APPENDIX E - EPD'S CAMx Photochemical Modeling Review

Georgia Department of Natural Resources
Environmental Protection Division • Air Protection Branch
4244 International Parkway • Suite 120 • Atlanta • Georgia 30354
404/363-7000 • Fax: 404/363-7100
Chris Clark, Commissioner
Carol A. Couch, PhD., Director

August 12, 2009
MEMORANDUM

To: Purva Prabhu
Thru: Jim Boylan JB
From: Byeong-Uk Kim BUK
Subj: CAMx Photochemical Modeling Review: Plant Washington, Washington County

Photochemical modeling was conducted by GA EPD for the single-boiler 850 MW (8,300 MMBtu/hr heat input capacity) electrical generating facility known as Plant Washington. The purpose of the modeling was to assess the impacts of Plant Washington emissions on ozone and PM2.5 concentrations on nearby monitoring stations. The simulations were conducted with the Comprehensive Air quality Model with extensions (CAMx). CAMx is a 3-D Eulerian (grid-based) photochemical transport model (includes gas-phase chemistry, aqueous phase chemistry, and equilibrium processes) that can simulate the hour-by-hour production of secondary air pollutants such as ozone and condensable particles in addition to primary particles. This memo discusses the procedures used to perform this modeling. The air contaminants that were modeled included NO, NO_2, SO_2, CO, NH_3, VOC, speciated direct PM2.5, and sulfuric acid mist.

Plant Washington has been proposed for development by Power4Georgians, LLC, a consortium of several electric membership cooperatives (EMCs). The electrical generating facility is to be sited on 1,641 acres located about 10 km northeast of the City of Sandersville, in Washington County, GA. The results of this modeling evaluation are summarized in the attached Tables 1-3 and indicate that air emissions associated with the proposed project will have minimal impacts on ozone and PM2.5 concentrations. All modeling input and output files generated in this analysis are available at GA EPD. A discussion of the photochemical modeling analysis follows.

INPUT DATA

The input data used in this modeling was based on CMAQ model-ready emissions and meteorological inputs (12-km grid resolution) used for GA EPD's ozone, PM2.5, and regional haze State Implementation Plans (SIPs). CAMx has a "flexi-nesting" functionality that allows users to conduct modeling at finer grid resolution than the resolution of prepared model inputs for emissions and meteorology without having inputs at finer scale grids. CMAQ to CAMx converting utilities were applied to 2009 CMAQ modeling files to prepare model inputs for the modeling domain.

1_ Meteorological Data: All meteorological inputs were prepared with the MM5CAMX utility provided by ENVIRON. This utility extracts and converts MM5 model outputs to CAMx model ready input files. The CAMx ready input files contain all the necessary meteorological variables required for the CAMx simulations at 12-km resolution. MM5CAMX has three options to generate vertical turbulent diffusivity input (Kz). GA EPD chose the option to make CAMx

inputs consistent with CMAQ inputs. Also, Kz minimum values at the surface were set according to land cover types.

2_ Source Data: Stack emissions parameters and emission rates are provided by MACTEC in the BACT section of the application and have been subjected to GA EPD engineering review. The emissions used in the CAMx modeling were identical to the emissions used in the AERMOD modeling. Both short-term and long-term SO2 emission rates were modeled. The 24-hour SO_2 emissions were used to assess impacts on ozone and daily PM2.5 concentrations. Annual SO_2 emissions were used to assess impacts on annual PM2.5 concentrations.

The CMAQ2CAMX utility was used to convert CMAQ three-dimensional emission inputs files for all source sectors (mobile, nonroad, area, EGU point, non-EGU point, biogenic, and fire) into two sets of CAMx emission inputs: elevated emission inputs and low-level emission inputs. Next, Plant Washington emissions were inserted into the elevated emission inputs prepared in the first step. Emissions provided in the permit application were not speciated for photochemical modeling; therefore, all emissions were speciated according to the approach provided in U.S. EPA's Emission Modeling Clearinghouse Speciation website (http://www.epa.gov/ttnchie1/emch/speciation/). Table 1 shows speciated emissions that were modeled for Plant Washington. For the purpose of this work, all PM2.5 emissions in the permit application were treated as filterable PM2.5, except sulfuric acid mist (SULF) emissions which were modeled separately.

Table 1. Plant Washington Emissions used in CAMx photochemical modeling

SRCID[1]	SRCTYP[1]	CO [g/s]	PEC [g/s]	PMFINE [g/s]	POA [g/s]	24-hour SO_2 [g/s]	Annual SO_2 [g/s]	SULF [g/s]	NO [g/s]	NO_2 [g/s]
MAIN	POINT	313.74	0.268861	12.500735	0.156405	120.83	54.38	4.18	47.061	5.229
FLYASH	POINT	-	-	0.004290	-	-	-	-	-	-
ASHEXH	POINT	-	-	0.006890	-	-	-	-	-	-
TRIP	POINT	-	-	0.015600	-	-	-	-	-	-
PRBSO	POINT	-	-	0.001300	-	-	-	-	-	-
CRUSH	POINT	-	-	0.020700	-	-	-	-	-	-
IL6SO	POINT	-	-	0.001300	-	-	-	-	-	-
SO3SILO	POINT	-	-	0.002030	-	-	-	-	-	-
HGSILO	POINT	-	-	0.002030	-	-	-	-	-	-
LSILO	POINT	-	-	0.000273	-	-	-	-	-	-
SODAASH	POINT	-	-	0.001010	-	-	-	-	-	-
LIMESO	POINT	-	-	0.002190	-	-	-	-	-	-
LIMEPR	POINT	-	-	0.007290	-	-	-	-	-	-
COOL1-34	POINT	-	-	0.000028	-	-	-	-	-	-
LANDASH	AREAPOLY	-	-	0.000000	-	-	-	-	-	-
LANDGYP	AREAPOLY	-	-	0.000000	-	-	-	-	-	-
ASHBUNK	AREAPOLY	-	-	0.000000	-	-	-	-	-	-
COALRAIL	AREAPOLY	-	-	0.000004	-	-	-	-	-	-
LIMERAIL	AREAPOLY	-	-	0.000002	-	-	-	-	-	-
PRBINAC	AREAPOLY	-	-	0.000000	-	-	-	-	-	-
IL6INAC	AREAPOLY	-	-	0.000000	-	-	-	-	-	-
LIMEPILE	AREACIRC	-	-	0.000002	-	-	-	-	-	-
PRBACTIV	AREACIRC	-	-	0.000003	-	-	-	-	-	-

IL6ACTIV	AREACIRC	-	-	0.000003	-	-	-	-	-	-
PAVED1-21	VOLUME	-	-	0.000112	-	-	-	-	-	-
UPAVED1-9	VOLUME	-	-	0.000126	-	-	-	-	-	-
UPAVED9-15	VOLUME	-	-	0.000144	-	-	-	-	-	-

SRCID[1]	SRCTYP[1]	NH3 [g/s]	ALD2 [g/s]	NR [g/s]	OLE [g/s]	PAR [g/s]	TOL [g/s]	XYL [g/s]
MAIN	POINT	6.435	0.000939	0.005385	0.003569	0.0662	0.005235	0.014144
FLYASH	POINT	-	-	-	-	-	-	-
ASHEXH	POINT	-	-	-	-	-	-	-
TRIP	POINT	-	-	-	-	-	-	-
PRBSO	POINT	-	-	-	-	-	-	-
CRUSH	POINT	-	-	-	-	-	-	-
IL6SO	POINT	-	-	-	-	-	-	-
SO3SILO	POINT	-	-	-	-	-	-	-
HGSILO	POINT	-	-	-	-	-	-	-
LSILO	POINT	-	-	-	-	-	-	-
SODAASH	POINT	-	-	-	-	-	-	-
LIMESO	POINT	-	-	-	-	-	-	-
LIMEPR	POINT	-	-	-	-	-	-	-
COOL1-34	POINT	-	-	-	-	-	-	-
LANDASH	AREAPOLY	-	-	-	-	-	-	-
LANDGYP	AREAPOLY	-	-	-	-	-	-	-
ASHBUNK	AREAPOLY	-	-	-	-	-	-	-
COALRAIL	AREAPOLY	-	-	-	-	-	-	-
LIMERAIL	AREAPOLY	-	-	-	-	-	-	-
PRBINAC	AREAPOLY	-	-	-	-	-	-	-
IL6INAC	AREAPOLY	-	-	-	-	-	-	-
LIMEPILE	AREACIRC	-	-	-	-	-	-	-
PRBACTIV	AREACIRC	-	-	-	-	-	-	-
IL6ACTIV	AREACIRC	-	-	-	-	-	-	-
PAVED1-21	VOLUME	-	-	-	-	-	-	-
UPAVED1-9	VOLUME	-	-	-	-	-	-	-
UPAVED9-15	VOLUME	-	-	-	-	-	-	-

[1]SRCID (source ID) and SRCTYP (source type) are exactly the same as those used for AERMOD modeling.

3_ Modeling Grid and Monitor Locations: A characteristic of photochemical grid models is that air pollutants emitted from a source are instantaneously dispersed throughout the volume of the grid cell containing the emission source. Therefore, the assessment of air quality changes near individual emission sources requires high resolution grids. GA EPD created two nested grids of 4-km and 1.333-km inside the 12-km grid domain centered on the cell where Plant Washington will be located. Figure 1 shows CAMx modeling domain grids with AERMOD receptors. The AERMOD grid consisted of site fenceline receptors every 100 meters and an offsite Cartesian receptor grid with the following spacings: 100 meters to a downwind distance from the boiler stack of at least 2 km, and 500 meters to about 13 km from the main boiler stack. The location of ozone and PM2.5 monitors relative to Plant Washington is contained in Figure 2.

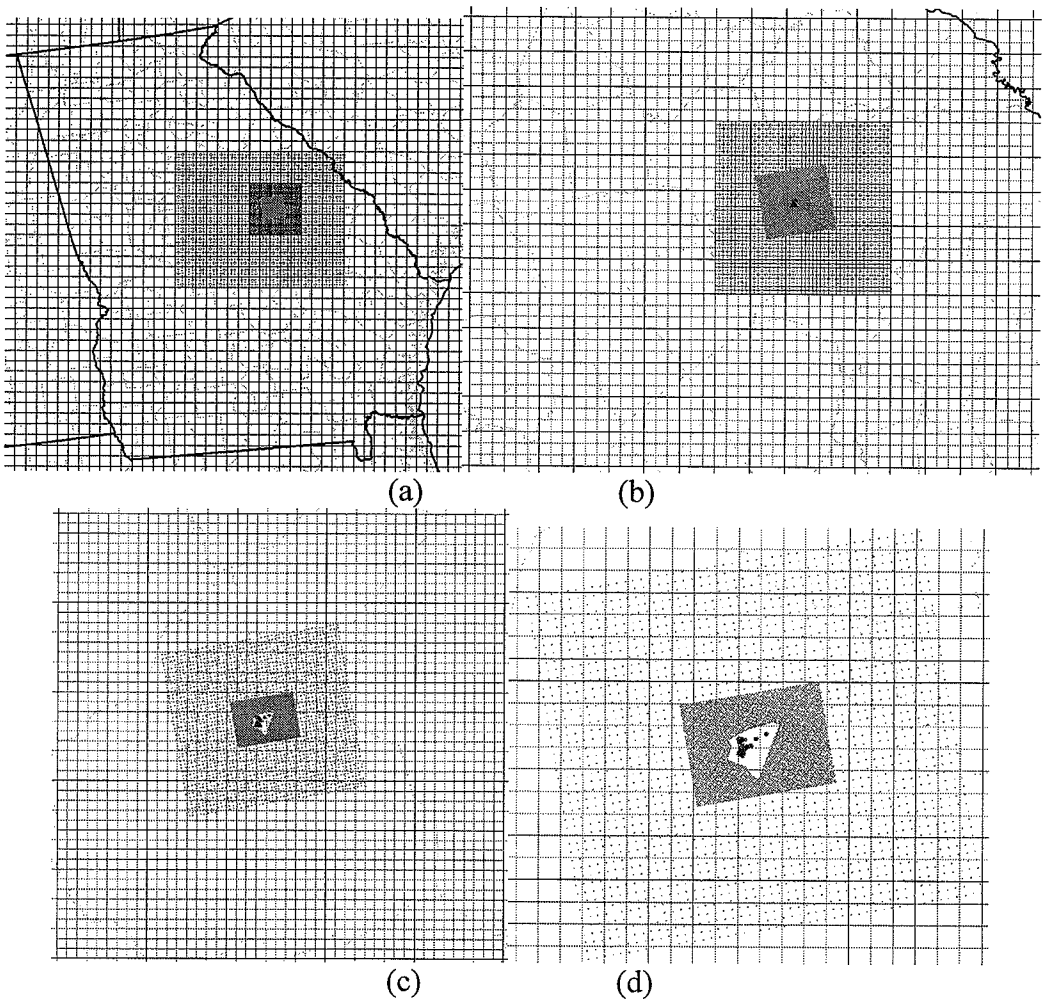

Figure 1. Modeling domains: (a) GA12 (12-km grid), (b) WA04 (4-km nested grid), (c) WA13 (1.333-km nested grid), and (d) zoomed view of AERMOD receptors in WA13 grid. Green dots in each domain figure are AERMOD receptor locations. Filled blue circles near the center represent Plant Washington modeled emission sources (the pink triangle is the main stack).

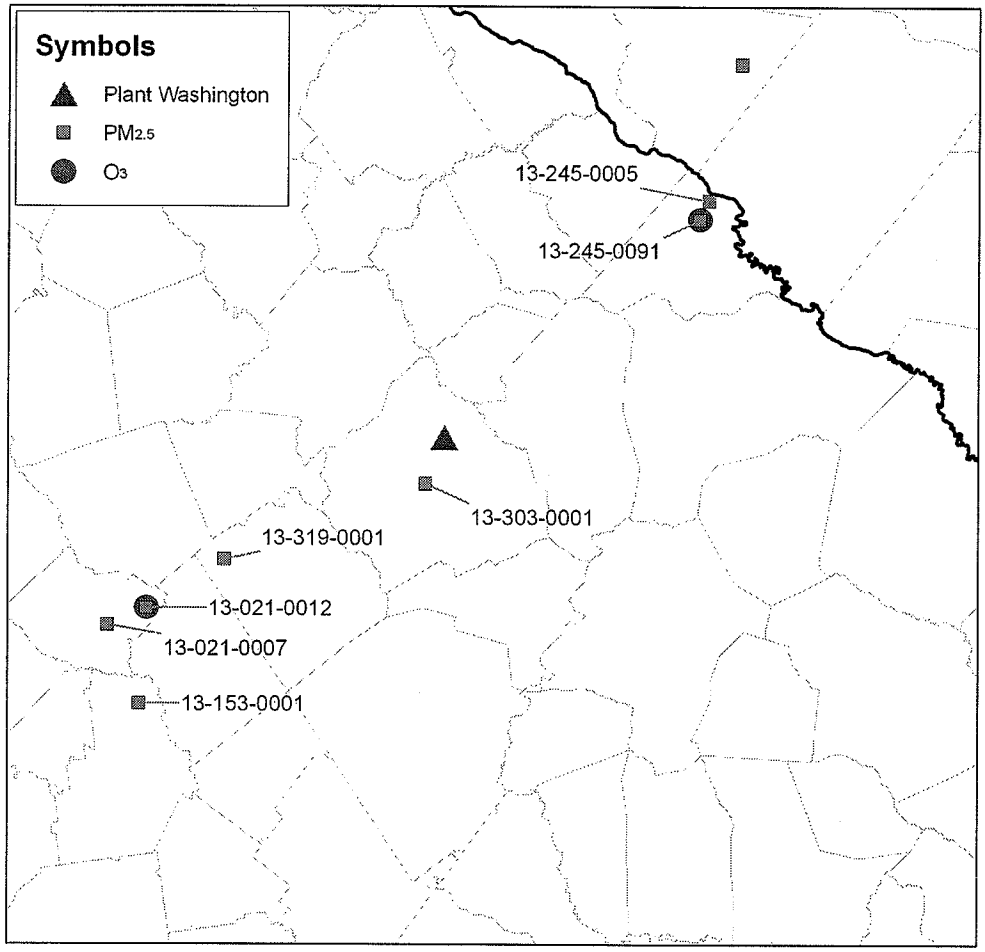

Figure 2. Location of Plant Washington relative to nearby ozone and PM2.5 monitors.

4_ Initial and Boundary Conditions: CMAQ-ready initial conditions files were converted to CAMx-ready file with CMAQ2CAMX utility. Boundary condition files for CAMx runs were converted from 2009 BaseG2 Typical CMAQ runs. Top conditions were also converted from CMAQ-ready top condition with the CMAQ2CAMX utility.

5_ Other inputs: Aerosol-Haze-Ozone Column (AHO) files were prepared with AHOMAP. Input files for this step were downloaded from the TOMS site albedo/haze/ozone (ftp://toms.gsfc.nasa.gov/pub/eptoms/data/ozone/Y2002/). Total UV (TUV) files were prepared with the TUV utility.

PLATFORM AND COMPILER

GA EPD utilized a Linux node equipped with Quad-core CPUs to run the OpenMP version of CAMx. Four CPUs were utilized for all model runs. The Intel Fortran compiler was used to compile CAMx (v 4.4.2) with the OpenMP option to utilize multiple CPUs to reduce model run

time. QA/QC was performed to ensure the numerical consistency between serial runs and parallel runs.

IMPACTS ANALYSIS

The impact of Plant Washington emissions was estimated with the approach prescribed in EPA's "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze" (April, 2007). The simulation without Plant Washington was used as the base case for the purpose of this procedure while the model run with Plant Washington emission was taken as the future case. The ratio of the modeled future case concentration to the modeled base case concentration is called the relative response factor (RRF). Modeled RRFs were applied to basecase concentrations to predict future concentrations. The impacts from Plant Washington are defined as the difference between the basecase and future concentrations.

1_ Ozone Impacts: There are two ozone monitors located near the proposed location of Plant Washington: Augusta (13-245-0091) and Macon SE (13-021-0012). Estimated daily maximum 8-hr ozone concentration increases were 0.035 ppb and 0.011 ppb for the Augusta and Macon SE monitors, respectively (Table 1). These impacts are small compared to the new ozone NAAQS of 75 ppb (less than 0.05% of the 8-hour NAAQS). The only other criteria pollutant with an 8-hour SIL is CO (SIL is 5% of the 8-hour NAAQS). The ozone impacts are 100 times smaller than this criterion.

Table 1. Estimated daily maximum 8-hr ozone concentration change due to Plant Washington

Monitor Name	AIRS	8-hr O3 (ppb)
Augusta	13-245-0091	0.035
Macon SE	13-021-0012	0.011

2_ Annual PM2.5 Impacts: There are seven monitor located near the proposed location of Plant Washington. Estimated annual PM2.5 concentration increases ranged from 0.015 $\mu g/m^3$ at the Augusta Medical College monitor (13-245-0005) to 0.065 $\mu g/m^3$ the Sandersville monitor (13-303-0001). Table 2 shows the impacts on annual PM2.5 concentrations at all the nearby monitors. Impacts at all monitors are well below the significant impact levels proposed by EPA (range of 0.3 - 1.0 $\mu g/m^3$).

Table 2. Estimated annual $PM_{2.5}$ concentration change due to Plant Washington

Monitor Name	AIRS	$PM_{2.5}$ ($\mu g/m^3$)
Sandersville	13-303-0001	0.065
Gordon	13-319-0001	0.040
Macon Allied Chem.	13-021-0007	0.027
Macon Forestry	13-021-0012	0.027
Warner Robins	13-153-0001	0.021
Augusta Bungalow Rd.	13-245-0091	0.016
Augusta Med. College	13-245-0005	0.015

3_ Daily PM2.5 Impacts: The daily PM2.5 concentration increase due to Plant Washington was estimated at the Sandersville monitor (13-303-0001). This monitor is the closest monitor and represents the worst case impacts of 0.407 $\mu g/m^3$. This impact is well below the significant impact levels proposed by EPA (range of 1.2 - 5.0 $\mu g/m^3$).

Table 3. Estimated daily $PM_{2.5}$ concentration change due to Plant Washington

Monitor Name	AIRS	$PM_{2.5}$ ($\mu g/m^3$)
Sandersville	13-303-0001	0.407

SUMMARY

The modeled air quality analysis above shows minimal impacts from Plant Washington on ozone and PM2.5 concentrations at nearby monitors. The results of these modeling simulations indicate there is no reason to deny the project the air permit for which it has applied on the basis of adverse air quality impacts.