Integration of GHGs into NCDAQ's Air Emissions Reporting Online (AERO) as a tool for State Planning

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Abstract

With emerging scientific evidence of the global and national impacts of greenhouse gases (GHGs), NC Division of Air Quality (NC DAQ) began the planning process toward the study of NC's contribution to this issue. In order to assess this contribution and to analyze the impact of federal regulations, NC DAQ incorporated GHGs into its electronic emission inventory reporting system, data reports and combustion emission calculation spreadsheets. All pollutants classified as GHGs were added to the pollutant list in NC's web-based emissions reporting system called the Air Emissions Reporting Online (AERO). Beginning with the reporting of calendar year (CY) 2007 emissions, facilities could voluntarily report GHGs at the same time that criteria and hazardous air pollutants were reported. Since the majority of NC's GHG emissions are emitted from combustion sources, the emission factors were added to combustion calculation spreadsheets and GHG reporting guidelines were provided on NC DAQ's web page for use by facilities. These calculation spreadsheets and guidance documents were updated when the federal GHG Mandatory Reporting Rule (MRR) was promulgated. Outreach to encourage voluntary reporting of GHGs was provided through on-site workshops and on-line webinars.

NC DAQ is using the GHG emissions data collected since CY2007 to assess what industries are contributing to the GHG issue, where those industries are located and how they are regulated by recent federal permitting rules. These GHG emissions data, along with the US Environmental Protection Agency (EPA) GHG data collected through the GHG MRR, are planned to be combined and made available to the public interested in further analysis.

Background

In June 2002, the NC General Assembly enacted into law Senate Bill 1078, which became known as the Clean Smokestacks Act. In addition to requiring that certain coal-fired facilities to reduce nitrogen oxide and sulfur dioxide emissions, this act tasked NC DAQ to study the impacts of carbon dioxide emissions from coal-fired power plants and other stationary sources and make specific recommendations for reduction strategies. In September 2005, the final report was submitted to the NC General Assembly identifying a number of impacts to North Carolina's economy and natural resources due to climate change. In later years, the NC Climate Action Plan Advisory Group and the NC Legislative Commission on Global Climate Change were formed to further evaluate climate change mitigation and adaptation strategies. In their final reports, both groups recommended the need for an emissions inventory system that would allow the state to quantify current GHG emissions and future emissions resulting from programs implemented through policy and voluntary measures.

In 2008, NC DAQ initiated a rule revision process to modify its emission inventory rule to collect GHG emissions data from facilities classified as Title V. These data would be collected during the annual point source emission inventory process required by the federal Consolidated Emissions Reporting Rule (effective June 10, 2002), superseded by the Air Emissions Reporting Requirement

(effective December 8, 2008). The amended rule would have incorporated GHG emissions in the existing emissions database that includes criteria air pollutants, federally-defined hazardous air emissions (HAP) and NC-defined toxic air pollutants (TAP).

Prior to finalizing this rule, the EPA promulgated the Mandatory Reporting of Greenhouse Gases (MRR) on October 30, 2009. This resulted in a decision by the NC Environmental Management Commission (EMC) to take no further action on the state GHG emissions data collection rule. The commission felt that facilities having to report GHGs to NC as well as the EPA would be burdensome, and NC DAQ could utilize the federally reported data to meet its state GHG inventory goals.

In the spirit of meeting the recommendations contained in the final Clean Smokestack Report, the NC Climate Action Plan Advisory Group Report, and the NC Legislative Commission on Global Climate Change Report, the DAQ increased its efforts to collect voluntary GHG data. Thus the state-wide GHG emissions inventory would be comprised of the MRR data reported to EPA plus the voluntary data reported to DAQ.

Voluntary Reporting to NC DAQ

To accomplish the goal of setting up a voluntary reporting program, the Emission Inventory User Group (EIUG) and IT joined efforts to create business rules that: 1) identify which GHGs to collect, 2) include GHGs at the top of the pollutant list when adding pollutants to the emissions reported, 3) show how GHG emissions would be totaled and reported and 4) identify where the GHG emissions would be displayed on the various system pages and reports. EIUG in cooperation with the Planning Section of NC DAQ decided to add the GHGs listed in Table 1 into NC DAQ's Integrated Build Environment for Application Management's (IBEAM) internal and external modules, Emissions Data (ED) and Air Emissions Reporting Online (AERO). IBEAM is a stand-alone application developed by NC DAQ to track emission inventory data, air quality permits, compliance status, and other records necessary to manage and operate an air quality program. AERO is an external module utilized by permitted facilities to electronically submit required emissions data, and ED is the internal module that incorporates quality assured AERO data to meet EPA emissions inventory submittal requirements and to assess operating permit fees based on the tonnage of pollution emitted.

Table 1. List of GHGs added in NC Emissions Inventory.

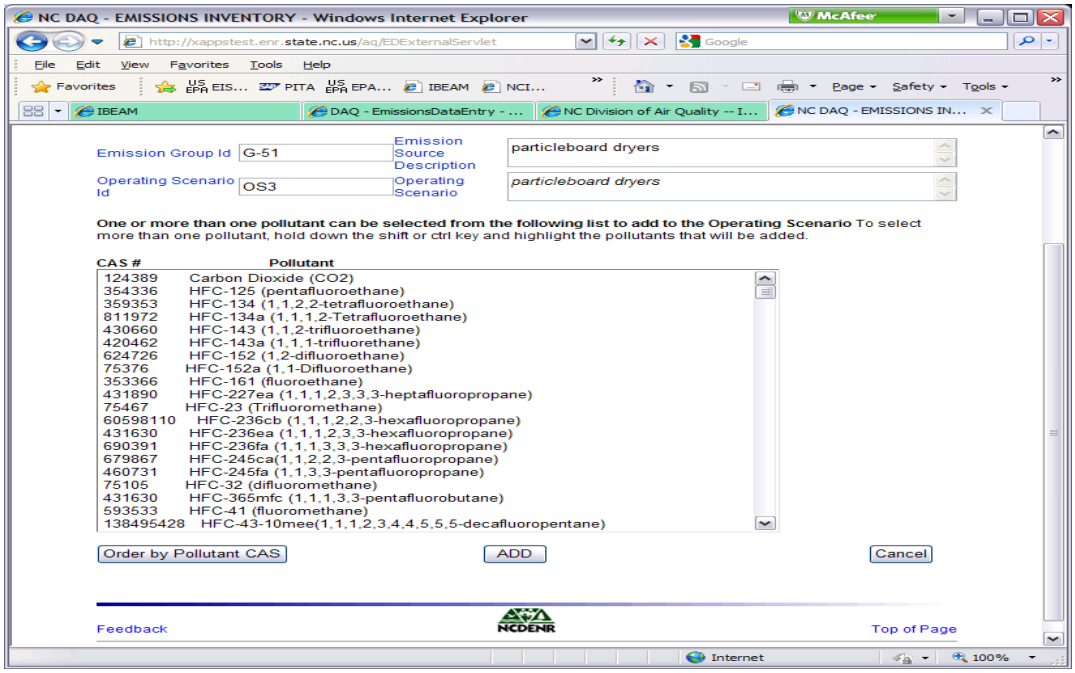
Pollutant Code (CAS)	Pollutant
124389	Carbon Dioxide (CO_2)
74828	Methane (CH_4)
10024972	Nitrous Oxide (N_2O)
2551624	Sulfur Hexafluoride (SF_6)
354336	HFC-125 (pentafluoroethane)
359353	HFC-134 (1,1,2,2-tetrafluoroethane)
811972	HFC-134a (1,1,1,2-Tetrafluoroethane)
430660	HFC-143 (1,1,2-trifluoroethane)
420462	HFC-143a (1,1,1-trifluorethane)
624726	HFC-152 (1,2-difluoroethane)
75376	HFC-152a (1,1-Difluoroethane)
353366	HFC-161 (fluoroethane)
431890	HFC-227ea (1,1,1,2,3,3,3-
75467	HFC-23 (Trifluoromethane)

60598110	HFC-236cb (1,1,1,2,2,3-hexafluoropropane)
431630	HFC-236ea (1,1,1,2,3,3-hexafluoropropane)
690391	HFC-236fa (1,1,1,3,3,3-hexafluoropropane)
679867	HFC-245ca(1,1,2,2,3-pentafluoropropane)
460731	HFC-245fa (1,1,3,3-pentafluoropropane)
75105	HFC-32 (difluoromethane)
408586	HFC-365mfc (1,1,1,3,3-pentafluorobutane)
593533	HFC-41 (fluoromethane)
138495428	HFC-43-10mee(1,1,1,2,3,4,4,5,5,5-
355259	Perfluorobutane (decafluorobutane)
115253	Perfluorocyclobutane (octafluorocyclobutane)
76164	Perfluoroethane (hexafluoroethane)
355420	Perfluorohexane (tetradecafluorohexane)
75730	Perfluoromethane (tetrafluoromethane)
678262	Perfluoropentane (dodecafluoropentane)
76197	Perfluoropropane (octafluoropropane)

The list was developed prior to EPA's MRR promulgation and was not changed as a result of EPA's rulemaking.

The addition of GHGs to the list of pollutants available to the NC reporters simply required adding the GHGs to the internal pollutant list. The business rules for AERO and ED were nearly identical since these modules mimic each other with a few exceptions. The EIUG elected to show the GHGs first in the pick lists regardless of whether the list was ordered by Chemical Abstracts Service (CAS) or name to encourage facilities to report GHG emissions (see Figure 1).

Figure 1. Screenshot of AERO pollutant list for addition.



Once the GHG(s) are selected for reporting, they are listed at the top of the emissions list on the Operating Scenario page in both ED and AERO. The Operating Scenario page shown in Figure 2

contains source information (id, name and description), operating parameters for the source (start and end date, hours per day, etc), emission control and release point information and emissions data. In AERO, if a facility has previously reported emissions for a source, all required information is contained on the Operating Scenario page. To be consistent with the other pollutants reported through AERO, EIUG decided to collect GHG emissions data in short tons rather than metric tons and to only report carbon dioxide equivalent in the Facility Totals report (Figure 3).

Figure 2. GHGs listed on AERO Operating Scenario page.

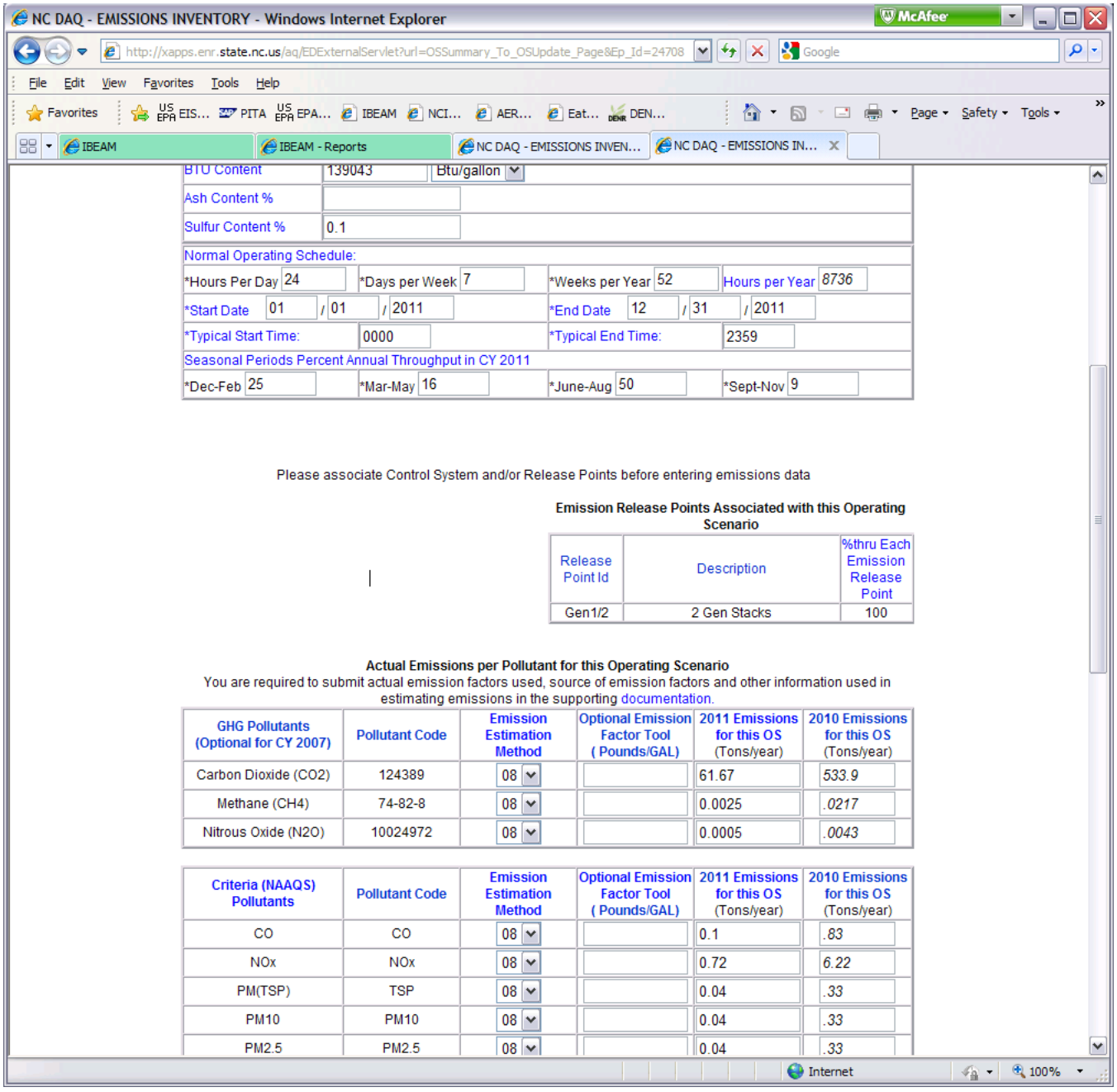
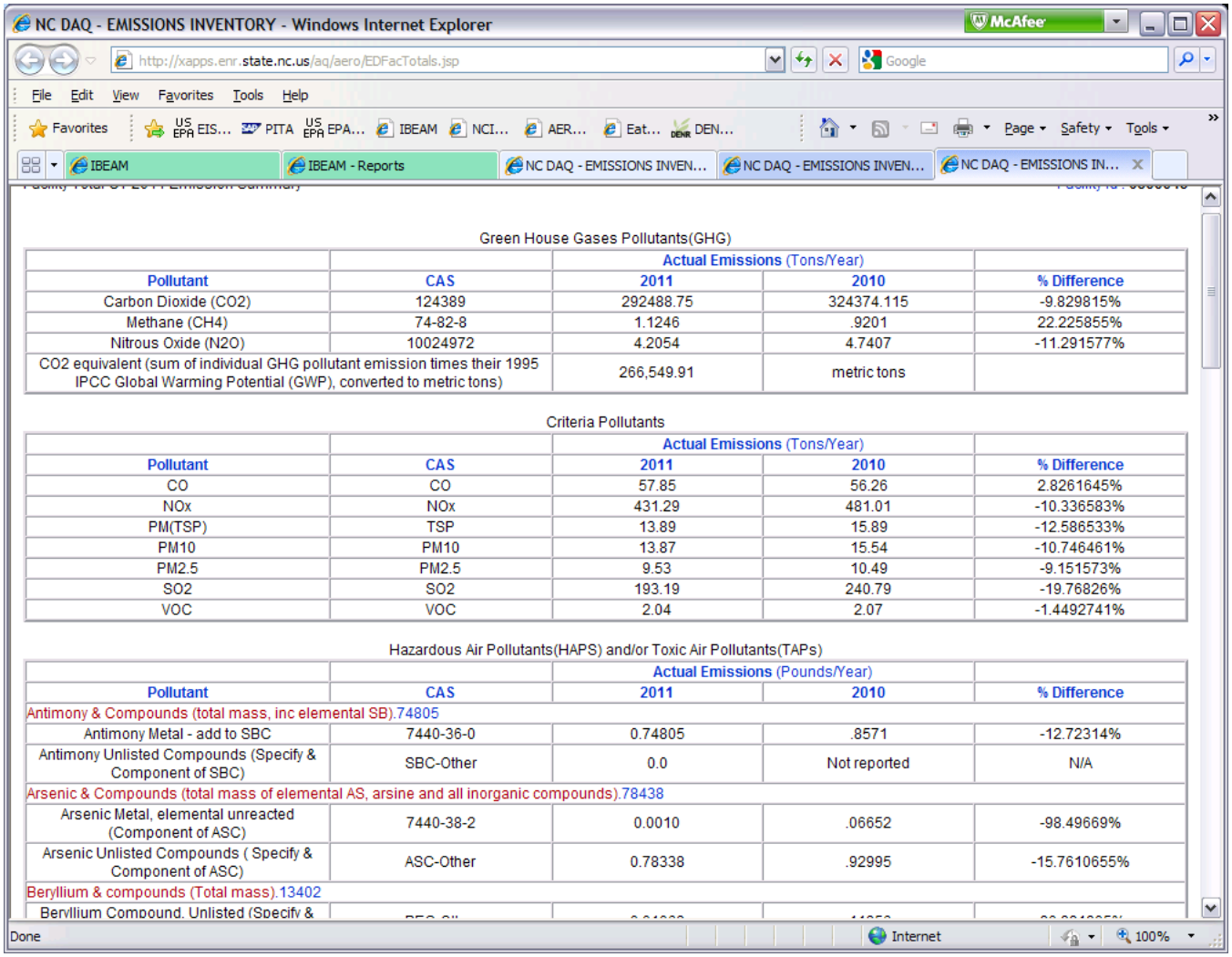


Figure 3. Facility Totals report from AERO.



NC DAQ - EMISSIONS INVENTORY - Windows Internet Explorer

http://xapps.enr.state.nc.us/aq/aero/EDFacTotals.jsp

Green House Gases Pollutants(GHG)

		Actual Emissions (Tons/Year)		
Pollutant	CAS	2011	2010	% Difference
Carbon Dioxide (CO2)	124389	292488.75	324374.115	-9.829815%
Methane (CH4)	74-82-8	1.1246	.9201	22.225855%
Nitrous Oxide (N2O)	10024972	4.2054	4.7407	-11.291577%
CO2 equivalent (sum of individual GHG pollutant emission times their 1995 IPCC Global Warming Potential (GWP), converted to metric tons)		266,549.91	metric tons	

Criteria Pollutants

		Actual Emissions (Tons/Year)		
Pollutant	CAS	2011	2010	% Difference
CO	CO	57.85	56.26	2.8261645%
NOx	NOx	431.29	481.01	-10.336583%
PM(TSP)	TSP	13.89	15.89	-12.586533%
PM10	PM10	13.87	15.54	-10.746461%
PM2.5	PM2.5	9.53	10.49	-9.151573%
SO2	SO2	193.19	240.79	-19.76826%
VOC	VOC	2.04	2.07	-1.4492741%

Hazardous Air Pollutants(HAPS) and/or Toxic Air Pollutants(TAPs)

		Actual Emissions (Pounds/Year)		
Pollutant	CAS	2011	2010	% Difference
Antimony & Compounds (total mass, inc elemental SB).74805				
Antimony Metal - add to SBC	7440-36-0	0.74805	.8571	-12.72314%
Antimony Unlisted Compounds (Specify & Component of SBC)	SBC-Other	0.0	Not reported	N/A
Arsenic & Compounds (total mass of elemental AS, arsine and all inorganic compounds).78438				
Arsenic Metal, elemental unreacted (Component of ASC)	7440-38-2	0.0010	.06652	-98.49669%
Arsenic Unlisted Compounds (Specify & Component of ASC)	ASC-Other	0.78338	.92995	-15.7610655%
Beryllium & compounds (Total mass).13402				
Beryllium Compound, Unlisted (Specify &				

To facilitate consistent and accurate calculation and reporting of GHG emissions, NC DAQ modified existing emission calculation spreadsheets that are routinely used by facilities to submit permit applications and meet point source emission inventory submittal requirements. The calculation spreadsheets are provided through NC DAQ's web page. The spreadsheets use source specific AP-42 emission factors or industry standard emission factors to generate a complete list of actual and potential criteria, hazardous and toxic air pollutant emission rates with minimum user input. The majority of these emission calculation spreadsheets were created for combustion sources. When the proposed NC rule revision was initiated, GHG emission factors were added to the combustion emission calculation spreadsheets to assist facilities with the calculation of GHG emissions. After the promulgation of the MRR, these calculation spreadsheets were modified to reflect the calculation strategies in this rule. In addition to this effort, NC DAQ developed written guidelines to assist calculation of GHG emissions for various industry types and source categories, and posted them on NCDAQ's web page for easy access.

DAQ organized and executed technical workshops at industry trade association gatherings and in-house training sessions to assist facilities voluntarily reporting GHG emissions. These technical workshops covered sources of GHG emissions, methods to calculate GHG emissions, references to written guidance, and demonstration of GHG data submittal through NC DAQ's web page into AERO.

Since the CY 2007 reporting period, NC DAQ has requested that facilities, especially Title V facilities, include GHG emissions along with other air emissions. Table 2 summarizes reported emissions to date. The number of facilities that reported at least one GHG has increased from 47 in 2007 to 163 in 2010 as noted in parentheses under the associated calendar year. The total emissions reported to NC DAQ in tons are shown with the number of contributing facilities shown in parentheses. Carbon dioxide equivalents (CO_2e) were calculated using global warming potentials consistent with the MRR.

Table 2. Voluntarily reported GHGs from 2007 to 2010.

Calendar year	Carbon dioxide, CO_2	Methane, CH_4	Nitrous Oxide, N_2O	Sulfur Hexafluoride, SF_6	HFC	PFC	Total in CO_2e,
	metric tons/yr (number of reporting facilities)						
2007 (47)	4,087,529 (43)	2,323 (33)	245 (30)	0.01 (1)	1,537 (7)	0.01 (1)	6,077,283
2008 (150)	6,593,619 (147)	11,422 (128)	583 (115)	0	7.63 (11)	0.04 (1)	7,752,994
2009 (144)	4,035,736 (139)	9,516 (121)	416 (109)	0	8.06 (8)	0	4,443,108
2010 (163)	4,060,446 (159)	6,456 (135)	2,119 (125)	0	8.56 (5)	0	4,935,438

Fluctuations in the GHG emissions reported can be attributed to several factors. NC DAQ had anticipated implementing the rule revision to collect GHG emissions beginning with CY2008; however, after promulgation of the MRR, GHG reporting remained voluntary. Many facilities had already collected GHG data in anticipation of the state rule so they included the GHG data in their emission inventory reporting. In IBEAM modules ED and AERO, GHG emissions data can be entered for any facility regardless of size or emission levels. The GHG emission values can be affected by both the number of facilities that reported and the emission values reported by an individual facility. Table 3 shows a breakdown of the voluntarily reported carbon dioxide emissions to illustrate some of the fluctuations in the collected GHG data. Twenty-two additional facilities reported in CY2010 compared to CY2009 but 16 of those facilities were classified as small and their emission values were relatively minor. One Title V facility reported 2,966,292 short tons (2,691,020 metric tons) of carbon dioxide in calendar year 2008; however, this facility has not voluntarily reported GHG emissions since that calendar year.

Table 3. Breakdown of voluntarily reported CO_2 emissions for CY2008-2010.

Calendar Year	Small facilities	Synthetic Minor facilities	Title V facilities
	short tons/yr (number of reporting facilities)		
2008 (147)	52,851 (30)	114.643 (19)	7,100,605 (98)
2009 (139)	6,691 (11)	148,391 (24)	4,293,480 (104)

2010 (159)	87,003 (26)	156,827 (26)	4,231,971 (107)

NC DAQ continues to encourage facilities to voluntarily submit GHG emissions when completing their point source emission inventory. The voluntary reporting program is a key component of a broader effort to combine the voluntary and federally mandated datasets into generating a state-wide multi-pollutant emissions inventory that includes facility level GHG data as well as criteria, hazardous and toxic air pollution information.

Integration of Voluntary and Mandatory Reported GHG Data

The EPA created an Integrated Project Team (IPT) of interested states to create an EPA-states data exchange of the GHG data reported electronically using EPA's Electronic Greenhouse Gas Reporting Tool (eGGRT). NC volunteered to be a member of the IPT so that NC could be involved in the process of the release of GHG data to the states. To expedite data analysis, NC hoped to be able to download MRR GHG data through the Central Data Exchange (CDX) node and incorporate that GHG data directly into the existing IBEAM database with the criteria air pollutants, HAP, TAP and GHGs reported to NC DAQ. EPA released the CY 2010 GHG data in May 2012. In the spring of 2012, the capability of a complete data download of GHG emissions data through the CDX node was still being developed.

The EPA Greenhouse Gas Reporting Program website posts Greenhouse Gas Reporting Program Data files for public use. Two files (2010 Summary GHG data and Parent Company data) were downloaded to test the feasibility of integrating NC's voluntary GHG data with the mandatory data reported by direct emitters. The first obstacle which also proved to be a major hurdle was that the facility identifiers were not compatible with EIS that is used by all states, tribes and local programs to submit air pollutants other than GHGs or the Federal Information Processing Standard (FIPS). The eGGRT assigned an identifier as facilities submitted their GHG data. EIS also assigns an identifier as states, tribes and local programs submit data for a facility; however, EIS includes the option to store an agency identifier, making identification of a specific facility by the submitting agency and retrieval of that facility's data easier. In the public release of eGGRT GHG data, a facility's FRS identifier, if available, was included. To associate this GHG data to the facility's other air pollutant data, a two-step process was necessary.

The first step was to acquire the necessary files needed to crosswalk the FRS identifier to NC's agency identifier. This task was accomplished by:

1) Accessing Envirofacts Federal Registry System (FRS) and running a query to recover a database of NC facilities which included the FRS and FIPS identifiers and
2) Using NC IBEAM system to generate a file containing all permitted facilities and their associated FIPS and NC agency identifiers.

The second step was to generate a query that used the two cross-walk files to match a facility's FRS identifier to that facility's FIPS identifier. These data were then associated with the facility's FIPS identifier to their NC's agency identifier. NC DAQ submits all emissions data for permitted facilities to EIS using their FIPS identifier so this crosswalk was easily obtainable from IBEAM. Problems arose when the EPA GHG data did not contain FRS, the FRS identifier had no equivalent FIPS identifier in the resulting crosswalk files, FRS to FIPS crosswalk file obtained from Envirofacts contained invalid or nonconventional FIPS identifiers, or the suspect facility did not have a NC air permit; therefore, did not have a FIPS or NC agency identifier.

Of 134 NC facilities reporting to eGGRT, 5 facilities had no FRS identifier associated and 20 facilities or 15 percent of the facilities did not have a corresponding FIPS identifier. In order for any

reliable multi-pollutant inventory to be developed, all facilities must have a proper and unique identifier assigned that can be readily accessed by the user so that GHG data from eGGRT can be associated with criteria and hazardous air pollutants. Many hours of manual manipulation of the GHG database was required to resolve most of the discrepancies.

The MRR-reported GHG data consisted of facility wide total emissions and total emissions by gas. The unit of measure for these emissions was metric tons of carbon dioxide equivalent so this unit of measure was established as the standard unit of measure for GHGs in the database. NC DAQ facilities that voluntarily reported GHG data for calendar year 2010 reported in units of tons of pollutant rather than metric tons of CO_2e. For these facilities, all pollutant values were converted to metric tons of (CO_2e) using global warming potentials to make the unit of measure consistent with the MRR GHG data.

In some cases, facilities voluntarily reported GHGs to NC DAQ and also reported through eGGRT for the MRR. Due to the quality assurance checks and additional review of the GHG data performed by the EPA, these data were preferentially selected over the GHG data voluntarily reported to NC DAQ.

MRR GHG emissions data differentiated biogenic and anthropogenic GHG emissions. However, facilities voluntarily reporting GHG emissions were not requested to separate biogenic and anthropogenic GHG emissions. In North Carolina, the vast majority of GHG emissions are due to anthropogenic sources. This is in agreement with the MRR data, where GHG emissions data classified as biogenic represented are about four percent of the total GHG emissions. At this time, all NC DAQ voluntarily reported GHG emissions are assumed to be emitted from anthropogenic sources. As time allows in future years, the GHG emissions data will be analyzed by fuel source and differentiated as biogenic or anthropogenic. Table 4 summarizes combined GHG emissions data for North Carolina.

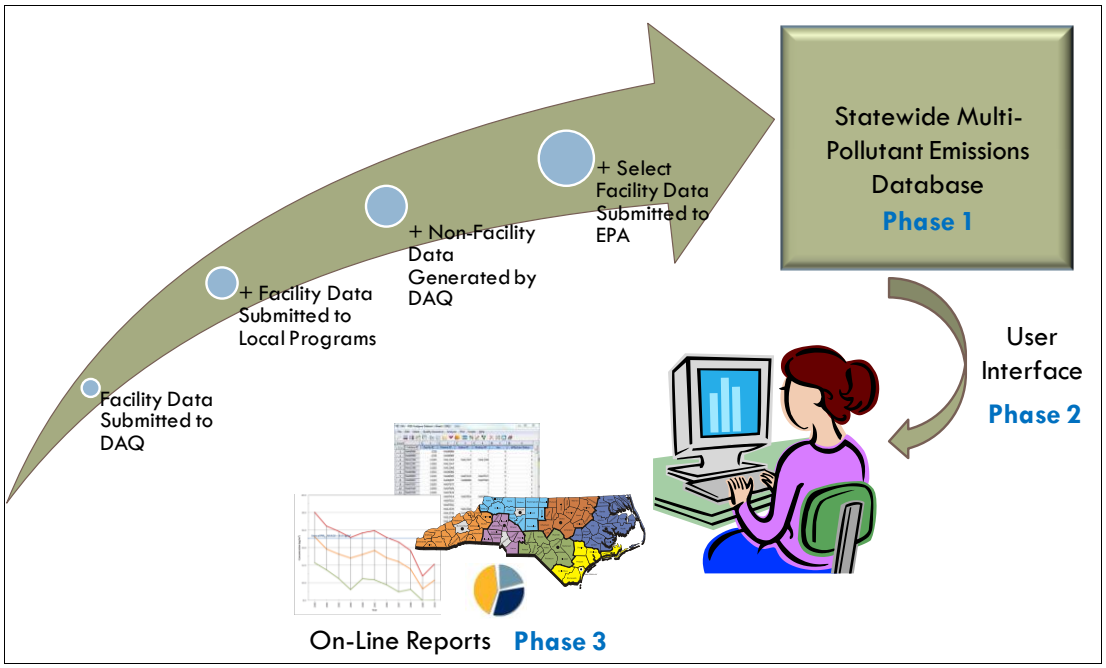
Table 4. 2010 GHG emissions for North Carolina from direct emitters.

	Voluntary	**Mandatory**	**NC Total**
Total GHGs (metric tons CO2e)	2,549,524	81,487,435	84,036,959
No. of Reporting Facilities	206	132	338
Note: Facilities that reported to both EPA (in 2010) and NC DAQ (in 2010 or most recent year of reporting) are represented in the Mandatory dataset.			

Next Steps in Developing a Statewide Multi-Pollutant Emissions Inventory

With increasing internal commitments and legislative and external requests for state-wide emissions data and data analysis, NC DAQ embarked on an effort to create a state-wide, multi-sector emissions database that could be used to make informed air quality planning decisions. Figure 4 illustrates the concept.

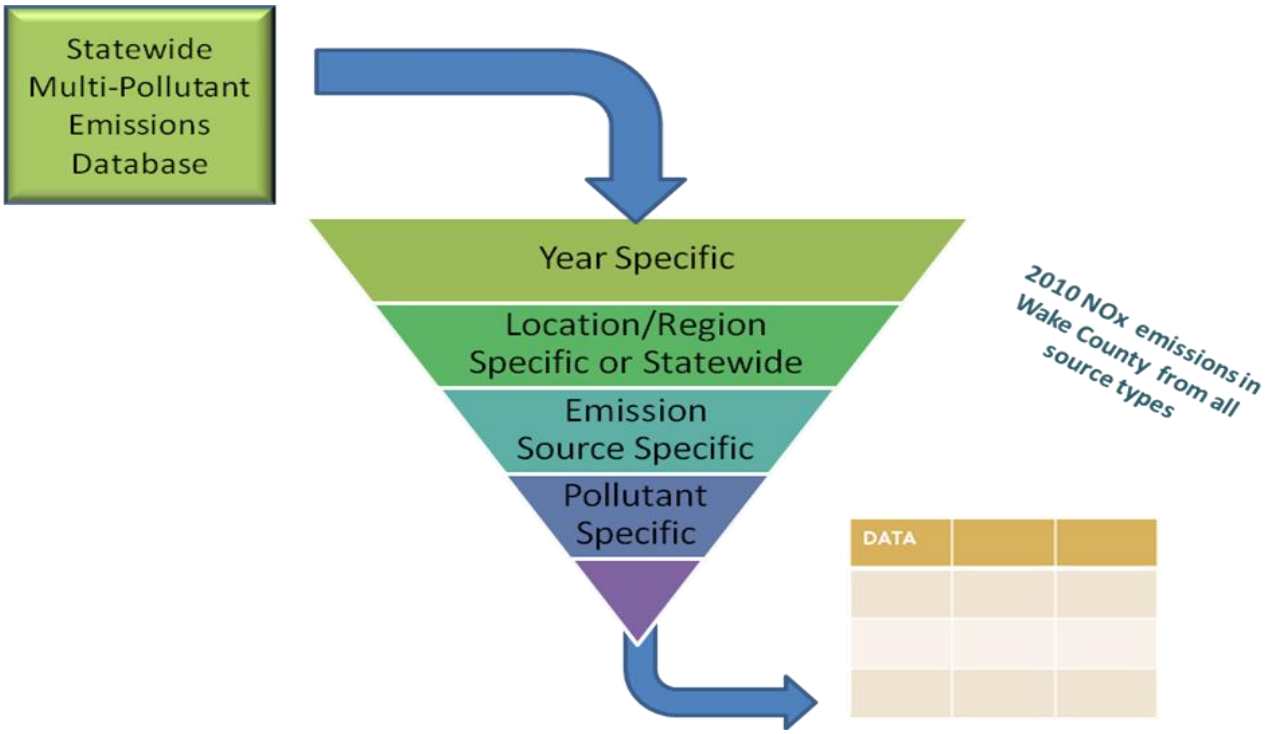
Figure 4. Multi-pollutant inventory system concept.



The database would be created as a three phase process. The first step in Phase 1 consists of combining facility level point source data reported to NC DAQ, NC's three local air agencies, and the EPA MRR data into single point source dataset. The second step in Phase 1 aggregating of non-point source data (i.e., on-road mobile, non-road mobile and commercial, light industry, and residential "area" sources). The non-point source inventory is generated by NC DAQ for state implementation plan development and transportation conformity efforts. However, the current system does not have the ability to aggregate all emissions data as a function of emission source category, geographic region, and pollutant type.

Phase 2 consists of creating an internal user interface to the multi-pollutant emissions database which allows users to generate unique queries and data subsets. Figure 5 illustrates an example output format.

Figure 5. User interface concept.



In Phase 3, certain aspects of the user interface will be integrated into the NC DAQ IBEAM system to expand emissions reporting features of the current website (contingent on the availability of IT resources). External users would be able to download the entire multi-pollutant inventory or create sub-tables that meet their unique record searches. Additionally, a geographical mapping application offered by Google Fusion will be provided to allow users to visualize NC's emissions data by county, pollutant, source category, facility name, and other identifiers.

The primary data element used to identify a facility would be the unique NC agency identifier which mimics but does not duplicate the FIPS format for NC DAQ facilities. The database should be flexible and be able to be updated annually. This database must also be a true state-wide emissions inventory that includes point source from all 97 counties overseen by NC DAQ, Buncombe, Mecklenburg and Forsyth counties local program data, MRR GHG emissions database, nonpoint emission estimates and mobile, onroad and nonroad, emissions estimates. The known challenges include differing data collection timelines, type of data elements reported, differences in air pollutants collected, and data formatting differences.

In January 2012, NC DAQ initiated a pilot effort to prepare the multi-pollutant emissions inventory for 2010 inventory year. Facility emission data were retrieved from NC DAQ's IBEAM database for all permitted facilities that operated in CY2010. The three local programs, Forsyth County Office of Environmental Assistance and Protection (FCOEAP), Mecklenburg County Air Quality (MCAQ) and Western North Carolina Regional Air Quality Agency (WNCRAQA) were contacted and their Emissions Inventory System staging tables were retrieved and formatted to fit the multi-pollutant database structure. Planning staff provided NC estimates of nonpoint and mobile source (onroad and nonroad) emissions estimates by county. The EPA MRR data were combined with the DAQ facility level data as discussed earlier. Using Access staging tables as the standard for the data format, queries were developed to pull the data in different formats into a standard format. All attempts were made to pull all available data and quality assure the resulting files. At this time, NC DAQ has completed Phase

1 and a 2010 multi-pollutant inventory database has been developed. The next enhancement will be to create an internal user interface for data reports. The user will have multiple search criteria so that the interface will be flexible but easy to use.

Conclusions

There were many lessons learned throughout this project and more lessons will be forthcoming as the project progresses. The process of integrating the varied databases from NC DAQ, NC local programs and MRR system, eGGRT would have been much quicker and infinitely smoother if EPA would use only one site identifier for all the databases. The FIPS identifier has been around for years and is a logical, informative identifier, since it includes a state and county code. EIS and eGGRT both generated a new, different site identifier when a facility was entered the first time; however, this site identifier gives the user no information about the site and is not used in any other database. Matching facilities using the two step process of converting the FRS identifier to FIPS site identifier to NC identifier proved time-consuming due to the manual manipulation necessary to clear the numerous blanks and unmatching FRS to FIPS identifiers.

Combining point, nonpoint, mobile onroad and mobile nonroad emissions data also presented several challenges. Nonpoint, mobile onroad and mobile nonroad emissions data are generated by NC DAQ for all 100 counties within NC; however, the format and pollutants generated differ from the point source emission inventory.

Another significant hurdle encountered in this process was that the publicly available MRR data did not contain CAS numbers for the GHG emissions data. The description of the GHG data had to be queried and matched to the appropriate CAS number. A considerable amount of quality assurance of the data was required that could have been eliminated by the inclusion of the CAS number with the MRR GHG data.

North Carolina has three local programs as well as DAQ, and each agency has different reporting requirements, reporting formats, naming of pollutants within the emissions files and different levels of reporting data to EPA. These issues proved to be a minor challenge and were overcome fairly easily. For example, carbon dioxide was described in the files as CO_2 and carbon dioxide so both names had to be taken into account.

The statewide multi-pollutant database will be a valuable asset both internally for use by multiple sections within DAQ and externally. NC DAQ may use this database in future legislative data analysis and requests, State Implementation Plan (SIP) planning, rules review, state forecasting and emissions modeling. Once this database has been made available via our web page, consultants and environmental groups will have immediate access to a complete NC emissions database for their review and analysis.

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Key Words

Climate change, greenhouse gases, air quality planning, emission inventory, multi-pollutant database.