

**January 21, 2026**Timothy Leon Guerrero  
EPA Region 3 Meteorologist  
Four Penn Center  
1600 JFK Blvd.  
Philadelphia, PA 19103**Subject: Request for Site-Specific Alternative Model for Characterizing 1-hour SO<sub>2</sub> Along Complex Terrain of Laurel Ridge in Westmoreland and Cambria Counties, Pennsylvania**

Dear Mr. Leon Guerrero,

On behalf of Conemaugh Generating Station and Seward Generating Station (the Stations), AECOM is providing the attached dispersion modeling report for review and acceptance demonstrating the need for a site-specific alternative model. The purpose of this modeling report is to address requirements in Appendix W (40 CFR, Part 51, available at 82 FR 5182 (Federal Register, November 29, 2024), Section 3.2.2 (b)).<sup>1</sup> This section of Appendix W details the approach for approval of an alternative model. Specifically, the request must meet one of the following three conditions:

- 1) If a demonstration can be made that the model produces concentration estimates equivalent to estimates obtained using a preferred model;
- 2) If a statistical performance evaluation has been conducted using measured air quality data and the results of that evaluation indicate the alternative model performs better for a given application than a comparable model in Addendum A; or
- 3) If there is no preferred model.

The Stations have elected to evaluate the alternative model from both a theoretical and a performance perspective before it is selected for use (Option 2).

As discussed in the modeling report, we have conducted a statistical performance evaluation that demonstrates the alternative model is more appropriate in capturing the unique dispersion environment along Laurel Ridge. A site-specific field study, conducted within the area of interest was used to evaluate the model's performance. The model selected for this performance evaluation is the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) modeling system. The version used is 24142, which was released in November 2024. The performance evaluation was conducted using two (2) separate model runs, each with the following options applied:

- 1) AERMOD default option (regulatory model)
- 2) AERMOD alpha option with LOW\_WIND, minimum sigma-v = 0.5 m/s (alternative model)

The contents of this modeling report package include the following:

- Exhibit A: Modeling Protocol for Site-Specific Alternative Model for 1-hour SO<sub>2</sub> Emissions of Conemaugh and Seward Impacts in Complex Terrain Along Laurel Ridge in Western Pennsylvania (originally submitted on September 26, 2025; approved by EPA on September 30, 2025),

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<sup>1</sup> Guideline on Air Quality Models (Appendix W of 40 CFR Part 51). November 29, 2024. Available at: [https://www.epa.gov/system/files/documents/2024-11/appendix\\_w-2024.pdf](https://www.epa.gov/system/files/documents/2024-11/appendix_w-2024.pdf)

- Exhibit B: Modeling Report for Site-Specific Alternative Model for 1-hour SO<sub>2</sub> Emissions of Conemaugh and Seward Impacts in Complex Terrain Along Laurel Ridge in Western Pennsylvania, and
- Electronic modeling archive containing files from the site-specific field study and AERMOD model input/output files.

On April 8, 2025, the Pennsylvania Department of Environmental Protection (PA DEP) and EPA Region 3 informed the Stations that a Clean Data Determination (CDD) modeling demonstration is an available option to evaluate the 1-hour SO<sub>2</sub> NAAQS attainment status on and in the vicinity of Laurel Ridge (i.e., portions of Cambria-Westmoreland Counties). The Stations have elected to proceed with a CDD approach. The CDD modeling should involve the use of recent actual SO<sub>2</sub> emissions data and meteorological data collected from the Ash Site #1 tower and SONic Detection And Ranging (SODAR) from the 1-year period between September 1, 2015 and August 31, 2016.

The Ash Site #1 meteorological station was comprised of a multi-level tower equipped with sensors at 2, 10, 50, 75, and 100 meters (m) along with a SODAR wind profiling system (with measurements starting at 50 m and extending vertically in 50-m increments to 500 m). The location of Ash Site #1 was approximately halfway between the Seward Generating Station and Conemaugh Generating Station, as shown in **Figure 1**. Tower and SODAR turbulence measurements (both the standard deviation of the horizontal wind direction (sigma-theta) and the standard deviation of the vertical wind speed (sigma-w)) were collected in addition to the typical wind speed and direction, ambient temperature, and other meteorological measurements (e.g., atmospheric pressure, precipitation, etc.).

In an attempt to address concerns about potential model overprediction bias for impacts along the higher terrain of the ridge, the Stations evaluated the model's performance and identified appropriate refinements to the minimum sigma-v parameter based on a historical field study that involved the same primary SO<sub>2</sub> sources (Conemaugh and Seward) and SO<sub>2</sub> monitors located along the ridge within the CDD modeling area. The intention is to apply the refinement (minimum sigma-v of 0.5 m/s) from the model performance evaluation that identifies a better performing alternative model for this site-specific application and use it for the CDD modeling demonstration.

Appendix W Section 3.2.2(e) prescribes the conditions that need to be addressed for approval of an alternative model. The following list goes through each element of the requirements needed to fulfill Section 3.2.2(e) of Appendix W and how the information in this report satisfies it. This information is also contained in Section 8.3 of the January 21, 2026 Modeling Report (see Exhibit B).

### **Conditions 1: The model or technique has received a scientific peer review**

EPA has acknowledged model performance issues during low wind conditions in complex terrain (EPA 2021). Introduced in AERMOD version 12345, LOWWIND1 and LOWWIND2 non-default options were added by EPA to address concerns regarding model performance under low wind speed conditions. LOWWIND1 and LOWWIND2 increased the minimum sigma-v value from 0.2 m/s (default) to 0.5 m/s and 0.3 m/s, respectively. Both were hardcoded values that the user could not modify. LOWWIND3 was later introduced in AERMOD version 15151 that also increased the minimum sigma-v to 0.3 m/s but included the use of the non-default FASTALL approach. In AERMOD 18181, a new LOW\_WIND keyword option replaced the former LOWWIND1, LOWWIND2, and LOWWIND3 options. The LOW\_WIND option, which is a non-default alpha option in AERMOD 24142, allows the user to specify values for minimum sigma-v, minimum horizontal wind speed, and maximum meander fraction. The LOW\_WIND technique, specifically where the minimum sigma-v is increased, has been evaluated using AERMOD in complex terrain in peer-reviewed journal articles (Hanna 1983; Hanna 1990).

### **Condition 2: The model or technique can be demonstrated to be applicable to the problem on a theoretical basis**

The evaluation described in the modeling report used a non-guideline, alpha low wind option (LOW\_WIND) that EPA itself proposed (in a similar form as "LOWWIND3" that was proposed by EPA in 2015 for inclusion

in Appendix W, as a guideline option). Plume meander can also be greatly affected by vertical shear, terrain induced eddies, and flow perpendicular to significant terrain features. A parameter that is used in the computation of the horizontal plume spreading in AERMOD (which accounts for meandering in low wind conditions) is the above-mentioned standard deviation of the crosswind component,  $\sigma_v$ , which can be parameterized as being proportional to the friction velocity,  $u^*$  (Smedman, 1988; Mahrt, 1998). These investigators found that there was a minimum, non-zero value of  $\sigma_v$  that can be attributed to wind meandering over the course of a given hour. Hanna<sup>11</sup> found that the hourly-averaged  $\sigma_v$  has a non-zero minimum value of about 0.5 m/s as the wind speed approaches zero. Chowdhury et al. (2016) noted, based upon research conducted by Hanna (1983) that a minimum  $\sigma_v$  of 0.5 m/s is justified as a part of the formulation for the advanced puff model SCICHEM.

Besides the technical issues about meander in stable conditions discussed above, the proposed LOW\_WIND option has the effect of introducing more meander into the plume centerline concentration that results from complex terrain and wind shear effects that are characteristics of the perpendicular flow across the Conemaugh River Valley and into Laurel Ridge. The site-specific challenges in properly accounting for the magnitude of horizontal plume meander can be more appropriately addressed using the LOW\_WIND option with an increased minimum  $\sigma_v$  value and is consistent with the findings from the peer-reviewed journal article (Hanna 1990).

### **Condition 3: The databases which are necessary to perform the analysis are available and adequate**

In the early 1990s, a field study was conducted by TRC to determine suitable modeling approaches, especially in elevated terrain, for several coal-fired electric generating stations located in Indiana and Armstrong Counties, Pennsylvania (funded by Penelec, the former owner and operator of the four stations that were the focus of the 1990-era modeling study). Ten (10) ambient air SO<sub>2</sub> monitors were deployed in 1990 in the vicinity of the Keystone, Homer City, Seward, and Conemaugh stations, with several of the monitors located in areas on Laurel Ridge, as shown in **Figure 2**. The purpose of this study was to evaluate alternative modeling approaches for estimating air quality impacts from the stations in areas that included elevated terrain on Laurel Ridge and Chestnut Ridge. The monitors on Laurel Ridge that were used for this model evaluation study are the following four (4) sites: Powdermill Run, Baldwin Creek, Sugar Run, and Terrys Run.

At the time the study was conducted, the 1-hour SO<sub>2</sub> NAAQS had not yet been established (it was promulgated in 2010). As a result, the analysis conducted by TRC focused on 3-hour, 24-hour, and annual average time periods. However, hourly averaged emissions data (collected by state-of-the-art Continuous Emissions Monitoring Systems (CEMS) at the time) and hourly averaged monitored concentrations were collected. Consequently, the ability to conduct 1-hour averaged modeling is readily available.

The location of the key SO<sub>2</sub> sources from the stacks at Conemaugh and Seward situated in the Conemaugh River Valley and the high, perpendicular (to the flow) terrain of Laurel Ridge to the east establishes a very unique dispersion environment. **Figure 3** illustrates the 1990 field study on a terrain map with a cross section extending west of Chestnut Ridge, passing through the Ash Valley meteorological tower collection site, across Laurel Ridge, and extending to the Johnstown SO<sub>2</sub> monitoring site. **Figure 4** shows the elevation profile path of the cross section and clearly shows the heights of the Conemaugh and Seward stacks are well below the top of Laurel Ridge.

A rigorous and exhaustive review of the data was performed to identify valid hours for use in a model evaluation demonstration. This review resulted in a total of 7,714 hours of the original 8,760 hours when emissions for all sources in operation had emissions, meteorological data and monitoring data available. This process is consistent with the standards that other modeling databases that EPA uses to evaluate AERMOD performance.

### **Condition 4: Appropriate performance evaluations of the model or technique are available**

These evaluations need to show that the model or technique is not inappropriately biased for regulatory application. Specifically, EPA prefers that a statistical performance evaluation is conducted using measured

air quality data and the result of that evaluation indicates that the alternative model performs better for the given application than a comparable model in Addendum A of Appendix W (default AERMOD). The modeling report (Exhibit B) describes, in detail, how a site-specific performance evaluation using ambient monitoring data in the area of the Seward and Conemaugh stations along Laurel Ridge was performed. The set of performance metrics that were used are consistent with other site-specific alternative model requests that have received EPA-approval. The suite of performance metrics used for this alternative model demonstration included the following:

- Peak and 99<sup>th</sup> percentile design concentration (predicted-to-observed) ratios at each monitor and across all four monitors,
- Quantile-Quantile (Q-Q) plots of the ranked hourly SO<sub>2</sub> predicted and observed hourly concentrations across all four monitor and at each monitor,
- Screening and statistical tests and their statistical measures (Robust Highest Concentrations (RHCs), fractional bias (FB), Composite Performance Measure (CPM), and Model Comparison Measure (MCM)), described in EPA's Protocol for Determining the Best Performing Model (EPA-454/R-92-025)

As discussed in Section 7 of the modeling report (Exhibit B), the performance evaluation of the alternative model (using minimum sigma-v of 0.5 m/s) showed through visual graphics (Q-Q plots) and the statistical measures (RHC, FB, CPM, MCM, CMCM) that the alternative model consistently outperformed the default model. The alternative model was found to reduce the overprediction bias of the default model, while remaining conservative relative to the observed concentrations.

The report also demonstrated that the proposed Ash Site #1 meteorological dataset also results in a similar level of improvement with the use of the alternative model compared to the default. The use of the Ash Site #1 meteorological also yields conservative modeled concentrations to the Ash Valley meteorological dataset. This was a key element of the analysis as the Ash Site #1 meteorology is the proposed dataset to be used for a CDD modeling demonstration that overlaps with the area that the Laurel Ridge study covers.

### **Condition 5: Modeling procedures that were established have been followed**

This modeling report (Exhibit B) provides the modeling procedures that were followed for the application of AERMOD using the LOW\_WIND with a minimum sigma-v of 0.5 m/s for receptors being modeled with the on-site meteorological data. The modeling procedures were approved by EPA on September 30, 2025 and are consistent with those described in Appendix W.

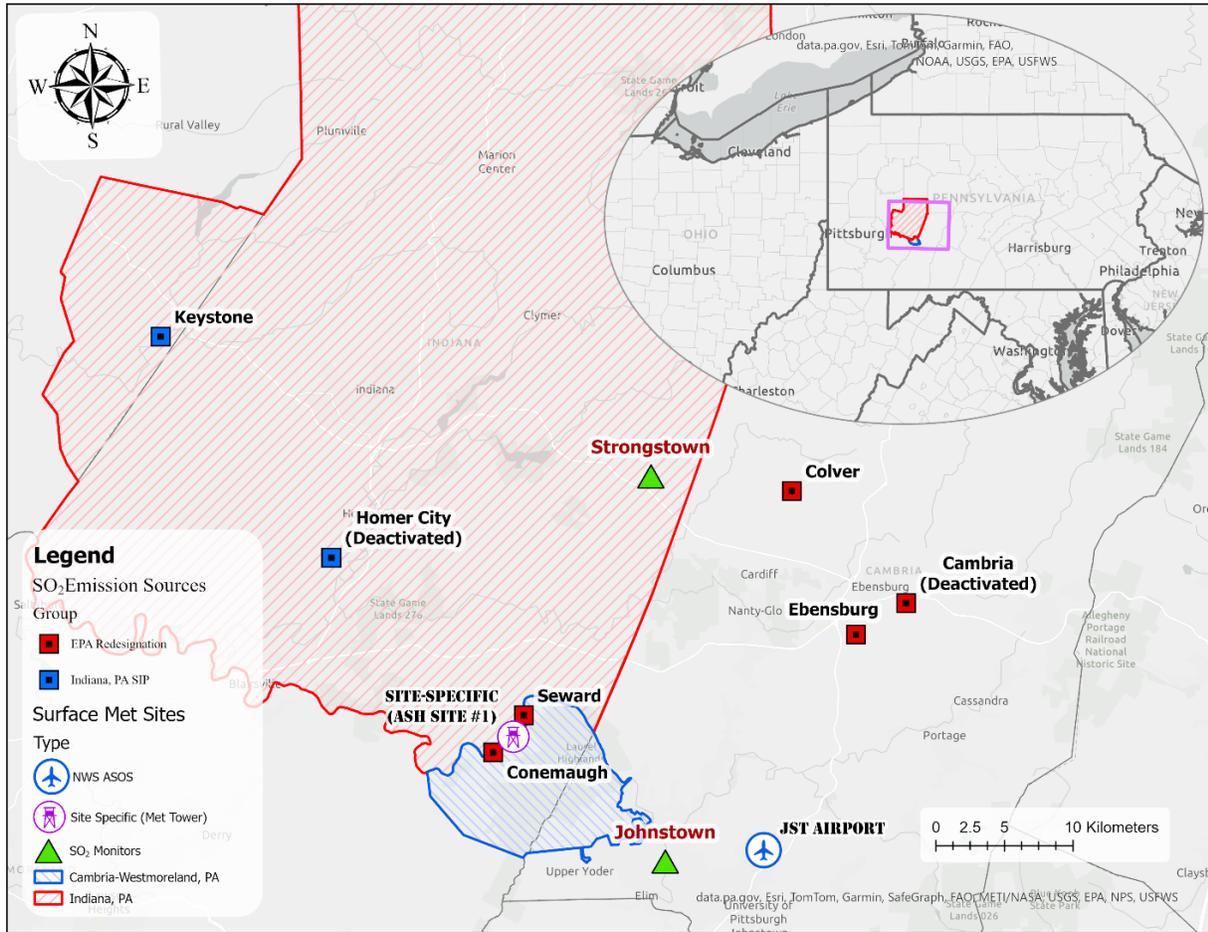
We appreciate your time in reviewing this submittal. Please reach out to us with any questions.

Sincerely,



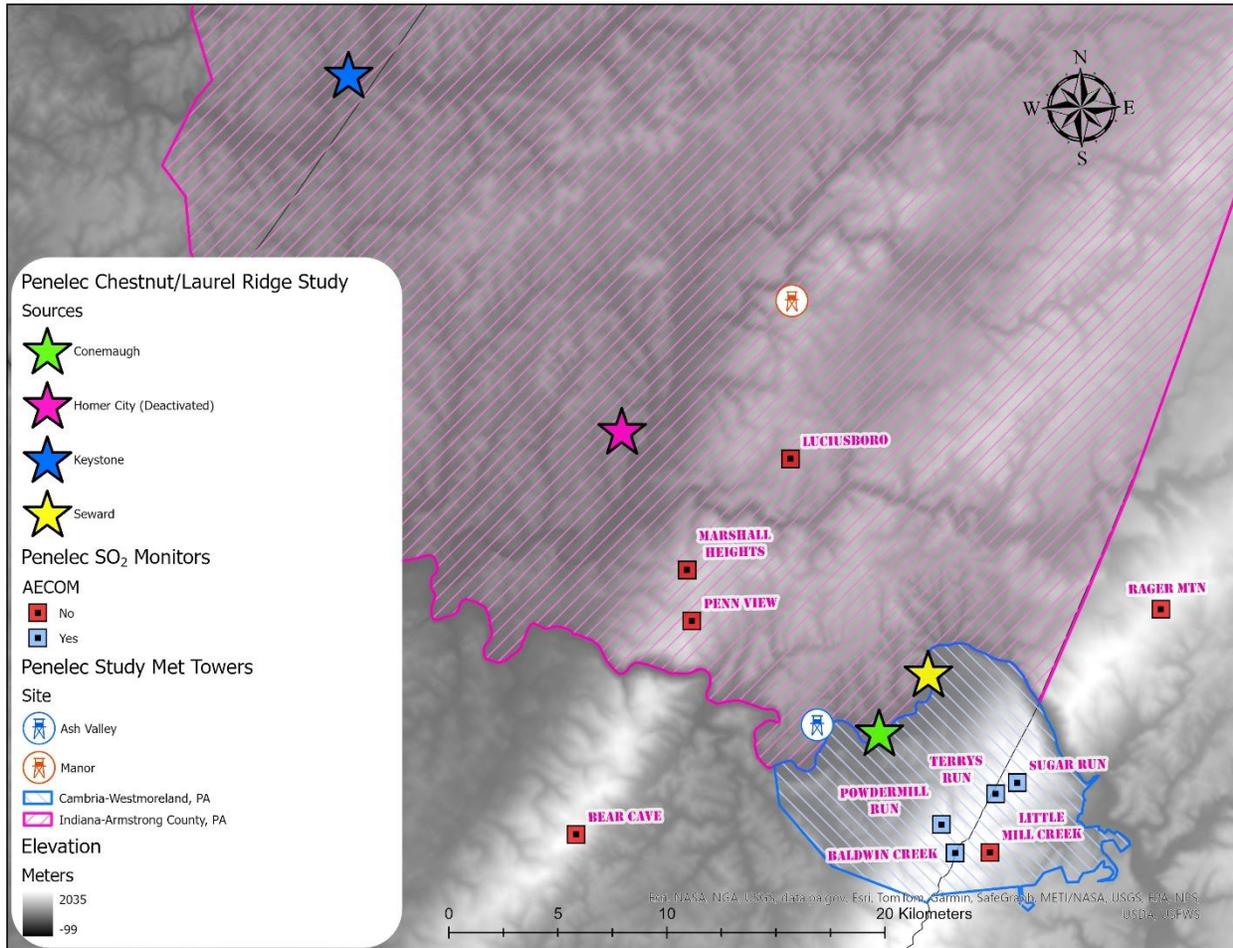
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**Figure 1: Cambria-Westmoreland, PA 1-hour SO<sub>2</sub> NAAQS Modeling Area of Interest**



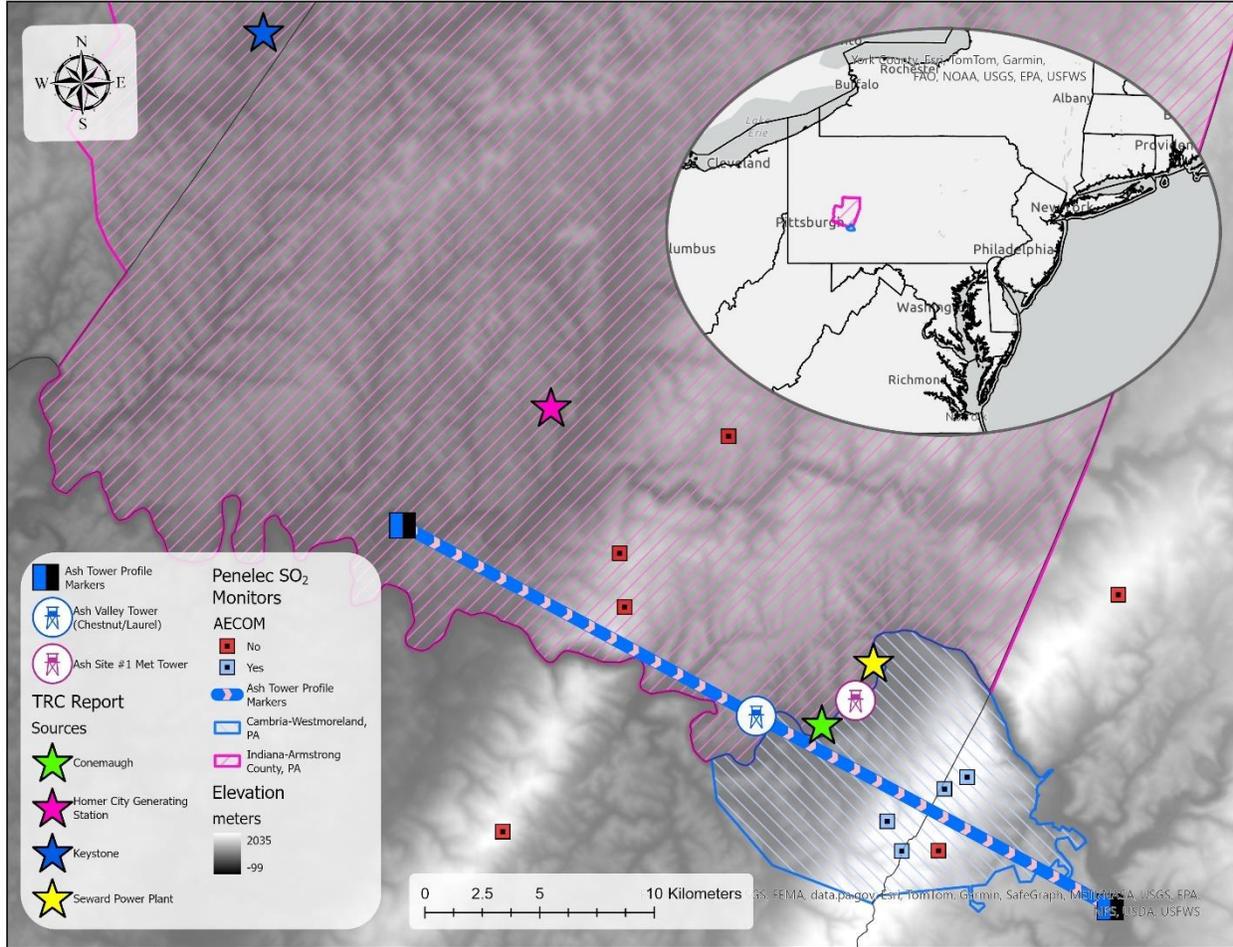
Note: Conemaugh, Seward and Keystone generating stations continue to operate today. Homer City decommissioned its units on July 1, 2023.

**Figure 2: Location of SO<sub>2</sub> Monitors, Meteorological Tower, and Sources for Historical Laurel Ridge Study**

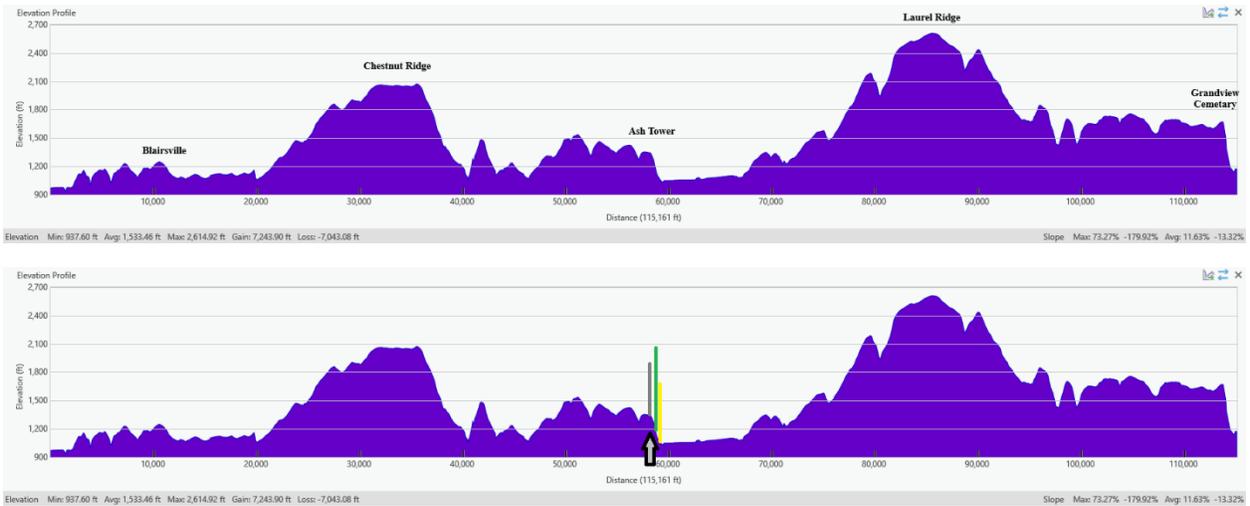


Note: Conemaugh, Seward and Keystone generating stations continue to operate today. Homer City decommissioned its units on July 1, 2023.

**Figure 3: Map of Laurel Ridge Study and Elevation Cross-Section Path**



**Figure 4: Cross-Section Profile Path**



## Exhibit A

Modeling Protocol for Site-Specific Alternative Model for 1-hour SO<sub>2</sub>  
Emissions of Conemaugh and Seward Impacts in Complex Terrain Along  
Laurel Ridge in Western Pennsylvania

## **Exhibit B**

Modeling Report for Site-Specific Alternative Model for 1-hour SO<sub>2</sub>  
Emissions of Conemaugh and Seward Impacts in Complex Terrain Along  
Laurel Ridge in Western Pennsylvania