

## Technical Memorandum

**To:** Jim Sullivan, Minnesota Pollution Control Agency  
**From:** Jennifer Koenen, Eric Edwalds Barr Engineering Company  
**Subject:** NorthMet Class II Modeling Analysis – Model Results Post-Processing with Microsoft Excel and Lakes Environmental AERMOD View™ Multi-Chemical Utility  
**Date:** December 4, 2017  
**Project:** NorthMet Project  
**c:** Kevin Pylka, Poly Met Mining, Inc.  
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This memo provides additional details regarding model results post-processing steps taken to develop the appropriate cumulative NAAQS modeled concentrations summarized in Section 5 of AQDM-06. This memo addresses two issues: 1) adjusting NAAQS concentrations from nearby sources on receptors within the nearby source's boundary using Microsoft Excel spreadsheets, and 2) combining PM<sub>10</sub> modeling results for deposition and non-deposition modeling runs using the Lakes Environmental AERMOD View™ Multi-Chemical Utility (Mulit-Chem).

### **Adjusting Model Results from Nearby Sources at Receptors Within the Nearby Source's Controlled Boundary**

For all pollutants (NO<sub>2</sub>, SO<sub>2</sub>, PM<sub>2.5</sub>, and PM<sub>10</sub>), post-processing procedures were required to adjust modeled concentrations for nearby sources so that modeled impacts from nearby sources do not contribute to the cumulative NAAQS concentration for receptors on the nearby source's property. Nearby sources for the modeled pollutants are as follows:

NO<sub>2</sub> – Mesabi Nugget, Laskin Energy Center  
SO<sub>2</sub> – Mesabi Nugget  
PM<sub>2.5</sub> – Mesabi Nugget, Nortshore Mining  
PM<sub>10</sub> – Mesabi Nugget, Nortshore Mining

The model results concentrations that followed the steps in Table 1 were the NAAQS averaging periods for NO<sub>2</sub> (1-hour), SO<sub>2</sub>, (1-hour), and PM<sub>2.5</sub> (24-hour and annual). PM<sub>10</sub> processing required additional processing (described in Table 2) before following the steps in Table 1.

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**Table 1 Post Processing Set up Steps**

Step 1: Each source group (all sources, all sources excluding Mesabi Nugget, all sources excluding Laskin (for NO<sub>2</sub>) and all sources excluding Northshore (for PM<sub>2.5</sub> and PM<sub>10</sub>) was imported into an Microsoft Excel spreadsheet as 3 separate columns using the "Import Data from Text" function. This function allows for a single initial setup of the post-processing spreadsheet which allows a user to set the column and rows from a defined text file (plot file) to import and populate the spreadsheet. Any future updated modeling run results plot files can be easily updated in the spreadsheet by a simple refresh button in Excel. However, there are some possibilities for user QA/QC errors that are discussed below this table. These air concentrations are used to determine the modeled values that are added to the background concentration and compared to the NAAQS.

Step 2: Using GIS, the receptors making up the modeled receptor grid were identified by their location on Mesabi Nugget property, Laskin Energy Center property, or Northshore Mining property. A column was added into the Excel worksheet to identify the modeled receptors based on their x, y coordinates. With this column and the individual source group 5 year average results columns, a conditional "if/then" function was used to combine the separate source group plot files into a single maximum 5 year average results plot file by selecting the results for source group "All excluding Mesabi Nugget" when the receptor is identified as Mesabi Nugget property, "All excluding Laskin" when the receptor is identified as Laskin Energy Center property, "All excluding Northshore" when the receptor is identified as Northshore Mining, and "All Sources" for all other receptors.

Step 3: The representative background concentration was added to each air concentration in the combined results column and the overall maximum result over the entire receptor grid was compared to the NAAQS.

The spreadsheet used to complete the steps listed in Table 1 is included as a supplemental electronic file to this memo and is titled "NorthMet Project Resultsv16216.xls". The column titled "MAXtrueup" completes Step 2 in the table above.

As mentioned in Step 1 above, the Microsoft Excel "Import Text File" function is used to efficiently import the modeling result plot files into the post-processing spreadsheet for analysis. Caution is needed when importing the plot files to confirm the correct columns are being imported and that the correct file is being selected for the results identified in the spreadsheet. Additional QA/QC is required of the spreadsheet to verify the results values listed in the columns for each source group match the plot file values output by the AERMOD run. Links in the spreadsheet will be broken when the file is opened by another user, such as MPCA, who does not have access to the folder path to where the plot files are located. That is why it is important for outside users opening the post-processing spreadsheet not to select the option to update links in the spreadsheet because the spreadsheet will be unable to find the plot files, which will cause errors to show up in place of the plot file values.

### ***PM<sub>10</sub> Results Post-Processing using Lakes AERMOD View™ Multi-Chemical Utility***

As described in AQDM-06 Section 5, the PM<sub>10</sub> modeling used AERMOD Method 1 plume depletion (deposition) for NorthMet fugitive sources, but no plume depletion was used for the NorthMet stack sources. However, because AERMOD cannot have both deposition and non-deposition sources in a single run, additional modeling set-up and post-processing using the Lakes AERMOD View™ Multi-Chemical Utility (Multi-Chem) was required to develop the cumulative NAAQS concentration for PM<sub>10</sub>.

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### ***What is Multi-Chem***

The Multi-Chem feature in AERMOD View™ allows a user to split a model run into individual source input files. Multi-Chem uses POSTFILE<sup>1</sup> model output for each source run, so that all the source impacts can be summed back together paired in space and time to show the correct cumulative results by receptor and averaging period. The sources in Multi-Chem are modeled at 1 g/s because it allows a user to input different emission rates for each source representing different pollutants. In this way, a single model run can be used to generate multiple pollutant concentration results. For the PM<sub>10</sub> NAAQS modeling analysis, Multi-Chem was used to combine results from the depletion and non-depletion runs without the use of the 1 g/s source runs since the POSTFILES were generated from AERMOD input files modeling the source PM<sub>10</sub> emission rates.

### ***Why use it***

Method 1 plume depletion in AERMOD is an option that cannot be applied to selected modeled sources; it is either all sources in the input file or none. PolyMet, per MPCA recommendation, is using Method 1 depletion for all surface based mechanically generated fugitive sources at the Plant and Mine site while keeping the remaining sources (i.e. stacks) at regulatory default without assuming any plume depletion. Because AERMOD does not allow specific sources to be modeled with depletion and without in a single input file, PolyMet utilized the POSTFILE output option as a way to run two separate AERMOD input files, but still allow the results from each AERMOD run to be paired simultaneously by hour and receptor to reflect the combined total impacts from all sources. Table 1 describes post processing steps using Microsoft Excel while the steps described in Table 2 provide details on how the AERMOD input file was setup to generate POSTFILES of specific sources and why it was necessary to use the Lakes Environmental software<sup>2</sup> to combine the POSTFILES from the depletion and non-depletion sources paired in space and time to provide an accurate air concentration of the total cumulative source impacts at all receptors.

### ***How it was used***

PM<sub>10</sub> outputs require additional processing with Multi-Chem to present the results in the form of the standard. This allows the results to be compared to the applicable thresholds. The following sections describe how the results were processed on a modeling evaluation specific basis.

### **24 Hour PM<sub>10</sub> NAAQS Modeling Runs**

The 24 hour PM<sub>10</sub> NAAQS is the high 6<sup>th</sup> high (H6H) modeled value over 5 years of meteorological data. However, several steps were taken to arrive at the NAAQS modeling result.

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<sup>1</sup> POSTFILES store the modeled concentration from each source group at each receptor for every hour in the meteorological data set.

<sup>2</sup> Other third-party modeling software also is available and could be used to combine the results from the POSTFILES.

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### ***AERMOD Model Set-up***

As discussed above, two sets of model runs were required, one using deposition (Year 8 and Year 13) and one without deposition (non-Dep; used in combination with both the Year 8 and Year 13 deposition runs). Deposition was only used for NorthMet fugitive sources and not for nearby source fugitive sources.

To utilize Multi-Chem, the AERMOD model set-up specified an averaging period of 1-hour (CO AVERTIME 1); model sources groups of ALL, NMET, NONSM, NOMND for the non-deposition runs, NMETY8 and NMETY13 for the deposition runs; and output options of POSTFILE and PLOTFILE for each source group.

### ***Multi-Chem Post-Processing***

In addition to the off-site source post processing, there are additional complex refinements in the PM<sub>10</sub> analysis that are necessary. These extra steps are needed to generate PM<sub>10</sub> NAAQS results for the full cumulative NAAQS sources modeled paired in time and space and are described below in Table 2.

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**Table 2 Model Results Post Processing Steps to Arrive at PM<sub>10</sub> NAAQS Value**

Step 1: Create three AERMOD input files using a single 5 year meteorological dataset for the following modeling input scenarios: non-deposition sources, deposition sources for year 8 mine layout, and deposition sources for year 13 layout. These input files contain the modeled emission rate for each source (i.e. not a 1 g/sec emission rate). The output options selected in each file generate an unformatted post file (.POS) that records the 1 hour air concentration for every receptor for every hour modeled. Additionally, source groups were created in the input file representing all sources, all sources excluding nearby source Mesabi Nugget, and all sources excluding nearby source Northshore Mining for use in the post-processing step identifying maximum results at receptors located within modeled nearby sources' ambient air boundaries. Only the non-deposition sources AERMOD input file included the source groups excluding nearby sources because the nearby sources were not modeled with deposition and were only included in this input file.

Step 2: The AERMOD outputs from these runs include a post file (.POS) representing air concentrations for every hour and receptor modeled for all non-deposition sources (ALLNAAQS.POS), all non-deposition sources excluding Mesabi Nugget (NOMNDNAAQS.POS), all non-deposition sources excluding Northshore (NONSMNAAQS.POS), NorthMet non-deposition sources only (NMETNAAQS.POS), all year 8 mine layout deposition sources (NMETY8NQSp.POS), and all year 13 mine layout deposition sources (NMETY13NQSp.POS). EPA's AERMOD suite currently has no executable or program to read and combine post files together, so the third party software Lakes Environmental AERMOD View™ with postfile combining capabilities was utilized. The Multi-Chem utility is a post file processing tool that combines multiple post files together paired in time and space (by hour and receptor) and allows the user to select the averaging period and high value for Multi-Chem to write to an AERMOD plot file (.PLT).

Step 3: To use Multi-Chem to combine the output from the deposition and non-deposition runs, a generic "test" input file was created in AERMOD View™ where the receptor grid and AERMET data match the NorthMet PM<sub>10</sub> AERMOD input file runs. Next, a generic source input was created (location and parameters do not matter) for each postfile to be combined. What is important and necessary is that the source input name matches the name of the postfiles generated and listed in Step 2.

Step 4: Select Run Multi-Chem in AERMOD View™ to open Multi-Chem Utility Window. This action creates a folder structure in your "test" case within the folder "test.mc". The two important folders created are called "Post" and "Plot" which is where the postfiles (.POS) and plotfiles (.PLT) for the 1 hour high 1st high concentrations generated in step 2 must be cut and pasted for purposes of combining impacts.

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Step 5: In the Multi-Chem window tab "Chemical Setup", the generic sources created using the postfile names are listed in a table that requires an emission rate before processing. For each source, the pollutant identified should have an emission rate of 1 g/s because the AERMOD run completed in Step 1 used the source specific PM<sub>10</sub> g/s emission rates and the rates do not need to be scaled in post-processing. Each source should be checked as active and be identified with a red font, which identifies them as unprocessed. Click on the update button which searches in the "plot" and "post" folders to confirm the existence of the .POS and .PLT files for those sources. This will change the sources in the table to black, which means they are ready for post-processing.

Step 6: Select the "Output Options" tab of the Multi-Chem window to select the averaging period and high value combined plot files you want Multi-Chem to generate. For PM<sub>10</sub>, select the 24 hour averaging time and the 6<sup>th</sup> highest value which represents the PM<sub>10</sub> NAAQS (high 6th high over 5 years).

Step 7: Return back to the "Chemical Setup" tab to complete the most important step in this scenario, which is identifying the post files to combine to output the correct cumulative NAAQS scenarios. There are four separate post-processing Multi-Chem runs that need to be run in order to complete the last step in the 24 hour PM<sub>10</sub> cumulative NAAQS analysis. To generate the appropriate 24 hour H6H scenario plot files, the correct combinations of post files for each scenario are listed in bullets below.

- Year 8 All Sources Plot File - ALLNAAQS.POS + NMETY8NQSp.POS
- Year 13 All Sources Plot File - ALLNAAQS.POS + NMETY13NQSp.POS
- Year 8 All Sources excluding Mesabi Nugget Plot File - NOMNDNAAQS.POS + NMETY8NQSp.POS
- Year 13 All Sources excluding Mesabi Nugget Plot File - NOMNDNAAQS.POS + NMETY13NQSp.POS
- Year 8 All Sources excluding Northshore Plot File - NONSMNAAQS.POS + NMETY8NQSp.POS
- Year 13 All Sources excluding Northshore Plot File - NONSMNAAQS.POS + NMETY13NQSp.POS
- Year 8 NorthMet Sources Only Plot File - NMETNAAQS.POS + NMETY8NQSp.POS
- Year 13 NorthMet Sources Only Plot File - NMETNAAQS.POS + NMETY13NQSp.POS

The 24 hour H6H plot files output by Multi-Chem are what is imported into the Excel spreadsheet following the same steps 1-3 from the setup analysis described in Table 2.

### ***Post Processing Setup***

Steps 1 through 3, described in Table 1, describe post processing using Microsoft Excel as it applies to off-site sources that are used in the post processing analysis.

The spreadsheet (NorthMet Project Resultsv16216.xls) used to complete the steps listed in Table 1 contains the information used to complete the PM<sub>10</sub> post-processing. The sheets titled "PM10 24h Cumulative NAAQS Y8" and "PM10 24h Cumulative NAAQS Y13" are where the 24 hour PM<sub>10</sub> NAAQS post-processing is conducted.