National Park Service (NPS) Regional Haze SIP Supplement feedback for the Ohio Environmental Protection Agency (OEPA)

February 16, 2024

Contents

1 Executive Summary

1.1 Overview

The NPS appreciates the opportunity to comment on the Supplement to the Ohio Regional Haze State Implementation Plan (SIP Supplement) for the Second Implementation Period (2018–2028). Ohio extended the public comment period to allow for Federal Land Manager (FLM) review of the SIP Supplement. The NPS also recognizes Ohio's commitment to make FLM comments available to the public by March 5, 2024. However, the FLMs, including the NPS, were not provided with an opportunity to consult with Ohio on the SIP Supplement prior to the public comment period. As a result, FLM conclusions and recommendations on the SIP Supplement materials were not considered by the state during development of the SIP Supplement and were not included in the public notice for the comment period. As detailed in Section 2.1, this does not meet NPS expectations for FLM consultation as required by the Clean Air Act (CAA) and the Regional Haze Rule.

The NPS manages 48 of the 156 mandatory Class I areas across the country where visibility is an important attribute. While Ohio does not contain any NPS-managed Class I areas, NPS analysis has found that emissions from sources in the state affect visibility at Shenandoah National Park in Virginia, Mammoth Cave National Park in Kentucky, and Great Smoky Mountains National Park in North Carolina and Tennessee. Reducing haze-causing emissions from Ohio facilities would make a difference for clean air and clear views in these parks and across the region.

The SIP Supplement includes emission limits for three Ohio power plants: General James M. Gavin Power Plant (Gavin), Cardinal Power Plant (Cardinal), and Ohio Valley Electric Corp., Kyger Creek Station (Kyger Creek). These proposed limits are well above the actual emissions from the facilities and will not reduce emissions that contribute to haze in NPS Class I areas. Therefore, these emissions limits do not meaningfully improve the existing SIP, and the NPS encourages OEPA to require reasonable and cost-effective emission reductions for the second implementation period.

Based on new information, including the SIP Supplement, the NPS has updated recommendations for the three power plants addressed by OEPA. NPS analyses identified cost-effective requirements that would result in substantial reductions of haze-causing emissions from these facilities. (See Section 1.2 and Section 3 for details.) In particular, the replacement of sulfur dioxide scrubbers at the Gavin facility could reduce projected annual sulfur dioxide (SO_2) emissions by over 24,000 tons/year. Gavin is currently the second highest contributor to visibility impacts at Shenandoah National Park and across the southeastern region and is projecting an increase in future SO_2 emissions. The Gavin facility provides OEPA with the single biggest opportunity to reduce haze-causing emissions and improve visibility in Class I areas in this planning period.

The NPS also provides comments in Sections 2.2 and 2.3 on the methods used by OEPA for identifying effectively controlled Electric Generating Units (EGUs) and evaluating existing Nitrogen Oxides (NO_x) controls, respectively.

The NPS appreciates the opportunity to provide public comment on the state's draft SIP Supplement for the second regional haze planning period and looks forward to working with OEPA to improve and protect air quality and visibility in NPS Class I areas.

1.2 Summary of NPS Conclusions and Recommendations for Ohio Facilities

NPS calculation workbooks are included in Attachment 2:

Gavin

The SIP supplement includes an SO_2 emission limit of 0.75 pounds per million British thermal units (lb/MMBtu) on a rolling 30-operating day average for the Gavin's two coal-fired boilers. This new limit will not reduce actual emissions and, in fact, allows for an increase beyond current emissions, as described in the facility analysis/projections in SIP Supplement, Appendix A.1.

The NPS finds that Gavin Units 1 and 2 are not effectively controlled for SO_2 and recommends implementing an annual emission limit of 0.075 lb/MMBtu consistent with cost-effective replacements for the aging Gavin scrubbers.[1] The updated control-cost estimate for Gavin SO_2 scrubber replacement is based on new information in the draft SIP Supplement and current economic variables. The NPS concludes that Wet Flue Gas Desulfurization (WFGD) replacement for Gavin Units 1 and 2 could reduce future SO_2 emissions from the facility by over 24,000 tons/year for an estimated $5,900–$7,100/ton (in 2022$). The NPS recommends that OEPA require implementation of an SO_2 emission limit of 0.075 lb/MMBtu annual average (99% control). This is based upon replacement of the 30-year-old WFGDs at Gavin with new WFGDs. If utility owners/operators find that control equipment replacements are not cost-effective based on anticipated useful life, then enforceable shutdown dates should be established in lieu of replacing existing controls.

With respect to NO_x, the NPS concludes that Gavin emission units are not effectively-controlled and that their emission control performance has significantly degraded in comparison to 2009–2012 annual averages and recent ozone season performance. The NPS recommends that OEPA implement a 30-day rolling average NO_x limit of 0.10 lb/MMBtu for Gavin EGUs. In addition, optimization of the 20-year-old SCR systems is likely very cost-effective. Optimization could likely achieve an annual emission limit of 0.08 lb/MMBtu reducing NO_x emissions by 1,700 tons/year. See Section 3.1 for additional details.

Cardinal

The SIP supplement includes a federally enforceable SO_2 emission limit of 4,858.75 pounds per hour as a rolling 30-day average for Cardinal's three EGUs combined. This SO_2 emission limit for Cardinal is equivalent to over 21,000 tons/year. Actual annual 2022–2023 SO_2 emissions were 11,000 tons/year.

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[1] Existing wet scrubbers at the Gavin power plant were installed in 1994 and 1995 and have reached their expected useful life. As documented in the OEPA SIP Supplement appendices, the Gavin scrubbers have experienced considerable operational and maintenance challenges along with existing system capacity limitations that have contributed to the below average wet scrubber control efficiency at the facility.

After reviewing recent data, the NPS concludes that Cardinal Units 1, 2, and 3 are not effectively controlled for SO_2 or NO_x emissions. In fact, recent data show increasing emission rates from all three units.

The NPS recommends that OEPA require an SO_2 scrubber optimization analysis for Cardinal EGUs and implement reasonable cost-effective control improvements identified through the analysis. Optimization should be expected to return these emission units to the SO_2 removal efficiency they previously attained. This would reduce SO_2 emissions from the facility by an estimated 3,500 tons per year in comparison to average 2019–2023 emissions.

The NPS also recommends that OEPA require a four-factor review of SCR optimization for the Cardinal EGUs and implement reasonable cost-effective control improvements identified through the analysis. Optimization of the 20-year-old SCR systems is likely very cost-effective and could achieve an emission limit of 0.04 lb/MMBtu. Implementation of this rate could reduce annual NO_X emissions from the Cardinal facility by over 1,800 tons compared to recent emissions. See Section 3.2 for additional details.

Kyger Creek

The NPS concludes that Kyger Creek emission units are effectively controlled for SO_2 emissions. However, based on recent emissions data, Units 1–5 are not effectively-controlled for NO_x on a year-round basis. The NPS continues to recommend that OEPA require four-factor analyses to explore NO_x emission reduction opportunities for Kyger Creek emission units and implement reasonable cost-effective control improvements identified through the analysis. Optimization of the 20-year-old SCR systems is likely very cost-effective and could achieve an emission limit of 0.08 lb/MMBtu. See Section 3.3 for additional details.

2 Overarching Recommendations

2.1 FLM Consultation

The NPS appreciates that Ohio extended the public comment time to allow for FLM review of the SIP Supplement as well as Ohio's commitment to make FLM comments available to the public by March 5, 2024. However, FLMs, including the NPS, were not provided with an opportunity to consult with Ohio on the SIP Supplement *prior* to the public comment period. As a result, FLM conclusions and recommendations on the SIP supplement materials were not considered by the state and were not included in the public notice announcing the comment period.

The regulatory requirement for FLM consultation specifies a minimum 60-day consultation period on any SIP or SIP revision *prior* to any public comment opportunity:

> *(2) The State* ***must provide the Federal Land Manager with an opportunity for consultation*** *. . .The opportunity for consultation will be deemed to have been early enough if the consultation has taken place at least 120 days* ***prior to holding any public hearing or other public comment opportunity on an implementation plan (or plan revision)*** *for regional haze required by this subpart. The opportunity for consultation on an implementation plan (or plan revision) or on a progress report* ***must be provided no less than 60 days prior to said public hearing or public comment opportunity****. This consultation must include the opportunity for the affected Federal Land Managers to discuss their: (i) Assessment of impairment of visibility in any mandatory Class I Federal area; and (i) Recommendations on the development and implementation of strategies to address visibility impairment. [40 CFR 51.308(i)(2)]*

The timeframes specified in the regulation ensure that states can meet the statutory requirement to include a summary of the FLM conclusions and recommendations in any public notice on a draft SIP or SIP revision:

> *(d) Consultations with appropriate Federal land managers*
>
> *Before holding the public hearing on the proposed revision of an applicable implementation plan to meet the requirements of this section, the State (or the Administrator, in the case of a plan promulgated under section 7410(c) of this title) shall consult in person with the appropriate Federal land manager or managers and* ***shall include a summary of the conclusions and recommendations of the Federal land managers in the notice to the public****. [42 U.S.C §7491 (d)]*

As noted in the regulations, the required consultation timeframes were developed so that the *"Federal Land Manager can meaningfully inform the State's decisions on the long-term strategy"* [40 CFR 51.308(i)(2)]. The Clean Air Act ensures public transparency in the regional haze process by requiring the state to inform the public of the FLM conclusions and recommendations in the public notice.

The NPS emphasizes the procedural requirements for FLM consultation under the regional haze process because it is one of the most significant opportunities for the federal agencies to carry out their congressionally designated "affirmative responsibility" to protect air quality related values in the Class I areas they manage. The SIPs will influence visibility in Class I areas for the next decade. The Environmental Protection Agency (EPA) underscored the value of FLM involvement in the SIP development process in the preamble to the Regional Haze Rule:[2]

> *As discussed in the proposed rule,* ***state consultation with FLMs is a critical part of the development of quality SIPs.*** *. .. We proposed to add a requirement that such consultation on SIPs and progress reports* ***occur early enough to allow the state time for full consideration of FLM input,*** *but no fewer than 60 days prior to a public hearing or other public comment opportunity.* [Emphasis added.]

The information provided in Ohio's SIP Supplement includes additional analyses and proposed emission limits for individual facilities and thereby constitutes a revision to the original 2021 Ohio Regional Haze SIP. In addition, economic factors that influence the cost analysis outcomes have changed dramatically since 2021. As such, the information found in the Supplement is relevant to FLM conclusions and recommendations on Ohio's long-term strategy. Moving forward, the NPS will continue to recommend that states provide an FLM consultation opportunity for all plan revisions, including supplements.

2.2 Identifying "Effectively Controlled" EGUs

In July 2021, OEPA submitted its final draft SIP for the second planning period to EPA for approval. The draft SIP concluded that emission units at the General James M. Gavin Power Plant (Gavin), Cardinal Power Plant (Cardinal), Plant and Ohio Valley Electric Corp., Kyger Creek Station (Kyger Creek) were effectively controlled and that no additional emission reductions are reasonable or warranted. The NPS disagrees with the conclusion that these emission units are all effectively controlled. As described in Section 3, NPS review finds that Gavin and Cardinal emission units are not effectively controlled for SO_2 and that none of the units considered under the Supplement are effectively controlled for NO_x.

According to the supplemental materials, and as described in communications with the NPS[3], the EPA requested that OEPA provide additional analysis materials in a SIP supplement. Specifically, OEPA was asked to address whether the three facilities could, at reasonable cost, achieve a consistently lower emission rates either through existing measures or potential low-cost upgrades. The EPA further requested that Ohio provide this information consistent with the 2021 clarification memo to determine whether a source is "effectively controlled."

Therefore, the "effectively controlled" determination is critical to the analysis outcome for these three facilities. The EPA addressed the analytical expectations for "effectively controlled"

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[2] Protection of Visibility: Amendments to Requirements for State Plans, Final Rule, 82 Fed. Reg. 3078 (January 10, 2017).

[3] Email from Holly Kaloz to Melanie Peters dated 12/21/2023.

determinations in the July 2021 EPA Clarification Memorandum. Section 2.3 of the clarification memo states:

> *The underlying rationale for the "effective controls" flexibility is that if a source's emissions are already well controlled, it is unlikely that further cost-effective reductions are available.* ***A state relying on an "effective control" to avoid performing a four-factor analysis for a source should demonstrate why, for that source specifically, <u>a four-factor analysis would not result in new controls</u> and would, therefore, be a futile exercise.*** *States should first assess whether the source in question already operates an "effective control" as described in the August 2019 Guidance.* ***<u>They should further consider information specific to the source, including recent actual and projected emission rates, to determine if the source could reasonably attain a lower rate</u>. It may be difficult for a state to demonstrate that a four-factor analysis is futile for a source just because it has an "effective control" if it has recently operated at a significantly lower emission rate****. In that case, a four-factor analysis may identify a lower emission rate (e.g., associated with more efficient use of the "effective existing controls") that may be reasonable and thus necessary for reasonable progress. If a source can achieve, or is achieving, a lower emission rate using its existing measures than the rate assumed for the "effective control," a state should further analyze the lower emission rate(s) as a potential control option. [Emphasis added.]*

Based on this guidance, there are two analytical steps to the "effectively controlled" determination. The first is to verify that a four-factor analysis *would not result in new controls*. The second requires an analysis of whether the facility could achieve a lower rate through existing control measures by making efficiency improvements or control system upgrades. The NPS addresses each of these questions by analyzing the three facilities addressed in this Supplement. (See Section 3 of these comments).

The recommendations in EPA's 2019 regional haze guidance provides additional insight that is pertinent to this Supplement (Gavin in particular). Footnotes 52 and 53 of the 2019 guidance suggests that EGU controls installed prior to first implementation period (i.e., December 17, 2007) may not be presumed "effectively controlled" and that any Flue Gas Desulfurization (FGD) installed after this date should have an effectiveness of 95 percent or higher to be deemed "effectively controlled":

> *Bullet 7, Page 24: For the purposes of SO_2 [sulfur dioxide] and NO_x control measures . . . an EGU . . .* ***that, during the first implementation period,***[52] *installed a FGD [Flue Gas Desulfurization] system that operates year-round with an effectiveness of at least 90 percent or by the installation of a selective catalytic reduction [SCR] system that operates year- round with an overall effectiveness of at least 90 percent (in both cases calculating the effectiveness as the total for the system, including any bypassed flue gas), on a pollutant-specific basis.*[53]

> [52] *For purposes of this consideration, the first regional haze implementation period started when SIPs were due on December 17, 2007.*
>
> [53] *While a 90 percent control effectiveness is used in this example,* ***we expect that any FGD system installed to meet CAA requirements since 2007 would have an effectiveness of 95 percent or higher****. This does not apply to a source that has recently achieved a higher level of control efficiency without the installation of a control system, for example if it has merely increased the flow rate of a reagent. In such a situation, the four factors should be fully considered. The outcome may still be that the current level of control is the measure that is necessary to make reasonable progress.*

The NPS interprets this to mean that (1) the potential exemption from four-factor analyses only applies to SO_2 and NO_x controls installed after December 17, 2007; (2) new FGD controls should be capable of *at least* 95% control efficiency, new NO_x controls at least 90% control efficiency; and that (3) sources that are not consistently achieving these levels of control should not be presumed "effectively controlled."

For example, the NPS finds that Gavin Units 1 and 2 are not effectively controlled and recommends implementing an annual emission limit of 0.075 lb/MMBtu consistent with cost-effective replacements for the aging Gavin scrubbers. The existing scrubbers were installed in 1994 and 1995 and have reached their expected useful life. As documented in the OEPA SIP Supplement appendices, the Gavin scrubbers have experienced considerable operational and maintenance challenges. These challenges, along with existing system capacity limitations, have contributed to the below average control efficiency at the facility. If utility owners/operators find that control equipment replacements are not cost-effective based on anticipated useful life, then enforceable shutdown dates should be established in the SIP in lieu of replacing existing controls. The NPS recommendations for Gavin are described in detail in Section 3.1.

2.3 Evaluating Existing NO_x Controls

The NPS provides comments on the existing NO_x controls for the three facilities considered in this Supplement for the following reasons:

1. SCR systems on some of the units are not achieving 90% control, and thus are not presumptively "effectively controlled" under regional haze guidance.
    a. The NPS generally recommends that the SCR systems achieve at least a 0.08 lb/MMBtu emission rate, consistent with the "good neighbor" proposal.
2. Evaluations of NO_x control efficiency should consider full SCR system optimization to minimize associated environmental disbenefits.
    a. As discussed in the materials provided in the initial SIP submittal, improvements in NO_x emissions can be achieved through increased injection of SCR system reagent, but this may result in environmental disbenefits including increased

mercury and SO_2 emissions.[4] As such, full system optimization should be evaluated, which could include, but is not limited to, catalyst replacements/enhancements.

b. Additional costs resulting from optimization to mitigate/reduce mercury or SO_2 emissions can be properly accounted for as part of the costs of compliance in a four-factor analysis.

c. See detailed comments on this issue under "Optimizing Existing SCR Systems" in Section 3.1.3.

3. NO_x controls should be efficiently run year-round, not just during the ozone season, to provide additional visibility protection outside of the ozone season.

    a. IMPROVE data at Shenandoah National Park for 2018-2022 show 35 "most-impaired" days during the ozone season versus and 83 "most-impaired" days during the non-ozone season. During 2018–2022, ammonium nitrate accounted for over 30% of the visibility impairment. The colder months, when nitrate impairment is at its peak, tended to show the most days. Reducing NO_x emissions during these cooler, non-ozone season, months would provide visibility benefits.

[4] NPS review finds that for Ohio EGUs periods of more effective NO_x reductions show no evidence of jeopardizing MATS compliance. (see attached workbooks in Attachment 2: *Gavin data.xlsx*, *Cardinal Data.xlsx*, and *Kyger Creek data.xlsx*)

3 Facility-Specific Review for Ohio

3.1 General James M. Gavin Power Plant

3.1.1 Location and Impacts

The General James M. Gavin Power Plant (Gavin) is the largest coal-fired power facility in Ohio and the 3rd[th] largest in the nation[5]. The nearest NPS Class I area is Shenandoah National Park located approximately 300 kilometers due east. Great Smoky Mountains National Park and Mammoth Cave National Park are located approximately 360 and 390 kilometers to the southwest, respectively. The NPS has determined that Gavin has the greatest cumulative emissions over distance (Q/d) impact of any facility in the Lake Michigan Air Directors Consortium (LADCO) states[6] on NPS Class I areas.

The NPS also used the Visibility Improvement State and Tribal Association of the Southeast (VISTAS)[7] Area of Influence (AoI) analysis results[8] to develop a list of 348 facilities that contribute up to 80% of the AoI impact in each of the 18 Class I areas in the VISTAS region.[9] AoI analyses produce a surrogate impact metric that considers meteorology, visibility monitoring information, and emissions data to identify the facilities most likely to contribute to haze in a Class I area.[10] The NPS used these lists to rank the relative importance of individual facilities. The NPS developed both individual Class I area rankings and cumulative impact rankings (summed AoI impacts across all 18 Class I areas) for each of the 348 facilities on the list. Based on this information:

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[5] Based on 2023 heat input according to EPA's Clean Air Markets Program Database (CAMPD) in 2023

[6] LADCO is a nonprofit air quality research and planning organization. Known as a Multi-Jurisdictional Organization (MJO), LADCO works with federal, state, tribal, and local air agencies to improve air quality in the Great Lakes region. LADCO membership includes state air agencies for: Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin.

[7] VISTAS is the Visibility Improvement State and Tribal Association of the Southeast, the Regional Planning Organization (RPO) responsible for convening state, local, and tribal air pollution control agencies and collaborating on regional air quality analysis work necessary to support development of regional haze SIPs. The ten SESARM states (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia), the Eastern Band of Cherokee Indians, and Knox County, Tennessee make up the participation and governing body of VISTAS.

[8] Available at: https://www.metro4-sesarm.org/content/task-5-area-influence-analysis

[9] Using the VISTAS analysis results, the NPS defined AoI impact by first calculating the impact for each individual facility using the EWRT for sulfate times the SO_2 emissions over distance (Q/d) *plus* the EWRT for Nitrate times the Q/d NOx (EWRT SO_4* Q/d SO_2 + EWRT NO_3 * Q/d NO_x) for each VISTAS class I area. These values were then ranked by greatest AoI impact to least, and the list of sources comprising 80% of the total AoI impact for each Class I area was culled. Cumulative AoI impacts across all Class I areas for each individual facility were also calculated. There are 348 sources in total on the 80% of the AOI impact lists *for all 18 VISTAS region Class I areas*. There are 175 sources on the 80% of the AOI impact lists for the 4 NPS Class I areas in the VISTAS region—Mammoth Cave, Great Smoky Mountains, Shenandoah and Everglades National Parks.

[10] AOI results do not provide a facility-specific absolute value contribution to extinction. Instead, an AOI analysis uses back-trajectory models coupled with visibility data for the 20% most impaired days to identify geographic areas most likely contributing to impairment. VISTAS refers to this as the Extinction-weighted Residence Time, or EWRT analysis. The EWRTs for each pollutant are then combined with individual facility emissions over distance information to develop a relative ranking of the facilities most likely to contribute to haze in a given Class I area.

- Gavin is on the 80% of total AOI impact list for 15 VISTAS Class I areas, including Mammoth Cave, Great Smoky Mountains, and Shenandoah National Parks.
- Overall, Gavin is ranked the number two most impacting facility (out of 348) contributing to cumulative AoI impacts across the VISTAS Class I areas.[11]
- Gavin is also ranked the number two most impacting facility (out of 64) contributing to visibility impacts in Shenandoah National Park using the AOI ranking results.

3.1.2 Sulfur Dioxide (SO_2) Emission Controls

SO_2 Emissions

From 2019–2023 the Gavin power plant averaged 23,839 tons of SO_2 emissions annually. In Table A-1 and A-2 in Appendix A.2 of the OEPA SIP Supplement, Gavin projects increasing future annual SO_2 emissions to 29,171 tons.

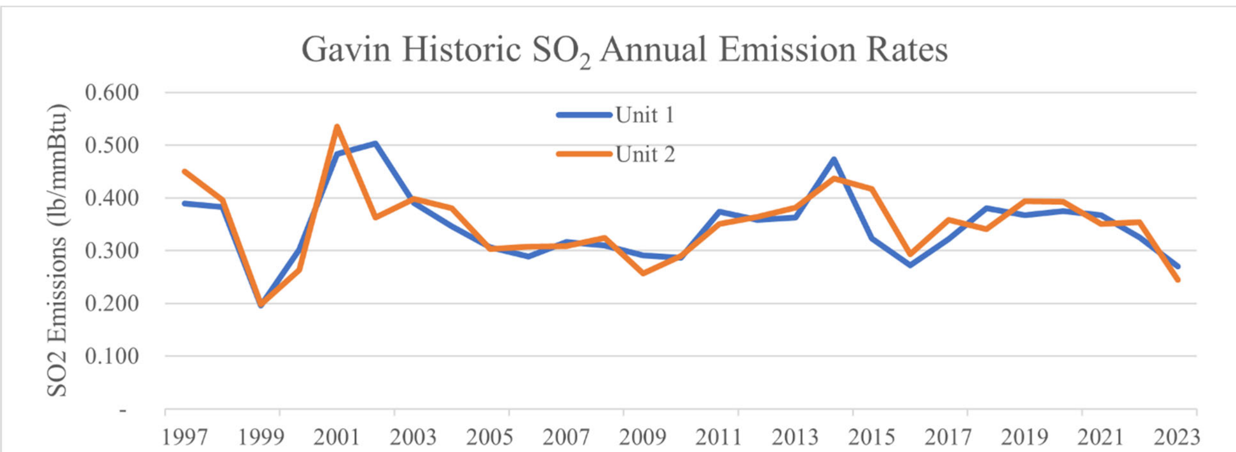

Figure 1. Gavin, historic annual SO_2 emission rates (CAMPD 1997–2023)

It appears that the recent scrubber upgrades cited by Gavin may have resulted in significant reductions in SO_2 emission rates during 2023 when SO_2 removal efficiencies approached 96%. However, Tables A-1 and A-2 in Appendix A.2 in Gavin's Supplement indicate that scrubber efficiency could decline to 93.7%. Additionally, the W. H. Sammis, Cardinal, and Kyger Creek power plants are achieving higher SO_2 removal efficiencies while burning similar coals.

Updated NPS Cost estimate for scrubber replacement

The updated NPS cost estimate demonstrates that replacing the WFGD scrubbers for Gavin Units 1 and 2 is cost-effective.

Description of input parameters for scrubber replacement cost estimation

The NPS prepared this cost estimate by applying EPA's Control Cost Manual (CCM) scrubber workbook using the parameters in "CCM" column in Table 1 below. The "Current uncontrolled SO_2 emissions" rates (lb/MMBtu) were derived from Energy Information Administration (EIA)

[11] This is based on the cumulative AOI impact for all 18 VISTAS Class I areas. Gavin is ranked 2nd highest among 348 total facilities that fall on any VISTAS region Class I area's 80% of total AOI impact list.

2022 fuels data and the 38S factor recommended by EPA for bituminous coals.[12] "Current uncontrolled SO_2" emissions are the product of the uncontrolled SO_2 emission rates and 2019–2023 average annual heat inputs. "Future uncontrolled SO_2 emissions" rates come from the Gavin portion of the OEPA SIP Supplement, Appendix A. The "SO_2 increase factor" compares the current uncontrolled SO_2 emissions to the future uncontrolled SO_2 emissions. The "estimated actual annual Megawatt-hour (MWh) output" was adjusted to produce the future annual uncontrolled emissions projected by Gavin in Tables A-1 and A-2 in Appendix A.2 of the OEPA SIP Supplement and shown in the "Gavin" columns below. Actual annual "gross heat input rates" were the 2019–2023 averages in EPA's Clean Air Markets Program Database (CAMPD).

In the absence of a federally enforceable closure date, scrubber life is assumed to be 30 years as recommended by the CCM. The NPS estimates applied the 8% After Tax Weighted Average Cost of Capital recommended by Gavin. New WFGD "future outlet SO_2 emissions" were based upon 99% "SO_2 removal efficiency" as suggested by the CCM. Existing WFGD "future outlet SO_2 emissions" were based upon the 93.7% control efficiency derived from Tables A-1 and A-2 in Appendix A.2 in the OEPA SIP Supplement.[13]

The values in the "Gavin" column were taken from Gavin's Supplement with the capital costs escalated to reflect the 2022 Chemical Engineering Plant Cost Index (CEPCI) for 2022 (816.0) versus 2019 (607.5). The "Adjusted Gavin" costs reflect higher operating costs associated with operating the new scrubbers at 99% control versus 98%.

Tables 2 and 3 show the updated NPS estimate and review of new (Table 2) and existing (Table 3) WFGD control costs for Gavin Units 1 & 2. These costs were derived using the inputs outlined in Table 4. The differentials values (Table 4) show the additional costs incurred due to the replacement scrubbers. The Capital Recovery Costs for replacement scrubbers would be completely new, while the Variable O&M Costs represent the costs of operating the new scrubbers at their higher SO_2 removal rates (versus operating the old scrubbers at their lower SO_2 removal rates). The Total Annual Costs are the sums of the Capital Recovery costs and the operating and maintenance cost at a higher removal efficiency. (Please see the included workbooks in Attachment 2: *Gavin #1 existing WFGD (2022$).xlsm*, *Gavin #1 new WFGD (2022$).xlsm*, *Gavin #2 existing WFGD (2022$).xlsm*, and *Gavin #2 new WFGD (2022$).xlsm*.)

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[12] AP-42, Vol. I, CH1.1 Bituminous and Subbituminous Coal Combustion (epa.gov)

[13] This is Gavin's estimated SO_2 removed/uncontrolled SO_2.

Table 1. Input Parameters for Updated NPS Estimate & Review of SO_2 Control Costs, Gavin Units 1 & 2

EGU	Unit 1			Unit 2			Units
Cost Methodology	**CCM**	**Gavin**	**Adjusted Gavin**	**CCM**	**Gavin**	**Adjusted Gavin**	
Gross MW rating at full load capacity	1430	1460		1460	1460		MW
Current Uncontrolled SO_2 Emissions	5.94	6.30		5.94	6.30		lb/MMBtu
Current Uncontrolled SO_2	214,052			197,396			ton/yr
Current Controlled SO_2 Emissions	0.341			0.347			lb/MMBtu
Current Controlled SO_2	12,304			11,535			ton/yr
Future Uncontrolled SO_2 Emissions	7.50	7.50		7.50	7.50		lb/MMBtu
Estimated Actual Annual MWh Output	6,923,000			6,841,000			MWh
Future Uncontrolled SO_2	251,137	251,139		243,615	243,603		ton/yr
SO_2 Increase Factor	1.17			1.23			
Gross heat input rate	9.7			9.5			MMBtu/MWh
Estimated equipment life	30	30		30	30		years
Desired dollar-year for Capital Costs	2022	2022		2022	2019		July
CEPCI	816.0	816.0		816.0	816.0		
Annual Interest Rate	8	8		8	8		Percent
Total System Capacity Factor	0.553	0.592		0.535	0.548		

Table 2. Updated NPS Estimate and Review of New WFGD Control Costs, Gavin Units 1 & 2

	Unit 1			Unit 2			
Cost Methodology	**CCM**	**Gavin**	**Adjusted Gavin**	**CCM**	**Gavin**	**Adjusted Gavin**	
Future Outlet SO_2 Emissions	0.075			0.075			lb/MMBtu
SO_2 Removal Efficiency	99.0	98.0	99.0	99.0	98.0	99.0	%
Total Capital Investment	$838,217,755	$822,709,215	$ 822,709,215	$843,718,048	$ 815,965,207	$ 815,965,207	
Capital Cost/MW	$ 586	$ 428	$ 428	$ 578	$ 559	$ 559	/MW
Capital Recovery Costs	$ 74,433,737	$ 73,056,578	$ 73,056,578	$ 74,922,163	$ 72,457,711	$ 72,457,711	/yr
Fixed O&M Cost	$ 12,751,439	$ 10,861,831	$ 10,861,831	$ 12,677,401	$ 10,785,615	$ 10,785,615	/yr
Variable O&M Cost	$ 50,599,233	$ 48,606,821	$ 49,102,809	$ 49,123,982	$ 47,157,414	$ 47,638,612	/yr
Total Annual Cost	$137,819,541	$132,525,230	$ 133,021,218	$136,723,545	$ 130,400,740	$ 130,881,938	/yr
SO_2 removed	248,626	245,891	248,628	241,179	238,513	241,167	ton/yr
Remaining SO_2 Emissions	2,511	5,248	2,511	2,436	5,090	2,436	ton/yr
Average Cost Effectiveness	$ 554	$ 539	$ 535	$ 568	$ 547	$ 543	/ton removed

Table 3. Updated NPS Estimate and Review of Existing WFGD Control Costs, Gavin Units 1 & 2

	Unit 1			Unit 2			
Cost Methodology	**CCM**	**Gavin**	**Adjusted Gavin**	**CCM**	**Gavin**	**Adjusted Gavin**	
Future Outlet SO_2 Emissions	0.470			0.410			lb/MMBtu
Control Efficiency	93.7	93.7	93.7	94.5	94.5	94.5	%
Capital Recovery Costs	$ -	$ -	$ -	$ -	$ -	$ -	/yr
Fixed O&M Cost	$ 12,751,439	$ 10,861,831	$ 10,861,831	$ 12,874,198	$ 10,785,615	$ 10,785,615	/yr
Variable O&M Cost	$ 47,363,297	$ 46,056,809	$ 46,056,809	$ 46,453,172	$ 45,113,831	$ 45,113,831	/yr
Total Annual Cost	$ 60,114,736	$ 56,918,640	$ 56,918,640	$ 59,327,370	$ 55,899,446	$ 55,899,446	/yr
SO_2 removed	235,399	235,423	235,423	230,298	230,148	230,148	ton/yr
Remaining SO_2 Emissions	15,738	15,716	15,716	13,318	13,455	13,455	ton/yr
Average Cost Effectiveness	$ 255	$ 242	$ 242	$ 258	$ 243	$ 243	/ton removed

Table 4. Updated NPS Estimate and Review of SO_2 Control Cost Differentials, Gavin Units 1 & 2

	Unit 1			Unit 2			
Cost Methodology	**CCM**	**Gavin**	**Adjusted Gavin**	**CCM**	**Gavin**	**Adjusted Gavin**	
Capital Recovery Cost	$ 74,433,737	$ 73,056,578	$ 73,056,578	$ 74,922,163	$ 72,457,711	$ 72,457,711	/yr
Fixed O&M Cost	$ -	$ -	$ -	$ -	$ -	$ -	/yr
Variable O&M Cost	$ 3,235,936	$ 2,550,012	$ 3,046,000	$ 2,670,809	$ 2,043,583	$ 2,524,781	/yr
Total Annual Cost	$ 77,704,805	$ 75,606,590	$ 76,102,578	$ 77,396,175	$ 74,501,294	$ 74,982,492	/yr
SO_2 removed	13,227	10,468	13,205	10,881	8,365	11,019	ton/yr
Average Cost Effectiveness	$ 5,875	$ 7,223	$ 5,763	$ 7,113	$ 8,906	$ 6,805	/ton removed

Improving from the projected 93.7% SO_2 control to 99.0% SO_2 control would remove over 24,000 tons of SO_2 annually. The cost effectiveness is the Total Annual Cost / ton of SO_2 removed and is $5,900–$7,100/ton (in 2022$).[14]

Updated NPS Conclusions & Recommendations for Gavin SO_2 Controls

The NPS recommends that OEPA require an SO_2 emission limit of 0.075 lb/MMBtu annual average (99% control) which could be achieved by replacement of the 30-year-old WFGDs at Gavin with new WFGDs. Scrubber replacement could reduce SO_2 emissions from the facility by over 24,000 tons/year for an estimated $5,900–$7,100/ton (in 2022$). This is well within the range of cost-effectiveness thresholds used by other states for regional haze in the second implementation period and is OEPA's single biggest opportunity to reduce haze causing emissions in this planning period.

[14] Cost of compliance: thresholds for cost-effectiveness for the second implementation period range from $4,000/ton (the bottom of the AZ range), $5,000/ton in AR (for EGUs) and TX, $5,000 - $10,000/ton in NV, $6,100 in ID, $6,250 in WA, $6,500/ton as the AZ upper end, $6,800/ton in HI, $7,000/ton in NM, and $10,000/ton in CO and OR.

3.1.3 Nitrogen Oxide (NO_x) Emission Controls

NO_x Emissions

SCRs were installed May 1, 2001, on Unit 1 & Unit 2. Beginning in 2009, emissions were reduced to about 0.1 lb/MMBtu and the SCR systems appear to be achieving 76-81% control.[15]

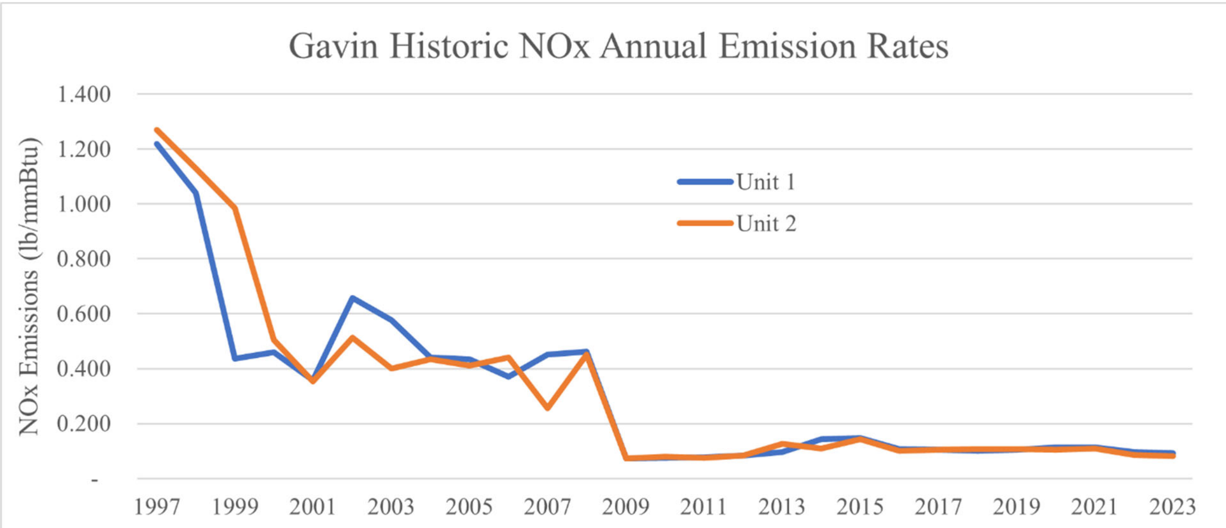

Figure 2. Gavin, historic annual NO_x emission rates (CAMPD 1997–2023)

The American Electric Power (AEP) Consent Decree stipulated that, *"No later than the dates set forth in the table below, Defendants shall install and Continuously Operate SCR on each Unit identified therein, or, if indicated in the table, Retire, Retrofit, or Re-power such Unit."* The applicable compliance date for the two Gavin units was January 1, 2009. The effect of the SCRs can be seen in the chart above.

The SCR systems[16] at Gavin were installed in 2001 prior to the first implementation period and do not appear to be achieving 90% control. Both criteria suggest that a four-factor analysis is warranted under the 2019 EPA regional haze guidance. In addition, the SCR systems for both Gavin units performed significantly better from 2009–2012 and during the most-recent two years (2022 & 2023).

[15] For 1999–2000 CAMPD shows that Unit 1 emitted NO_X at 0.447 lb/mmBtu while Unit 2 emitted NO_X at 0.491 lb/mmBtu in 2000. For 2019–2023, Unit 1 emitted NO_X at 0.105 lb/mmBtu while Unit 2 emitted NO_X at 0.097 lb/mmBtu. For 2022–2023, Unit 1 emitted NO_X at 0.094 lb/mmBtu while Unit 2 emitted NO_X at 0.083 lb/mmBtu. Comparing past versus current NO_X emission rate indicates 75-83% control.

[16] A "selective catalytic reduction system" does not include the Low-NO_X Burners which were installed separately a few years prior to SCR installation.

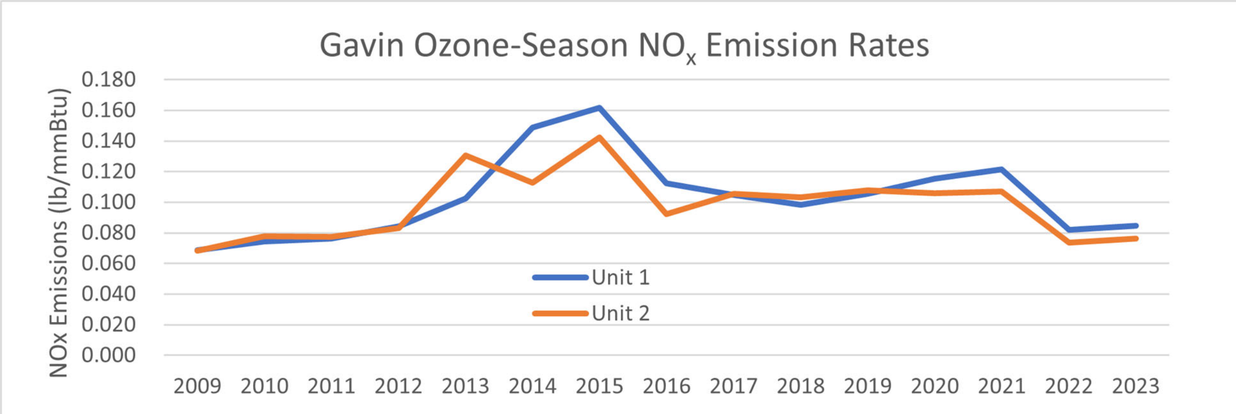

Figure 3. 2009-2023 ozone season NO_x emission rates for Gavin Units 1 & 2 (CAMPD 2023)

It appears that the Gavin SCR systems may not be *"continuously operated so as to minimize emissions to the greatest extent possible in accordance with the requirements of the AEP Consent Decree and federally- enforceable Title V permit,"* as there are periods of much better SCR performance than others.

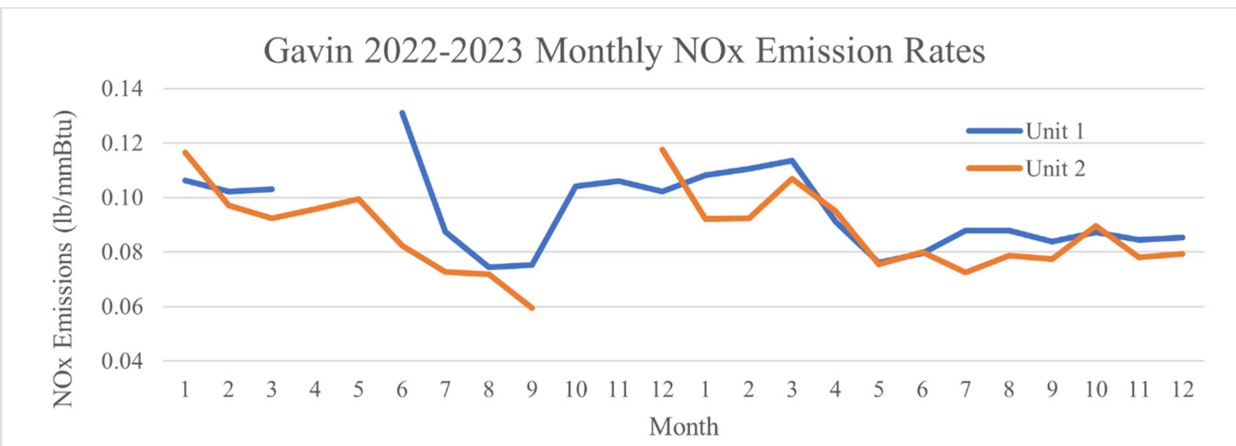

Figure 4. 2022–2023 monthly NO_x emission rates for Gavin Units 1 & 2 (CAMPD 2023)

Replacing the SCR Systems

Updated NPS estimates for the costs associated with replacing the SCR systems to reduce NO_x emissions for Gavin Units 1 and 2 found annual costs of about $15,500/ton for Unit 1 and $30,000/ton for Unit 2. These costs are well above the $10,000/ton cost-thresholds used by Colorado and Oregon in this round of regional haze planning and may not be considered cost-effective.

Optimizing Existing SCR Systems

In April 2022, EPA proposed its federal ''Good Neighbor Plan'' (GNP) for the 2015 Ozone National Ambient Air Quality Standards. In this plan, EPA estimates that, for SCR systems, *"the* *cost of optimizing is often much lower than $1,600 per ton and is often under $900 per ton,"* which is very reasonable.

According to the GNP, the EPA evaluated the feasibility of optimizing idled SCRs for the 2023 ozone season. Based on industry past practice, the EPA determined that idled controls can be restored to operation quickly (*i.e.,* in less than 2 months). This timeframe is informed by many electric utilities' previous long-standing practice of utilizing SCRs to reduce EGU NO_x emissions during the ozone season while putting the systems into protective lay-up during the non-ozone season months.

NPS review finds that potential issues related to improving NO_x emission controls are not unique to Gavin and can be mitigated through SCR optimization and good operating practices. For example:

- Mercury (Hg) emissions are well below the Mercury and Air Toxics Standards (MATS) and can be further mitigated by proper operation and maintenance of the SCR systems (including more frequent catalyst replacement) and potentially injection of activated carbon derivatives. Additional costs associated with this can be included as part of cost of compliance in a four-factor analysis.
- NPS review of CAMPD data shows that from 2022–2023 30-day rolling average value of Hg emissions did not approach the 1.2 lb Hg/TBtu MATS limit at Gavin Units 1 and 2. This clearly demonstrates that reduced NO_X emissions did not jeopardize MATS compliance as asserted by Gavin and OEPA. In fact, Hg emission rates decreased along with NO_X emission rates during the ozone season. See attached workbook in Attachment 2, *Gavin data.xlsb.*
- A parasitic load penalty is inherent in all SCR applications and ammonia use can be controlled with proper operation to minimize ammonia slip. The extra reagent and electricity costs can be monetized as part of cost of compliance in a four-factor analysis.
- Gavin presented no recent evidence of increased outages resulting from increased NO_x control during ozone-season operation.
- SO_2 emission rates may tend to increase as NO_x rates decrease. This could be mitigated through SCR optimization and/or replacement of the old scrubbers or both.
- Gavin presented no recent evidence of adverse impacts of ammonia slip on ash sales resulting from increased NO_x control during ozone-season operation.

Although these boilers are approaching 50 years of age, neither OEPA nor Gavin have provided any federally enforceable limits on their lives. It is not appropriate to consider the age of the emission unit in the absence of an enforceable limit.

Updated NPS Conclusions & Recommendations for Gavin NO_x Controls

The NPS review and analysis finds that Gavin emission units are not effectively controlled for NO_x emissions. In fact, emission control performance for these units has significantly degraded in comparison to 2009–2011 annual operation and recent ozone seasons.

The NPS recommends that OEPA implement a 30-day rolling average NO_x limit of 0.10 lb/MMBtu for Gavin EGUs to ensure that the SCRs are *"continuously operated so as to minimize emissions to the greatest extent possible in accordance with the requirements of the AEP Consent Decree and federally- enforceable Title V permit."* In addition, optimization of the 20-year-old SCR systems is likely very cost-effective. Optimization could likely achieve an annual emission limit of 0.08 lb/MMBtu reducing NO_x emissions by 1,700 tons/year.

3.2 Cardinal Power Plant

3.2.1 Location and Impacts

The Cardinal Power Plant (Cardinal) is the 18th largest coal-fired power plant in the nation[17]. The nearest NPS Class I areas are Shenandoah National Park located approximately 275 km southeast of the facility and Great Smoky Mountains National Park and Mammoth Cave National Park located approximately 580 km southwest. The NPS has determined that Cardinal has the fifth-greatest cumulative Q/d impact of any facility in the LADCO states on NPS Class I areas.

The NPS also used the VISTAS AoI analysis results[18] to develop a list of 348 facilities that contribute up to 80% of the AoI impact in each of the 18 Class I areas in the VISTAS region.[19] The AoI analyses produce a surrogate impact metric that considers meteorology, visibility monitoring information, and emissions data to identify the facilities most likely to contribute to haze in a Class I area.[20] The NPS used these lists to rank the relative importance of individual facilities. The NPS developed both individual Class I area rankings and cumulative impact rankings (summed AoI impacts across all 18 Class I areas) for each of the 348 facilities on the list. Based on this information:

- Cardinal is on the 80% of total AOI impact list for seven VISTAS Class I areas, including Shenandoah National Park.
- Overall, Cardinal is ranked the 27th most impacting facility (out of 348) contributing to cumulative AoI impacts across the VISTAS Class I areas.[21]
- Cardinal is also ranked the tenth most impacting facility (out of 64) contributing to visibility impacts in Shenandoah National Park using the AOI ranking results.

3.2.2 Sulfur Dioxide (SO_2) Emission Controls

Cardinal has an existing federally enforceable SO_2 emission limit of 4,858.75 pounds per hour as a rolling 30-day average for the three emission units combined. The OEPA SIP Supplement incorporates this limit in the proposed regional haze SIP for the second implementation period.

[17] See footnote 5
[18] See footnote 8
[19] See footnote 9
[20] See footnote 10
[21] See footnote 11

This current SO_2 emission limit for Cardinal is equivalent to over 21,000 tons/year. Actual annual 2022–2023 SO_2 emissions were 10,400 tons/year.

NPS review of recent emissions data finds that from 2019–2023:

- Cardinal Unit 1 achieved 0.190 lb/MMBtu; 96.4% control.
- Cardinal Unit 2 achieved 0.240 lb/MMBtu; 95.5% control.
- Cardinal Unit 3 achieved 0.181 lb/MMBtu; 96.6% control.

However, as shown in Figure 5, each of the Cardinal Units has achieved higher levels of SO_2 removal efficiency in the past than they are currently achieving, indicating that a scrubber optimization analysis is warranted for all three units. Cardinal Unit 1 SO_2 emission rates have increased from 0.163 lb/mmBtu in 2020. Cardinal Unit 2 SO_2 emission rates have increased from a low of 0.170 lb/mmBtu in 2011 and are now higher than either of the other units. Cardinal Unit 3 performed most efficiently in 2015 when it achieved an SO_2 emission rate of 0.066 lb/mmBtu.

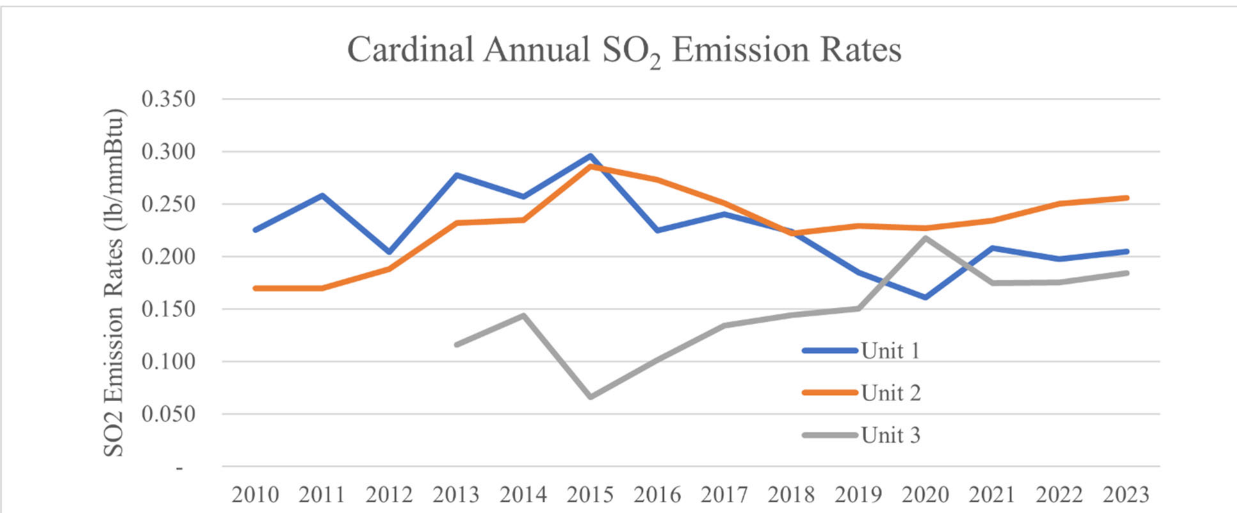

Figure 5. 2010–2023 Annual SO_2 emission rates for Cardinal Units 1 & 2 and 2013–2023 Annual SO_2 emission rates for Cardinal Unit 3 (CAMPD 2023)

Based on recent SO_2 WFGD performance at Cardinal, the NPS concludes that an SO_2 scrubber optimization analysis is warranted for all three emission units. Optimization to the levels of efficiency previously attained for each of the Cardinal units could reduce a combined 3,500 tons of SO_2 emissions annually, in comparison to 2019–2023 average emissions.

- Unit 1 potential SO_2 reductions (461 tons/year) are based on 0.163 lb/mmBtu.
- Unit 2 potential SO_2 reductions (1,219 tons/year) are based on 0.170 lb/mmBtu.
- Unit 3 potential SO_2 reductions (1,885 tons/year) are based on 0.066 lb/mmBtu.

3.2.3 Nitrogen Oxide (NO_x) Emission Controls

The current SIP Supplement does not address NO_x emissions controls for Cardinal. However, NPS review of recent data finds that Cardinal Units 1, 2, and 3 are not effectively controlled for NO_x emissions. In fact, recent data show increasing NO_x emissions from all three units.

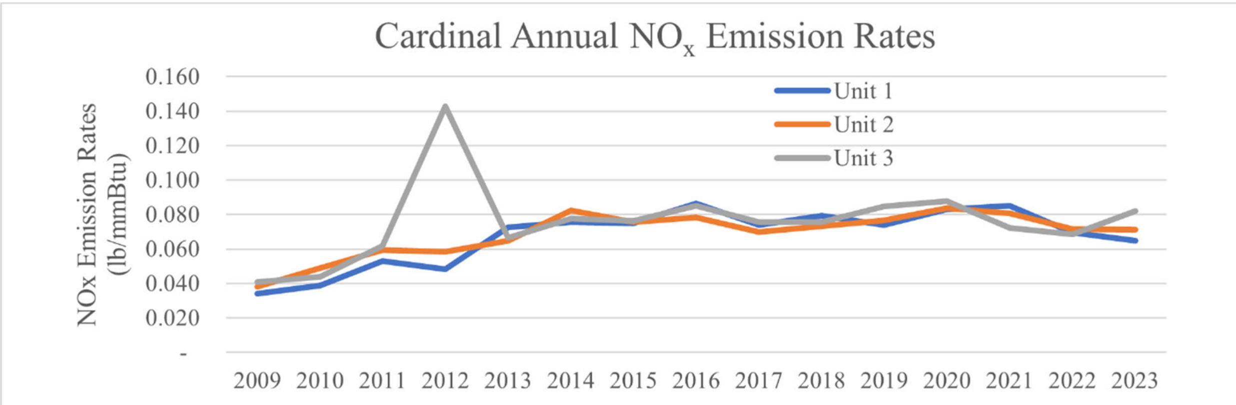

Figure 6. 2009–2023 Annual NO_x emission rates for Cardinal Units 1–3, CAMPD 2023

The EPA's 2021 Clarification Memo recommends analysis of lower emission rate(s) previously achieved as a potential control option for reasonable progress.

The NPS recommends that OEPA require a four-factor analysis of SCR optimization for these units and implementation of reasonable cost-effective control improvements identified through the analysis. Optimization of the 20-year-old SCR systems is likely very cost-effective and could achieve an emission limit of 0.04 lb/MMBtu for Cardinal. Implementation of this rate could reduce annual NO_X emissions from the Cardinal facility by over 1,800 tons.

3.3 Ohio Valley Electric Corp., Kyger Creek Station

3.3.1 Location and Impacts

The Kyger Creek Power Plant (Kyger Creek) is owned and operated by the Ohio Valley Electric Corporation. The nearest NPS Class I areas are Shenandoah National Park located at 300 km due east, Great Smoky Mountains National Park located at 400 km south, and Mammoth Cave National Park located at 400 km southwest of the facility. The NPS Q/d analysis has determined that Kyger Creek has the 24th greatest cumulative Q/d impact of any facility in the LADCO states on any NPS Class I areas.

The NPS also used the VISTAS AoI analysis results[22] to develop a list of 348 facilities that contribute up to 80% of the AoI impact in each of the 18 Class I areas in the VISTAS region.[23] The AoI analyses produce a surrogate impact metric that considers meteorology, visibility

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[22] See footnote 8
[23] See footnote 9

monitoring information, and emissions data to identify the facilities most likely to contribute to haze in a Class I area.[24] The NPS used these lists to rank the relative importance of individual facilities. The NPS developed both individual Class I area rankings and cumulative impact rankings (summed AoI impacts across all 18 Class I areas) for each of the 348 facilities on the list. Based on this information:

- Kyger Creek is on the 80% of total AOI impact list for nine VISTAS Class I areas, including Shenandoah and Great Smoky Mountains National Parks.
- Overall, Kyger Creek is ranked number 44 for most impacting facility (out of 348) contributing to cumulative AoI impacts across the VISTAS Class I areas.[25]
- Kyger Creek is also ranked the 24th most impacting facility (out of 64) contributing to visibility impacts in Shenandoah National Park using the AoI ranking results.

3.3.2 Sulfur Dioxide (SO_2) Emission Controls

The Energy Information Administration fuels data for Kyger Creek in 2022 indicate that uncontrolled SO_2 emissions from Kyger Creek would be 5.26 lbSO_2/MMBtu. The CAMPD data for 2018–2023 show SO_2 emission rates are 0.132–0.136 lb/MMBtu. This yields estimates of SO_2 control efficiency of over 97%. Further, SO_2 emission rates have remained relatively steady at 0.11–0.14 lb/MMBtu. Based on this, the NPS concludes that Kyger Creek is "effectively controlled" for SO_2.

3.3.3 Nitrogen Oxide (NO_x) Emission Controls

The OEPA SIP Supplement proposes a NO_X limit of 0.4 lb/MMBtu on a 30-day rolling average for each stack at Kyger Creek. This proposed limit is more than double the current annual average achieved by Kyger Creek Units from 2019–2023. This limit also represents less than 60% SCR control efficiency and is five-times the GNP 0.08 lb/mmBtu trigger.

As noted earlier, the SCR systems were installed prior to the first implementation period and are not achieving 90% control. In addition, the SCR systems have *"recently operated at a significantly lower emission rate"* and OEPA has not demonstrated that a four-factor analysis of SCR optimization would not be cost effective.

For these reasons, the NPS concludes that Kyger Creek Units 1–5 are not effectively-controlled for NO_x on a year-round basis. The NPS continues to recommend that OEPA require a four-factor analysis to explore NO_x emission reduction opportunities for Kyger Creek emission units.

Table 5 shows monthly ozone season NO_x emission rates from CAMPD, averaged over 2019–2023. This highlights the results of pre-ozone season SCR optimization efforts at the Kyger Creek emission units.

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[24] See footnote 10
[25] See footnote 11

Table 5. 2019–2023 annual and ozone season average NO_x emission rates for Kyger Creek Units 1–5

Unit	NO_x Emission Rates (lb/MMBtu)	
	2019–2023 Annual Averages	2019–2023 O3 Season Averages
1	0.155	0.074
2	0.158	0.076
3	0.140	0.071
4	0.147	0.072
5	0.145	0.072

As this table shows, NO_x emission rates during ozone season operation are about half the rates over the course of the entire year.

The NO_x emissions from the Kyger Creek facility could be significantly reduced if Units 1–5 were to meet 0.08 lb MMBtu on an annual basis. The NPS estimates that if Kyger Creek reduced annual NO_x emissions to 0.08 lb/MMBtu, total annual NO_x emissions would drop by over 1,700 tons per year.

In the GNP, EPA estimates that optimizing existing SCR systems to meet 0.08 lb/MMBtu would cost $900–$1,600/ton. This cost is very reasonable in the context of cost-effectiveness thresholds used by other states in this round of regional haze planning.

The slight increase in Hg emissions when the SCR systems are operating at higher efficiency does not jeopardize MATS compliance and could be mitigated by reducing ammonia slip, increasing catalyst replacement frequency, and/or adding powdered activated carbon (or similar agents). These costs can be quantified in a four-factor analysis. (Please see the attached workbook in Attachment 2, *Kyger Creek data.xlsb* for details).

The technological and economic impacts of lowering non-ozone season NO_x emissions can be mitigated and properly accounted for in the cost of control portion of a four-factor analysis.