Arkansas Regional Haze Planning Period II

State Implementation Plan

CHAPTER II: ARKANSAS FEDERAL CLASS I AREAS

Chapter II: Arkansas Federal Class I Areas

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II. Arkansas Federal Class I Areas

The RHR at 40 CFR § 51.308(f)(1) requires states to calculate baseline, current, and natural visibility conditions for federal Class I areas located in the state, evaluate progress to date toward natural visibility conditions, and determine the URP necessary to achieve natural visibility conditions by 2064. Sections A and B of this chapter provide updates to previous SIP submittals consistent with amendments to the RHR and revised EPA guidance.

In determining baseline and current conditions, the RHR requires states to examine the twenty percent most impaired days and the twenty percent clearest days each year. The most impaired days are those days during which decreased visibility results primarily from anthropogenic emissions, as determined by application of EPA's recommended method for selecting the twenty percent most impaired days.[1] The clearest days are days during which the least visibility impairment occurs. Whether the visibility impairment results from anthropogenic or natural sources of impairment is not a factor in selecting the clearest days.

Natural conditions cannot be measured directly and must be estimated. Generally, visibility impairment resulting from episodic and routine natural contributions to visibility impairment are used to estimate natural conditions. Episodic natural contributions are those that occur infrequently and variably from year to year, such as wildfires and large dust storms. Routine natural contributions are those that occur on all or most days of the year and are more consistent from year to year, such as secondary biogenic aerosols.[2]

Progress toward natural visibility conditions is tracked on both an annual basis and on a rolling five-year average. The five-year average metric was included in the RHR in order to minimize the impacts of year to year variability resulting from extreme natural events such as wildfires.

The URP is the amount of visibility improvement in deciviews that would be needed to stay on a linear path from the baseline period to natural conditions.[3] EPA guidance instructs states to calculate the URP by subtracting natural visibility conditions for the twenty percent most impaired days from baseline (2000–2004) visibility conditions for the twenty percent most impaired days and dividing the difference by sixty.[4] The formula is as follows:

$$URP = [(\text{baseline visibility})_{20\%\ \text{most impaired}} - (\text{natural visibility})_{20\%\ \text{most impaired}}]/60$$

[1] See EPA (2018). Technical Guidance on Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program. Pgs. 5–14. https://www.epa.gov/sites/production/files/2018-12/documents/technical_guidance_tracking_visibility_progress.pdf
[2] Id.
[3] Id.
[4] Id.

The Regional Haze Rule at 40 CFR 51.308(f)(1)(vi)(B) allows states to adjust the URP formula to account for international anthropogenic sources. International anthropogenic emissions contribute to visibility impairment in federal Class I areas, but these emissions are beyond the control of the state. DEQ has adjusted the URP for each Arkansas federal Class I area to account for international anthropogenic emissions in accordance with EPA guidance. The international anthropogenic contributions for Caney Creek and Upper Buffalo Wilderness are 4.88 Mm^{-1} and 7.02 Mm^{-1}, respectively.[5] The international anthropogenic contribution in the unit of inverse megameters (Mm^{-1}) can be converted to deciviews using the following formula:

$$\text{deciviews} = 10 * \ln (\text{bext}_{\text{natural conditions}} + \text{bext}_{\text{international anthropogenic}}) / \text{bext}_{\text{natural conditions}};$$

where bext is the atmospheric light extinction coefficient in Mm^{-1}

The adjusted URP glidepath endpoint of 2064 is calculated by adding the contribution of international anthropogenic emissions to the natural visibility condition. The adjusted URP endpoint for CACR and UPBU are 11.26 deciviews and 11.83 deciviews, respectively. The adjusted URP is calculated in accordance with the following formula:

$$\text{URP} = [(\text{baseline visibility})_{\text{20\% most impaired}} - (\text{natural visibility})_{\text{20\% most impaired}} + (\text{International anthropogenic impacts})_{\text{20\% most impaired}}]/60$$

Sections A and B of this chapter establish adjusted URPs, examine trends in visibility-impairing particulate species impacts, projected sources of visibility impairment in 2028, and areas of influence for each Arkansas federal Class I area.

A. Caney Creek

The Caney Creek Wilderness includes 14,460 acres of forested area, streams, and hiking trails.[6] It is located in the Ouachita National Forest in southwest Arkansas. Caney Creek supports multiple recreational activities including hiking, horse riding, and camping. Figure II-1 illustrates the scenic quality of the Caney Creek Wilderness.

[5] https://www3.epa.gov/ttn/scram/reports/Updated_2028_Regional_Haze_Modeling-TSD-2019.pdf
[6] U.S. National Forest Service, https://www.fs.usda.gov/recarea/ouachita/recarea/?recid=10792

Figure II-1: Katy Creek Falls (Left) and Little Missouri River (Right), Caney Creek Wilderness[7]

1. Ambient Data Analysis

The Caney Creek monitor is located at latitude 34.4544, longitude -94.1429 in Polk County, Arkansas at an elevation of 683 meters (m) above mean sea level (MSL). DEQ uses data from this monitor to determine visibility conditions for Caney Creek consistent with the requirements of 40 CFR § 51.308(f).

a. Baseline, Current, and Natural Visibility Conditions

DEQ is revising its previous determinations for baseline visibility conditions pursuant to 40 CFR § 51.308(f). In its Planning Period I SIP, DEQ determined baseline and current visibility conditions for Caney Creek for the twenty percent haziest days and the twenty percent clearest days. The 2017 amendments[8] to the RHR require states to examine the most impaired twenty percent days in place of the twenty percent haziest days. Table II-1 lists DEQ's revised determinations for baseline, natural, and current visibility conditions for the most impaired days and clearest days based on IMPROVE data and EPA's guidance[9] on determining the twenty percent most impaired days at Caney Creek.

[7] Image Credit: Tricia Treece

[8] EPA (2017). "Protection of Visibility: Amendments to Requirements for State Plans." 82 FR 3078

[9] EPA (2018). "Technical Guidance on Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program." https://www.epa.gov/sites/production/files/2018-12/documents/technical_guidance_tracking_visibility_progress.pdf

Table II-1: Baseline (2000–2004), Current (2014–2018), and Natural Visibility Conditions for the Twenty Percent Most Impaired Days and Twenty Percent Clearest Days at Caney Creek[10]

Metric	Baseline Visibility Conditions[11] (deciviews)	Current Visibility Conditions[12] (deciviews)	Natural Visibility Conditions (deciviews)
Most Impaired Days	23.99	17.65	9.54
Clearest Days	11.24	7.79	4.23

Consistent with 40 CFR § 51.308(f)(1)(iv) and (v), DEQ has determined the actual progress toward natural visibility conditions made to date for the clearest and most impaired days since the baseline period and actual progress made during the previous planning period. Table II-2 lists these metrics and the difference between current visibility conditions and natural visibility conditions.

Table II-2**:** Progress Toward Natural Visibility Conditions at Caney Creek

Metric	Progress to Date[13] (deciviews)	Progress During Planning Period I[14] (deciviews)	Difference between Current and Natural Visibility Conditions[15] (deciviews)
Most Impaired Days	6.34	5.7	8.11
Clearest Days	3.46	3.22	3.56

b. Uniform Rate of Progress

DEQ is revising its previous URP calculation for Caney Creek included in the Planning Period I SIP submittals. This revision is necessary to comply with the 2017 amendments[16] to the RHR, which require states to examine the twenty percent most anthropogenically impaired days in place of the twenty percent haziest days. In addition to revising the metric used for evaluating visibility progress, DEQ is also adjusting the URP to account for international anthropogenic contributions in accordance with EPA guidance. The revised URP is -0.212 deciviews per year

[10] Baseline and Natural Conditions from EPA (2020). “Technical addendum including updated visibility data through 2018 for the memo titled ‘Recommendation for the Use of Patched and Substituted Data and Clarification of Data Completeness for Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program.”
Data used to calculate current visibility conditions obtained from IMPROVE data files sia_impairment_group_means_12_20 (Most Impaired Days) and SIA_group_means_12_20 (Clearest Days)
[11] 2000–2004 average
[12] 2015–2019 average
[13] Difference between baseline (2000–2004) average conditions and 2015–2019 average conditions
[14] Difference between baseline (2000–2004) average conditions and 2014–2018 average conditions
[15] Difference between 2015–2019 average conditions and natural conditions
[16] EPA (2017). “Protection of Visibility: Amendments to Requirements for State Plans.” 82 FR 3078

based on an adjusted endpoint of 11.26 deciviews.

Figure II-2 demonstrates progress on the twenty percent most impaired days as compared to the glidepath set by the revised URP. The glidepath represents the URP that needs to be maintained throughout each implementation period in order to reach the 2064 goal. Figure II-2 includes both annual observations and the rolling five-year average of annual observations for visibility impairment on the most impaired days. Figure II-2 marks the point on th glidepath in 2028, the last year in the Planning Period II, for comparison with observed trends in visibility impairment.

Figure II-2: Progress on the Twenty Percent Most Impaired Days at Caney Creek Compared to the Glidepath[17]

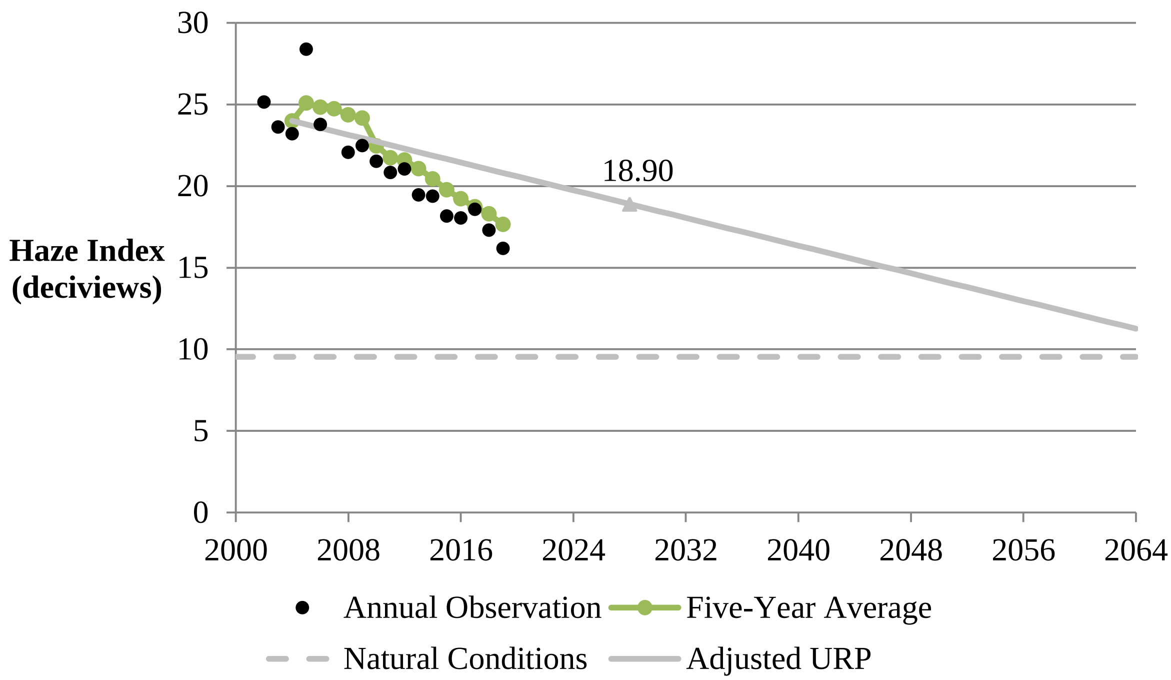
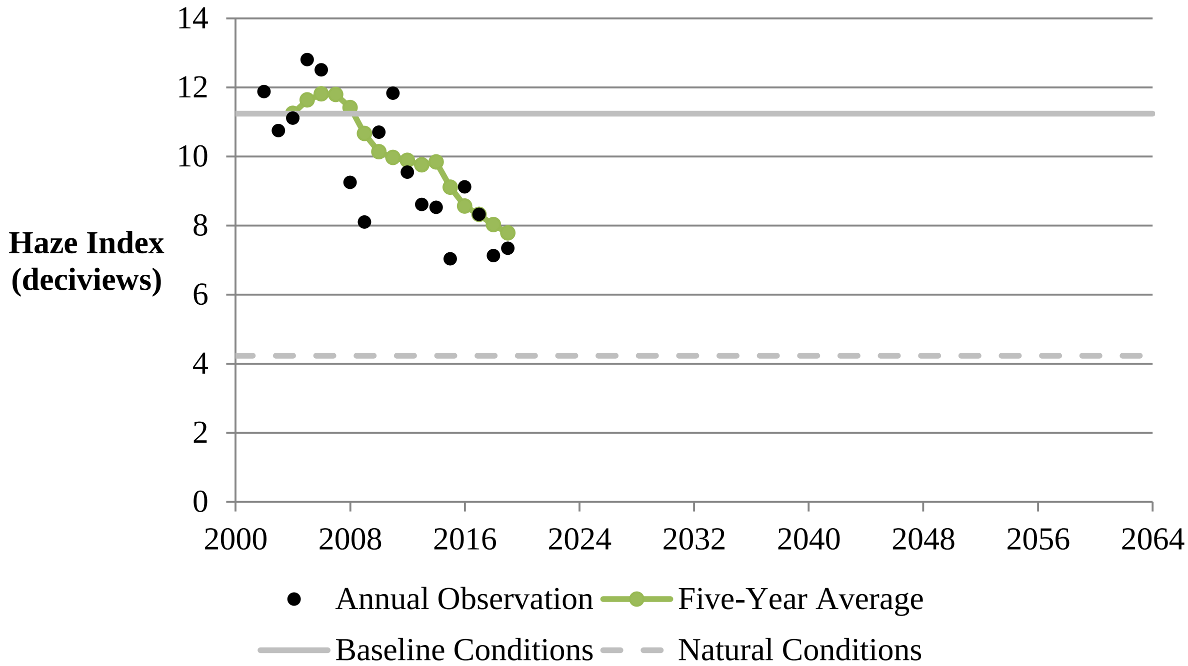


Figure II-2 shows continued improvement in visibility conditions at Caney Creek, particularly since 2009. The rolling five-year average of the twenty percent most impaired days has remained below the revised glidepath since 2010. The most recent five-year average (2015–2019) is below the URP value for 2028.

The RHR requires states to prevent degradation of visibility on the twenty percent clearest days from baseline conditions (2000–2004). Figure II-3 demonstrates progress on the twenty percent clearest days relative to baseline conditions and natural conditions.

[17] Annual observations obtained from IMPROVE data file sia_impairment_group_means_12_20

Figure II-3: Progress on the Twenty Percent Clearest Days Compared to Natural and Baseline Conditions at Caney Creek[18]



The five-year rolling average of the twenty percent clearest days illustrates continued improvement since 2007 with five-year averages remaining below baseline conditions since 2009.

c. Key Pollutants Impacting Visibility

Figure II-4 shows annual visibility tracking metrics for the twenty percent most impaired days at Caney Creek. The bars show the relative contribution of each particulate species to visibility impairment in each year in terms of Mm^{-1} (left y-axis). The line shows annual visibility impairment in terms of deciviews (right y-axis).

[18] Annual observations obtained from IMPROVE data file SIA_group_means_12_20

Figure II-4: Annual Extinction Composition, Most Impaired Days at Caney Creek, 2002–2019[19]

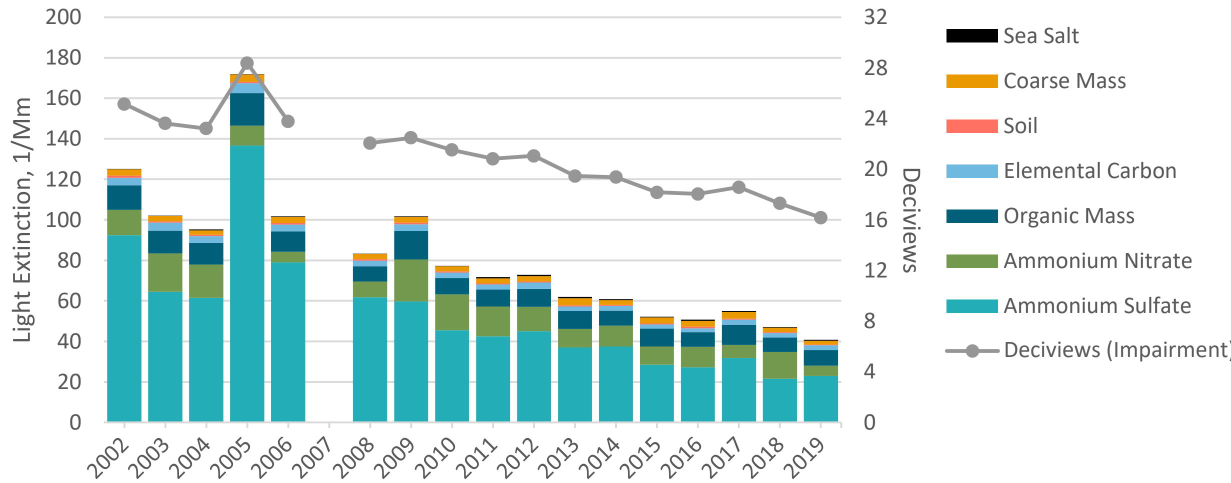


Figure II-4 shows that visibility impairment on the most impaired days has decreased over time at Caney Creek as light extinction due to ammonium sulfate, organic mass, and elemental carbon has decreased. Light extinction due to ammonium nitrate, coarse mass, and soil has fluctuated over time, but no apparent trend is evident. Light extinction due to sea salt has increased over time.

Figure II-4 indicates that, in 2019, ammonium sulfate was the largest contributor to light extinction at Caney Creek on the most impaired days followed by organic mass. Ammonium nitrate is the third largest contributor to light extinction. Elemental carbon and coarse mass each make up approximately four percent and three percent, respectively, of the annual light extinction composition in 2019 on the most impaired days. Sea salt and soil make up a very small fraction of the light extinction composition on the most impaired days.

Figure II-5 shows daily haze composition due to anthropogenic sources and Figure II-6 shows daily haze composition due to natural sources on the most impaired days at Caney Creek in 2018. In combination, these figures provide information about potential pollutants to include in DEQ's analysis of potential strategies for reasonable progress during Planning Period II.

[19] Data obtained from IMPROVE data file sia_impairment_group_means_12_20.

Figure II-5: Daily Haze Composition Due to Anthropogenic Sources, Most Impaired Days at Caney Creek, 2019[20]

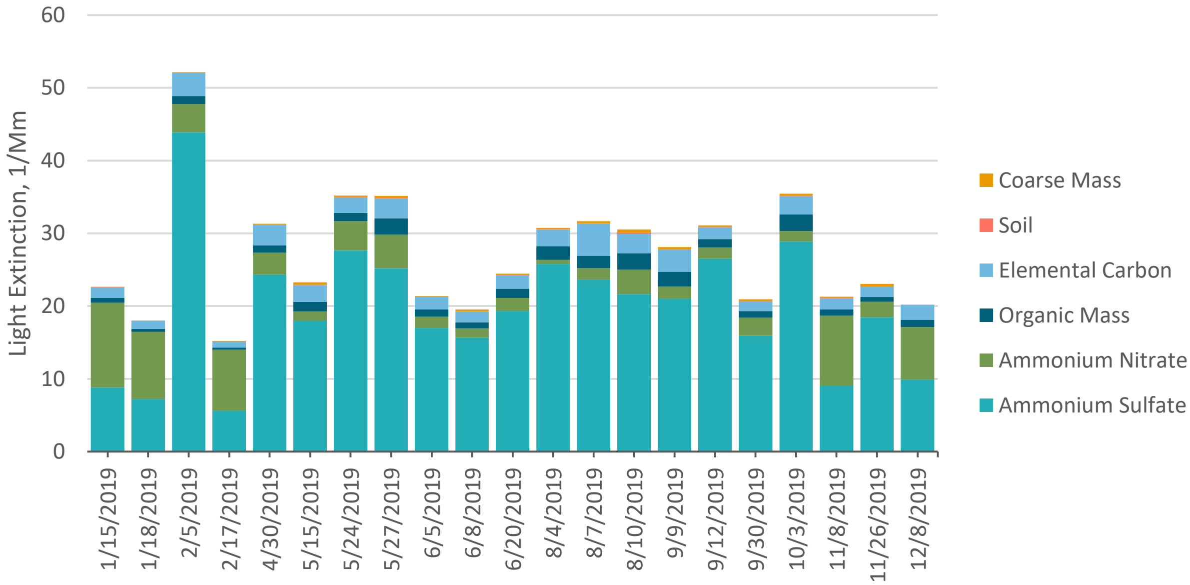
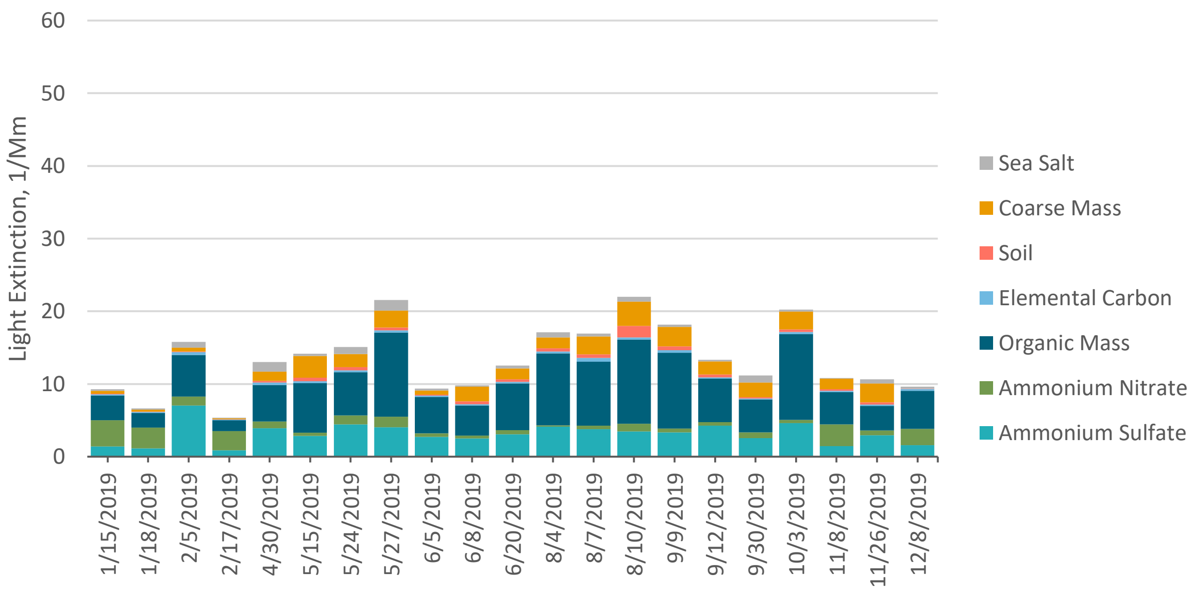


Figure II-6: Daily Haze Composition Due to Natural Sources, Most Impaired Days at Caney Creek, 2019[21]



Figures II-5 and II-6 show that light-extinction from ammonium nitrate, ammonium sulfate, and elemental carbon on the most impaired days at Caney Creek is primarily anthropogenic in nature. Light extinction on the most impaired days at Caney Creek due to coarse mass, organic mass,

[20] Data obtained from IMPROVE data file sia_impairment_daily_budgets_12_20.
[21] Data obtained from IMPROVE data file sia_impairment_daily_budgets_12_20.

and soil are primarily due to natural sources.

Figure II-7 shows annual visibility tracking metrics for the twenty percent clearest days at Caney Creek. The bars show the relative contribution of each particulate species to visibility impairment in each year in terms of Mm^{-1} (left y-axis). The line shows annual visibility impairment in terms of deciviews (right y-axis).

Figure II-7: Annual Extinction Composition, Clearest Days at Caney Creek, 2002–2019[22]

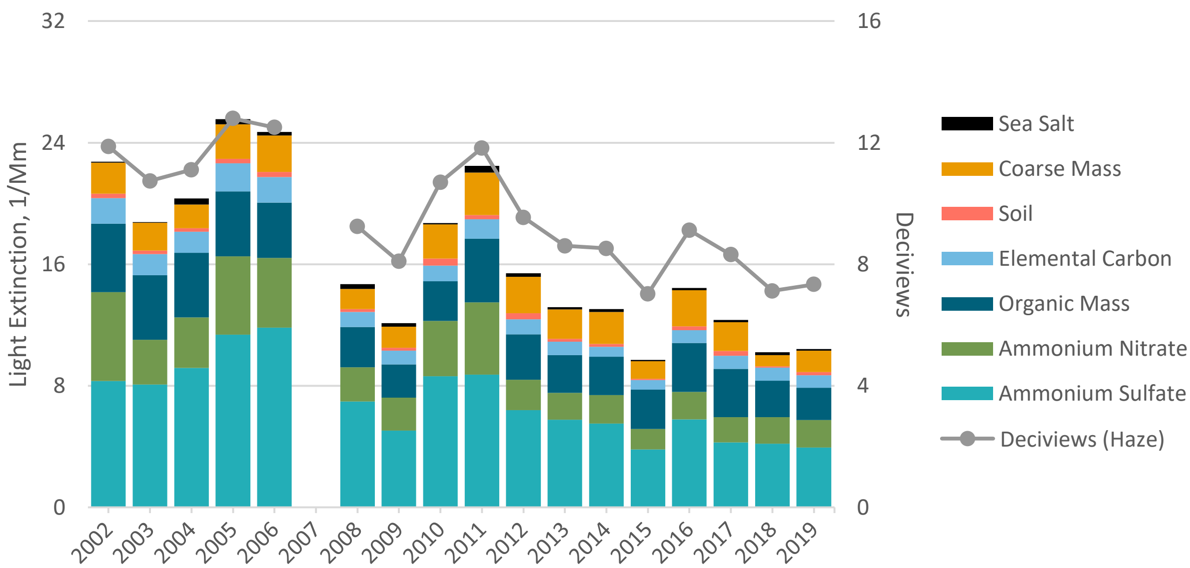


Figure II-7 shows a reduction of visibility impairment on the clearest days at Caney Creek. This reduction appears to correspond to decreased light extinction from ammonium sulfate and ammonium nitrate. The impacts from ammonium sulfate and ammonium nitrate continue to outweigh the impacts from elemental carbon at Caney Creek.

Based on these observations, strategies to reduce visibility impairment at Caney Creek from manmade air pollution during Planning Period II should focus on the following key pollutants: ammonium nitrate and ammonium sulfate.

2. Modeling Data Analysis

Multiple modeling studies have been performed to project 2028 visibility conditions at federal Class I areas. EPA performed air quality modeling using a 2016-based platform for all federal Class I areas in the United States. The results of EPA's modeling study are reported in EPA's 2019 "Technical Support Document for EPA's Updated 2028 Regional Haze Modeling Platform." [23] Alpine Geophysics, LLC and Eastern Research Group, Inc., conducted an air

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[22] Data obtained from IMPROVE data file SIA_group_means_12_20.

[23] EPA (2019). "Technical Support Document for EPA's Updated 2028 Regional Haze Modeling."

quality modeling study using a 2011-based platform on behalf of the VISTAS RPO to project 2028 visibility conditions at federal Class I areas in the Southeastern United States and at federal Class I areas that may be impacted by sources of air pollution located in the Southeastern United States.[24] Each modeling exercise provides useful information regarding the projected relative contribution of particulate matter species and sources of air pollution to visibility impairment at the end of Planning Period II.

EPA's modeling provides projected 2028 visibility conditions and source sector contribution information. In particular, the modeling results differentiate between visibility impairment contribution from United States anthropogenic sources of emissions and international anthropogenic sources of emissions. DEQ used this data to adjust the URP glidepath for Arkansas federal Class I areas. In addition, the modeling results provide insight into the relative impact of emission source categories on projected visibility impairment in 2028. The EPA modeling does not provide information about the relative contribution to projected visibility impairment in 2028 from particular stationary sources, states, or regions.

The VISTAS modeling also provides projected 2028 visibility conditions information. In addition, particulate source apportionment was performed for many stationary sources in the Southeast and surrounding states and for certain states and regions. Because of the source-specific and region-specific tagging performed as part of the VISTAS modeling effort, the VISTAS modeling results are useful in assessing the potential visibility benefits of control strategies under evaluation by states, including Arkansas, on federal Class I areas within the model domain.

The EPA and VISTAS modeling differ in 2028 emission inventory projections and meteorology. For non-EGUs, 2016 emissions and meteorology were used for the EPA modeling and 2011 emissions and meteorology were used for VISTAS modeling. For EGUs, the Integrated Planning Model (IPM) was used to project future EGU emissions for the EPA modeling and the Eastern Regional Technical Advisory Committee (ERTAC) EGU projection tool was used to project future EGU emissions for the VISTAS modeling. The IPM model is primarily an economic model that may make unrealistic choices, such as shutting down must-run units or changing fuels at plants not designed for and with no plans for fuel switching. The ERTAC EGU tool does not make assumptions about new units, retirements, and fuel changes. Instead, the tool incorporates state-provided information about new units, retirements, controls, etc. to project future year hourly activity and emissions estimates. In addition, the VISTAS RPO reached out to states for input on any additional changes in controls since the ERTAC EGU v16 results were posted prior to conducting modeling. DEQ provided adjusted emission rates (lb/MMBtu) for two sources in

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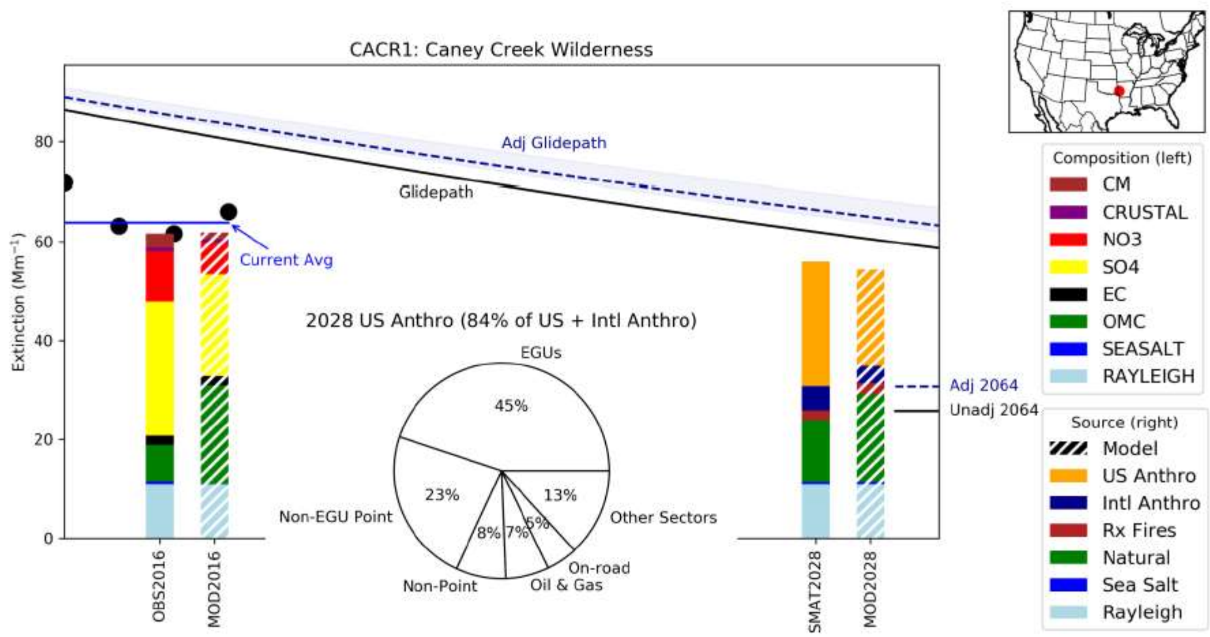
https://www.epa.gov/visibility/technical-support-document-epas-updated-2028-regional-haze-modeling

[24] See Task 2 (Emissions Inventories), Task 6 (Air Quality Modeling), and Task 7 (Source Apportionment Modeling/Tagging) on the VISTAS Regional Haze Program webpage: https://www.metro4-sesarm.org/content/vistas-regional-haze-program

Arkansas that recently switched to lower sulfur coal and installed low NOx burners. The difference in EPA and VISTAS modeling inventory inputs results in different 2028 visibility conditions projections, with the VISTAS modeling results projecting greater visibility impairment on the twenty percent most impaired days in 2028 at Arkansas federal Class I areas than the EPA modeling results.

Figure II-8 illustrates for Caney Creek the results of EPA's modeling effort. The figure presents observed data for 2014–2017, 2028 base case projections, and possible glidepaths under different assumptions. The dashed line represents EPA's default adjusted glidepath, which was adjusted based on relative international anthropogenic model contributions and ambient natural conditions.[25] The figure also includes a pie chart representing the specific anthropogenic emissions sector contributions identified as contributing to visibility impairment at Caney Creek.

Figure II-8: EPA Regional Haze Modeling Summary Plot for Caney Creek Wilderness[26]



The blue dashed line, the black line, and the blue shaded area in Figure II-8 indicate that, without additional emission reductions beyond those already required by regulations on the books, the rate of progress towards natural visibility would be faster than the range of URP options calculated by EPA, including the URP determined by Arkansas. The model predicts a visibility impairment value of 16.97 deciviews in 2028 for the most impaired days at Caney Creek. This

[25] The different glidepaths EPA included in their summary plots are based on different 2064 endpoint adjustment assumptions. DEQ's adjusted endpoint (11.26 deciviews) is higher than EPA's default adjusted endpoint (11.21 deciviews), but lower than EPA's maximum endpoint (12.49 deciviews).

[26] EPA (2019). "Technical Support Document for EPA's Updated 2028 Regional Haze Modeling." https://www.epa.gov/visibility/technical-support-document-epas-updated-2028-regional-haze-modeling

projected impairment value is lower than the 18.90 deciviews glidepath value in 2028 created by DEQ's URP. The visibility impairment value in 2019 for the most impaired days (16.18 deciviews) and the most recent (2015–2019) five-year average of most impaired days (17.65 deciviews) at Caney Creek are also below the glidepath value in 2028.

The pie chart in Figure II-8 represents specific source categories contributing to visibility impairment at Caney Creek in 2028 and indicates that the most prominent source categories are EGUs and Non-EGU point sources with smaller contributions from other U.S. anthropogenic sources. Other U.S. anthropogenic sources include oil and gas, area sources, mobile sources, and prescribed fires. The source apportionment presented in the pie chart suggests that strategies to reduce visibility impairment in 2028 should focus on reducing emissions from the following source categories: EGU and non-EGU point.

Figures II-9 and II-10 illustrate the 2028 base case results for Caney Creek of the VISTAS modeling effort. The VISTAS modeling base case results project visibility impairment in 2028 at Caney Creek on the most impaired days (18.32 deciviews) to be above the unadjusted glidepath (18.18 deciviews) and below the DEQ glidepath (18.90 deciviews). The projected most impaired days impairment value in 2028 at Caney Creek is higher than the 2019 monitor observation and 2015–2019 five-year average of monitor observations.[27] The projected base case results for the clearest days (8.79 deciviews) show no degradation from the 2000–2004 baseline (11.24 deciviews).

[27] Actual emissions data demonstrates a downward trend in pollutants affecting visibility at federal Class I sites; the VISTAS projections for most impaired days' impairment values are higher than actuals, due to shut-downs and on the books controls that may not be reflected in VISTAS modeling.

Figure II-9: VISTAS Base Case Results for Caney Creek Wilderness (Most Impaired Days)[28]

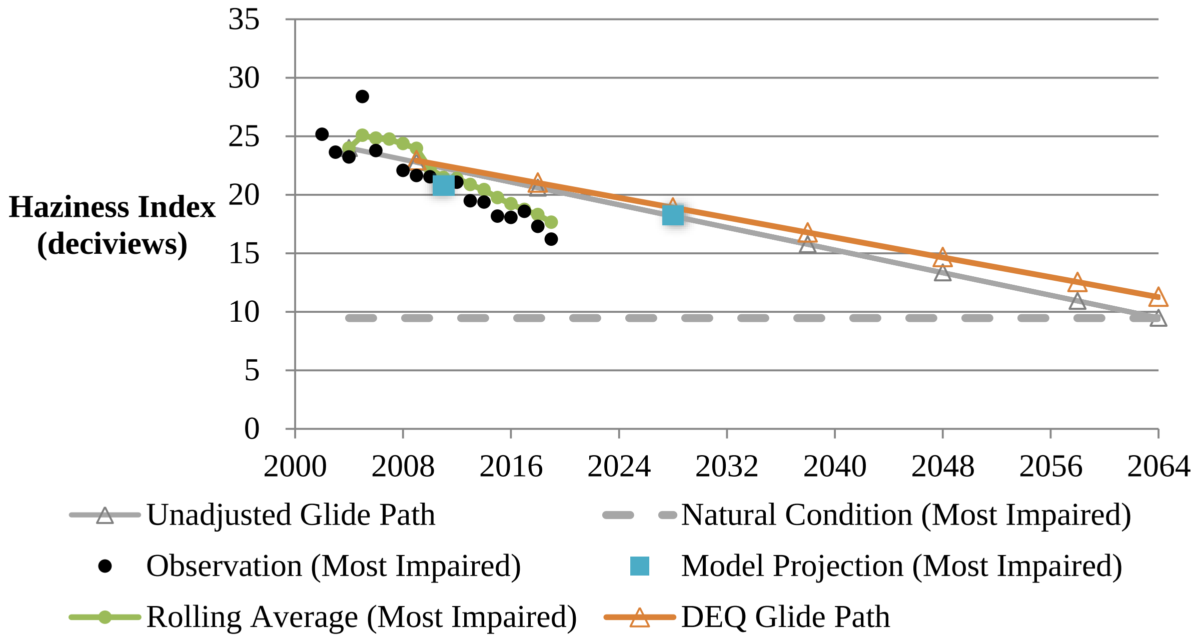
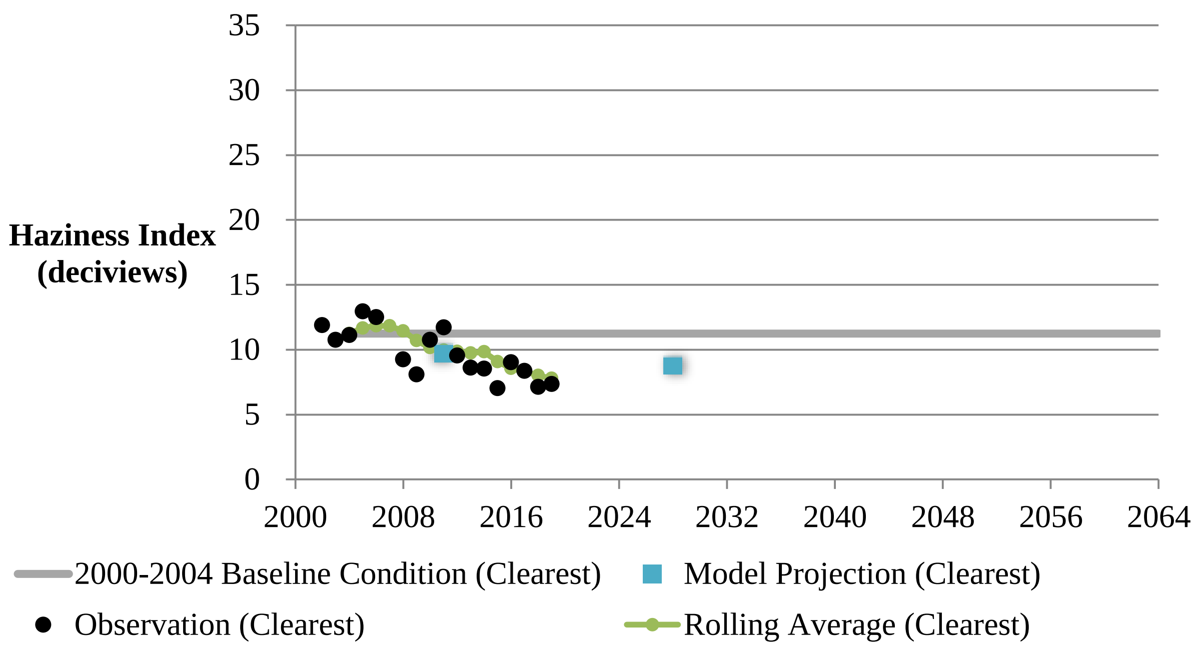


Figure II-10: VISTAS Base Case Results for Caney Creek Wilderness (Clearest Days)[29]



In addition to photochemical models, the WinHaze visual modeling tool enables the user to visualize various levels of visibility impairment in each federal Class I area. Figure II-11 shows

[28]Model results obtained from Metro 4/SESARM: Copy of V5_GlidePath_MI20_unit_Deciview_07-17-2020_jb
[29] Model results obtained from Metro 4/SESARM: Copy of V5_GlidePath_20C_unit_Deciview_07-17-2020

how a vista at Caney Creek Wilderness would look during the most impaired days in 2002 (left), 2019 (center), and under natural conditions (right). The improvement between the center image and the left image shows how the visibility has improved over time on the most impaired days.

Figure II-11: Caney Creek Wilderness WinHAZE Visualization Twenty Percent Most Impaired: 2002, 2019, and Natural Conditions

3. Area of Influence (AOI) Analysis

The Central States Air Resources Association (CENSARA) contracted with Ramboll US Corporation (Ramboll) to perform an area of influence (AOI) analysis for federal Class I areas in the CenSARA states and for federal Class I areas that might potentially be impacted by emissions from the CenSARA states. The CenSARA region includes Arkansas, Iowa, Kansas, Louisiana, Missouri, Nebraska, Oklahoma, and Texas. The analysis used a back-trajectory model, 2016 actual emissions and projected 2028 emissions from stationary sources, and extinction composition data for each federal Class I area to identify the geographic areas and anthropogenic emission sources with a high probability of impacting visibility at federal Class I areas within the CenSARA region and in nearby states. The AOI analysis used the following trajectory ending altitudes to model back-trajectories: 100m, 200m, 500m, and 1000m. Results were produced for each trajectory height and for all trajectory heights combined. The analysis focused on NOx and SO_2 because monitoring data indicate that these are the primary anthropogenic particulate species precursors that impair visibility at federal Class I areas in the CenSARA region. Other particulate species (such as salt, soil, and organic material) are often biogenic in nature. Elemental carbon is often influenced by prescribed and wildfire.

The AOI analysis generated several metrics that states could use. One metric is the distance-weighted residence time, which states can use to generally assess the probability of air parcels originating outside a given federal Class I area reaching the area. A second metric is the "extinction-weighted residence time" (EWRT) for NOx and for SO_2, which states can use to identify areas of influence for each pollutant at each federal Class I area. Another metric states can use is extinction-weighted residence time multiplied by emissions from a stationary source divided by the distance from the source to the federal Class I area (EWRT*Q/d). When the EWRT*Q/d values for SO_2 and NOx are summed for a source, this provides a surrogate for visibility impact for the source. Ramboll produced a report that summarizes the approach of the analysis and a spreadsheet that the CenSARA states could use to evaluate the results.[30]

DEQ applied a 0.05% threshold to the 2016 EWRT NOx results and 2016 EWRT SO_2 results for all trajectory heights combined to identify pollutant-specific areas of influence for each federal Class I area included in the AOI analysis.[31] For sources with an EWRT value greater than or equal to 0.05% for either pollutant, DEQ included the source in the AOI for each federal Class I area. Sources that did not meet this threshold—sources that have less than a 0.05% chance of impacting the relevant federal Class I area—were not included in the AOI.

DEQ summed the EWRT*Q/d values for NOx and SO_2 to produce a total visibility impact surrogate value for each source in each AOI. Throughout this proposal, DEQ refers to this combined EWRT*Q/d value for NOx and SO_2 as "the visibility impact surrogate." An overview of DEQ's methods and the results, with the visibility impact surrogate values ranked from largest to smallest for each federal Class I area, are included in Appendix C. This approach allows DEQ to identify the sources that are having the largest impact on each federal Class I area by holistically looking at the combination of impacts from the key pollutants from stationary sources.

Based on DEQ's evaluation of the 2016 AOI results, sources in the following states may impact visibility on the most impaired days at Caney Creek: Texas, Arkansas, Louisiana, Oklahoma, Missouri, Illinois, Indiana, Kansas, Iowa, Nebraska, Kentucky, Minnesota, Tennessee, North Dakota, Wisconsin, and Mississippi. Figure II-12 shows the relative percentage from each state of the visibility impact surrogate for all sources in the AOI.

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[30] The report and the all-trajectories spreadsheet used by DEQ in the development of this SIP are included in Appendix B.

[31] DEQ's methods for examining AOI results are detailed in the spreadsheet AR Screening Method included with Appendix C.

Figure II-12: Relative Visibility Impact Surrogate of Source in AOI analysis on Most Impaired Days at Caney Creek in 2016[32]

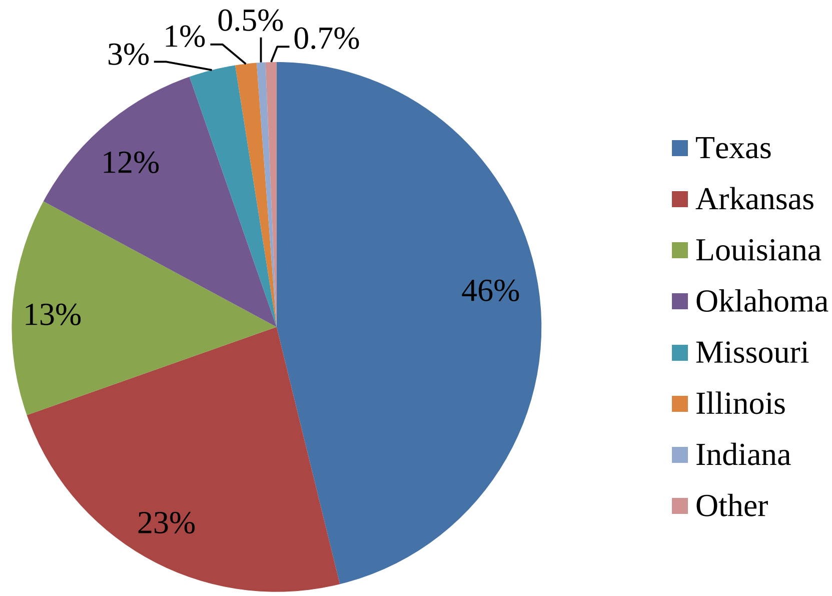


Figure II-12 indicates that stationary sources in Texas contributed the most to visibility impairment on the most impaired days at Caney Creek out of the stationary sources in the 2016 AOI. Sources in Arkansas were the second largest contributor.

B. Upper Buffalo

The Upper Buffalo Wilderness is located in the Ozark-Saint Francis National Forest in northern Arkansas. The area includes approximately 12,000 acres of mostly second and third growth oak-hickory forest with scattered areas of Shortleaf Pine.[33] The Buffalo River, which has been designated as a national wild and scenic river, flows through the Upper Buffalo Wilderness. The Upper Buffalo Wilderness supports multiple recreational activities including camping, kayaking and canoeing, fishing, hiking, horseback riding, and hunting. Figure II-13 shows two photographs taken within the Upper Buffalo Wilderness that illustrate the scenic quality of the area.

[32] The "Other" category includes Kansas, Iowa, Offshore, Nebraska, Kentucky, Minnesota, Tennessee, North Dakota, Wisconsin, and Mississippi. Combined visibility impact surrogate from sources in each of these states are less than one percent of the total visibility impact surrogate from all sources in the 2016 AOI results.

[33] U.S. National Forest Service. https://www.fs.usda.gov/recarea/osfnf/recarea/?recid=43499

Figure II-13: Buffalo River (Left) and Whitaker Point (Right), Upper Buffalo Wilderness[34]

1. Ambient Data Analysis

The Upper Buffalo Wilderness monitor is located one mile north of the U.S. Forest Service workstation near Deer, AR at an elevation of 722 meters above MSL. DEQ uses data from this monitor to determine visibility conditions for Upper Buffalo consistent with the requirements of 40 CFR § 51.308(f).

a. Baseline, Current, and Natural Visibility Conditions

DEQ is revising its previous determinations for visibility conditions pursuant to 40 CFR § 51.308(f) to be consistent with the requirements of the 2017 RHR amendments and EPA's guidance.[35] Table II-3 lists DEQ's revised determinations for baseline, natural, and current visibility conditions for the most impaired days and clearest days at Upper Buffalo Wilderness.

[34] Image Credit: National Park Service https://www.nps.gov/buff/planyourvisit/floating.htm (Left Image) and Tricia Treece (Right Image)

[35] Technical Guidance on Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program. https://www.epa.gov/sites/production/files/2018-12/documents/technical_guidance_tracking_visibility_progress.pdf

Table II-3: Baseline (2000–2004), Current (2014–2018), and Natural Visibility Conditions for the Twenty Percent Most Impaired Days and Twenty Percent Clearest Days at Upper Buffalo Wilderness[36]

Metric	Baseline Visibility Conditions (deciviews)[37]	Current Visibility Conditions[38] (deciviews)	Natural Visibility Conditions (deciviews)
Most Impaired Days	24.21	17.52	9.41
Clearest Days	11.71	8.17	4.18

Consistent with 40 CFR § 51.308(f)(1)(iv) and (v), DEQ has determined the actual progress toward natural visibility conditions made to date for the clearest and most impaired days since the baseline period and actual progress made during the previous planning period. For both the twenty percent most impaired days and the twenty percent clearest days, Table II-4 lists actual progress to date since the baseline period, progress during Planning Period I, and the difference between current visibility conditions and natural visibility conditions.

Table II-4: Progress Toward Natural Visibility Conditions at Upper Buffalo

Metric	Progress to Date[39] (deciviews)	Progress During Planning Period I [40] (deciviews)	Difference between Current and Natural Visibility Conditions[41] (deciviews)
Most Impaired Days	6.70	6.26	8.11
Clearest Days	3.54	3.51	3.993

b. Uniform Rate of Progress

DEQ is revising its previous URP calculation for Upper Buffalo included in the Planning Period I SIP submittals for consistency with the 2017 amendments[42] to the RHR, including adjustments to the 2064 endpoint based on international anthropogenic contributions in accordance with EPA guidance. The revised URP is -0.206 deciviews per year. Figure II-14 demonstrates progress on

[36] Baseline and Natural Conditions from EPA (2020). "Technical addendum including updated visibility data through 2018 for the memo titled 'Recommendation for the Use of Patched and Substituted Data and Clarification of Data Completeness for Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program." Data used to calculate current visibility conditions obtained from IMPROVE data files sia_impairment_group_means_12_20 (Most Impaired Days) and SIA_group_means_12_20 (Clearest Days)

[37] 2000–2004

[38] 2015–2019

[39] Difference between baseline (2000–2004) average conditions and 2015–2019 average conditions

[40] Difference between baseline (2000–2004) average conditions and 2014–2018 average conditions

[41] Difference between 2015–2019 average conditions and natural conditions

[42] EPA (2017). "Protection of Visibility: Amendments to Requirements for State Plans." 82 FR 3078

the twenty percent most impaired days as compared to the glidepath set by the revised URP.

Figure II-14: Progress on the Twenty Percent Most Impaired Days at Upper Buffalo Compared to the Glidepath[43]

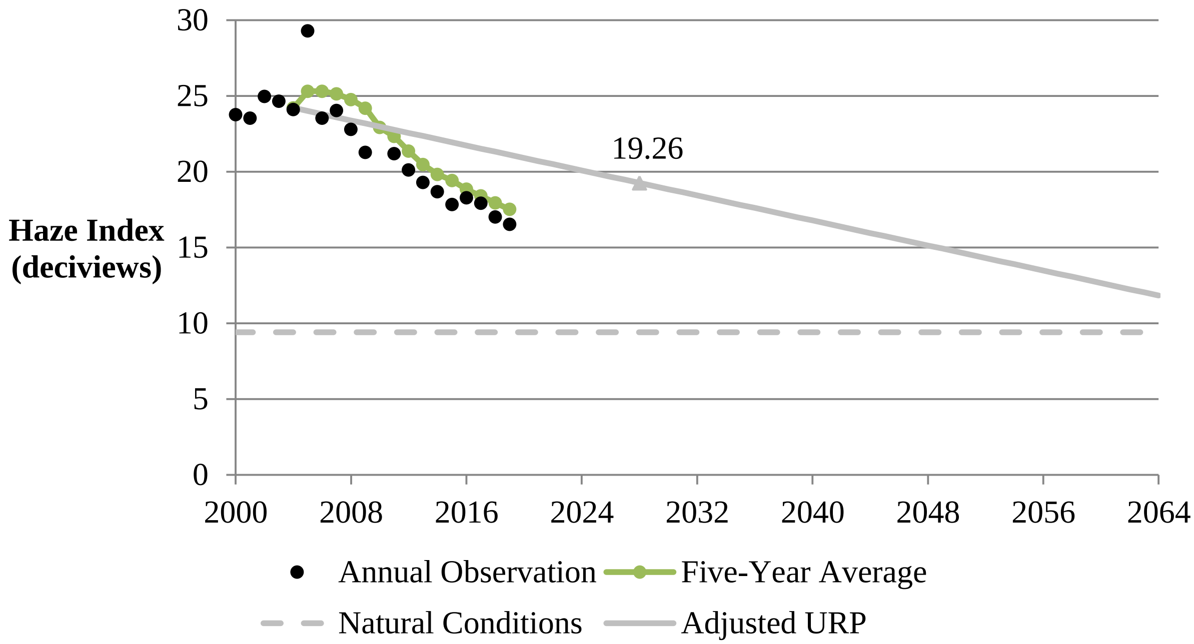
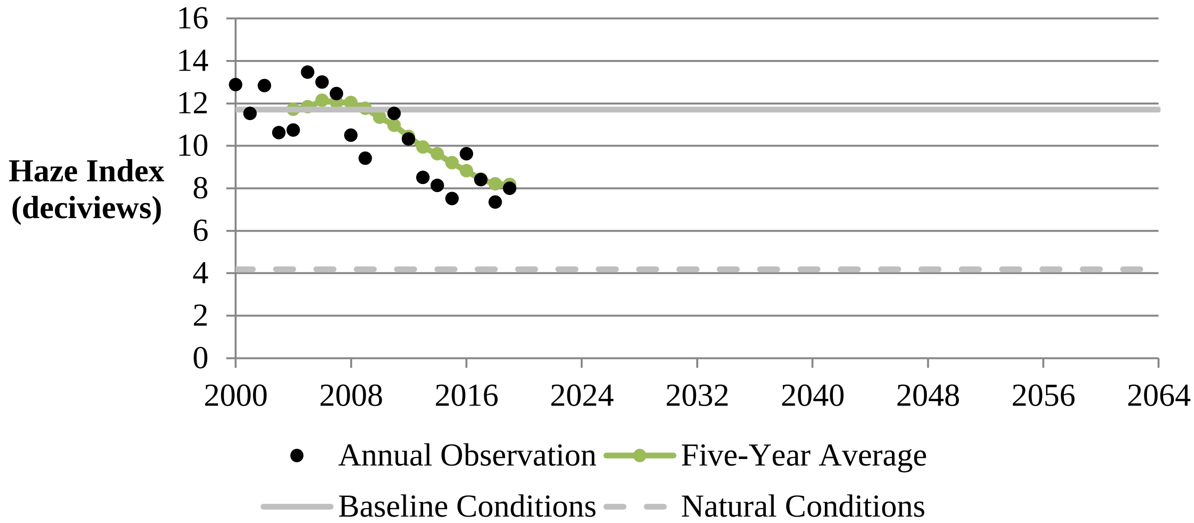


Figure II-14 shows continued improvement in visibility conditions at Upper Buffalo, particularly since 2006. The rolling five-year average of the twenty percent most impaired days has remained below the glidepath since 2010. The most recent five-year average (2015–2019) is below the URP value for 2028, the last year in Planning Period II.

Figure II-15 demonstrates progress on the twenty percent clearest days relative to baseline conditions and natural conditions.

[43] Annual observations obtained from IMPROVE data file sia_impairment_group_means_12_20

Figure II-15: Progress on the Twenty Percent Clearest Days Compared to Natural and Baseline Conditions[44]



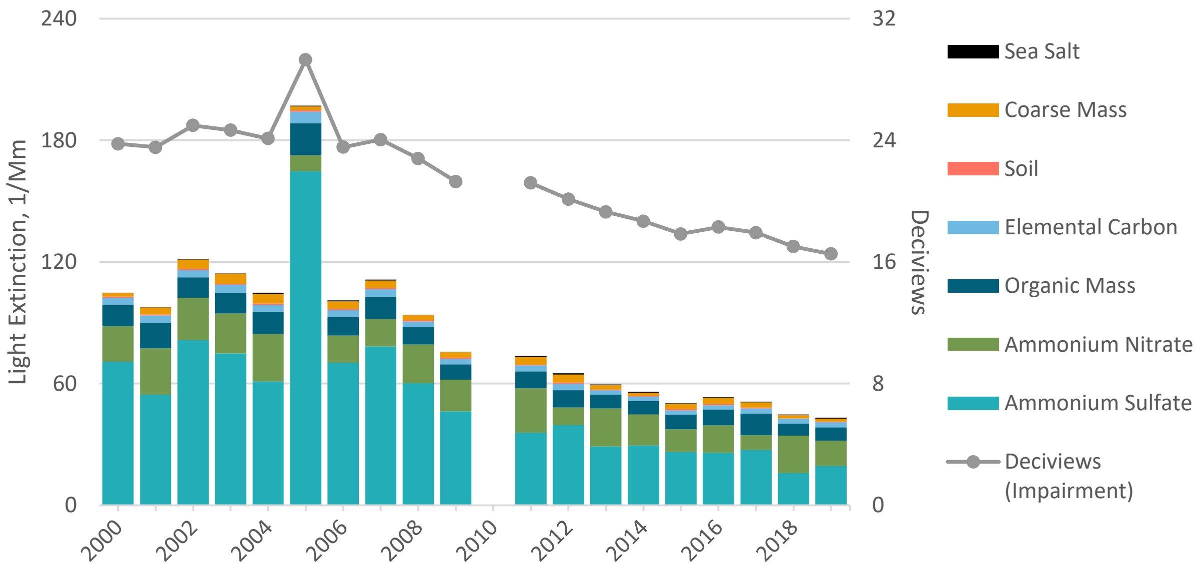
The five-year rolling average of the twenty percent clearest days in Figure II-15 illustrates continued improvement since 2007, indicating no degradation of the clearest days during Planning Period I.

c. Key Pollutants Impacting Visibility

Figure II-16 shows that visibility impairment on the most impaired days has decreased over time at Upper Buffalo as light extinction due to ammonium sulfate—and to a lesser extent coarse mass, elemental carbon, organic mass and soil—has decreased. Light extinction due to ammonium nitrate has fluctuated over time, but no trend is apparent.

[44] Annual observations obtained from IMPROVE data file sia _group_means_12_20

Figure II-16: Annual Extinction Composition, Most Impaired Days at Upper Buffalo, 2000–2019[45]



In 2019, ammonium sulfate was the largest contributor to light extinction at Upper Buffalo on the most impaired days, followed by ammonium nitrate. Organic mass was the third largest contributor to light extinction in 2019. Elemental carbon contributed six percent of light extinction and coarse mass contributed four percent. Sea salt and soil make up a small fraction of the light extinction on the most impaired days.

Figure II-17 shows daily haze composition due to anthropogenic sources and Figure II-18 shows daily haze composition due to natural sources on the most impaired days at Upper Buffalo in 2019. In combination, these figures provide information about potential pollutants to include in DEQ’s analysis of potential strategies for reasonable progress during Planning Period II.

[45] Data obtained from IMPROVE data file sia_impairment_group_means_12_20.

Figure II-17: Daily Haze Composition Due to Anthropogenic Sources, Most Impaired Days at Upper Buffalo, 2019[46]

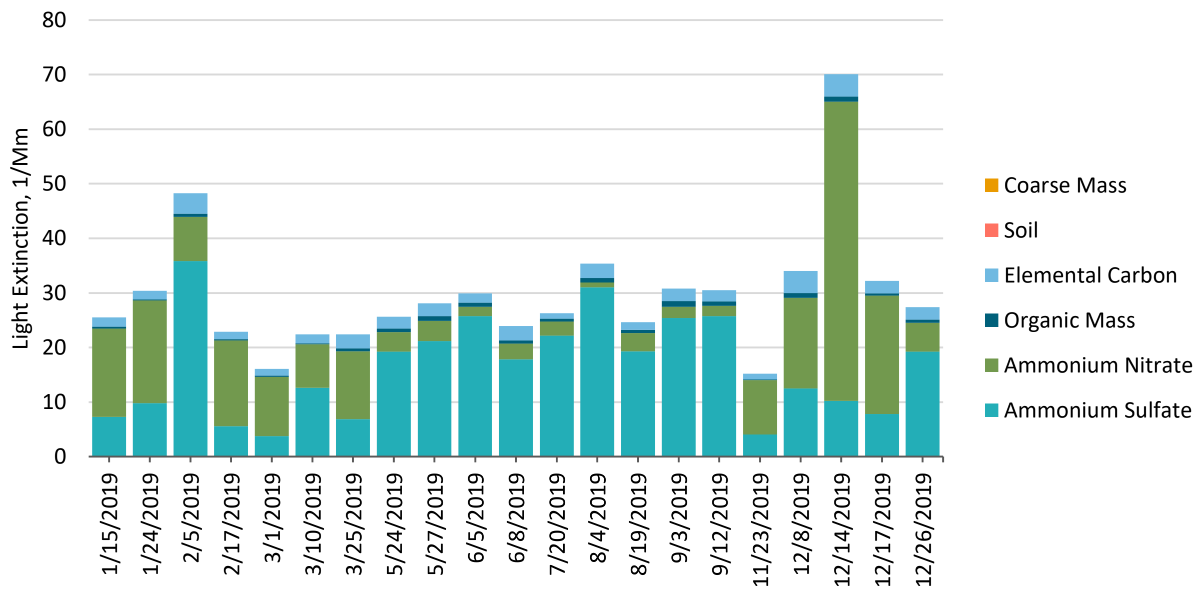
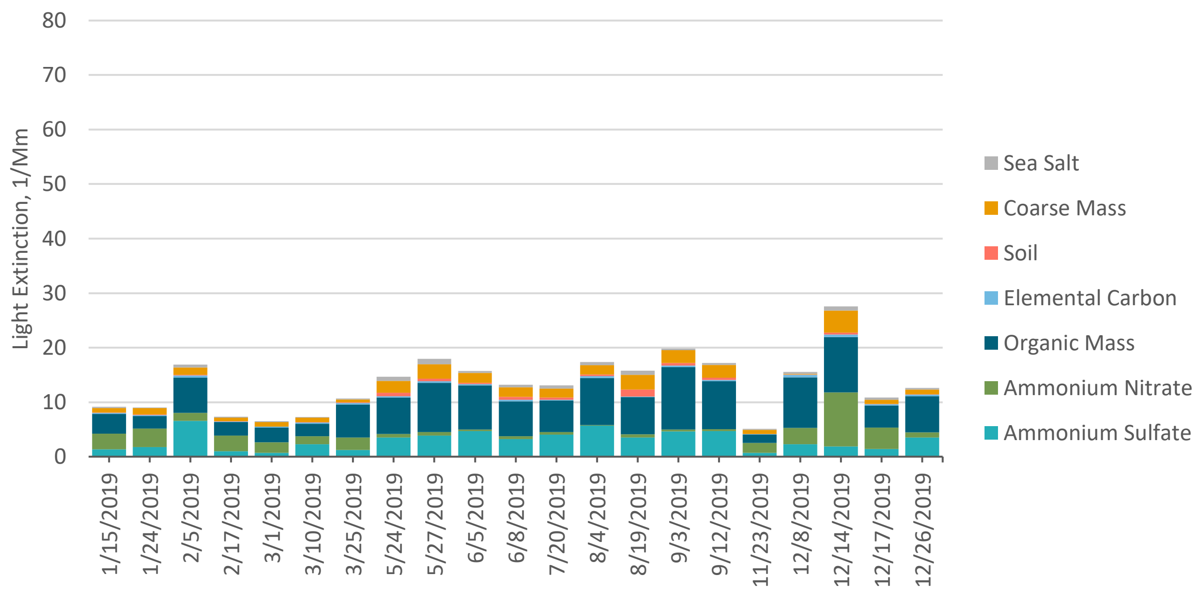


Figure II-18: Daily Haze Composition due to Natural Sources, Most Impaired Days at Upper Buffalo, 2019[47]



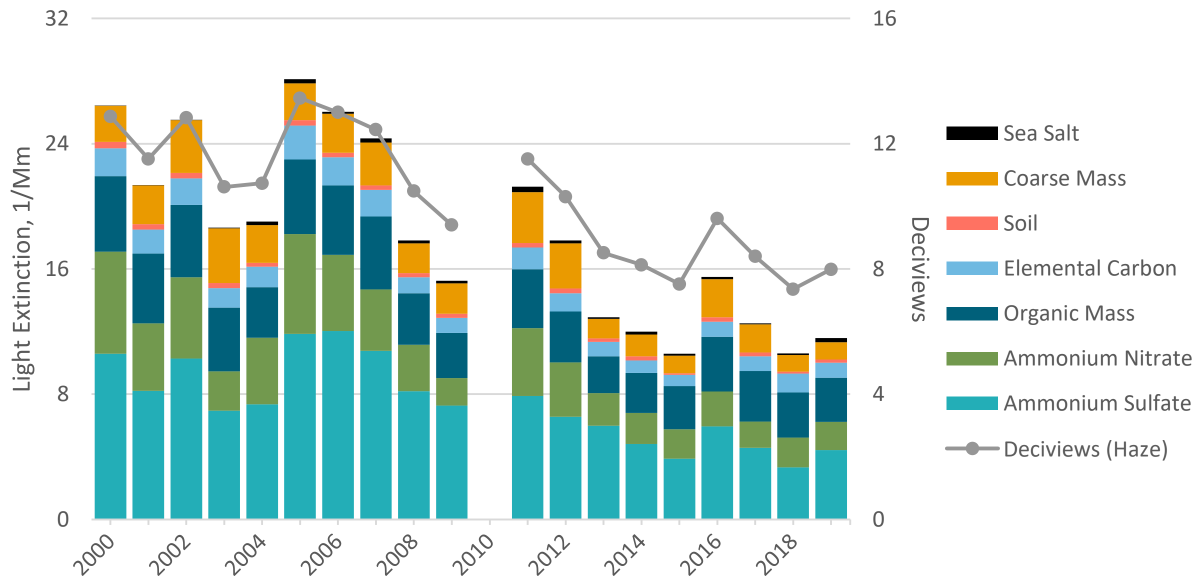
Figures II-17 and II-18 show that light extinction from ammonium nitrate, ammonium sulfate, and elemental carbon on the most impaired days at Upper Buffalo is primarily anthropogenic in nature. Natural sources are the primary contributor of light extinction due to organic mass, coarse

[46] Data obtained from IMPROVE data file sia_impairment_daily_budgets_12_20.
[47] Data obtained from IMPROVE data file sia_impairment_daily_budgets_12_20.

mass, sea salt, and soil.

Figure II-19 shows annual visibility tracking metrics for the twenty percent clearest days at Upper Buffalo. The bars show the relative contribution of each particulate species to visibility impairment for each year in Mm^{-1} (left y-axis). The line shows annual visibility impairment on the clearest days in deciviews (right y-axis).

Figure II-19: Annual Extinction Composition, Clearest Days at Upper Buffalo, 2000–2019[48]



The data show a reduction of visibility impairment on the clearest days at Upper Buffalo. This reduction appears to correspond to decreased light extinction from ammonium sulfate and ammonium nitrate.

Based on these monitoring data observations, strategies to reduce visibility impairment at Upper Buffalo from manmade air pollution during Planning Period II should focus on the following key pollutants: ammonium nitrate and ammonium sulfate.

2. Modeling Data Analysis

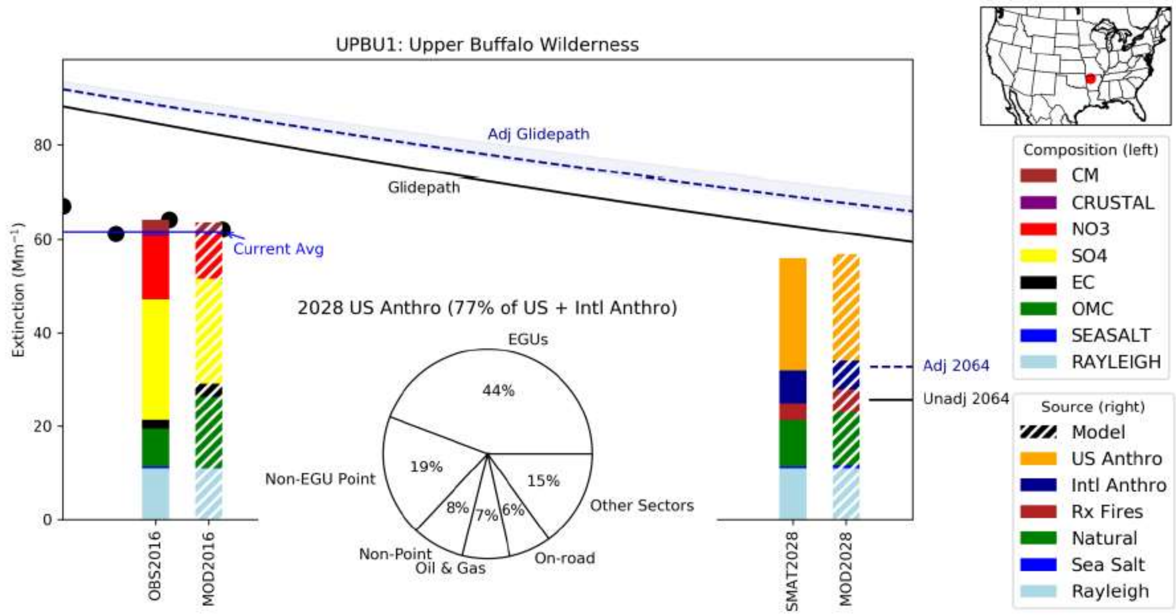
Figure II-20 illustrates for Upper Buffalo the results of EPA's modeling effort. The figure presents observed data for 2014–2017, 2028 base case projections, and possible glidepaths under different assumptions for the most impaired days. The dashed line represents EPA's default adjusted glidepath, which was adjusted based on relative international anthropogenic model contributions and ambient natural conditions.[49] The figure also includes a pie chart representing

[48] Data obtained from IMPROVE data file SIA_group_means_12_20.

[49] The different glidepaths EPA included in their summary plots are based on different 2064 endpoint adjustment assumptions. DEQ's adjusted endpoint (11.26 deciviews) is higher than EPA's default adjusted endpoint (11.21 deciviews), but lower than EPA's maximum endpoint (12.49 deciviews).

the specific anthropogenic emissions sector contributions identified as contributing to visibility impairment at Upper Buffalo.

Figure II-20: EPA Regional Haze Modeling Summary Plot for Upper Buffalo Wilderness[50]



The blue dashed line, the black line, and the blue shaded area in Figure II-20 indicate that, without additional emission reductions beyond those already required by regulations on the books, the rate of progress towards natural visibility at Upper Buffalo would be faster than the range of URP options calculated by EPA, including the URP determined by Arkansas. The model predicts a visibility impairment value of 16.92 deciviews in 2028 for the most impaired days at Upper Buffalo. This projected impairment value is lower than the 19.26 deciviews glidepath value in 2028 created by DEQ's URP. Recent monitoring data are also below the glidepath value in 2028.

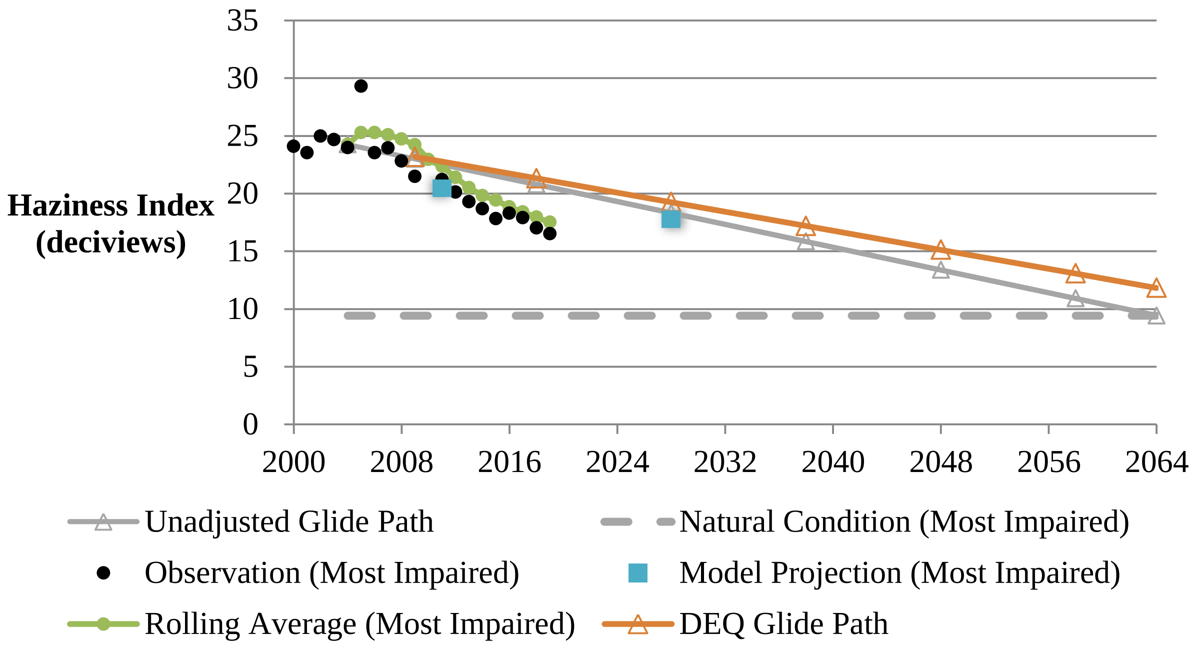
The pie chart in Figure II-20 indicates the most prominent source categories are EGUs and Non-EGU point sources, with smaller contributions from other U.S. anthropogenic sources, non-point sources, and the oil and gas sector. The source apportionment presented in the pie chart suggests that strategies to reduce visibility impairment in 2028 should focus on reducing emissions from the following source categories: EGU and non-EGU point.

Figures II-21 and II-22 illustrate the 2028 base case results for Upper Buffalo of the VISTAS modeling effort. The VISTAS modeling base case results project visibility impairment in 2028 at Upper Buffalo on the most impaired days (17.82 deciviews) to be below both the unadjusted

[50] EPA (2019). "Technical Support Document for EPA's Updated 2028 Regional Haze Modeling." https://www.epa.gov/sites/production/files/2019-10/documents/updated_2028_regional_haze_modeling-tsd-2019_0.pdf

glidepath (18.32 deciviews) and the DEQ glidepath (19.26 deciviews). The projected most impaired days impairment value in 2028 at Upper Buffalo is higher than current monitor observations.[51] The projected base case results for the clearest days (8.93 deciviews) show no degradation from the 2000–2004 baseline (11.71 deciviews).

Figure II-21: VISTAS Base Case Results for Upper Buffalo Wilderness (Most Impaired Days)[52]



[51] Actual emissions data demonstrates a downward trend in pollutants affecting visibility at federal Class I sites; the VISTAS projections for most impaired days' impairment values are higher than actuals, due to shut-downs and on the books controls not reflected in VISTAS modeling.

[52] Model results obtained from Metro4/SESARM: Copy of V5_GlidePath_MI20_unitDeciview_07-17-2020_jb

Figure II-22: VISTAS Base Case Results for Upper Buffalo Wilderness (Clearest Days)[53]

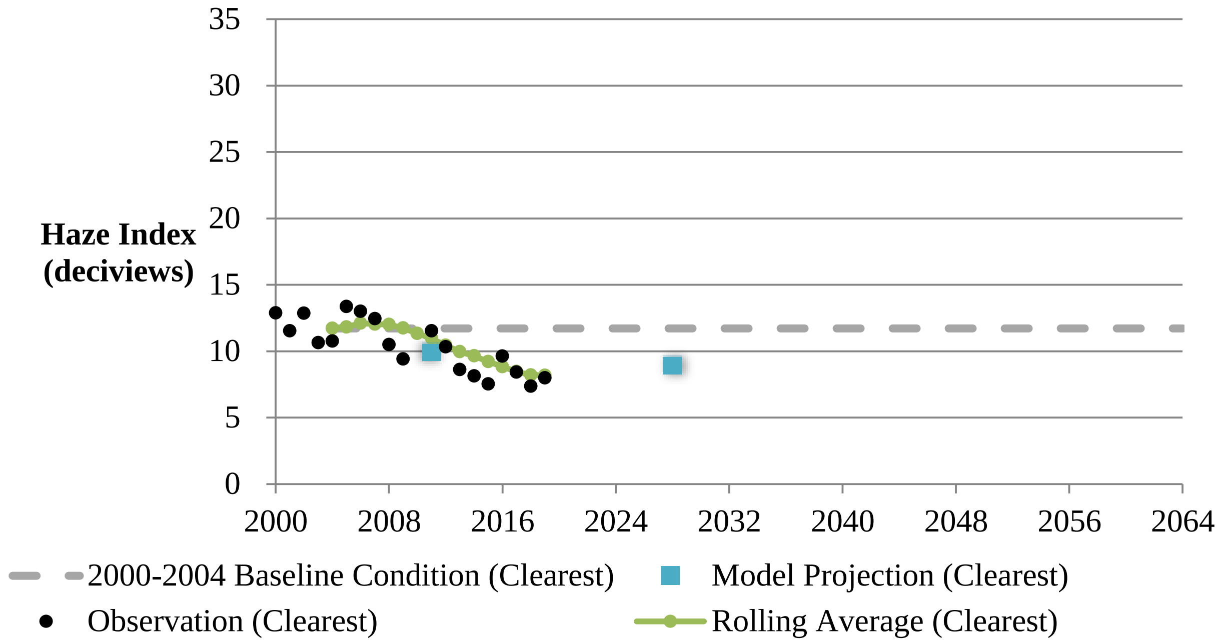


Figure II-23 created using the WinHaze visual modeling tool shows how a vista at Upper Buffalo Wilderness would look during the most impaired days in 2002 (left), 2019 (center), and under natural conditions (right). The improvement between the center image and the left image shows how the visibility has improved over time on the most impaired days.

Figure II-23: Upper Buffalo Wilderness WinHAZE Visualization Twenty Percent Most Impaired: 2002, 2019, and Natural Conditions[54]

[53] Model results obtained from Metro 4/SESARM: Copy of V5_GlidePath_20C_unitDeciview_07-17-2020

[54] Interagency Monitoring of Protected Visual Environments. http://vista.cira.colostate.edu/Improve/winhaze/

3. AOI Analysis

Based on DEQ's evaluation of the 2016 AOI results, as described in section A of this chapter, sources in the following states may impact visibility on the most impaired days at Upper Buffalo: Arkansas, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Minnesota, Mississippi, Missouri, Nebraska, Oklahoma, South Dakota, Tennessee, Texas, and Wisconsin. Figure II-24 shows the relative percentage from each state of the visibility impact surrogate for all sources in the AOI.

Figure II-24: Relative Visibility Impact Surrogate of Sources in AOI Analysis on Most Impaired Days at Upper Buffalo in 2016[55]

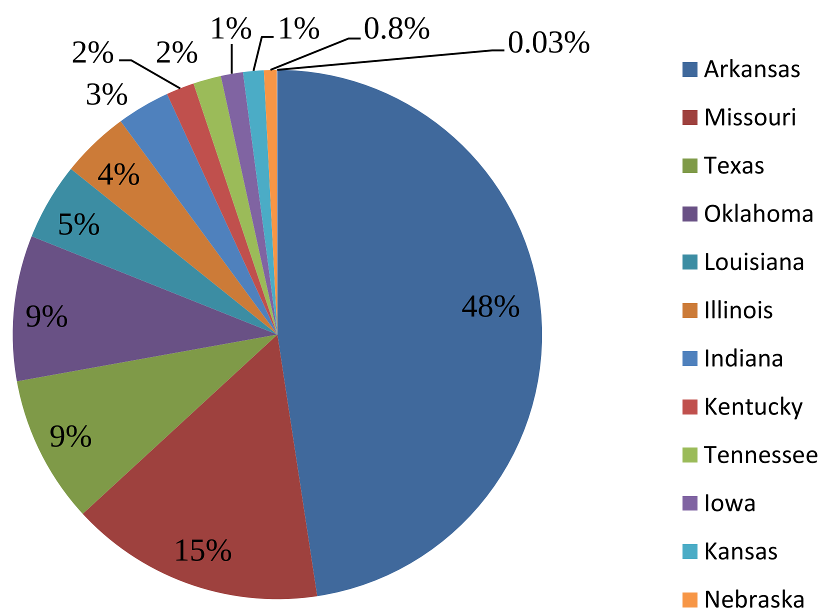


Figure II-24 indicates that point sources in Arkansas contributed the most out of the sources in the AOI to visibility impairment at Upper Buffalo on the most impaired days. Sources in Missouri were the second largest contributor.

[55] The "Other" category includes Offshore, Minnesota, Wisconsin, Mississippi, South Dakota, and Tribal. Combined visibility impact surrogates from sources in each of these states are less than once percent of the total visibility impact surrogate from all sources in the 2016 AOI.