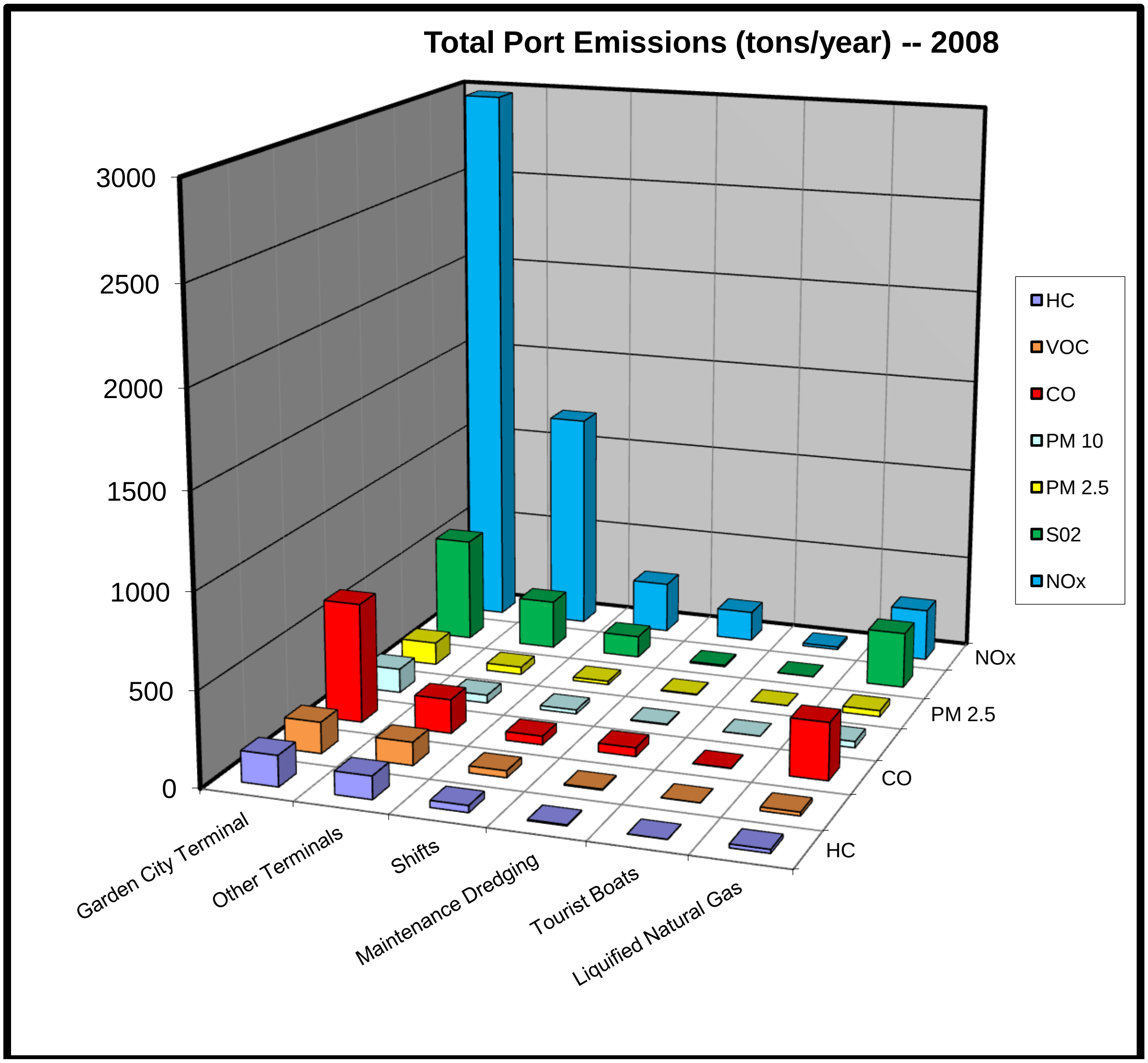

Figure 6-1. Port of Savannah - 2008 air emissions by source at existing -42 foot depth.

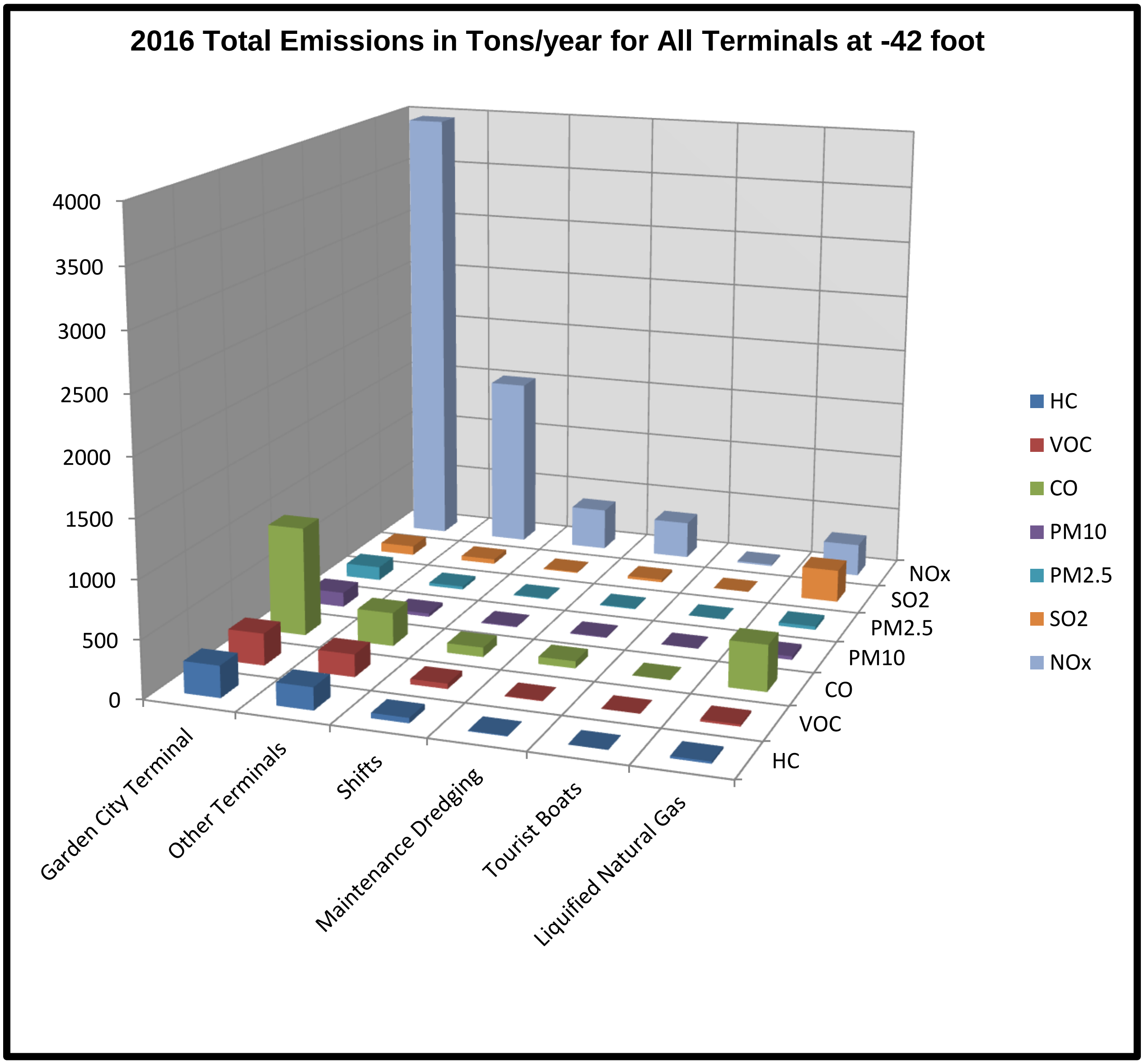

Figure 6-2. Port of Savannah - 2016 air emissions by source at existing -42 foot depth.

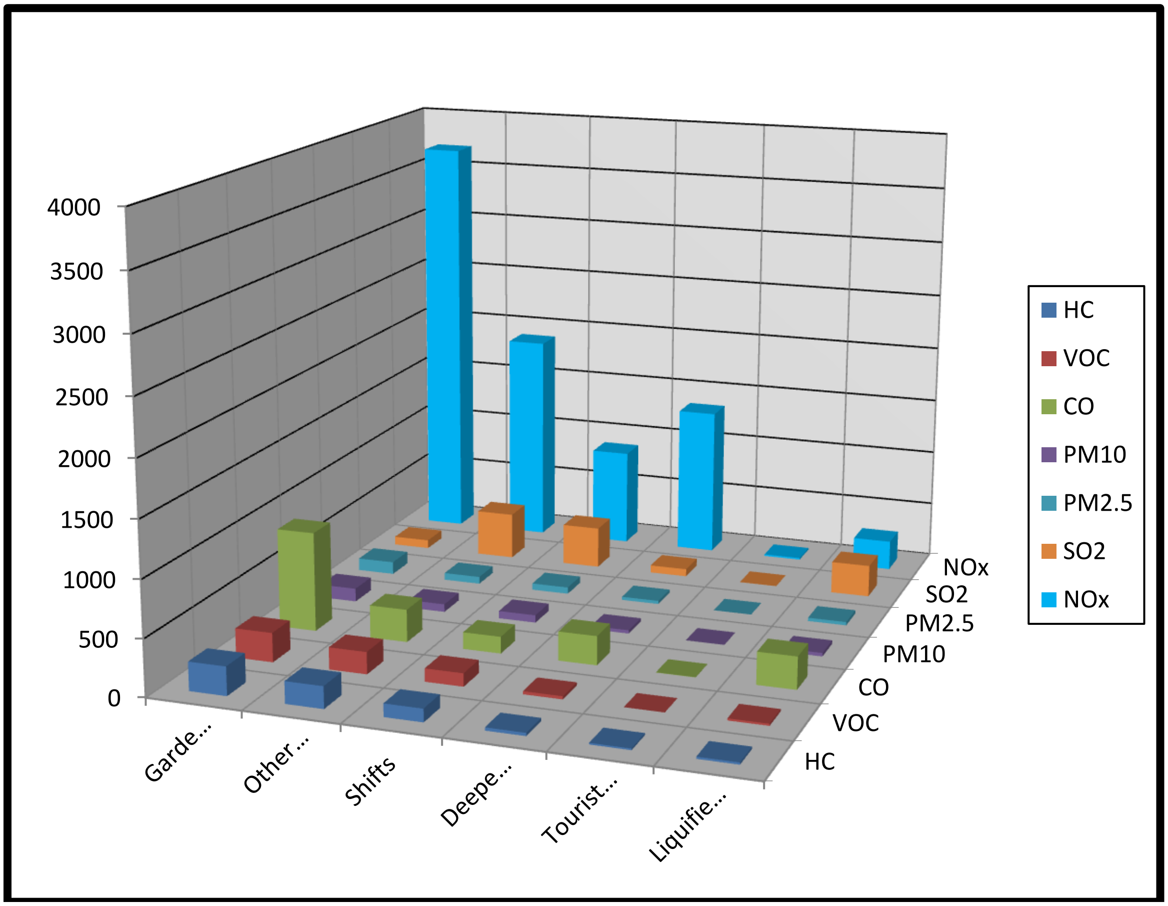

Figure 6-3. Port of Savannah - 2016 air emissions by source with 47/48-foot deepening project (assumes 3-year construction period*) (emissions in tons).

The effects of harbor deepening on air emissions are more apparent when comparing Figures 6-4 and 6-5, which show emissions in 2030/2066 With and Without a 47/48-foot harbor deepening.

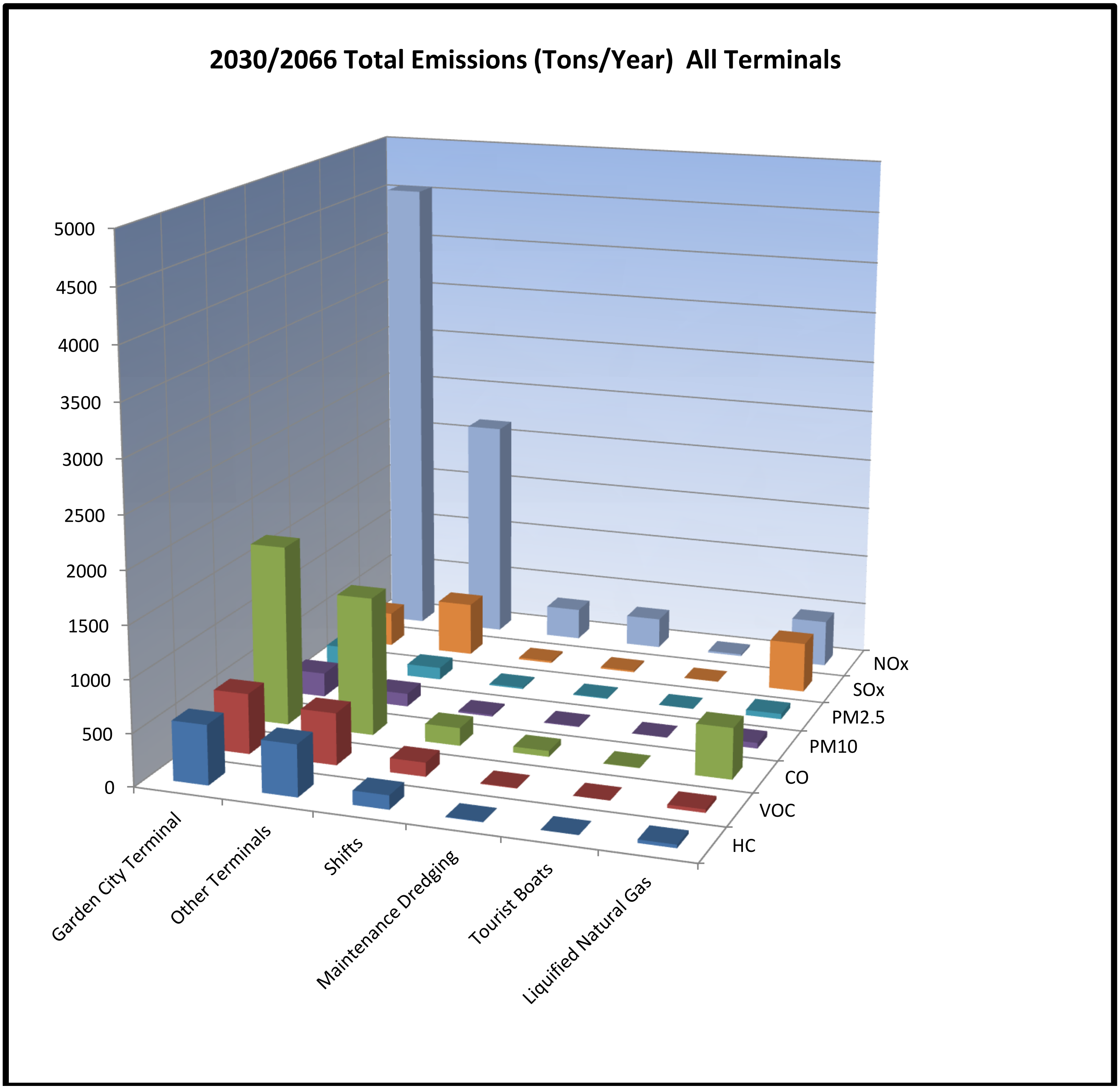

Figure 6-4. Port of Savannah – 2030/2066 air emissions by source all 22 terminals -42 foot depth (No Action Alternative).

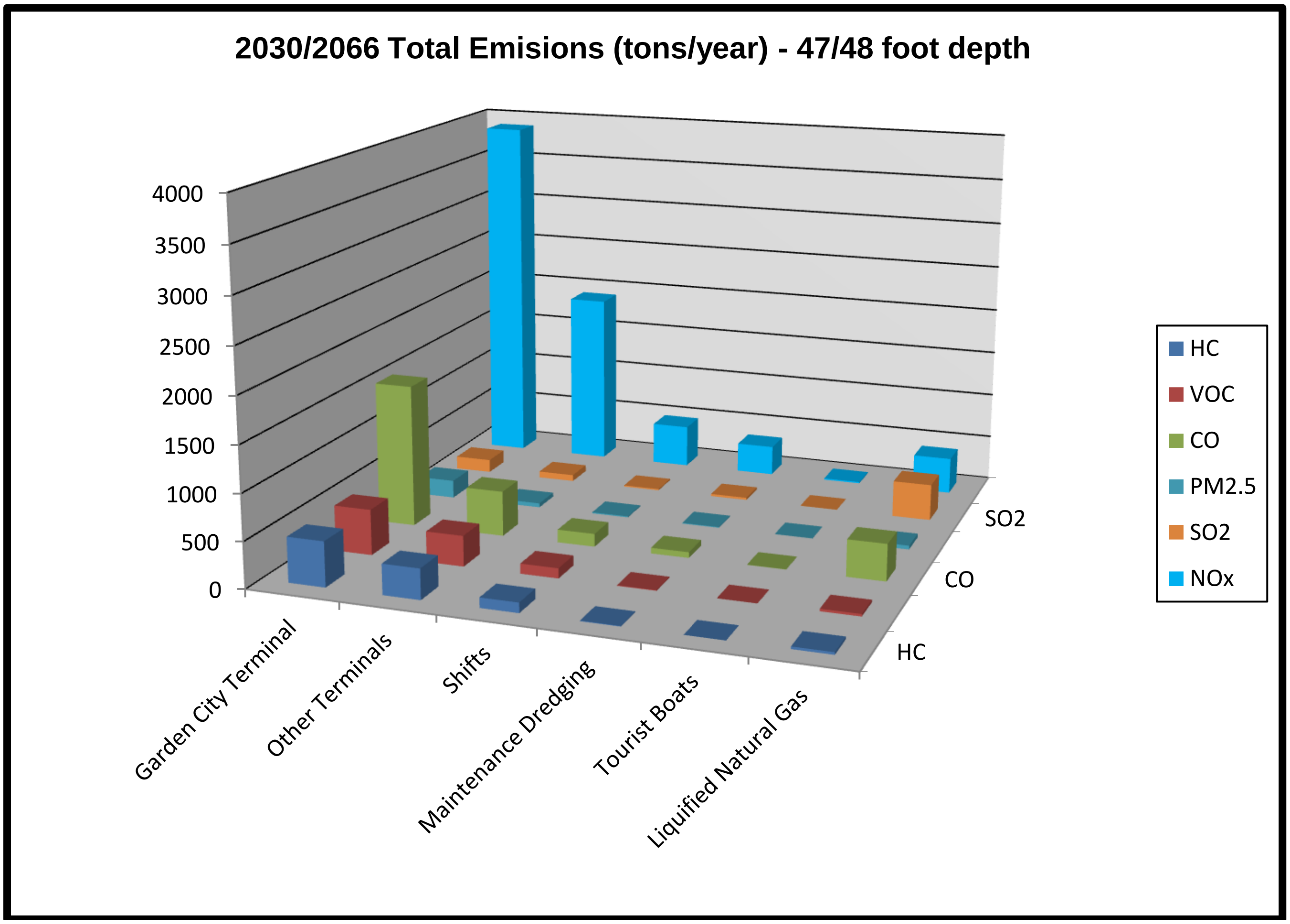

Figure 6-5. Port of Savannah – 2030/2066 air emissions by source for all 22 terminals with 47/48-foot deepening project.

Emissions By Vessel Type

Figure 6-6 and Figure 6-7 shows the air emissions from the various types of deep-draft vessels that call at the harbor. The vessel types are shown, as are the priority pollutants.

The figures show that Container vessels are the source of the most emissions, but that would be expected since more Container vessels call at the port than any other type of vessel. NOx is emitted in the largest quantity by all the vessel types. SO2 is the pollutant emitted in the second largest quantity. Tanker vessels produce the second largest amount of pollutants. When viewed on a per ship basis, Tankers followed by RO/RO vessels release more of the following pollutants than the other vessel types: NOx, HC, VOC, CO, PM10, PM2.5, and SO2. RO/RO vessels produce more NOx on a per transit basis than all other vessel types.

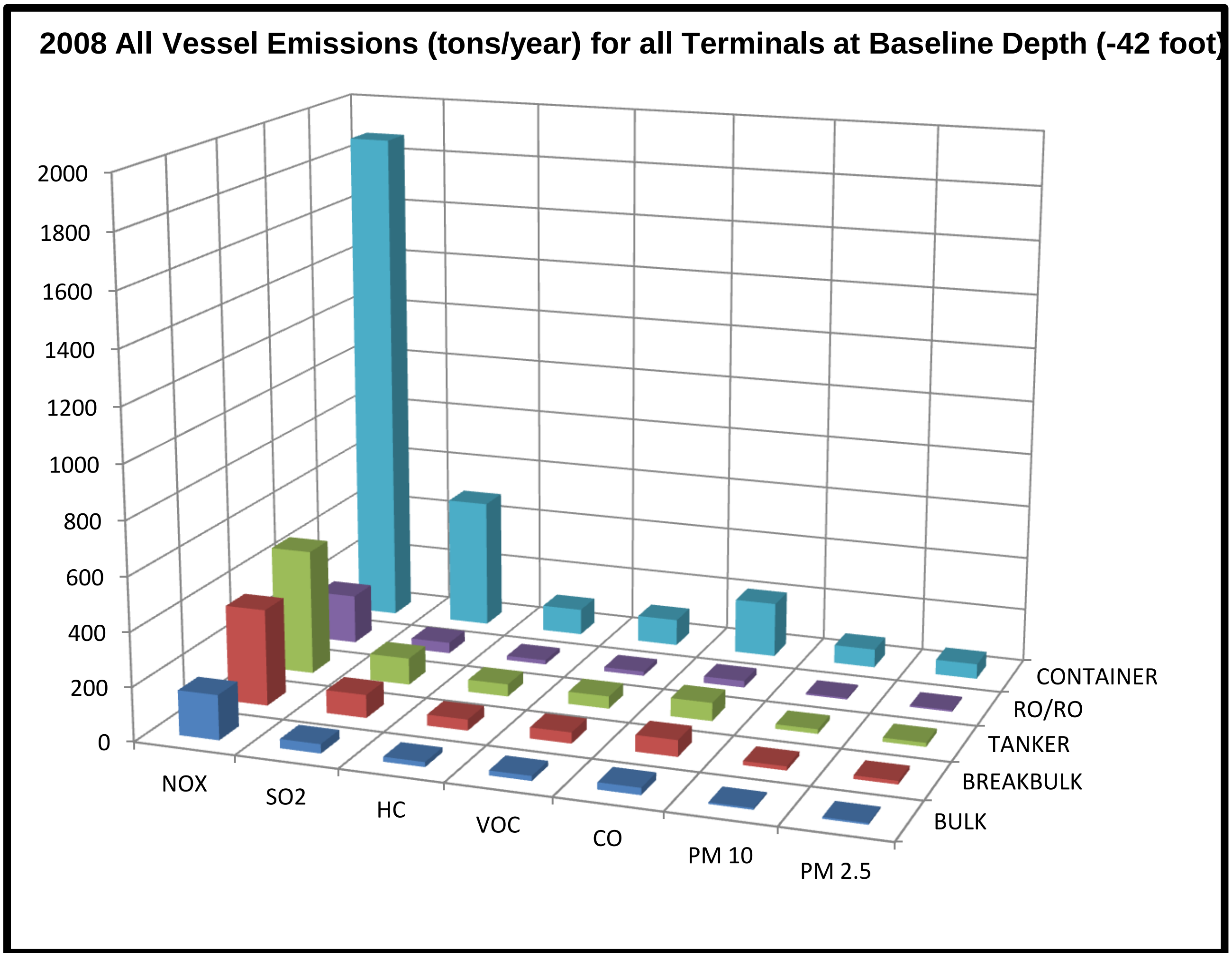

Figure 6-6. Vessel emissions by vessel type – 2008 existing depth of -42 feet.

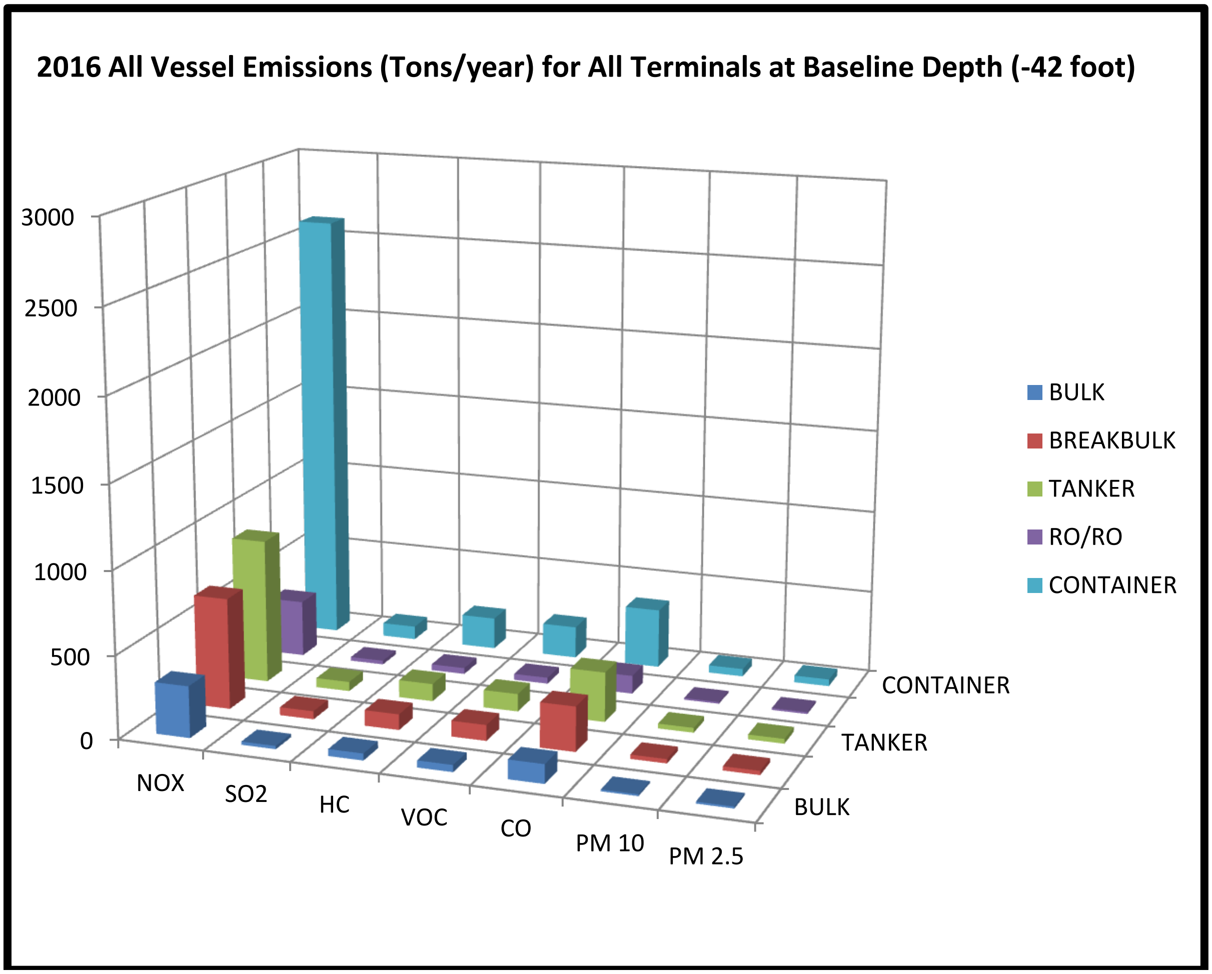

Figure 6-7. Emissions by vessel type – 2016 existing depth of -42 feet.

Figure 6-8 shows the air emissions that would occur from the various types of deep-draft vessels that call at the harbor in 2016 if a 47/48-foot deepening project is implemented.

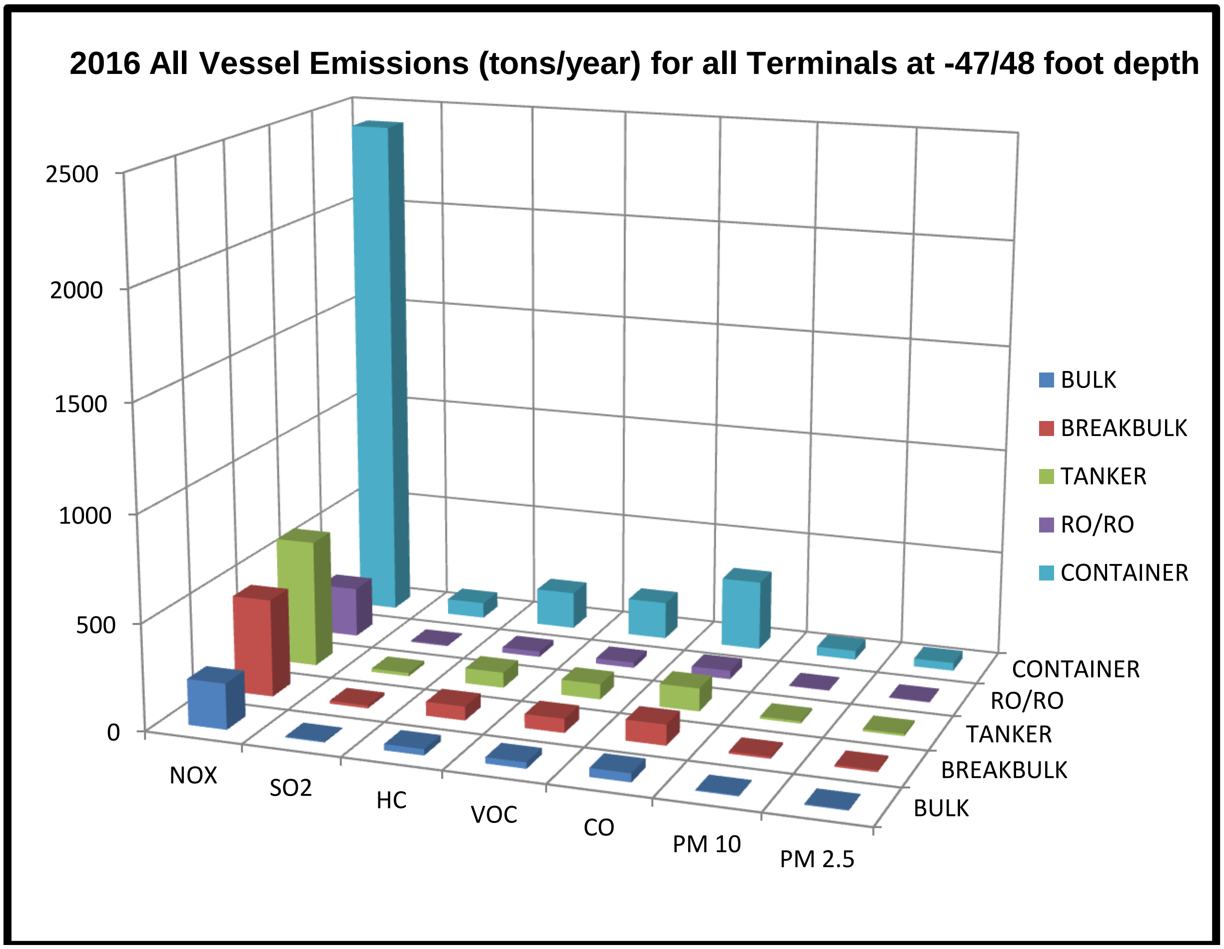

Figure 6-8. Emissions by vessel type – 2016 with 47/48-foot deepening project.

Figure 6-9 and 6-10 show the air emissions that would occur from the various types of deep-draft vessels that call at the harbor in 2025. The reduction in emissions resulting from the harbor deepening (when compared to the without project condition) is more evident than in 2016 because of the greater reduction in the number of vessels that would have called at the port in that year to handle the same volume of cargo.

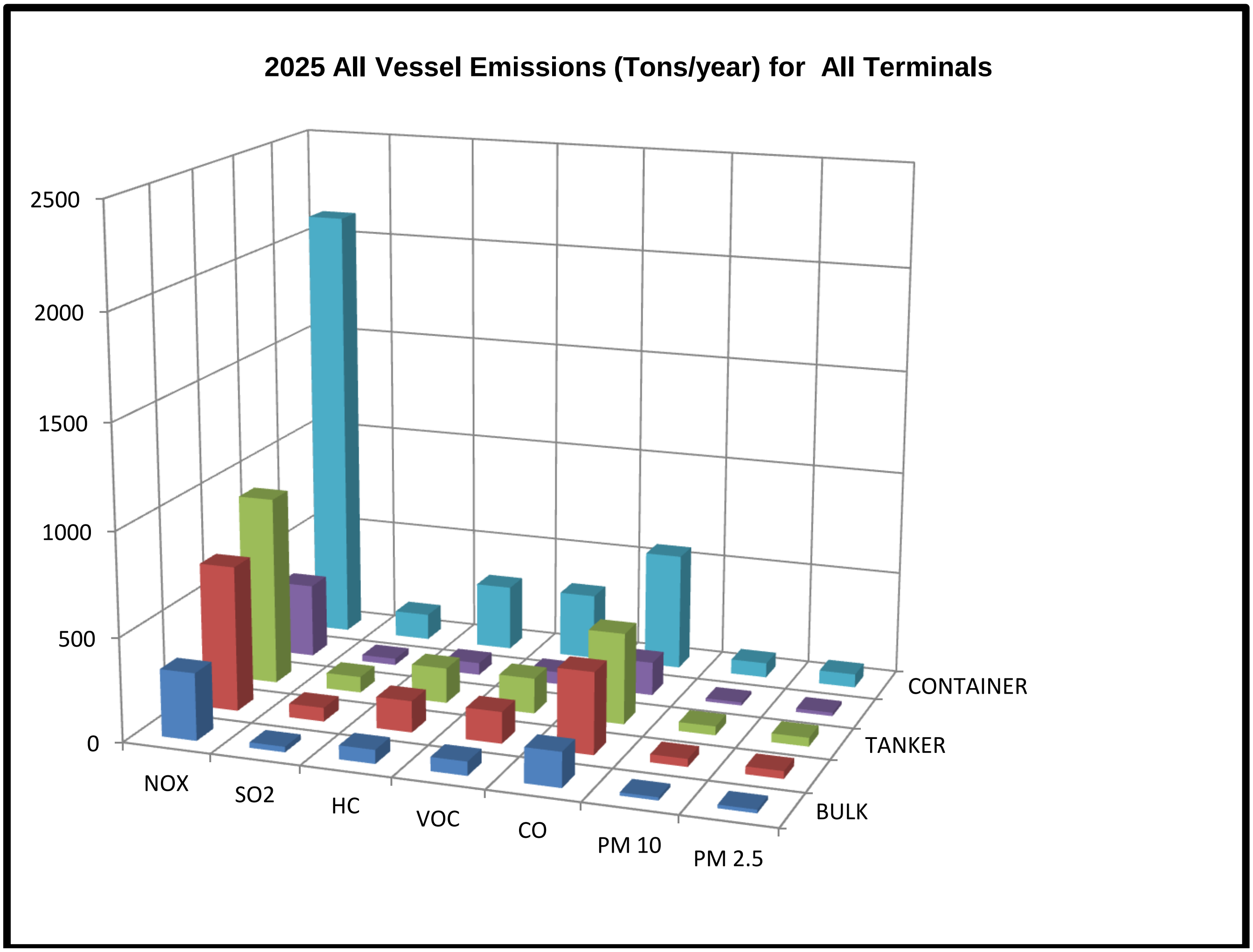

Figure 6-9. Emissions by vessel type – 2025 all terminals baseline depth (42-foot).

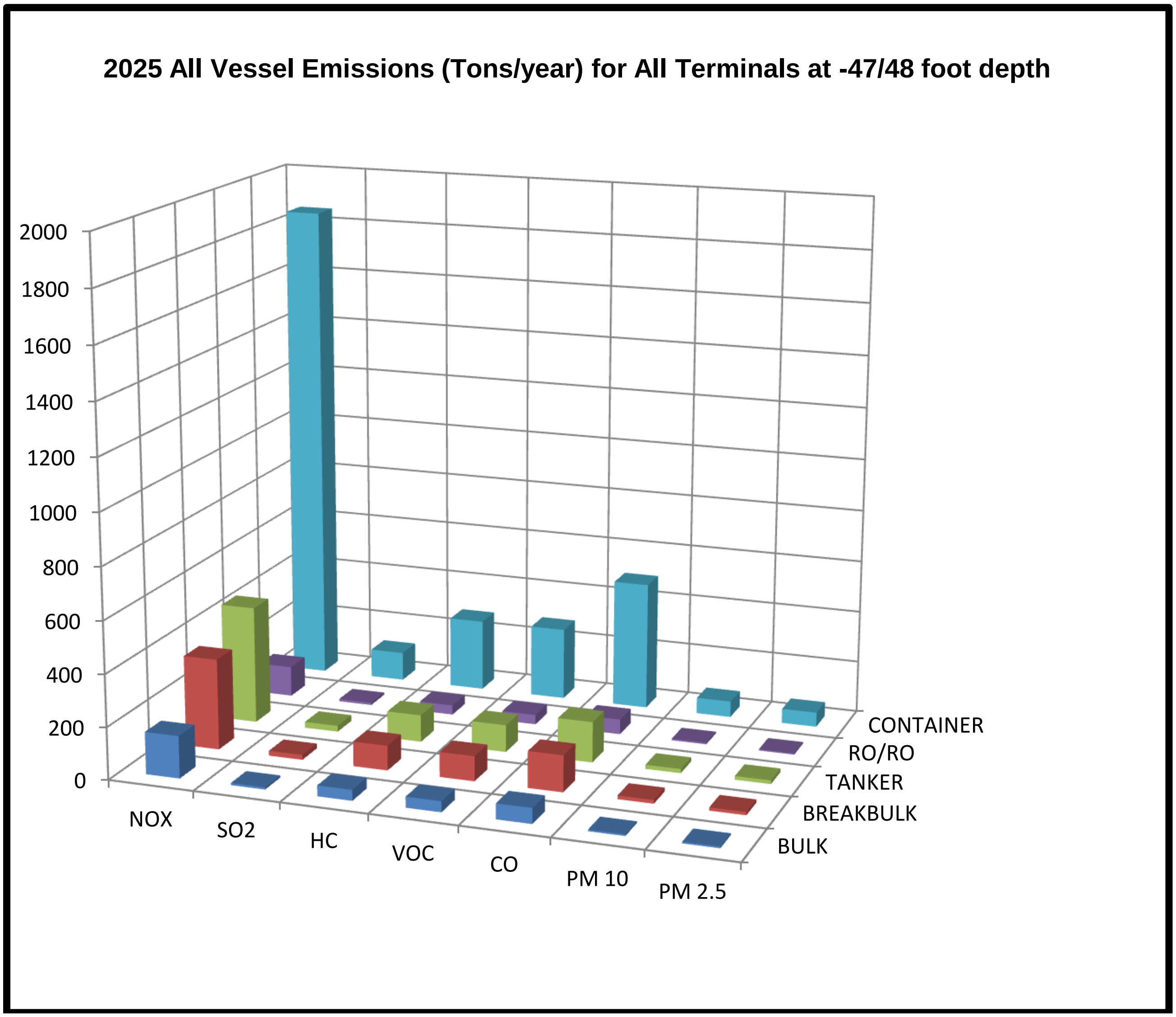

Figure 6-10. Emissions by vessel type – 2025 all terminals 47/48-foot depth.

Emissions at Garden City Terminal

The chart below shows the total air emissions associated with operations of the Garden City Terminal. The chart shows that Ocean-Going Vessels are the source of the most emissions and that NOx and SO2 are released in the largest quantity.

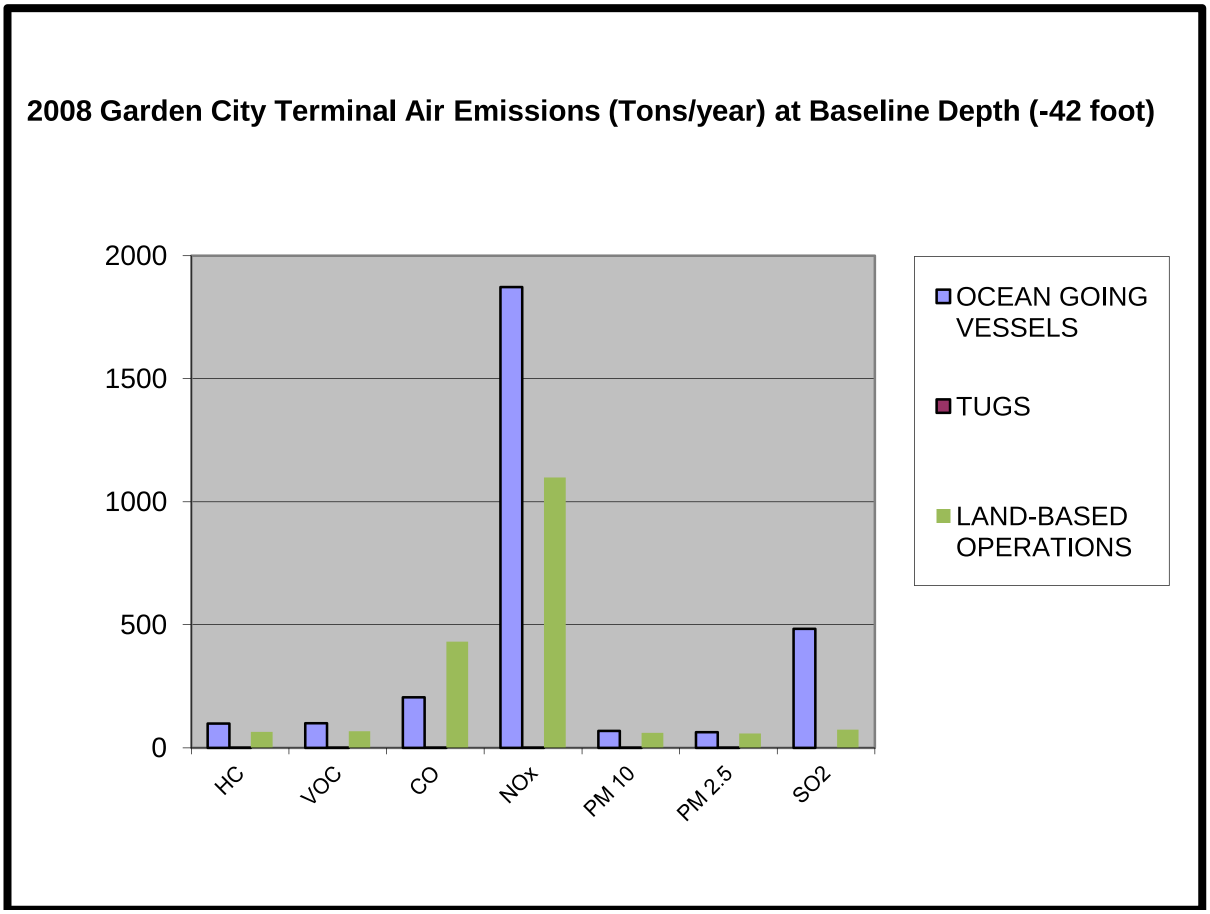

Figure 6-11. Emissions at Garden City Terminal – 2008 existing depth of -42 feet.

The following figure shows the same information for the Base Year of 2016 with the existing channel depth. The same general patterns are evident as in the previous figure, but the total quantity of emissions is expected to be higher as a result of the growth in containerized cargo volumes between 2008 and 2016.

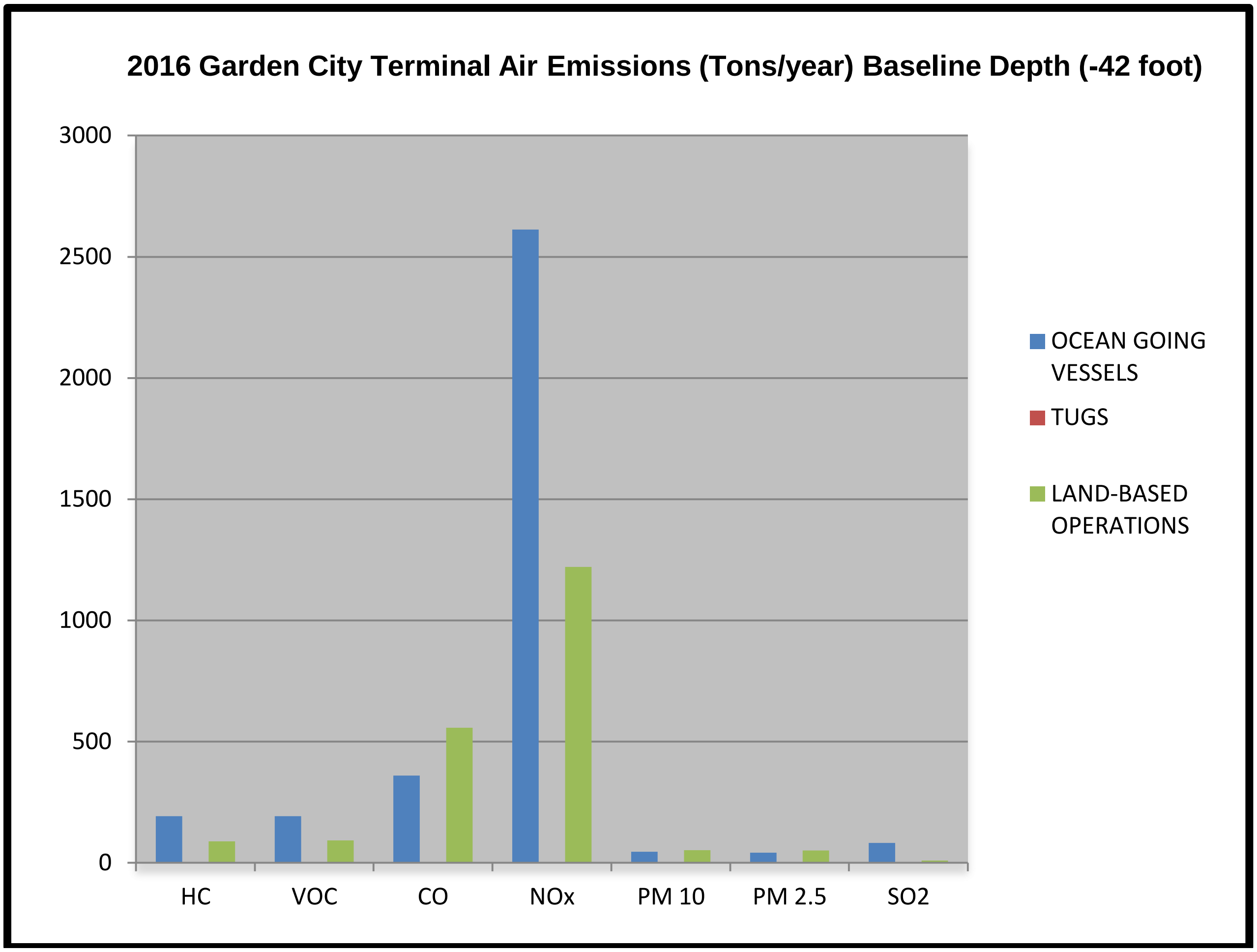

Figure 6-12. Emissions at Garden City Terminal – 2016 base year. Existing depth of -42 feet.

The following figure shows the same information for the Base Year of 2016 with a 47-48 foot harbor deepening. The minimal reduction in emissions with the deeper channel is not evident. The reduction becomes more noticeable over time as the fleet is projected to increase to handle the larger volumes of cargo expected With or Without a deepening project.

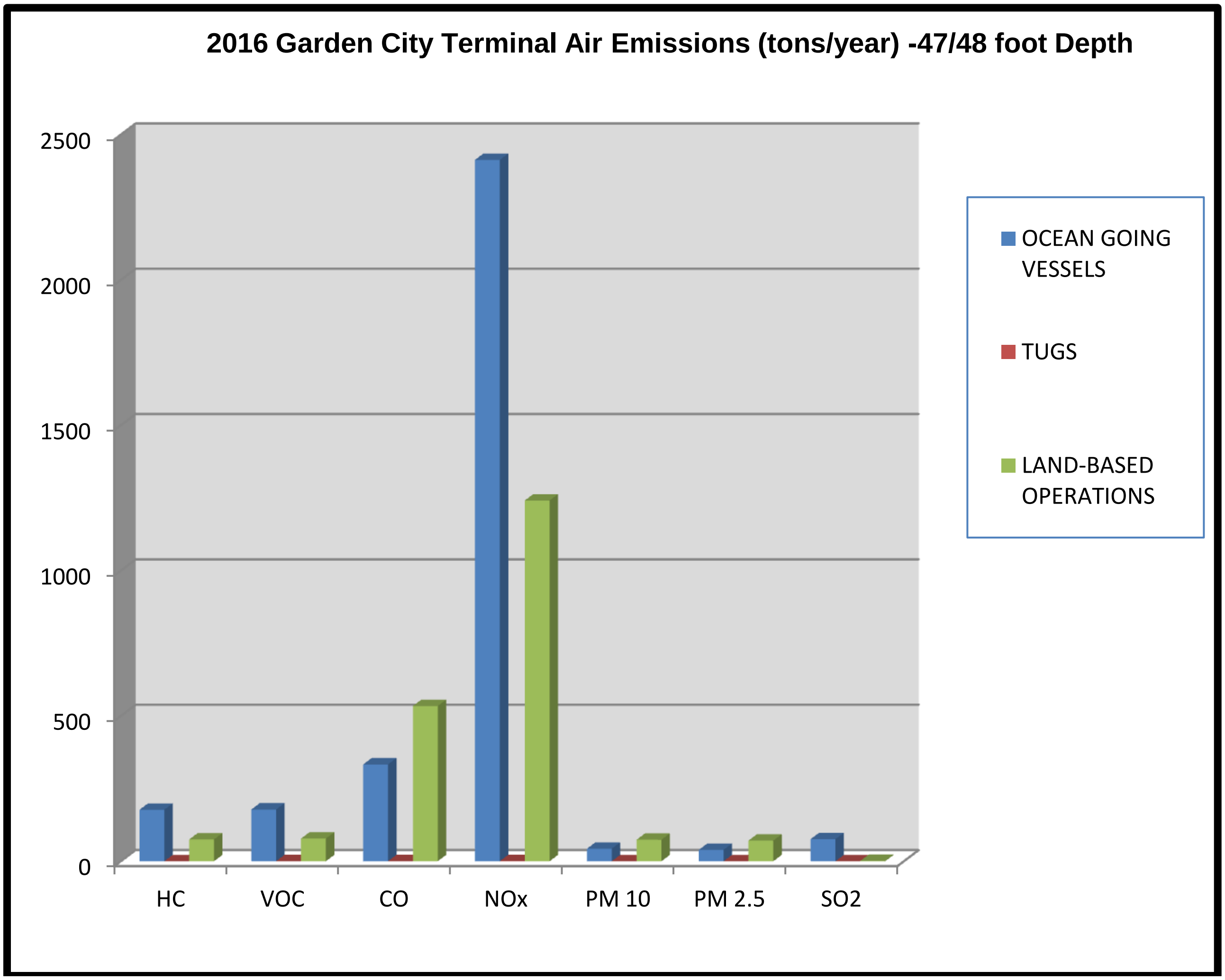

Figure 6-13. Emissions at Garden City Terminal – 2016 with 47/48-foot deepening project.

The SO_2 and NOx emissions from Cargo Handling Equipment (CHE) at GPA's Garden City Terminal are shown in Figures 6-14 and 6-15. Figure 6-14 shows a decline in SO_2 emissions from 2008 to 2016. That is the result of the EPA's requirements for use of cleaner fuels. The emissions would gradually increase from 2016 as the result of additional cargo being handled at the Garden City Terminal. The emissions would level off after year 2030 because the Garden City Terminal is expected to reach its full capacity at that time. Figure 6-15 shows the difference in SO_2 emissions at various points in time with a 47/48 foot harbor deepening. The figure shows a slight reduction would occur in SO_2 emissions if the harbor is deepened. The reduced emissions reflect the lower number of container ships that would call in a given year with a deeper harbor.

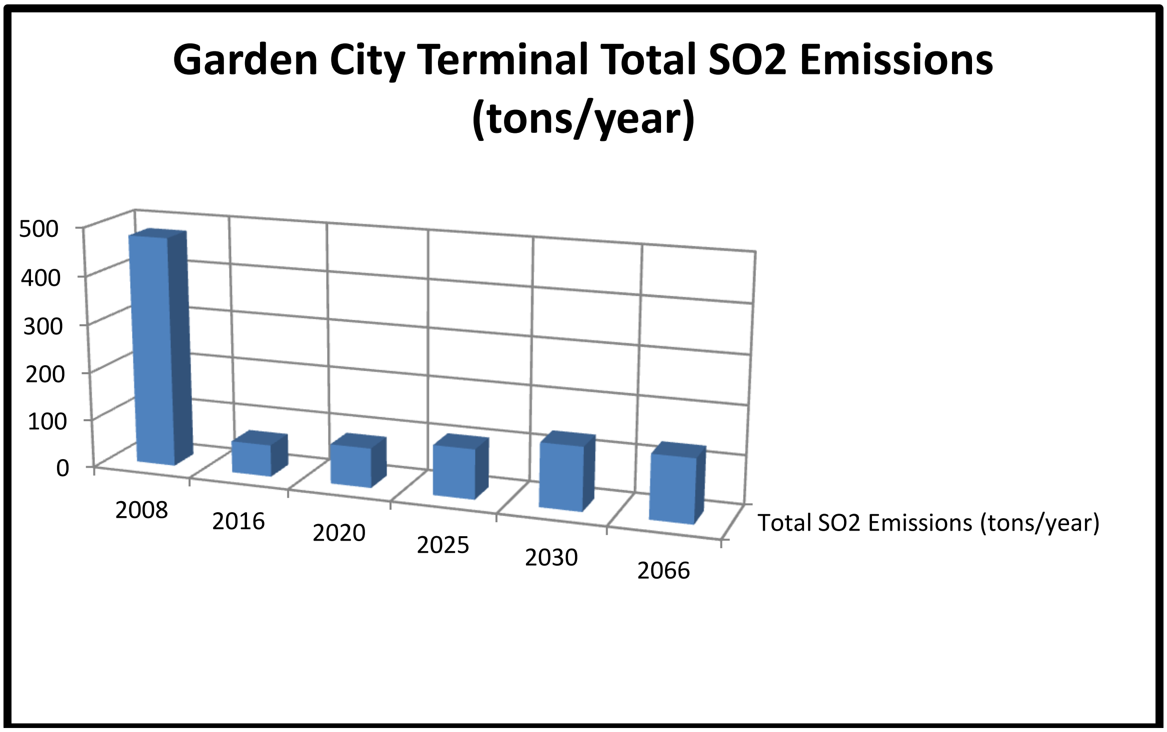

Figure 6-14. Garden City Terminal SO2 emissions.

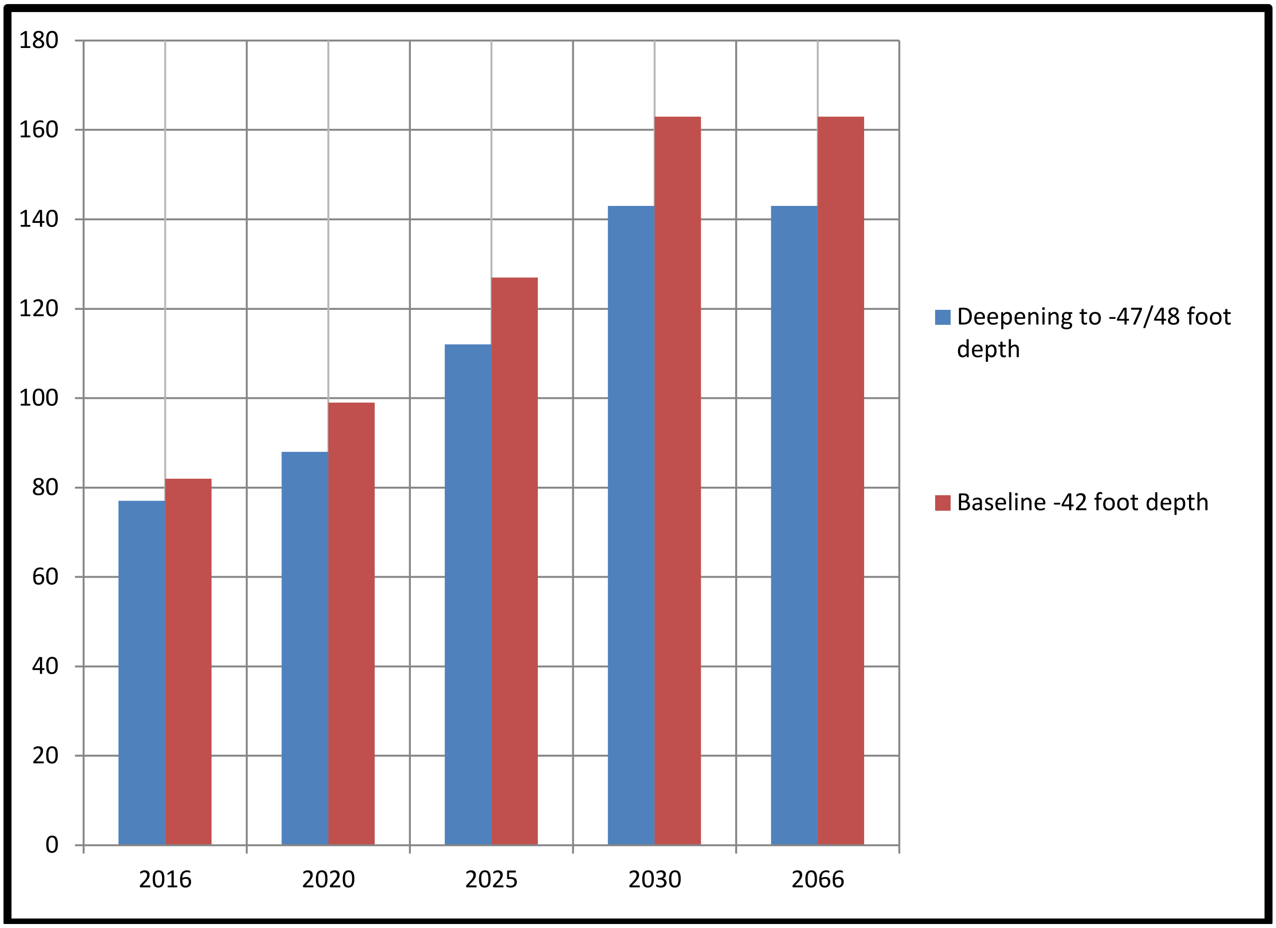

Figure 6-15. Garden City Terminal SO2 emissions (Tons/Year).

For the Garden City Terminal, the air emissions from the Land-Based Operations are shown in Figures 6-16 and 6-17. From these figures, one first sees that more NOx are emitted than any other of the priority pollutants. CO is the pollutant released in the second largest quantity. By looking at the various sources of the emissions, one sees that Rubber-Tired Gantry Cranes produce most of the air emissions at the terminal, followed by Trucks, Toplifts, and Jockey Trucks, which produce similar emissions. There were 47 RTGs at the terminal in 2008. The Toplifts produce the next highest total amount of emissions. There were 54 Toplifts (full container handlers) at the terminal in 2008.

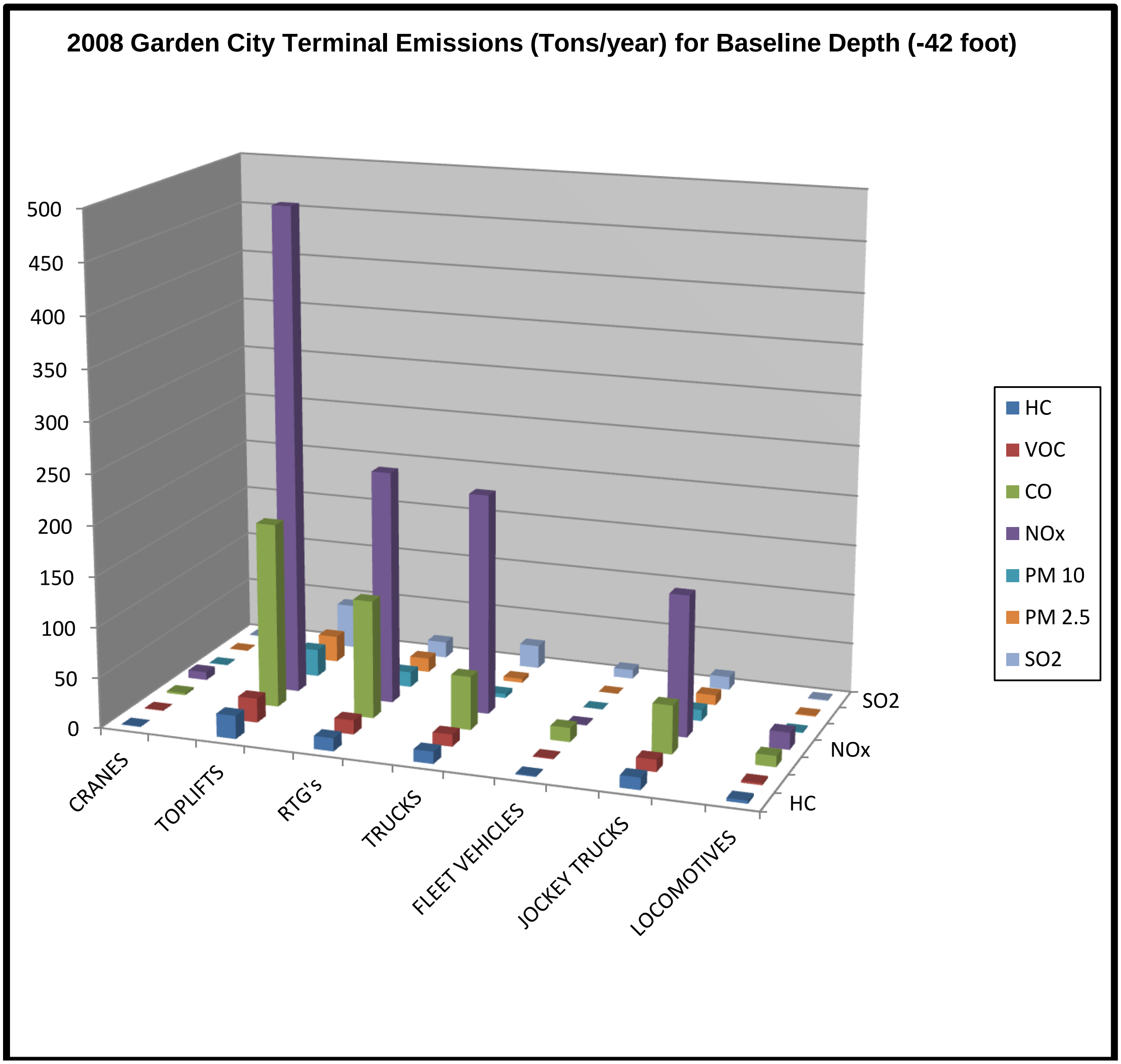

Figure 6-16. Garden City Terminal emissions from land-based operations – 2008.

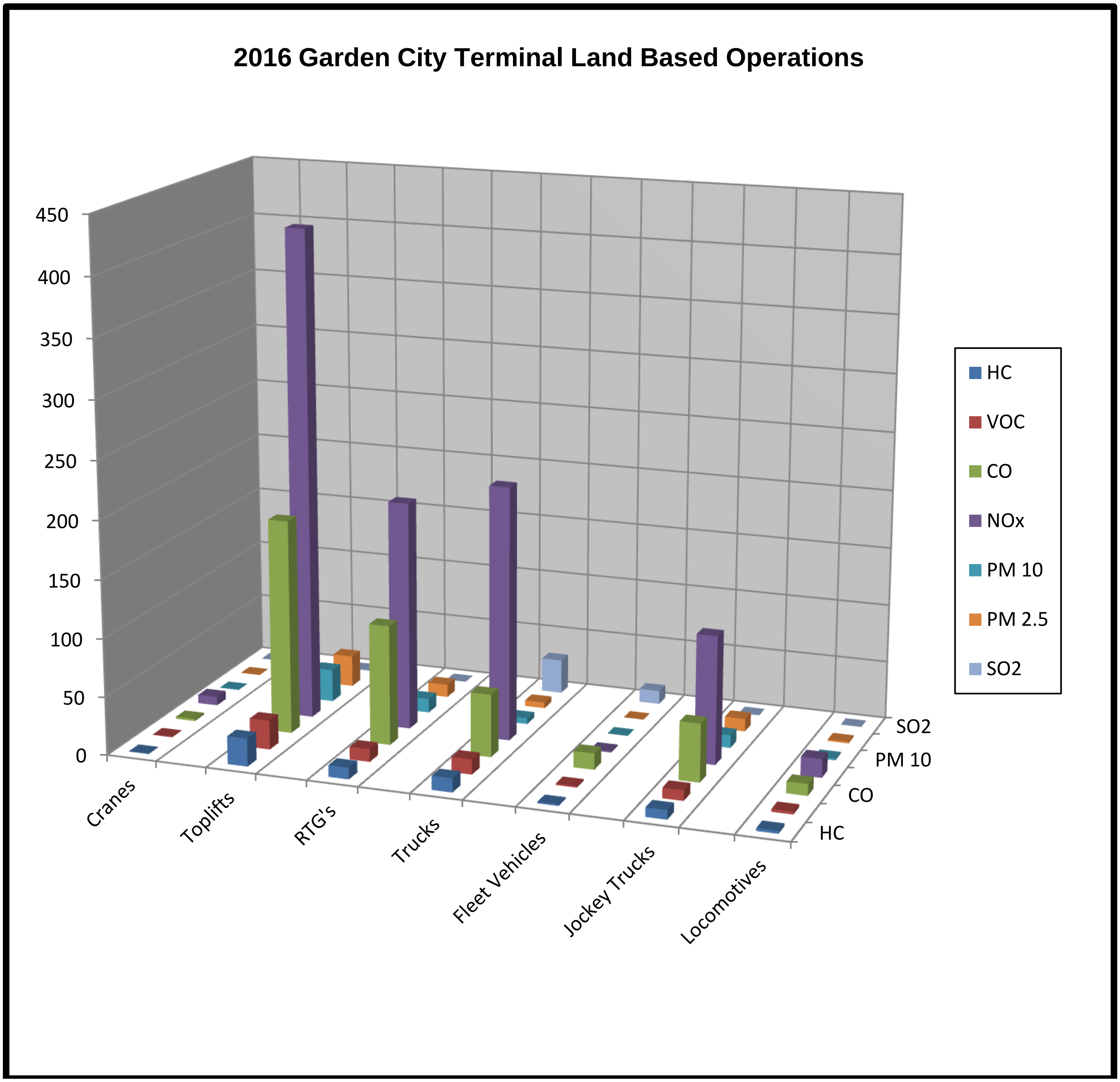

Figure 6-17. Garden City Terminal CHE emissions 2016 (Tons/Year).

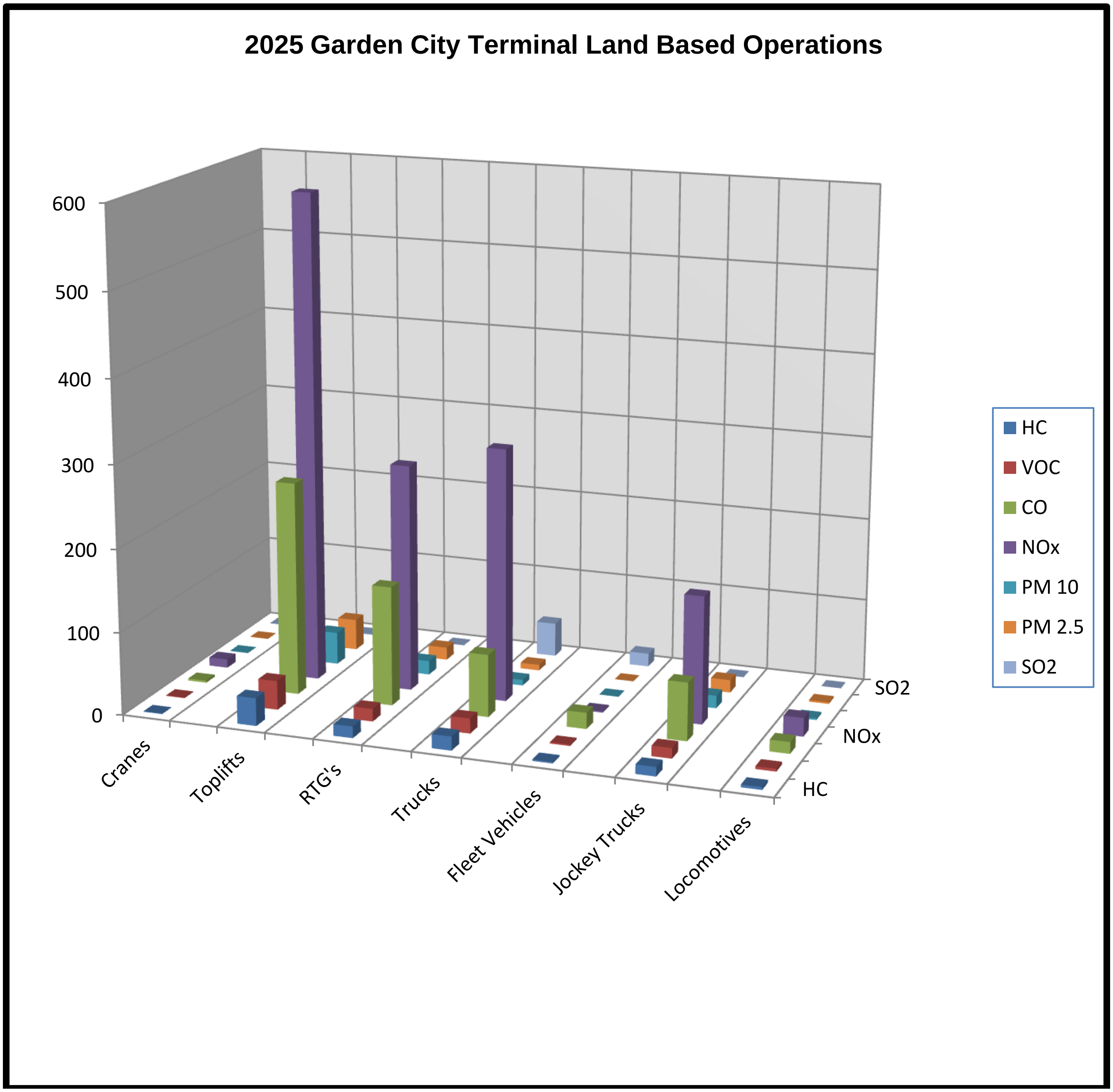

Figure 6-18. Garden City Terminal CHE emissions 2025 (Tons/Year).

The emissions from land-based terminal operations would not be affected by the proposed harbor deepening because the proposed deepening is not expected to result in more cargo moving through the port or the Garden City Terminal.

The emissions of CO_2 from Cargo Handling Equipment at the Garden City Terminal are shown below. From this figure, one can see that the Rubber-Tired Gantry Cranes and Toplifts produce about equal amounts of CO_2 emissions and are the largest dischargers of that pollutant, followed by Jockey Trucks.

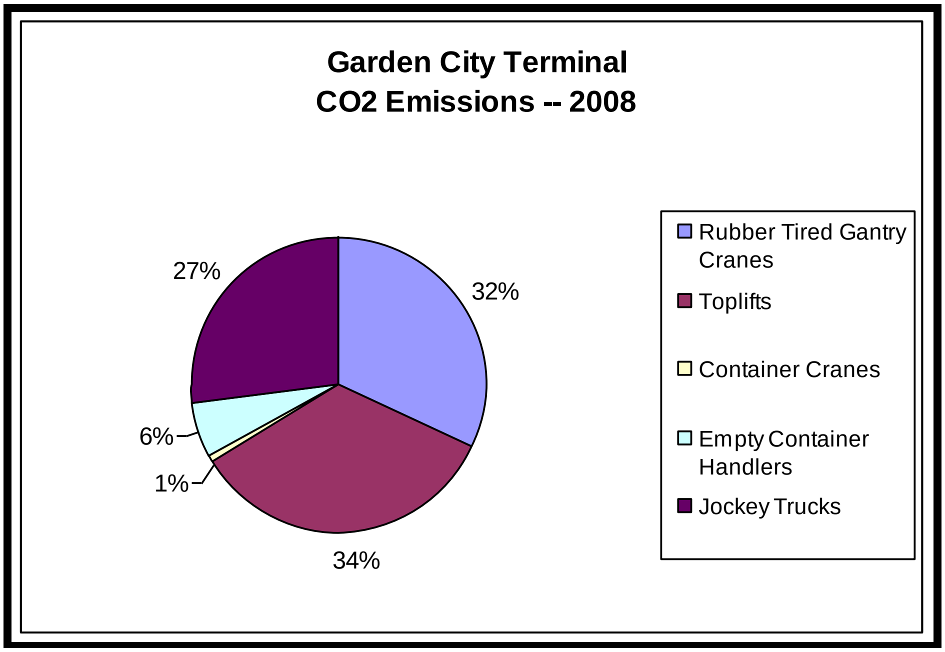

Figure 6-19. Garden City Terminal CHE -- 2008 CO_2 emissions.

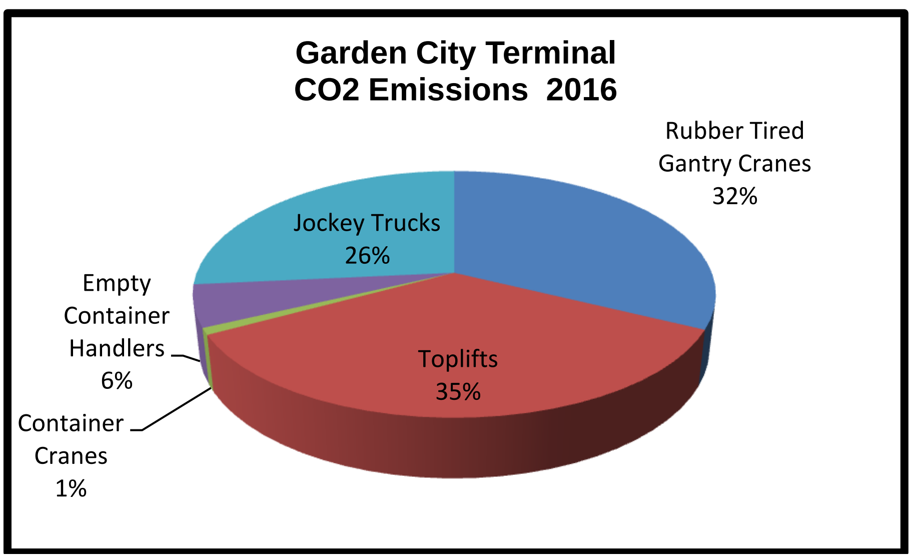

Figure 6-20. Garden City Terminal CHE -- 2016 CO_2 emissions.

Emissions at GPA's Ocean Terminal

The amount of emissions from Cargo Handling Equipment (CHE) at GPA's Ocean Terminal in 2008 and 2016 is shown in Figures 6-21 and 6-22, below. From this graph, one can see that Jockey Trucks produce most of the air emissions at that terminal. Jockey Trucks comprise 30 of the total 38 pieces of equipment (Jockey Trucks, Toplifts and Container Cranes) that service that terminal. These values do not include the Fleet Vehicles that are dedicated to Ocean Terminal, since all of GPA's Fleet Vehicles were included in the emissions for the Garden City Terminal. The overwhelming majority of GPA's Fleet Vehicles service the Garden City Terminal.

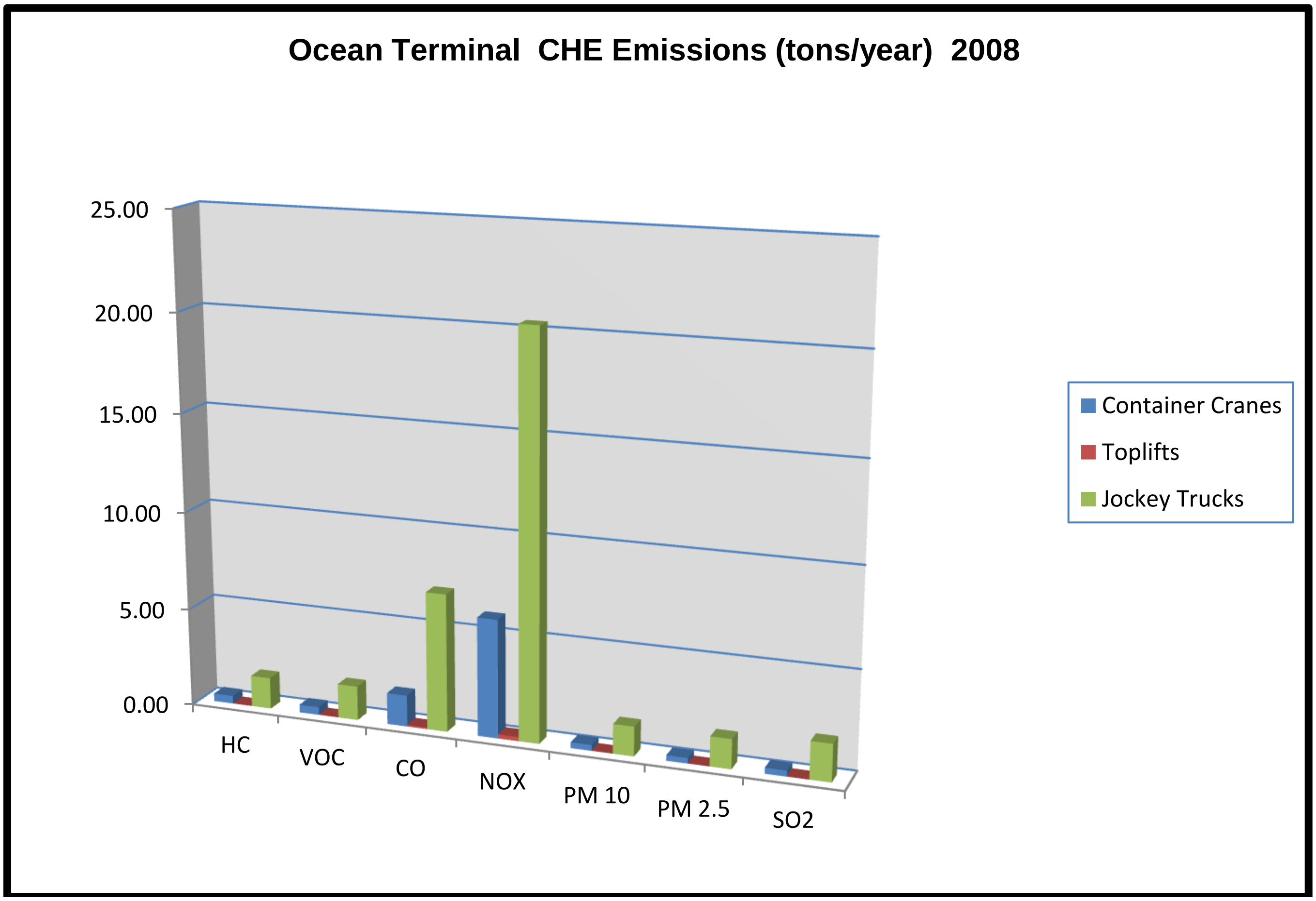

Figure 6-21. Ocean Terminal CHE emissions – 2008.

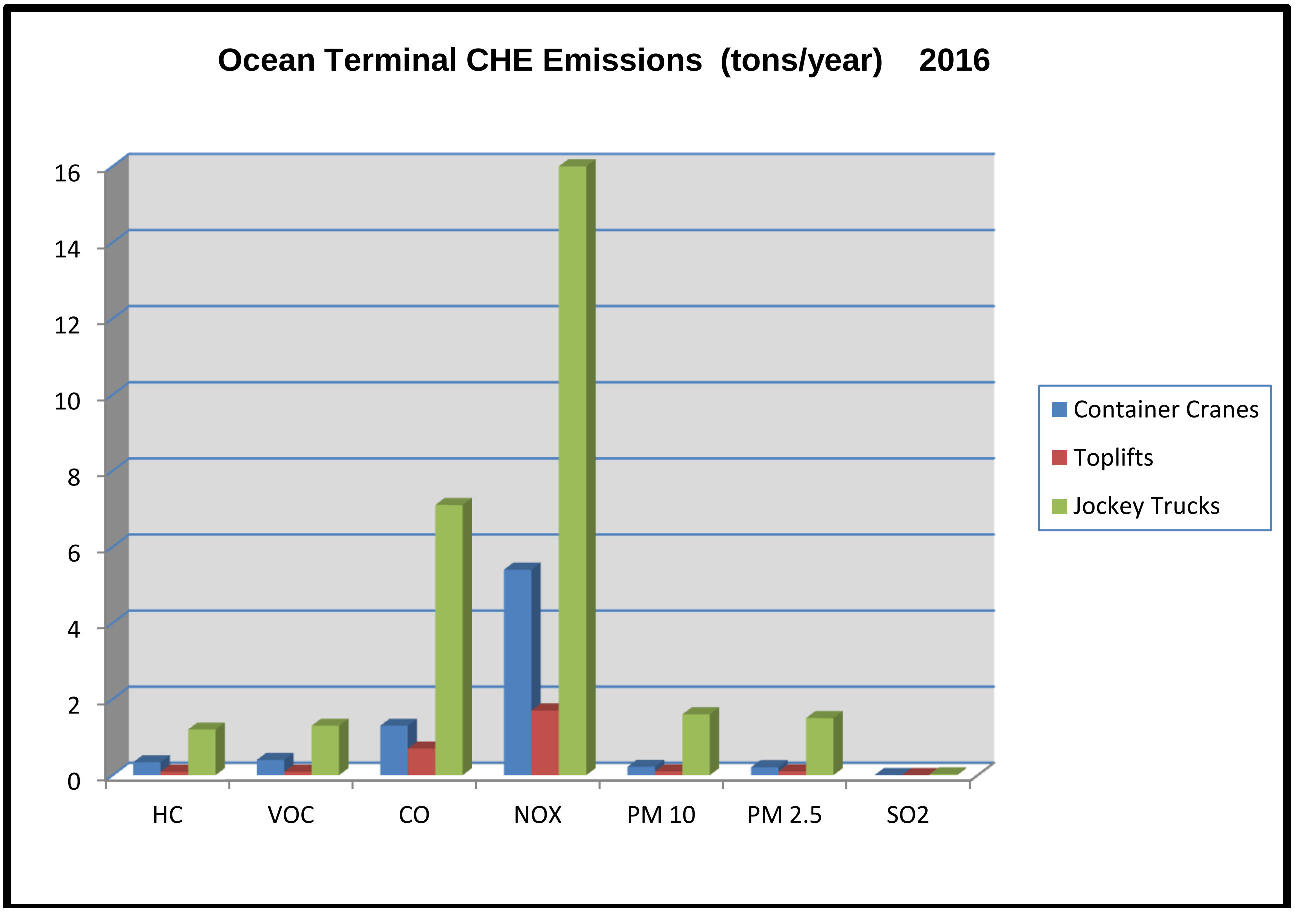

Figure 6-22. Ocean Terminal CHE emissions – 2016.

Emissions While Hotelling at GPA's Garden City Terminal

The following Table 6-1 shows the percentage of emissions from Hotelling of Container vessels at the Garden City Terminal compared to the total emissions for the port. The numbers are based on an average stay at the dock of 16 hours for each containership. This reveals that Hotelling of Containerships is a minor part of the overall port emissions for HC, VOC, CO, NOx, PM, and SO2.

Table 6-1
Emissions while Hotelling at GCT
Percentage of 2008 Hotelling Emissions compared to Total Port Emissions

	HC	VOC	CO	NOx	PM10	PM2.5	SO2
Containerships	3.7%	3.7%	2.6%	9.0%	6.9%	6.8%	11.7%

Although small, there are at least three ways in which these emissions could be further reduced. (1) The quality of the fuel could be improved. Cleaner fuels would result in lower air emissions. Since the containerships that call at Savannah are engaged in international trade and generally call at several US ports on its round-the-world transit, multi-national treaties may be needed to alter the fuel used by these international trading vessels. Congress and EPA are presently involved in this issue. (2) The second potential method is to reduce the dwell time for each vessel (time it spends at the dock). This is an issue that GPA continues to address, as it is a direct reflection of how well it serves its customers by providing quick turn-around times. Increases on cargo handling efficiency would allow reductions in the dwell time and, thereby, the air emissions occurring while at the dock. (3) The third potential method of reducing these emissions is through a process called "cold ironing". This process allows vessels to use electrical power from land while at the dock rather than its on-board auxiliary engines. Currently the Ports of Los Angeles, Long Beach, Oakland, and Seattle are using "cold ironing" at their terminals. Along the east coast, the Ports of Charleston and Everglades (Miami) are either in the process of looking into or have implemented this alternative.

Emissions from Trucks calling at GPA's Garden City Terminal

The Corps calculated emissions from the Trucks which carry containers to and from the Garden City Terminal, see Table 6-2, below. GPA provided information on the number of trucks that called at the Garden City Terminal in 2008, and an average length of time those trucks were on the terminal. The times varied depending on whether the trucks conducted a single transaction (21 percent) (dropping off a container) or conducted multiple transactions (79 percent) (both dropped off and picked up a container).

The Corps added 15 minutes of travel time each way for each truck to account for the time trucks travel in the vicinity of the port, but outside the terminal gates. This additional 30 minutes of engine time accounts for time spent while traveling between the Interstate highway system and the Garden City Terminal. This is in addition to the time spent within the terminal dropping off or picking up its load.

Table 6-2
2008 Emissions from Trucks Calling at the Garden City Terminal

	HC	VOC	CO	NOx	PM10	PM2.5
Emissions (tons)	12.2	12.3	53.7	218.4	4.9	4.6
% of GCT	7.8	8.0	8.8	8.0	4.0	4.2
% of Total Port	3.4	3.5	3.8	4.3	2.0	2.0

These values indicate that emissions from these Trucks are a relatively small contribution to the total emissions from both the port and the Garden City Terminal. NOx represent the largest pollutant by weight from these trucks – 218 tons in 2008. That amount was 8.0 percent of the NOx emitted at the Garden City Terminal and 4.3 percent at the total emitted at the port. The largest contribution by percentage was in Carbon Monoxide (CO), where their emissions constituted 8.8 percent of the total at the Garden City Terminal. On a percentage basis, the Trucks (tractor trailers) which move containers over the roads do not comprise a major source of air pollution either at the port or at the Garden City Terminal.

Comparison of Emissions at Port with Emissions in Chatham County

This section attempts to place the emissions calculated for the Port in a larger perspective, primarily by comparing them to emissions from the entire county. Table 6-3, below shows (1) the total air emissions for Chatham County in 2001 (reported by EPA), (2) the NEI emissions reported by EPA in 2002, (3) the emissions identified by EPA in 2002 as being from Ocean-Going Vessels calling at the port, (4) the NEI emissions reported by EPA in 2005, (5) the emissions identified by EPA in 2005 as being from Ocean-Going Vessels calling at the port, and (6) emissions calculated in this Air Inventory for the port in 2008.

Table 6-3
Summary of Air Emissions in Chatham County (Tons)

DATA SOURCE	HC	VOC	CO	NOx	PM10	PM2.5	SO2
From EPA Air Data Website* (2001 Data) *	19,996	20,096	127,367	31,220	15,264	8,841	19,000
EPA 2002 National Emissions Inventory	17,983	18,073	98,653	25,531	6,489	2,183	22,086
Ocean-Going Vessels (reported in EPA 2002 NEI)	215	216	912	6,923	293	270	1,029
EPA 2005 National Emissions Inventory	17,349	17,435	81,229	34,778	7,175	2,893	23,418
Ocean Going Vessels (reported in EPA 2005 NEI) **	170	170	719	5,451	229	211	247
Corps Total Port Emissions (2008 values -42 foot depth in Table 5-78)	**348**	**352**	**1,394**	**5,042**	**230**	**216**	**1,177**

NOTE: * As reported in "Cumulative Impact Analyses Report and Interactive Area Reporter For Fort Stewart and Hunter Army Airfield, Georgia", dated August 2007, prepared by The Environmental Company

** 2005 USEPA NEI Data **does not include** 2280003100 Marine Vessels, Commercial, Residual, Port emissions or 2280003200 Marine Vessels, Commercial, Residual, Underway emissions

The results calculated by the Corps for the entire port are in general agreement with those estimated by EPA in 2002 and 2005 for Ocean-Going Vessels calling at Savannah. Table 5-78 shows the total port air emissions in 2008 for all 22 terminals at the existing -42 foot depth (i.e., baseline or No Action Alternative). Table 6-4, below compares the Total Port Emissions for 2008 (in Table 5-78) to the EPA 2002 NEI and 2005 NEI data for Chatham County. For both the EPA 2002 and 2005 NEI data for Chatham County, the port is a minor contributor of HC, VOC, CO, PM10, PM2.5, and SO2. However, according to the EPA 2002 NEI data for the county, it is a substantial contributor to NOx emissions (about 18.3%). However, as also indicated in Table 6-4, according to the EPA 2005 NEI data, the percent NOx emissions are reduced from 18.3% to 13.5%.

Table 6-4
2008 Port Emissions Comparison (% Percent) to
Chatham County EPA 2002 NEI and EPA 2005 NEI Emissions

	HC	VOC	CO	NOx	PM10	PM2.5	SO2
EPA 2002 NEI							
Port of Savannah (includes all 22 Terminals)	1.9	1.9	1.3	18.3	3.4	9.5	5.4
EPA 2005 NEI							
Port of Savannah (includes all 22 Terminals)	2.0	2.0	1.6	13.5	3.1	7.2	5.1

The District was able to use both the EPA 2002 and 2005 NEI data for Chatham County, Georgia and compare them to the emissions calculated for the 2008 Total Port Emissions shown in Table 5-78. The Corps believes that Table 6-4 provides a good relationship comparing the calculated 2008 Total Port Emissions to both the 2002 and 2005 NEI County data. The expected larger County-wide emissions in 2008 would further reduce the percentage contribution shown for the port.

As indicated in Table 6-7 US EPA Emissions for the Kraft Steam Electric Plant in Port Wentworth, below, this plant discharged about 7,705 tons of SO2 in 2007. The Total Port Emission (2008 values) in Table 6-3, above shows that the SO2 emissions for all 22 terminals in the port was about 1,177 tons (see also Table 5-78). This means that the Kraft Steam Electric Plant discharges more than 6.45 times (7,705 tons SO2/1,177 tons SO2) the amount of SO2 than all 22 terminals in the port.

Emissions from New Work Dredging

The proposed Savannah Harbor Expansion Project would be a major construction project requiring large equipment to be used over a substantial period of time. The emissions expected from the new work dredging for the proposed harbor deepening project were calculated and are shown below compared to the total emissions for the Port and Chatham County.

Table 6-5
Summary of New Work Dredging Emissions (Tons)

	HC	VOC	CO	NOx	PM10	PM2.5	SO2
44-Foot Depth	47	47	445	2,318	54	52	135
45-Foot Depth	53	53	500	2,604	58	56	122
46-Foot Depth	60	60	566	2,947	68	66	165
48-Foot Depth	70	70	671	3,495	81	78	214
% of Total Port (2016)	8.8	8.9	24.5	29.3	21.8	22.4	19.7
% of Chatham County (2002 EPA NEI)	0.4	0.4	0.7	13.6	1.2.	3.6	0.9

NOTE: The percentages use the maximum channel depth being considered (48-Foot Depth Alternative) and EPA's 2002 National Emissions Inventory.

The emissions for the new work dredging would occur over a three-year period, so a direct comparison to yearly totals for the Port and County is not appropriate. The timing of the construction (number of dredges working at the same time) is not firm at this time, so a precise calculation of the emissions per year cannot be made. The percentages shown above assume an equal distribution of the emissions over a three-year construction period. One item to remember is that a good deal of the new work dredging would be performed in the entrance channel. That channel starts roughly 20 miles east of the City center and extends another 19 miles into the ocean. With the prevailing winds being west to east, emissions from dredging the entrance channel would likely not add measurably to emissions from dredging the inner harbor or other emissions in Chatham County.

Emissions from Annual Maintenance Dredging

Figure 6-23 shows the emissions from the maintenance dredging that the Corps performs each year to maintain the authorized Federal Navigation Project. The figure shows that the greatest quantity of emissions are from NOx (270 tons/yr) followed by CO (52 tons/year) and SO2 (20 tons/year).

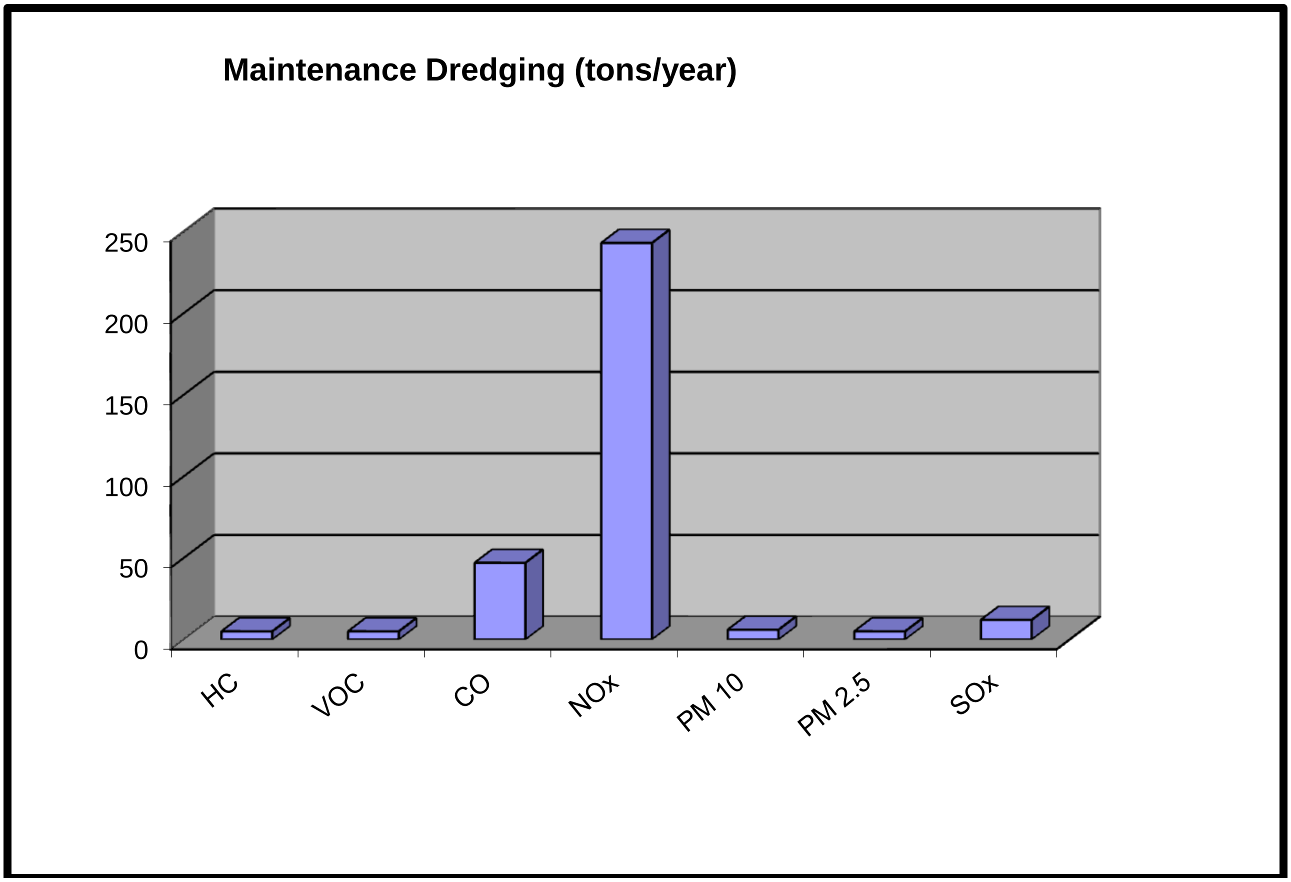

Figure 6-23. All maintenance dredging emissions (Tons/Year).

If one looks at the emissions of Hydrocarbons as being representative of the other pollutants that were evaluated, Figure 6-24 shows that the majority of the emissions come from pipeline dredging that is performed on the inner harbor (as opposed to hopper dredging performed on the entrance channel).

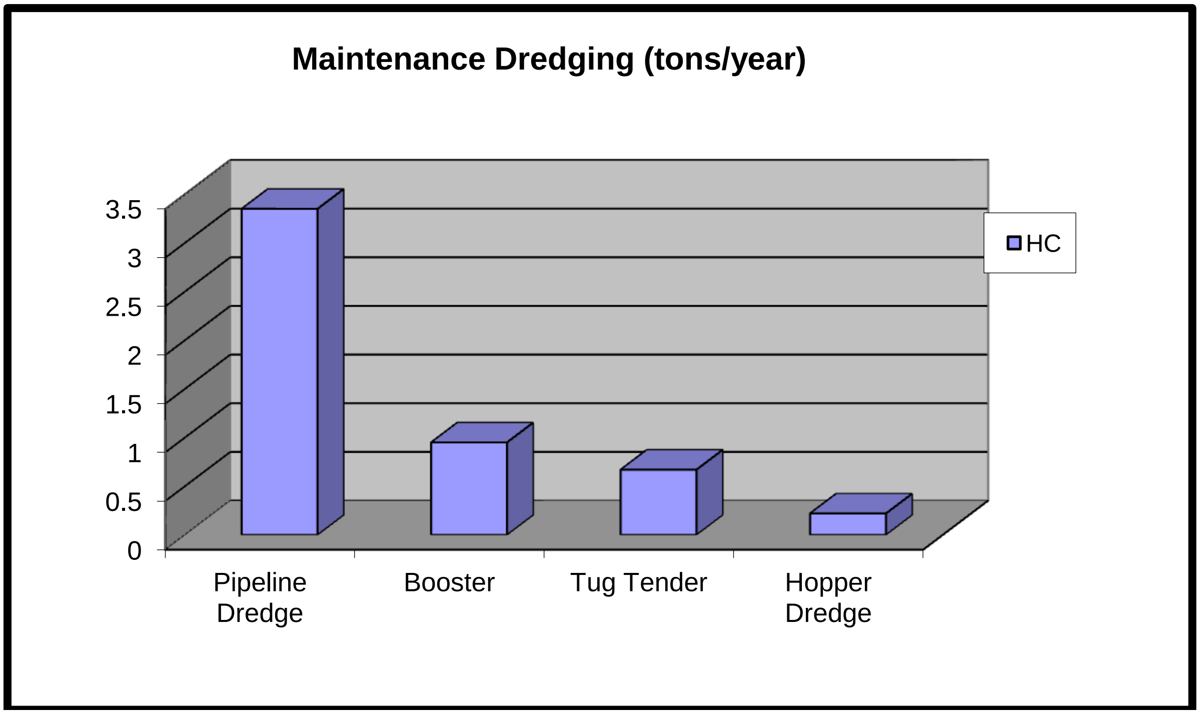

Figure 6-24. Maintenance dredging emissions for different dredges (Tons/Year).

Emissions of Air Toxics

Table 6-6 shows the 28 types of air toxics that are being emitted in Chatham County at the largest quantities. The emission quantities are from the 2002 National Emissions Inventory published by EPA and from the Corps' Savannah Harbor air emission inventory for 2008 (see Table 5-78 for criteria pollutant emission amounts). The quantity of air toxics were calculated using the air toxic ratios taken from the NMIM "SCCToxics" database table, which was provided by US EPA, Office of Transportation and Air Quality Ann Arbor, Michigan. The Corps then multiplied these air toxic ratios by either the 2002 NEI VOC or PM10 emissions and placed the results in Column 5 (2002 EPA NEI Data, Chatham County, Tons/Year) of Table 6-6. The Corps multiplied these same air toxic ratios by the 2008 estimated VOC and PM10 emissions and placed the results in Column 6 in Table 6-6 (Port Air Toxics in 2008).

The Corps calculated emissions of air toxics at the Port of Savannah (includes all 22 terminals, land based operations, dredging, tourist boats, shifts, OGVs, etc.) for the 28 air toxics in the 2008 base year by quantity and compared them to the reported 2002 EPA NEI air toxic emission. To calculate Ethyl Benzene, the Corps multiplied the total VOC emissions in 2008 (see Table 5-78), which is 352.54 tons times 0.0031 equals 1.09 tons. The total PM10 emissions in 2008 (see Table 5-78) were 229.76 tons. Additionally, the Corps calculated the percent of the 2008 air toxics emissions to the 2002 EPA NEI Chatham County data. All of these quantities are shown below in Table 6-6.

Table 6-6 shows the quantities of air toxic emitted in the County as a whole and the quantity emitted from port-related operations in 2008 (base year). The Corps' air inventory developed information for 2008 that could be compared with the data published by EPA in 2002. Table 6-6 on the following page shows these results. In general, the air toxic values for the port in 2008 are significantly lower than the 2002 values for Chatham County. The reason for this is likely that the Port of Savannah is a small subset of the air emissions in the entire County. The highest portion of the 28 air toxics calculated for 2008 Port Emissions was Phenanthrene. This was about 3.54% of the 2002 USEPA NEI data for Chatham County. The remainder of the 27 air toxics calculated for the 2008 Port Emissions were on average 3% or less of the 2002 USEPA NEI data for Chatham County.

With or without the harbor deepening, the amount of air toxics would increase until the port reaches capacity in 2030 with 6.5 million TEUs. The Corps' projected increases in cargo volumes moving through Savannah may result in approximately a doubling of the quantity of air toxics emitted in the port in 2066 from that released in 2016. For air toxics, these results can be seen in Tables 5-64 through 5-67. If the air toxic emissions in Chatham County remain at their 2002 levels through 2066, the port would still be a small contributor to the County's emissions of air toxics (<4 percent in most cases).

Tables 5-68 through 5-76 show how changes in emissions of air toxics would change at the Garden City Terminal over time with the various depth alternatives. Emissions from Land-Based Equipment would not change with channel depth, because the same number of containers would move through the GCT With and With-out harbor deepening on a given year.

Fewer transits are required from large ships to carry the same amount of cargo when compared to small ships. Therefore, the proposed harbor deepening – which would allow larger vessels to regularly use the harbor – would result in lower emissions of air toxics than would the fleet that can use the present 42-foot deep authorized channel.

Table 6-6
Comparison of Major Air Toxic Emissions in Chatham County (Tons)

	AIR TOXIC PARAMETER		AIR TOXIC RATIOS TAKEN FROM NMIM "SCC TOXICS" DATABASE"	AIR TOXICS For Port In 2008 (TONS / YEAR)	2002 EPA NEI DATA CHATHAM COUNTY (TONS/YEAR)	PERCENT OF 2008 PORT BASE YEAR TO 2002 EPA NEI COUNTY DATA
1	Ethyl Benzene	VOC	0.0031001	1.092907	56.028	1.95%
2	Styrene	VOC	0.00059448	0.209578	10.74	1.95%
3	1,3-Butadiene	VOC	0.0018616	0.656287	33.64	1.95%
4	Acrolein	VOC	0.00303165	1.068776	54.79	1.95%
5	Toluene	VOC	0.014967	5.276454	270.50	1.95%
6	Hexane	VOC	0.0015913	0.560996	28.76	1.95%
7	Anthracene	PM10	0.00000043	0.000099	0.00279	3.54%
8	Propionaldehyde	VOC	0.0118	4.159963	213.26	1.95%
9	Pyrene	PM10	0.0000029	0.000666	0.0188	3.54%
10	Xylene	VOC	0.010582	3.730570	191.25	1.95%
11	Benzo(g,h,i)perylene	PM10	0.00000019	0.000044	0.00123	3.54%
12	Indeno(1,2,3,c,d)pyrene	PM10	0.000000079	0.000018	0.0005	3.54%
13	Benzo(b)fluoranthene	PM10	0.00000049	0.000113	0.0032	3.54%
14	Fluoranthene	PM10	0.000017	0.003906	0.110	3.54%
15	Benzo(k)fluoranthene	PM10	0.00000035	0.000080	0.00227	3.54%
16	Acenaphthylene	PM10	0.000084	0.019300	0.55	3.54%
17	Chrysene	PM10	0.0000019	0.000437	0.0123	3.54%
18	Formaldehyde	VOC	0.118155	41.654271	2135.42	1.95%
19	Benzo(a)pyrene	PM10	0.00000035	0.000080	0.00227	3.54%
20	Dibenzo(a,h)anthracene	PM10	2.9E-09	0.000001	0.188181	3.54%
21	2,2,4-Trimethylpentane	VOC	0.00066	0.232676	11.93	1.95%
22	Benz(a)anthracene	PM10	0.00000071	0.000163	0.0046	3.54%
23	Benzene	VOC	0.020344	7.172058	367.68	1.95%
24	Acetaldehyde	VOC	0.05308	18.712781	959.31	1.95%
25	Acenaphthene	PM10	0.0001	0.022976	0.649	3.54%
26	Phenanthrene	PM10	0.00026	0.059738	1.69	3.54%
27	Fluorene	PM10	0.0001	0.022976	0.65	3.54%
28	Naphthalene	PM10	0.00046	0.105691	2.98	3.54%

Greenhouse Gas Emissions (GHG)

While the majority of greenhouse gas emissions from ships are CO_2, additional GHG emissions include methane (CH_4) and nitrous oxide (N_2O). The EPA 2002 NEI inventory for Chatham County does not include greenhouse gases. However, EPA website at http://camddataandmaps.epa.gov/gdm/index.cfm has the following information on CO_2 being discharged at the Kraft Steam Electric Plant in Port Wentworth, near Savannah, Chatham County Georgia for 2002 and 2007:

Table 6-7
US EPA Air Emissions for the Kraft Steam Electric Plant in Port Wentworth

State	Facility Name	Facility ID (ORISPL)	Stack/Unit/ Pipe ID	Associated Units	Year	Operating Time	# of Months Reported	SO_2 Tons	Avg. NO_x Rate (lb/mmBtu)	NO_x Tons	CO_2 Tons	Heat Input (mmBtu)
GA	Kraft	733	1		2002	7,124	12					3,064,196
GA	Kraft	733	2		2002	6,345	12					2,791,889
GA	Kraft	733	3		2002	6,962	12					6,084,813
GA	Kraft	733	4		2002	2,787	12					1,389,001
GA	Kraft	733	CS001	1, 2, 3, 4	2002	8,533	12	7,189.4	0.51		1,367,644.9	13,329,914

** Site is located at http://camddataandmaps.epa.gov/gdm/index.cfm

The following information is taken from USEPA Monitoring Location Level Emissions Quick Report** June 12, 2009
Your query will return data for 1 facilities.
You specified: Year(s): 2002 Facility(s): Kraft Steam Electric Plant located in Savannah GA

State	Facility Name	Facility ID (ORISPL)	Stack/Unit/ Pipe ID	Associated Units	Year	Operating Time	# of Months Reported	SO_2 Tons	Avg. NO_x Rate (lb/mmBtu)	NO_x Tons	CO_2 Tons	Heat Input (mmBtu)
GA	Kraft	733	1		2007	7,973	12					4,298,198
GA	Kraft	733	2		2007	7,904	12					3,888,570
GA	Kraft	733	3		2007	7,788	12					7,599,687
GA	Kraft	733	4		2007	647	12					325,600
GA	Kraft	733	CS001	1, 2, 3, 4	2007	8,760	12	7,704.7	0.55		1,653,099.4	16,112,059

** Site is located at http://camddataandmaps.epa.gov/gdm/index.cfm

From Table 6-7 above, for 2002 and 2007, the Kraft Steam Electric Plant in Port Wentworth, near Savannah, Chatham County, Georgia emitted 1,367,644 and 1,653,099 tons of CO_2, respectively. The Kraft Steam Electric Plant in Port Wentworth is located just upstream of the Garden City Terminal in Chatham County, Georgia.

According to USEPA's Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories, Ocean Going Vessels, ICF International, Final dated April 2009, on page 2-16, the following information is found:

While the majority of greenhouse gas emissions from ships are CO_2, additional GHG emissions include methane (CH4) and nitrous oxide (N2O). Emission factors for various engine types listed in Table 2-13 are taken from the IVL 2004 update 38. To estimate CO2 equivalents, CH4 emissions should be multiplied by 21 and N2O emissions should be multiplied by 310. Therefore, to estimate CH4 and N20, CO2 should be divided by 21 and 310, respectively. Since C02=CH4 X 21 and CO2=N20 X 310.

Therefore CH4 = CO2/21 and N2O = CO2/310.

On page 3-11 of this same document, it states:

> *In addition to the greenhouse gas emission factors discussed above, it is possible to estimate elemental carbon emission factors from the EPA's SPECIATE4 model for emissions of PM2.5. For diesel harbor craft, the diesel commercial marine vessel (SCC 2280002000) sector is appropriate. That sector is assigned an emission fraction of*

77.12% elemental carbon. That is: EFEC = 77.12% x 97% x EFPM10 after adjusting the PM10 emission factor for fuel sulfur.

Therefore Elemental Carbon = 0.7712 x 0.97 x PM10.

These formulas were used to estimate the GHGs emissions for marine diesel vessels (i.e., OGVs, tugs, tourist boats, pipeline and hopper dredges, and shifts within the harbor) at all depths and years for all 22 terminals in the Port of Savannah. These GHGs estimates are shown in Table 6-8, below.

Comparing the measured 1,653,099 tons of CO_2 air emissions for 2007 at the Kraft Steam Electric Plant in Port Wentworth (which is adjacent to the Garden City Terminal) to the calculated CO_2 for all 22 terminals at the Port of Savannah in Table 6-8, below, the proposed deepened harbor is not a significant source of GHGs in Chatham County.

Table 6-8
Estimated Greenhouse Gases for All Vessels and All Depths

42-Foot Depth					
Year	# of Vessels	CO_2	N_20	CH_4	Carbon
2008	2,724	131993.04	425.78	6285.38	130.42
2016	4,146	200896.90	648.05	9566.52	198.50
2020	4,713	228371.23	736.68	10874.82	225.65
2025	5,886	285209.64	920.03	13581.41	281.81
2030	7,205	349122.57	1126.20	16624.88	344.96
2066	7,205	349122.57	1126.20	16624.88	344.96

44-Foot Depth					
Year	# of Vessels	CO_2	N_20	CH_4	Carbon
2008	NA	NA	NA	NA	NA
2016	4,034	268274.58	865.40	12774.98	107.61
2020	4,508	243821.57	786.52	11610.55	102.16
2025	5,601	300310.63	968.74	14300.51	122.02
2030	6,833	371372.78	1197.98	17684.42	146.23
2066	6,833	371372.78	1197.98	17684.42	146.23

45-Foot Depth					
Year	# of Vessels	CO_2	N_20	CH_4	Carbon
2008	NA	NA	NA	NA	NA
2016	4,010	266678.50	860.25	12698.98	106.97
2020	4,469	241712.20	779.72	11510.10	101.27
2025	5,549	297522.53	959.75	14167.74	120.89
2030	6,760	367405.24	1185.18	17495.49	144.67
2066	6,760	367405.24	1185.18	17495.49	144.67

46-Foot Depth					
Year	# of Vessels	CO_2	N_20	CH_4	Carbon
2008	NA	NA	NA	NA	NA
2016	3,998	265880.46	857.68	12660.97	106.65
2020	4,451	240738.65	776.58	11463.75	100.87
2025	5,522	296074.86	955.08	14098.80	120.30
2030	6,726	365557.34	1179.22	17407.49	143.94
2066	6,726	365557.34	1179.22	17407.49	143.94

47-Foot Depth					
Year	**# of Vessels**	**CO_2**	**N_20**	**CH_4**	**Carbon**
2008	**NA**	**NA**	**NA**	**NA**	**NA**
2016	**3,994**	**265614.45**	**856.82**	**12648.31**	**106.54**
2020	**4,442**	**240251.87**	**775.01**	**11440.57**	**100.66**
2025	**5,511**	**295485.07**	**953.18**	**14070.72**	**120.06**
2030	**6,714**	**364905.15**	**1177.11**	**17376.44**	**143.68**
2066	**6,714**	**364905.15**	**1177.11**	**17376.44**	**143.68**

47-Foot Depth					
48-Foot Depth					
Year	**# of Vessels**	**CO_2**	**N_20**	**CH_4**	**Carbon**
2008	**NA**	**NA**	**NA**	**NA**	**NA**
2016	**3,994**	**265614.45**	**856.82**	**12648.31**	**106.54**
2020	**4,442**	**240251.87**	**775.01**	**11440.57**	**100.66**
2025	**5,511**	**295485.07**	**953.18**	**14070.72**	**120.06**
2030	**6,714**	**364905.15**	**1177.11**	**17376.44**	**143.68**
2066	**6,714**	**364905.15**	**1177.11**	**17376.44**	**143.68**

Air Quality Standards

Chatham County is considered by EPA to be in an Attainment area since it meets the National Ambient Air Quality Standards, which are shown in Table 6-9, below:

Table 6-9
National Ambient Air Quality Standards

Pollutant	Primary Standard	Secondary Standard
PM_{10}	150 ug/m3 (daily)	Same
$PM_{2.5}$	15 ug/m3 (annual) 35 ug/m3 (daily)	Same
NO_x	0.053 ppm (annual) 100 ppb (1-hour)	0.053 ppm (annual)
SO_2	75 ppb (1-hour)	0.5 ppm (3-hour)
CO	9 ppm (8-hour) 35 ppm (1-hour)	None
Lead	0.15 ug/m3 (3-month average)	Same
Ozone	0.075 ppm (8-hour)	Same

EPA published information in January 2008 about air quality in Chatham County in its “Latest Findings on National Air Quality, Status and Trends Through 2006”. In that document, EPA stated that Savannah’s 2006 Ozone level ranged from 0.065 to 0.084 ppm (4^{th} highest daily maximum 8-hour concentration), below the standard of 0.08 ppm. Ground level ozone is formed when NOx and VOC react in the presence of sunlight. That document also reported that ozone levels had improved in Savannah from 2000 to 2006. The summer daily maximum 8-hour ozone concentrations decreased by 0.002 ppm between 2000-2001 (average) and 2005-2006 (average) (from Figure 12 in EPA's document). For a number of years, EPA has indicated that they may promulgate a new ozone standard. At this time, the Corps does not know when or if this may occur.

EPA also reported a small increase in PM 2.5 concentration from 2000-2006. Figure 14 of that document showed that PM 2.5 had changed -1 to 4 ug/m3 over that period. The average annual PM 2.5 concentrations were in the range of 12.1 to 15 ug/m3, with 66 out of 895 measurements exceeding 15.1 ug/m3. The daily range of PM2.5 was in the range of 16 to 35 ug/m3, with 126 out of 895 measurements (14%) exceeding 35 ug/m3 (Figure 15 of EPA's document).

EPA reported that PM 10 levels for Savannah ranged from 0 to 54 ug/m3 (Figure 21 in EPA's document), with 425 out of 904 measurements exceeding 54 ug/m3.

These values indicate that the air quality is within the standards for Ozone and PM2.5 and well within the standard for PM10.

The State Implementation Plan (SIP) identifies how the State will attain and maintain the primary and secondary NAAQS. Each State is required to have a SIP that describes control measures and strategies that each state will use to attain and maintain the NAAQS. SIP requirements applicable to all areas are provided in Section 110 of the Act. Part D of title I of the Act specifies additional requirements applicable to nonattainment areas. Section 110 and part D describe the elements of a SIP and include, among other things, emission inventories, a monitoring network, an air quality analysis, modeling, attainment demonstrations, enforcement mechanisms, and regulations which have been adopted by the State to attain or maintain NAAQS. EPA has adopted regulatory requirements that describe the procedures for preparing, adopting and submitting SIPs and SIP revisions that are codified in 40 CFR Part 51.

Under CAA Section 176(c), certain Federal actions must be analyzed to determine whether they conform with the applicable SIP(s). However, a Conformity Determination is not required for the SHEP under Section 176(c) because 40 CFR Section 93.153 (b) provides: "For Federal actions not covered by paragraph (a) of this section, a conformity determination is required for each pollutant where the total of direct and indirect emissions in a <u>non-attainment or maintenance area</u> (emphasis added by the writer) caused by a Federal action would equal or exceed any of the rates in paragraphs (b)(1) or (2) of this section." Since both Chatham and Jasper Counties have been designated by the States as attainment areas, a Conformity Determination is not required.

Table 5-78 "Summary of all Pollutants (Tons/Year) for all Vessels and all Land Based Emissions for the 22 Terminals" clearly shows that the air emissions (including greenhouse gases, primarily CO2) at the existing depth (No Action Alternative) of -42 foot depth would be greater than the emissions for the -47/48 foot depth in all years from 2016 to 2066. Table 5-78 also depicts the project future condition analysis that the air emissions for the No Action Alternative (-42 foot depth) would be greater than with a deepened harbor. Additionally, Table 5-78 indicates that since air toxics are ratios of either VOC or PM10, the amount of air toxics discharged by the 22 terminals would be greater for the No Action Alternative than with a deepened harbor. The reason why there would be less air emissions in the deepened harbor is that fewer larger vessels (more heavily loaded) would be needed to transport the same volume of containers than with the existing depth (No Action Alternative) of -42 foot. This does not mean that larger vessels discharge less air pollutants than smaller vessels; they do not (see EPA 2009). Fewer larger vessels (more heavily loaded) would be needed to transport 6.5 million TEUs in a deepened harbor than with the No Action Alternative. This fact is also reflected in the Commodity and Fleet Forecasts found in the GRR.

Since the proposed harbor deepening is not expected to increase the number of vessels or total cargo moving through the port (when compared to the Without Project Condition), no increases in air emissions would occur as a result of the project. Increases in air emissions at the port are expected over time as a result of growth in demand for goods that move through the port. With or without deepening of the harbor, air emissions at the port are expected to increase. Those increases would occur independent of a harbor deepening project.

The Corps' calculations of 2008 emissions for the Port indicate that the Port was a substantial contributor of NOx (18.3 percent compared to the EPA 2002 NEI and 13.5 percent compared to the EPA 2005 NEI data) emissions in Chatham County (Table 6-4). (It should be noted that some of the emissions the Corps calculated for the Port occur while ships move through the entrance channel located in the ocean east of the coastline.) The Port contributes only minor amounts to emissions of SO2 (5.4 and 5.1 percent compared to the EPA 2002 and 2005 NEI data), PM10 (3.4 and 3.1 percent compared to the EPA 2002 and 2005 NEI data), PM2.5 (9.5 and 7.2 percent compared to the EPA 2002 and 2005 NEI data), HC (1.9 and 2.0 percent compared to the EPA 2002 and 2005 NEI data), VOC (1.9 and 2.0 percent compared to the EPA 2002 and 2005 NEI data), and CO (1.3 to 1.6 percent compared to the EPA 2002 and 2005 NEI data).

Emissions of NOx, SO2, and PM2.5 are expected to decrease as terminal operators replace their equipment with newer engines that do not emit as much pollution and use the lower sulfur fuels mandated by EPA. The port's contributions to SO2 emissions are expected to decrease as a result of EPA's requirements for use of cleaner fuels. These new standards should substantially reduce SO2 emissions, as the SO2 content in the fuels used by non-road diesel, locomotives, and marine diesel engines transitioned from 500 ppm sulfur in 2007 to ultra low sulfur diesel (ULSD) -- which is 15 ppm -- in 2010. For Ocean-Going Vessels, EPA issued new emission standards in late 2009 for Category 3 marine diesel engines which will require an 80 percent reduction in NOx emissions beginning in 2016. EPA also adopted standards for engines covered by MARPOL Annex VI that require Ocean-Going Vessels within 200 miles of the US to use fuel with a maximum of 1% Sulfur (10,000 ppm) beginning in 2012 and 0.10% (1,000 ppm) beginning in 2015. Again, the port's contributions of NOx and SO2 emissions in the County should substantially decrease as a result of these new requirements for cleaner fuels.

With these new EPA fuel standards in place for both NOx and SO2, the Port of Savannah will in the future contribute a minor amount of air emissions (including air toxics) when compared to the overall county's emissions. Since, (1) the calculated air emissions for the Future Without Project Condition (i.e., baseline or existing depth of -42 feet) would be greater than with the Proposed Action (i.e., 47-foot depth), and (2) both Chatham County, Georgia and Jasper County, South Carolina are designated as attainment areas, air quality modeling is not warranted to evaluate the effects of the Proposed Action (i.e., 47-foot depth).

Therefore, over the life of the project (from 2016 to 2066) the proposed deepening of the harbor will not interfere with the area remaining in attainment of the NAAQS under Section 110 of the Clean Air Act.

Ongoing actions that improve air quality – GPA

In 2002, GPA required 1.44 gallons of diesel fuel to process a TEU through the terminal. In FY08, GPA reported it needed 0.89 gallons to move a similar container. GPA encourages the use of freight by rail, which EPA says emits one third the NOx (nitrogen oxides) of other modes of transportation.

GPA continually evaluates methods to reduce diesel consumption and emissions. These actions protect the environment and the local population. Examples include the following:

- GPA has converted the older ship-to-shore cranes to electric and purchased new cranes that run off of electricity. Of the 23 ship to shore cranes, 21 are electric, which avoids the use of 1.9 million gallons of diesel each year. The four new post-panamax cranes that GPA put in service in early 2008 eliminated the use of 400,000 gallons of diesel each year.
- The Garden City Terminal is the largest shipper of refrigerated cargo on the east coast and has installed electric refrigerated container racks which eliminate the use of diesel generators for the refrigerated containers. The use of these racks in place of generators avoids the consumption of nearly 2.4 million gallons of diesel annually.
- In 2008 -- two years ahead of the federal mandate -- GPA completed its conversion of yard cranes, trucks and other equipment to cleaner-burning ultra-low-sulfur diesel (ULSD), cutting emissions by an additional 10 percent.
- In 2010, EPA awarded GPA a Diesel Emissions Reduction Grant to repower 17 rubber tire gantry cranes (RTGs), which is one of the primary types of container handling equipment. By repowering these RTGs, GPA will avoid using 129,000 gallons annually throughout the life of the equipment.
- GPA recently conducted a pilot project on use of a diesel additive in the container handling equipment. The study showed that the additive reduced fuel consumption and lowered emissions. GPA now uses the additive in all container handling equipment. This avoids use of 100,000 gallons of diesel fuel annually.
- The Garden City Terminal has a total of 33 on-road truck container interchange lanes divided between two locations on the terminal, which have processed over 8,200 gate transactions on a single day. GPA's facility master plan includes construction of a third set of gates which would then provide access to the terminal from the east, west and south, thereby spreading out traffic and reducing waiting times at the gates. The dispersal of truck traffic reduces congestion and its accompanying air emissions. GPA expects to implement this improvement within the next 10 years.
- Containers are shipped by rail using the two Intermodal Container Transfer Facilities (rail yards). At those facilities, trains are built for particular destinations as far west as

Chicago. This effort reduces transit times of up to 3 days and avoids central train yard switching of cars, thereby reducing emissions. Moving freight by rail emits three times less NOx and PM than on-road trucks. With the only East Coast ICTFs located on the container terminal, GPA's on-dock rail volumes have increased 135% over the past five years (2008).

- During periods of heavy cargo volumes, GPA coordinates extended gate hours (earlier morning and later evening hours and Saturdays) to decrease on-road and terminal congestion. This improves productivity, reduces truck idling, and decreases diesel emissions.
- Forklifts of 15,500 pound capacity or smaller (86) are now fueled with LP gas, rather than diesel.

As a result of programs GPA implemented throughout the Garden City Terminal, approximately 4.5 million gallons of diesel and the associated emissions are avoided on an annual basis. While GPA has increased the total volume of containers moved, the gallons of diesel per container handled decreased 54% from FY01 to FY10.

The reduction in air emissions in the movement of cargo through the port reduces local and multi-state regional air pollution. The improved air quality benefits the thousands of personnel on GPA terminals and on neighboring industrial sites, as well as those who reside in nearby Georgia and South Carolina communities.

Prior to 2012, all 10 tugs (owned by Moran and Crescent Towing Companies) operating at the Port will be using ULSD fuel (15 ppm Sulfur) and will be "cold ironed" at the dock when not in use.

Ongoing actions that improve air quality - EPA

EPA has issued new standards for diesel fuels that will result in less air pollution. Fuels used in non-road diesel, locomotives, and marine diesel engines transitioned from 5,000 ppm sulfur to 500 ppm in 2007, and will move to ultra low sulfur diesel (ULSD), which is 15 ppm in 2010.

For trucks calling at the Garden City Terminal, the 15 ppm ULSD was used throughout the calculations because EPA indicates that the majority of trucks used the ULSD fuel in 2008. For all other equipment, the calculations include the effects of cleaner fuels on engine emission rates as those fuels become common in the Savannah area.

On March 14, 2007, EPA announced new emission standards for locomotives and marine diesel engines. For locomotives, the regulations apply to all diesel line-haul, passenger, and switch locomotives that operate extensively within the US, including new locomotives and re-manufactured locomotives. That would include the locomotives that service the Garden City Terminal. For marine diesel engines, the regulations apply to new and re-manufactured commercial marine diesel engines above 600 kilowatt (kW) or 800 horsepower (hp) with displacement less than 30 liters per cylinder installed on vessels flagged or registered in the United States. EPA divides marine diesel engines into three categories for the purposes of their standards. Category 1 represents engines up to 7 liters per cylinder displacement. Category 2 includes engines from 7 to 30 liters per cylinder. Finally, Category 3 engines are those at or above 30 liters per cylinder. Category 3 engines are not included in this rule. They are typically used for propulsion on ocean-going vessels and will be addressed in a separate EPA rulemaking.

Marine diesel engines covered by EPA's regulations are used in a variety of applications. Commercial propulsion applications range from fishing and tug boats to Great Lakes freighters. Recreational propulsion applications range from sailboats to super-yachts. Auxiliary power units range from small generator sets to large auxiliary engines on ocean-going vessels. This final group would be of most interest to the port of Savannah. The effect of the rulemaking will be limited, as the marine engine component only applies to vessels flagged or registered in the United States. Most of the vessels that call at Savannah are registered in another country, so these new standards would not apply to them.

The March 2007 rule consists of three parts.

First, there will be new standards for existing locomotives and marine diesel engines when they are remanufactured. They would also apply to newly manufactured locomotives. The standards take effect as soon as certified remanufacture systems are available, as early as 2008.

Second, the rule sets near-term emission standards, referred to as Tier 3 standards, for newly-built locomotive and diesel marine engines. These standards reflect the application of currently available technologies to reduce engine emissions of PM and NOx and phase-in starting in 2009. The rule also creates new idle reduction requirements for new and remanufactured locomotives and establishes a new generation of clean switch locomotives, based on clean non-road diesel engine standards.

Third, the final long-term emissions standards, referred to as Tier 4, apply to newly-built locomotives and marine diesel engines. These standards are based on the application of high-efficiency catalytic after-treatment technology and would phase-in beginning in 2014 for marine diesel engines and 2015 for locomotives. These standards are enabled by the availability of ultra-low sulfur diesel fuel with sulfur content capped at 15 parts per million, which will be available by 2012. These marine Tier 4 engine standards apply only to commercial marine diesel engines above 600 kW (800 hp).

EPA estimates this final rule will result in PM reductions of about 90 percent and NOx reductions of about 80 percent from engines meeting these standards, compared to engines meeting the current standards. The standards would also yield sizeable reductions in emissions of HC, CO, and other air toxics.

On December 18, 2009, EPA finalized emission standards for new marine diesel engines with per-cylinder displacement at or above 30 liters (called Category 3 marine diesel engines) installed on US vessels. These emission standards are equivalent to those adopted in the amendments to Annex VI to the International Convention for the Prevention of Pollution from Ships (MARPOL Annex VI). The emission standards apply in two stages—near-term standards for newly built engines will apply beginning in 2011; long-term standards requiring an 80 percent reduction in NOx emissions will begin in 2016. EPA also finalized a change to its diesel fuel program that will allow for the production and sale of 1,000 ppm sulfur fuel for use in Category 3 marine vessels. In addition, the new fuel requirements will generally forbid the production and sale of other fuels above 1,000 ppm sulfur for use in most U.S. waters, unless alternative devices, procedures, or compliance methods are used to achieve equivalent emissions reductions. EPA adopted further provisions under the Act to Prevent Pollution from Ships, especially to apply the emission standards to engines covered by MARPOL Annex VI that are not covered by the Clean Air Act, and to require that these additional engines use the specified fuels (or equivalents).

The final regulations also include technical amendments to EPA's motor vehicle and non-road engine regulations; many of these changes involve minor adjustments or corrections to our recently finalized rule for new non-road spark-ignition engines or adjustment to other regulatory provisions to align with this recent final rule.

According to this new standard, OGV within 200 miles of the USA are required to comply with the following:

> Sulfur fuel standards will change in 2012 to 1% or 10,000 ppm S. In 2015 sulfur content will be reduced to 1,000 ppm or 0.10% sulfur. In 2016 NOx will be 3.0 g/kW-hr, no change in PM and SOx (since low sulfur fuel reduces these two pollutants), HC and CO are 2.0 g/kW-hr and 5.0 g/kW-hr respectively. No standards are being developed for CO2.

In 2008, the Pilots in Savannah indicated that OGV are currently using RO with 10,000 ppm sulfur. The current emission inventory uses this 10,000 ppm SO2 standard for 2008 (well before the 2012 deadline). Years 2016, 2020, 2025, 2030, and 2066 have been revised to reflect the new US EPA NOx and Sulfur standard.

On January 22, 2010, EPA strengthened the health-based National Ambient Air Quality Standard (NAAQS) for nitrogen dioxide (NO_2). The new standard will protect public health, including the health of sensitive populations – people with asthma, children and the elderly. EPA set a new 1-hour NO_2 standard at the level of 100 parts per billion (ppb). This level defines the maximum allowable concentration anywhere in an area. It will protect against adverse health effects associated with short-term exposure to NO_x, including respiratory effects that can result in admission to a hospital. In addition to establishing an averaging time and level, EPA also set a new “form” for the standard. The form is the air quality statistic used to determine if an area meets the standard. The form for the 1-hour NO_2 standard is the 3-year average of the 98th percentile of the annual distribution of daily maximum 1-hour average concentrations.

EPA also retained, with no change, the current annual average NO_2 standard of 53 ppb. EPA states that this suite of standards will protect public health by limiting people’s exposures to short-term peak concentrations of NO_2 – which primarily occur near major roads – and by limiting community-wide NO_2 concentrations to levels below those that have been linked to respiratory-related emergency department visits and hospital admissions in the United States. To determine compliance with the new standard, EPA established new ambient air monitoring and reporting requirements for NO_2. In urban areas, monitors are required near major roads, as well as in other locations where maximum concentrations are expected.

Additional monitors are required in large urban areas to measure the highest concentrations of NO_2 that occur more broadly across communities. Working with the States, EPA will site a subset of monitors in locations to help protect communities that are susceptible and vulnerable to NO_2-related health effects.

EPA is setting new requirements for the placement of new NO_2 monitors in urban areas. These include:

A. Near Road Monitoring

At least one monitor must be located near a major road in any urban area with a population greater than or equal to 500,000 people. A second monitor is required near another major road in areas with either:

(1) population greater than or equal to 2.5 million people, or
(2) one or more road segment with an annual average daily traffic (AADT) count greater than or equal to 250,000 vehicles.

These NO_2 monitors must be placed near those road segments ranked with the highest traffic levels by AADT, with consideration given to fleet mix, congestion patterns, terrain, geographic location, and meteorology in identifying locations where the peak concentrations of NO_2 are expected to occur. Monitors must be placed no more than 50 meters (about 164 feet) away from the edge of the nearest traffic lane.

EPA estimates that the new NO_2 monitoring requirements will result in a network of approximately 126 NO_2 monitoring sites near major roads in 102 urban areas.

B. Community-Wide Monitoring

A minimum of one monitor must be placed in any urban area with a population greater than or equal to 1 million people to assess community-wide concentrations. An additional 53 monitoring sites will be required to assess community-wide levels in urban areas. Some NO_2 monitors already in operation may meet the community-wide monitor siting requirements.

EPA expects to identify or designate areas not meeting the new standard, based on the existing community-wide monitoring network, by January 2012. New monitors must begin operating no later than January 1, 2013. When three years of air quality data are available from the new monitoring network, EPA intends to re-designate areas as appropriate. It may be January 1, 2016, before EPA has the required data to re-designate areas as appropriate.

The US Census Bureau defines the Savannah Metropolitan Statistical Area (MSA) as Bryan, Chatham, and Effingham counties. Between 2000 and 2008, the estimated population of the Savannah MSA grew from 293,000 to 334,353 an increase of 14 percent.

According to the Georgia Department of Transportation (GADOT) in 2008, no highways in the Savannah MSA had an AADT count greater or equal to 250,000 vehicles (GADOT 2010).

Ongoing actions that improve air quality – Port of NY/NJ

The Port of New York/New Jersey completed an Emission Inventory Update in 2005 and found that emissions from their Cargo Handling Equipment had dropped, even though the fleet had increased by 19 percent, their average operating hours had increased by 5 percent, and the total number of containers handled increased by 25 percent. The reductions were attributed to a modernization of the fleet and lower sulfur fuels. Their 2005 report explains that EPA found that newer engines produce less pollution, and as they replaced their fleet with newer models, the overall pollution levels would decrease. EPA's data is summarized as follows:

Table 6-10
NONROAD Emission Factors (Grams/HP-Hr)

Engine Tier	Year of Engine	NOx	PM10
Tier 2	2002 – 2004	4.90	0.15
Tier 1	1996 – 2001	6.90	0.25
Base	Pre-1996	10.90	0.49

NOTE: The Base emissions are estimated

Based on this information, engines manufactured today produce roughly half the NOx and PM10 emissions that engines did which were manufactured before 1996. One could expect similar decreases in emissions from Cargo Handling Equipment in Savannah as the terminal operators modernize their equipment and begin to use the cleaner fuels.

Conclusions

Four categories of activities in the Port of Savannah were found to have relatively minor amounts of air emissions (Figures 6-1 and 6-2). Those four consist of (1) internal movement of vessels within the port (Shifts); (2) Maintenance Dredging performed by the Corps; (3) Tourist Boats (Chatham County's shuttle service and two large private tour boats); and operations associated with Liquefied Natural Gas vessels. Those activities do not adversely affect the quality of air in Chatham County or at the Port.

NOx is the pollutant that is emitted in the largest quantities in the port (Figures 6-1 and 6-2). This pollutant comprises roughly 58 percent of the quantity of emissions among the pollutants analyzed (HC, VOC, CO, NOx, PM10, PM2.5 and SO2).

Container vessels are the source of most air emissions among the various types of vessels that call at the port (Figure 6-6). That is to be expected, as the port services more Container vessels than any other vessel type.

Most of the air emissions at the Port result from the deep-draft vessels which call there (Figure 6-11). The tugs which guide those vessels and the land-based operations that handle their cargoes were found to contribute much less air emissions than the vessels or their land-based support operations.

It is apparent from the Corps' Fleet Forecast (Attachment A, April 2011) , that the numbers of vessels expected to call on the Port of Savannah for years 2016, 2020, 2025, 2030, and 2066 will be substantially greater for the existing depth of -42 feet than the maximum proposed depth of -48 feet (see Table 4-3). In 2030, for the -42 and -48 foot depths, the numbers of vessels arriving in Savannah would change from 7,205 to 6,714 respectively. In 2030, the Fleet Forecast estimates 7.3% more vessels arriving in Savannah for the existing depth of - 42 feet than for the maximum proposed depth of -48 foot. More vessels calling on the Port for the existing -42 foot depth during this projected time (i.e., 2016 to 2066) would result in a greater amount of criteria pollutants, air toxics and greenhouse gases being discharged in Chatham County. Those emissions would be reduced by a deeper harbor that would allow a fleet of larger vessels that each carries more cargo. The same cargo volumes could be moved through the port with fewer container ships. Tables showing the Summary of all Emissions (i.e., Table 5-78) and mentioned throughout this document show this trend.

For the Land-Based Operations at GPA's Garden City Terminal (Figures 6-16 and 6-17), Top lifts were found to produce the most air emissions, followed by Rubber-Tired Gantry Cranes, Jockey Trucks, and Aerial Cranes. The Trucks that bring containers to the port and take them to their US destination were found to be relatively small contributors to the total air emissions. Although Trucks emitted more NOx than other pollutants, they contributed a larger percentage of CO (4.8 percent) to the emissions from the terminal (Table 6-2). Truck emissions comprise less than 5 percent of all air emissions produced by the port.

While containerships are docked and being serviced (referred to as Hotelling) at Garden City Terminal, they contribute less than 12% of the total emissions of the total port emissions (Table 6-1). The emissions while Hotelling represent less than 12% of the emissions from the Garden City Terminal (vessels, tugs, and landside CHE). With the proposed future EPA reductions in both NOx and Sulfur emissions for containerships, this percentage would be further reduced. Therefore, Hotelling is not a major contributor to the port's emissions.

New Work Dredging to deepen the harbor would be a substantial contributor (>10 percent) of the port's emissions of CO and NOx during the four-year construction period (Table 6-5). However, a large portion of those emissions would occur offshore while deepening the entrance channel and are not likely to contribute to air pollution in the City or County.

The Corps' calculations of 2008 emissions for the Port indicate that the Port was a substantial contributor of NOx (18.3 percent compared to the EPA 2002 NEI and 13.5 percent compared to the EPA 2005 NEI data) emissions in Chatham County (Table 6-4). (It should be noted that some of the emissions the Corps calculated for the Port occur while ships move through the entrance channel located in the ocean east of the coastline.) The Port contributes only minor amounts to emissions of SO2 (5.4 and 5.1 percent compared to the EPA 2002 and 2005 NEI data), PM10 (3.4 and 3.1 percent compared to the EPA 2002 and 2005 NEI data), PM2.5 (9.5 and 7.2 percent compared to the EPA 2002 and 2005 NEI data), HC (1.9 and 2.0 percent compared to the EPA 2002 and 2005 NEI data), VOC (1.9 and 2.0 percent compared to the EPA 2002 and 2005 NEI data), and CO (1.3 to 1.6 percent compared to the EPA 2002 and 2005 NEI data).

The Corps understands that the port and navigation channels are located in both Chatham County, Georgia and Jasper County, South Carolina. The Corps compared the 2008 calculated Port emissions (all 22 terminals) to the combined US EPA NEI data for both Chatham and Jaspers Counties for 2002 and 2005. Table 6-11 shows the comparison.

Table 6-11
Comparison of the 2008 Port Emissions to US EPA NEI data for Chatham County, Georgia and Jasper County, South Carolina for 2002 and 2005.

	HC	VOC	CO	NOx	PM10	PM2.5	SO2
2002 NEI (Tons/Year)							
Jasper County	5,851	5,880	29,028	3,975	4,698	962	993
2005 NEI (Tons/Year)							
Jasper County	4,584	4,607	30,083	3,482	3,331	1,296	655
2002 NEI (Tons/Year)							
Chatham County	18,198	18,289	99,565	32,454	6,782	2,453	23,115
2005 NEI (Tons/Year)							
Chatham County	17,518	17,606	81,948	40,230	7,405	3,104	23,665
Combined Chatham and Jasper Co's							
2002	24,049	24,169	128,593	36,429	11,480	3,415	24,108
2005	22,102	22,213	112,031	43,712	10,736	4,399	24,319
2008 Port Emissions (-42 foot depth) in Tons	348	352	1,394	5,042	230	216	1,177
% 2008 Port Emissions/Combined							
2002 Chatham and Jasper County's	**1.45%**	**1.46%**	**1.08%**	**13.84%**	**2.00%**	**6.33%**	**4.88%**
2005 Chatham and Jasper County's	**1.58%**	**1.59%**	**1.24%**	**11.53%**	**2.14%**	**4.91%**	**4.84%**

Table 6-11 also indicates that the overall port emissions for all 22 terminals in Savannah are not a significant emitter of criteria pollutants in the project area.

Emissions of NOx, SO2, and PM2.5 are likely to decrease as the terminal operators replace their equipment with newer engines that do not emit as much pollution and use the lower sulfur fuels mandated by EPA. The port's contributions to SO2 emissions are expected to decrease as a result of EPA's requirements for use of cleaner fuels. These new standards should substantially reduce SO2 emissions, as the SO2 content in the fuels used by non-road diesel, locomotives, and marine diesel engines transitioned from 500 ppm sulfur in 2007 to ultra low sulfur diesel (ULSD) -- which is 15 ppm -- in 2010. For Ocean-Going Vessels, EPA issued new emission standards in late 2009 for Category 3 marine diesel engines which will require an 80 percent reduction in NOx emissions beginning in 2016. EPA also adopted standards for engines covered by MARPOL Annex VI that require OGV within 200 miles of the US to use fuel with a maximum of 1% Sulfur (10,000 ppm) beginning in 2012 and 0.10% (1,000 ppm) beginning in 2015. Again, the port's contributions of NOx and SO2 emissions in the County should substantially decrease as a result of these new cleaner fuel requirements.

Comparing the calculated port air toxic emissions in 2008 to EPA's 2002 County-wide air toxic emissions, the Port is not a significant contributor of any air toxics in Chatham County (Table 6-6). The Port contributes minor amounts (less than 5%) of the County's totals for the 28 air toxics that were calculated.

For the 50-year project life, the Port does not appear to be a significant emitter of greenhouse gases (Table 6-6). Port operations contribute less CO2 than the one facility that is included in EPA's public database for Chatham County - the existing coal-fired Kraft Steam Electric Plant in Port Wentworth, Georgia, which has emitted on average over 1.3 million tons per year of CO_2 into the atmosphere since 2002.

More detailed analyses -- such as dispersion analyses to identify "hot spots" of pollution -- were not conducted because the Port is not a major contributor to the overall emissions in the County. In addition, the dispersed nature of many of those "Port" emissions along the 38-mile length of the navigation channel reduces the potential for adverse effects at any given location. At the request of EPA Region 4, the Georgia Ports Authority is separately conducting additional air analyses, including a dispersion analysis, on the present operations at its two terminals in Savannah. The results of that analysis are not yet available.

Future growth in cargo movements and accompanying air emissions are expected at Savannah. With or without the harbor deepening, these air emissions are expected to grow. Those increases would be the result of increasing demand for the goods which move through the port and not a result of a harbor deepening. Those higher total emission levels in the future would be lessened if larger container vessels are allowed to regularly call at the port. The expected future growth in total emission levels would be substantially lessened by the recently-mandated use of cleaner fuels.

Any of the proposed harbor deepening alternatives would reduce air emission levels in the Port of Savannah from what would occur with the existing 42-foot navigation channel. The beneficial effect increases with the amount of deepening. Construction of a deeper channel would result in temporary increases in air emissions. However, since those temporary increases would be distributed along the length of the 38-mile channel – almost half of which is in the ocean on the entrance channel -- the overall effects of a harbor deepening project would be beneficial and not warrant mitigation.

Under both the Without and With project conditions, the Corps expects the Garden City Terminal to reach its build-out capacity near 2030 when the total number of TEUs processed through the terminal reaches 6.5 million. That capacity is the maximum number of containers that could reasonably be processed through the Garden City Terminal in a year. That determination includes factors such as the size of the terminal, the number of gates that provide access to the property, the number and size of the berths, the number and size of the container cranes, the number of jockey trucks that move the containers within the terminal, how the containers are stacked within the terminal, and the number of railroads that service the terminal and the frequency of their trains. It is anticipated that without deepening, more vessels will be required to transport the cargo that is expected to move through the port. With deepening, the total number of vessels would decrease as vessels would be able to load more deeply under the improved conditions.

To better understand uncertainties in the level of air emissions that could occur at the Port of Savannah, EPA requested the Corps evaluate alternate scenarios for the number of containers expected to move through the port in the future. In Attachment C, the Corps discusses and evaluates alternative future conditions in the level of air emissions in the Port of Savannah.

No increases in cargo are expected to occur as a result of the proposed harbor deepening. As a result, the project would not affect the number of containers that move through the areas that surround the port. The economic benefits of the project would result from the use of larger, more cost-effective container ships, not an increase in the number of containers. Noise, air emissions (including air toxics), and traffic would not be increased as a result of the proposed deepening. Therefore, the proposed harbor deepening would have no adverse landside impacts.

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ATTACHMENT A

Container Fleet Forecast
(April 2011)

Expected Container Vessel Calls (One-way)
Garden City Terminal

2008	Post-Panamax Gen II	Post-Panamax Gen I	Panamax	Sub-Panamax	Total
-42 feet Baseline	0	32	1,261	228	1,521

2016	Post-Panamax Gen II	Post-Panamax Gen I	Panamax	Sub-Panamax	Total
-42 feet Baseline	134	483	1,171	505	2,293
-44 feet	267	293	1,116	505	2,181
-45 feet	266	292	1,094	505	2,157
-46 feet	265	292	1,084	505	2,145
-47 feet	265	292	1,079	505	2,141
-48-feet	265	292	1,079	505	2,141

2020	Post-Panamax Gen II	Post-Panamax Gen I	Panamax	Sub-Panamax	Total
-42 feet Baseline	271	866	778	593	2,509
-44 feet	533	478	700	593	2,304
-45 feet	527	474	671	593	2,265
-46 feet	524	471	658	593	2,247
-47 feet	524	471	649	593	2,238
-48-feet	524	471	649	593	2,238

2025	Post-Panamax Gen II	Post-Panamax Gen I	Panamax	Sub-Panamax	Total
-42 feet Baseline	382	1,006	1,122	758	3,267
-44 feet	761	471	992	758	2,982
-45 feet	753	467	952	758	2,930
-46 feet	749	465	932	758	2,903
-47 feet	749	462	924	758	2,892
-48-feet	749	462	924	758	2,892

2030	Post-Panamax Gen II	Post-Panamax Gen I	Panamax	Sub-Panamax	Total
-42 feet Baseline	527	1,421	1,196	947	4,092
-44 feet	1,035	672	1,067	947	3,720
-45 feet	1,027	666	1,007	947	3,647
-46 feet	1,021	662	982	947	3,613
-47 feet	1,018	661	975	947	3,601
-48-feet	1,018	661	975	947	3,601

2066	Post-Panamax Gen II	Post-Panamax Gen I	Panamax	Sub-Panamax	Total
-42 feet Baseline	527	1,421	1,196	947	4,092
-44 feet	1,035	672	1,067	947	3,720
-45 feet	1,027	666	1,007	947	3,647
-46 feet	1,021	662	982	947	3,613
-47 feet	1,018	661	975	947	3,601
-48-feet	1,018	661	975	947	3,601

General Cargo and LNG Vessel Fleet Calls for all Depths

YEAR	2008	2016	2020	2025	2030
GENERAL CARGO	1,083	1,733	2,068	2,468	2,946
LNG	120	120	136	151	167
Total	**1,203**	**1,853**	**2,204**	**2,619**	**3,113**

Expected Liquefied Natural Gas Vessel Calls (One-Way)
Southern LNG Terminal

Year	Total Vessels	BU SAMRA (266,000 BCM) (17.4%)	AL UWAILA (217,000 BCM) (12.7%)	MERSK ARWA (165,500 BCM) (23.9%)	LUSAIL (145,000 BCM) (23.5%)	BRITISH TRADER (135,000 BCM) (22.5%)
2016	120	21	15	29	28	27
2020	136	24	17	32	32	30
2025	151	26	19	36	35	34
2030	167	29	21	40	39	37

ATTACHMENT B

Emission Calculation Spreadsheets
(Available on CD)

ATTACHMENT C

Evaluation of Alternate Future Conditions

Evaluation of Alternate Future Conditions

In their review of the Draft EIS, EPA commented on the uncertainty that surrounds the Corps' projections for the volume of containers expected to move through the port in the future. As with any prediction of the future, there is uncertainty around the resulting numbers. The District predicts consistent growth in the number of containers, based primarily upon expected increases in GDP in the Southeast. That expectation of future growth is independent of whether the harbor is deepened. This approach assumes that a harbor deepening to -47/48 foot depth would not alter the Port of Savannah's competitiveness compared to nearby ports. This approach is the one that the US Army Corps of Engineers typically takes in its evaluations of the feasibility of proposed improvements to container ports. It is a conservative one from which to assess the economic viability of such proposed actions. In this case, it is supported by the Corps' 2006 Multiport Analysis (included as supplemental materials in the GRR Economic Appendix) that found that vessel voyage cost savings resulting from deepening Savannah Harbor would not be sufficient to divert containers from other ports on the basis of least total transportation cost (voyage, port, and hinterland).

For both the **With Project Base Condition** and the **Without Project Base Condition** scenarios (see Tables 1 & 2), the Total Port Capacity would be reached in 2030 with 6.5 million TEUs. After the terminal capacity is reached, the container volume and resulting air emissions would stay constant for the future. The **With Project Base Condition** scenario includes no change in the Port of Savannah's competitiveness as a result of harbor deepening, which is supported by the conclusion of the Corps' 2006 Multiport Analysis.

To address uncertainty in the level of air emissions that could occur at the Port, EPA requested the Corps evaluate alternate scenarios for the number of containers expected to move through the port in the future.

EPA pointed out that GPA has stated that harbor deepening is required for this port to remain competitive – to keep its present market share. If no deepening occurs, another potential scenario is that the growth in container volume and/or the number of containers decreases for a period of time as shippers use other ports which can efficiently handle the larger, more cost-effective vessels. With that scenario, one could assume that that cargo volume resumes its long term growth rate (that is dependent upon GDP) after a few years of transition. The Corps calculated air emissions for such a scenario of the future, which are found in Table 5-78 in Appendix K. For this **Without Project Reduced Cargo Scenario** (see Table 3), the cargo volumes would be constant for about 10 years after the base year of 2016, then resume growth until the Total Port Capacity of 6.5 million TEUs is reached in 2040 (a later date than 2030 because growth slowed). After the terminal capacity is reached, the container volume and resulting air emissions would stay constant for the future.

Another scenario of the future is that harbor deepening would result in more goods being moved through this port. For this to occur, the improved transportation efficiencies would result in containers moving through Savannah that would otherwise move through other ports. Savannah would increase its market share and over other ports. Vessel transportation costs are one of several factors that a shipper considers when he decides which port to use in moving his goods. Those factors include the speed that goods are moved through the port, the process for the goods to clear customs, the security of goods while on the terminal, access to railroads, road congestion near the terminal, trucking or rail distance, and port fees. The 2006 Multiport Analysis does not support this scenario, but the Corps examined it for discussion purposes. For this **With Project Additional Cargo Scenario** (see Table 4, below), additional growth would occur after the harbor is deepened, but it could only continue until the 6.5 million TEU capacity of the Garden City Terminal is reached (in 2025, an earlier date than 2030 due to the faster growth). After the terminal capacity is reached, the container volume and resulting air emissions would stay constant for the future.

The District evaluated the air emission quantities that it calculated for the port to identify the potential range in emissions that could occur under these three scenarios of future conditions. All calculated air emission quantities for the entire port were taken from Table 5-78 in Appendix K Air Emission Inventory. The following tables show the Corps predictions for future emissions in the port under these three alternate scenarios of the future:

(1) Tables 1 and 2 shows the expected emissions in the **With and Without Project Base Scenarios**. The **With and Without Project Base** conditions are the Corps' expectation for the total port emissions with the proposed -47/48 foot and the existing 42-foot channel depth, respectively. The District believes that for both scenarios the port would handle about 2.8 million TEUs in 2016, Port Capacity would be reached in 2030, and air emissions would stay constant from 2030 to 2066. The total air emissions would be lower in the deepened -47/48 foot depth **With Project Base Condition** (when compared to the existing -42 foot depth **Without Project Condition**) because fewer but larger vessels could move the cargo through the port.

(2) Table 3 shows the expected emissions in the **Without Project Reduced Cargo Scenario**. The Corps defines the Reduced Cargo Scenario as being what would occur if the harbor is not deepened (depth remains at -42 foot depth) and shippers move a greater share of their containers through other ports, and cargo decreases (remains constant) for a period of time and then resumes growth until the Total Port Capacity is reached in 2040 with 6.5 million TEUs. Air emissions would stay constant from 2040 to 2066. The analysis is based on about a 10-year delay in the container fleet expected to call at Savannah.

(3) Table 4 shows the expected emissions in the **With Project Additional Cargo Scenario**. The Corps defines the Additional Cargo Scenario as being what would occur if the harbor is deepened to -47/48 foot depth and shippers move a greater share of their containers through Savannah. In this scenario, the deepened port would handle about 2.8 million TEUs in 2016 and would handle an additional 1.2 million TEUs over what was expected for 2025 (6,714 vs. 5,511 TEUs). Port Capacity would be reached in 2025 with 6.5 million TEUs and air emissions stay would constant from that date to 2066.

Tables 1, 2, 3 and 4, as well as Figures 1, 2, 3 and 4, show the calculated air emissions for the Port of Savannah under these alternate future condition scenarios.

As indicated in the tables and figures below, the port emissions are expected to vary over time (in response to GDP growth in the southeast). These analyses also show that the port emissions could vary with the different scenarios of future conditions. More or fewer goods could be moved through the Port of Savannah in response to the decision to deepen the harbor. The District makes the following observations from these four scenarios:

1. Air emissions would be lower in the **With Project Base Condition** (when compared to the **Without Project Condition**) because fewer but larger vessels could move the cargo through the port.

2. Air emissions would initially be greater under the **With Project Additional Cargo** scenario than in the **With Project Base Condition** for the future (both scenarios include a deepened harbor to -47/48 foot depth). The higher total air emissions (tons/year) would continue until the port reaches its landside capacity.

3. Once the total port capacity has been reached for the **Without and With Project Base Condition** in 2030, **With Project Additional Cargo** scenario in 2025, and the **Without Project Reduced Cargo** scenario in 2040, total air emissions for the port would remain constant to the end of the project life in 2066.

Table 1. With Project Base Condition Scenario Air Emissions for the Port of Savannah

Depth -47/48 feet									
Year	# of Vessels	HC	VOC	CO	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO_2
2008	2,724	348.34	352.54	1,394.06	5,042.24	229.76	216.14	1,177.49	258,153.99
2016	3,994	548.72	560.46	1,978.62	7,238.60	227.42	215.90	497.60	427,762.23
2020	4,442	625.68	632.16	2,005.80	5,810.42	230.54	218.22	498.97	423,671.23
2025	5,511	756.36	764.17	2,354.17	5,731.20	273.40	258.50	569.82	511,543.41
2030*	6,714	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26
2035	6,714	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26
2040	6,714	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26
2066	6,714	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26

***Total Port Capacity is reached**

Table 2. Without Project Base Condition Scenario Air Emissions for the Port of Savannah

Depth -42 feet									
Year	# of Vessels	HC	VOC	CO	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO_2
2008	2,724	348.34	352.54	1,394.06	5,042.24	229.76	216.14	1,177.49	258,153.99
2016	4,146	566.82	352.54	1,394.06	7,500.77	235.87	223.90	1,177.49	446,818.70
2020	4,713	663.09	578.86	2,041.34	6,238.08	247.18	233.98	503.08	461,222.15
2025	5,886	806.26	670.16	2,130.17	6,202.50	295.26	279.18	509.67	561,166.22
2030*	7,205	991.74	814.83	2,517.67	6,396.84	353.36	333.77	584.43	684,375.12
2035	7,205	991.74	1,002.19	2,988.15	6,396.84	353.36	333.77	671.22	684,375.12

2040	7,205	991.74	1,002.19	2,988.15	6,396.84	353.36	333.77	671.22	684,375.12
2066	7,205	991.74	1,002.19	2,988.15	6,396.84	353.36	333.77	671.22	684,375.12

*** Total Port Capacity is reached**

Table 3. Without Project Reduced Cargo Scenario Air Emissions for the Port of Savannah

Depth -42 feet									
Year	# of Vessels	HC	VOC	CO	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO_2
2008	2,724	348.34	352.54	1,394.06	5,042.24	229.76	216.14	1,177.49	258,153.99
2016	4,146	566.82	352.54	1,394.06	7,500.77	235.87	223.90	1,177.49	446,818.70
2020	4,146	566.82	352.54	1,394.06	7,500.77	235.87	223.90	1,177.49	446,818.70
2025	4,146	566.82	352.54	1,394.06	7,500.77	235.87	223.90	1,177.49	446,818.70
2030	4,713	663.09	578.86	2,041.34	6,238.08	247.18	233.98	503.08	461,222.15
2035	5,886	806.26	670.16	2,130.17	6,202.50	295.26	279.18	509.67	561,166.22
2040*	7,205	991.74	1,002.19	2,988.15	6,396.84	353.36	333.77	584.43	684,375.12
2066	7,205	991.74	1,002.19	2,988.15	6,396.84	353.36	333.77	584.43	684,375.12

***Total Port Capacity is reached**

Table 4. With Project Additional Cargo Scenario Air Emissions for the Port of Savannah

Depth -47/48 feet									
Year	# of Vessels	HC	VOC	CO	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO_2
2008	2,724	348.34	352.54	1,394.06	5,042.24	229.76	216.14	1,177.49	258,153.99
2016	3,994	548.72	560.46	1,978.62	7,238.60	227.42	215.90	497.60	427,762.23
2020	4,442	625.68	632.16	2,005.80	5,810.42	230.54	218.22	498.97	423,671.23
2025*	6,714	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26
2030	6,714	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26
2035	6,714	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26
2040	6,714	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26
2066	6,714	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26

***Total Port Capacity is reached**

Figure 1. Comparison of the Calculated Air Emissions (Tons/Year) for Alternate Future Condition Scenarios

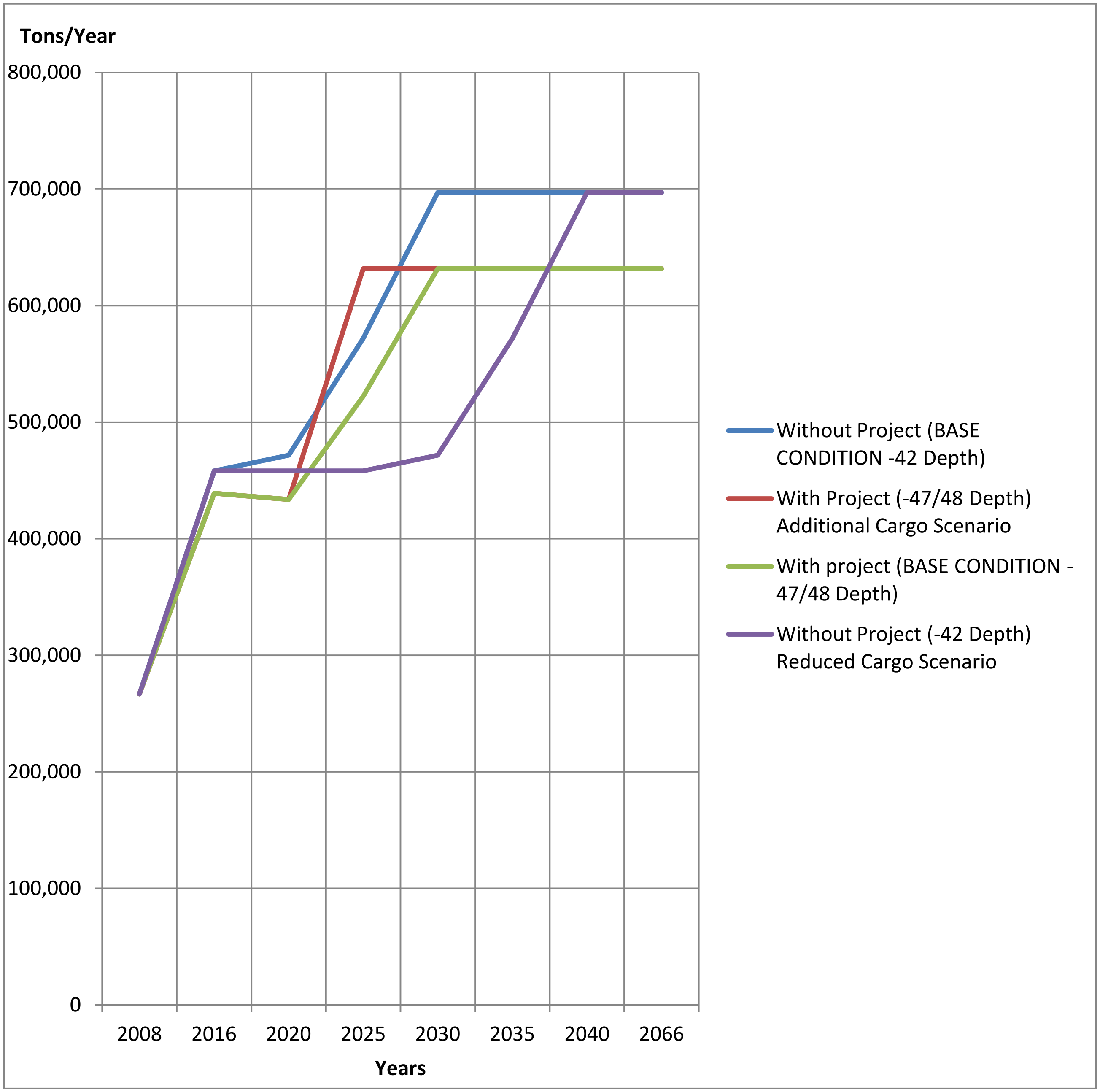

Figure 2. Comparison of the Calculated Air Emissions (Tons/Year): Without Project Base Condition (-42 foot depth) and With Project Base Condition (-47/48 foot depth), 2008 to 2066

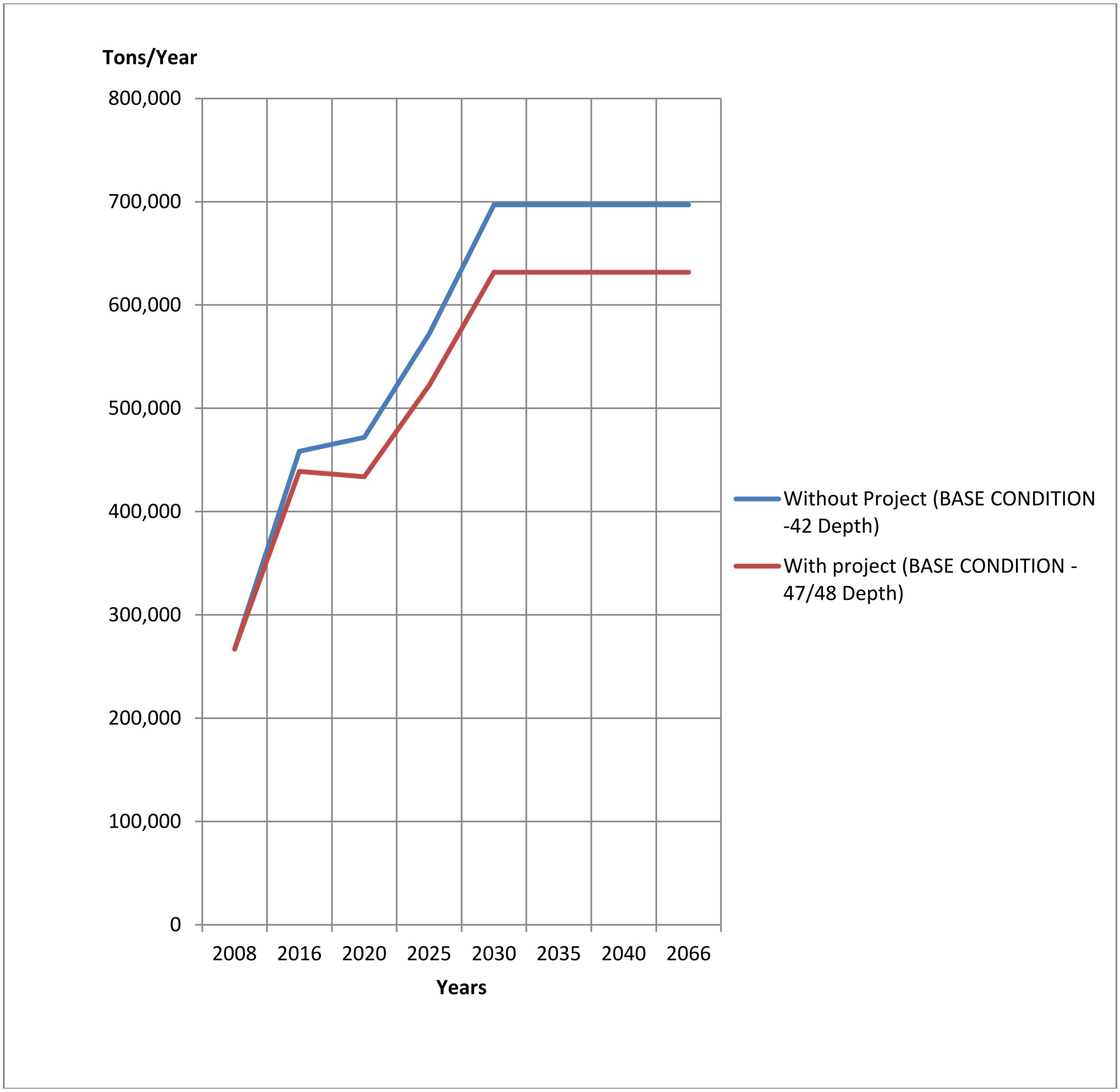

Figure 3. Comparison of the Calculated Air Emissions (Tons/Year): Without Project Base Condition (-42 foot depth) and Without Project Reduced Cargo Scenario (-42 foot depth), 2008 to 2066

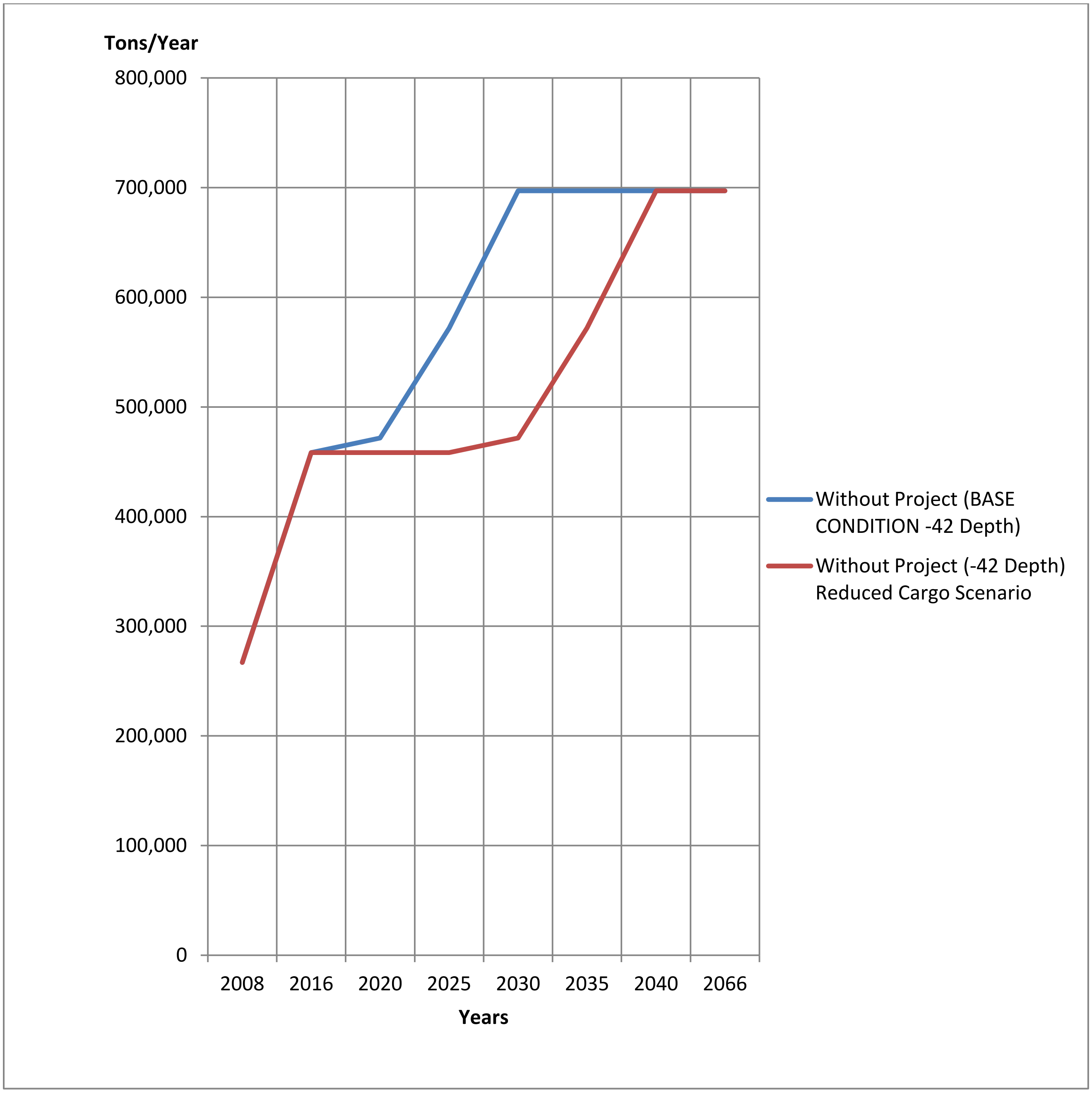

Figure 4. Comparison of the Calculated Air Emissions (Tons/Year): With Project Base Condition (-47/48 foot depth) and With Project Additional Cargo Scenario (-47/48 foot depth), 2008 to 2066