REGIONAL HAZE SECOND PLANNING PERIOD FOUR-FACTOR ANALYSES

ASARCO, LLC – Mission Complex

Arizona Department of Environmental Quality

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1. INTRODUCTION

The U.S. Environmental Protection Agency ("**EPA**") Regional Haze Program is designed to reduce anthropogenic visibility impairment in national Class I areas. The program includes a requirement to determine the reductions of emissions of visibility-impairing pollutants within Arizona that must be achieved by the year 2028 and a requirement that the State submit for EPA's review a plan to achieve the reductions ("**RH2 SIP**"). This has entailed the development and implementation, by Arizona's Department of Environmental Quality ("**ADEQ**"), of a "Four Factor Screening" methodology to identify the stationary and mobile sources of visibility-impairing pollutants that will be required to participate in the determination. For each source that is required to participate, an analysis must be prepared to assess the additional capture or control technologies or practices ("**controls**" or "**control measures**") that the source may be required to implement, in order to contribute to the State-wide reduction of visibility-impairing emissions. The analyses must consider four statutory factors, and thus are termed four-factor analyses ("**4FAs**").

ADEQ in July 2019 informed ASARCO LLC ("**Asarco**") that, based on ADEQ's application of the "Four Factor Screening" methodology, 4FAs must be prepared for Asarco's Mission Complex. On September 25, 2019, ADEQ e-mailed to Asarco a list of the processes and pollutants for which 4FAs must be performed:

- PM_{10} emissions caused by trucks hauling ore and waste rock; and
- PM_{10} emissions caused by rubber tire rigs on unpaved roads.

This report details the method used to complete the 4FAs for these processes and pollutants and discusses the results of the 4FAs.

The 4FAs were conducted in accordance with 40 C.F.R. § 51.308 and the following guidance:

- EPA's Guidance on Regional Haze State Implementation Plans for the Second Implementation Period ("**RH2 Guidance**");[1]
- EPA's Control Cost Manual;[2] and
- Other guidance documents and references cited in this report.

The 4FAs entailed:

- Consideration of emissions control options, including their effectiveness at reducing the emissions and their energy and non-air quality environmental impacts, and elimination of technically infeasible controls; and,
- Evaluation of the cost to implement each of the remaining control measures taking into account the control measure's useful life for purposes of amortizing capital expenditures,[3] the time necessary for the control measure to be implemented,[4] and its potential visibility benefits.[5]

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[1] EPA-457/B-19-003, August 2019.

[2] Final revised chapters of the Control Cost Manual are found at https://www.epa.gov/economic-and-cost-analysis-air-pollution-regulations/cost-reports-and-guidance-air-pollution.

[3] EPA recommends that, generally, states can consider "the useful life of the control system rather than the source." RH2 Guidance § II.B.4(f). According to EPA, the remaining useful life of the source itself typically "will be longer than the useful life of the emission control system under consideration unless there is an enforceable requirement for the source to cease operation sooner. The presumption is that after the end of the useful life of the emission control system, it will be replaced by a like system. Thus, annualized compliance costs are typically based on the useful life of the control equipment rather than the life of the source, unless the source is under an enforceable requirement to cease operation." *Id.* EPA advises, therefore, that states should "consider remaining useful life by using it to calculate emissions reductions, annualized compliance costs, and cost/ton values." RH2 Guidance § II.B.5(d).

[4] EPA recommends that states "consider the time necessary for compliance as part of their determination of what compliance deadlines for selected control measures are reasonable, rather than as part of their determination whether to adopt the control measures in the first instance." RH2 Guidance § II.B.5(b). There is no requirement that controls determined to be necessary under 40 C.F.R. § 51.308 must be installed as expeditiously as practicable; rather, such controls should be in place by 2028, unless the State concludes that the control cannot reasonably be installed and become operational until after 2028. RH2 Guidance §§ II.B.4(d) and II.B.5(b).

[5] EPA recommends that, "[w]hile visibility impacts and/or potential benefits may be considered in the source selection step in order to prioritize the examination of certain sources for further analysis of emission control measures, visibility benefits may again be considered in that control analysis to inform the determination of whether it is reasonable to require a certain measure." RH2 Guidance § II.B.4(g). EPA anticipates "that the outcome of the decision-making process by a state regarding a control measure may most often depend on how the state assesses the balance between the cost of compliance and the visibility benefits, with the other three statutory factors either being subsumed into the cost of compliance or not being major considerations." RH2 Guidance § II.B.5(a).

2.1. PM_{10} EMISSIONS CAUSED BY TRUCKS HAULING ORE AND WASTE ROCK

Section 2.1.1 considers control options for PM_{10} emissions caused by trucks hauling ore and waste rock at the Mission Complex, in term of their effectiveness at reducing the emissions and their energy and non-air quality environmental impacts, and identifies the controls that are technically infeasible.

Section 2.1.2 evaluates the cost to implement each of the remaining controls taking into account the control measure's useful life for purposes of amortizing capital expenditures (if applicable) and the time that would be necessary for the control measure to be implemented. Section 3 evaluates the potential visibility benefits of these control measures.

2.1.1. Considerations of Control Options and Elimination of Technically Infeasible Controls

The following PM_{10} control options were identified based on a review of the RACT/BACT/LAER Clearinghouse ("**RBLC**") database, ADEQ guidance, other technical literature, practices at other open pit copper mines, and engineering experience both generally and at the Mission Complex:

- Reduce the speed limit for haul trucks
- Apply additional water to haul roads
- Apply additional chemical dust suppressant to haul roads
- Apply and maintain surface gravel on haul roads
- Require haul trucks to be covered
- Increase freeboard in the haul trucks
- Pave the haul roads and maintain the pavement

2.1.1.1. Reduce the Speed Limit for Haul Trucks

Based on information from Asarco, the speed limit for haul trucks and other vehicles at the Mission Complex is 35 mph. Haul trucks at the mine regularly approach that speed limit on flat terrain. Reducing the speed limit for haul trucks would significantly impact overall operations, considering that haul truck travel is critical to the ore throughput of the Mission Complex. If a stricter speed limit were to be enforced, then Asarco would have to deploy additional haul trucks to make up for the loss in production. This would ultimately result in increased PM_{10} emissions and fuel consumption depending on site-specific considerations and the prevailing market price of copper. That said, reducing the speed limit for haul trucks at the Mission Complex to 25 mph is technically feasible.

2.1.1.2. Apply Additional Water to Haul Roads

A combination of magnesium chloride (a chemical dust suppressant) and water is already applied to the haul roads of the Mission Complex outside the pit, for which a PM_{10} control efficiency of 80% has been used in Asarco's emissions inventories. [6] Magnesium chloride is not used on haul roads inside the pit because of the danger of slippage; only water is applied to roads inside the pit, for which a control efficiency of 75% has been used in Asarco's emissions inventories. ADEQ reportedly has accepted a control efficiency of up to 90% for the use of water to suppress dust from unpaved roads.

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[6] *See* AP-42, Section 13.2.2 for unpaved roads.

Applying more water to haul roads at the Mission Complex, in an effort to increase the control efficiency for unpaved roads from 80% to 90% outside the pit and from 75% to 90% inside the pit would require Asarco to deploy additional water trucks, as there are often summer months when the current fleet is used at full capacity. The use of an expanded fleet to transport more water to remote areas of the mine, where the haul roads are located, would increase PM_{10} emissions and fuel consumption. Too much watering could also lead to traction problems between the haul trucks and the roads, thus reducing the fuel economy of each haul truck. It has been reported that wet tires are more prone to puncture by sharp materials on the haul roads.[7] The application of additional water to the haul roads inside the pit would also pose safety concerns due to slippage over inclines/declines.

Maintenance costs associated with the above scenarios are not readily quantifiable. That said, applying additional water to the haul roads at the Mission Complex, in an effort to achieve 90% control efficiency, is technically feasible for haul roads outside the pit which currently achieve 80%, as stated above. Applying additional water to haul roads inside the pit would not be technically feasible because of the safety concerns.[8]

2.1.1.3. Apply Additional Chemical Dust Suppressant to Haul Roads

As stated in Section 2.1.1.2, magnesium chloride, a chemical dust suppressant, is already applied, in combination with water, to the haul roads. However, the force of the haul trucks, along with other vehicles, substantially decreases the effectiveness of the magnesium chloride. In addition, chemical dust suppressants cause tire slippage, especially when the haul trucks make turns or travel on inclines/declines. Therefore, applying additional chemical dust suppressant to the haul roads, beyond that which is already applied, in an effort to achieve a control efficiency above the 80% that is currently achieved by the existing combination of dust suppressant and water, would be technically infeasible.

2.1.1.4. Apply and Maintain Surface Gravel on Haul Roads

Asarco occasionally places surface gravel on sloped portions of haul roads of the Mission Complex in order to improve haul-truck traction during storm events, but the gravel is quickly bladed off the roads after the rain. Surface gravel cannot otherwise be used, let alone maintained, on the haul roads. The haul trucks weigh from 300,000 pounds to 800,000 pounds, such that the force of the trucks, along with other vehicles, either quickly obliterates the gravel to dust or pushes the gravel to the side of the roads and creates tracks. Constant application of new gravel would be needed to replace the gravel destroyed by the trucks. The Sisyphean nature of this control measure makes it technically infeasible.

2.1.1.5. Require Haul Trucks to Be Covered

The time that would be required to put a cover on each loaded haul truck and then remove the cover to enable the truck to unload the ore and waste rock would substantially slow production at the Mission Complex. Moreover, according to the Mission Complex truck maintenance team, haul truck covers are not commercially available to accommodate the size of the haul trucks. Covers would either have to be

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[7] *See* https://www.cat.com/en_US/by-industry/mining/articles/haul-road-maintenance.html.

[8] Trinity Consultants ("**Trinity**") in August 2019 completed and submitted to ADEQ a study that indicates pit retention, in and of itself, may result in a control efficiency of 90% for airborne PM_{10} caused by haul truck traffic and other mining activities inside the pit. ADEQ has responded that additional study is needed. An appropriate pit retention efficiency should be determined for the Mission Complex and factored into the RH2 SIP before it is completed.

made in-house or a new type of cover would have to be prototyped and sourced. According to EPA guidance, a control measure is not technically feasible if (1) it has not been installed and operated successfully for the type of source under review under similar conditions or (2) the technology cannot be applied to the source under review if the technology cannot be readily obtained through commercial channels; e.g., it has not yet reached the stage of licensing and commercial availability.[9] In addition, covering and uncovering loaded haul trucks could be accomplished only with manual labor and would pose unacceptable safety risks that could not be harmonized with applicable Mine Safety and Health Act ("**MSHA**") rules.[10] For these reasons, covering haul trucks would be technically infeasible.

2.1.1.6. Increase Freeboard in the Haul Trucks

Increasing freeboard could potentially reduce the amount of spillage onto haul roads, which can be a source of PM_{10} emissions from vehicular traffic, though no PM_{10} control efficiency has been reported for this measure. Increasing freeboard would, however, reduce the amount of material hauled in each truck, which would trigger the necessity to use additional haul trucks—including the purchase of more haul trucks by Asarco—in order to maintain throughput at the Mission Complex. This would result in more haul truck traffic, leading to an increase in PM_{10} emissions from the haul truck traffic, and a corresponding increase in fuel consumption. That said, increasing freeboard in the haul trucks is technically feasible.

2.1.1.7. Pave the Haul Roads and Maintain the Pavement

Paving unpaved roads in an effort to reduce PM_{10} emissions from haul truck traffic would require a substantial capital investment to pave the roads. Moreover, due to the weight of the haul trucks at the Mission Complex, which ranges up to 800,000 pounds, constant replacement of the pavement would be required, since it would quickly be degraded by the weight and movement of the trucks. Due to these considerations, paving the haul roads and maintaining the pavement would not be technically feasible.

2.1.2. Consideration of Technically Feasible Controls

Based on the analysis in Section 2.1.1, the following options for enhancing the control of PM_{10} emissions caused by trucks hauling ore and waste rock at the Mission Complex are technically feasible:

- Reduce the speed limit for haul trucks to 25 mph
- Apply additional water to haul roads outside the pit
- Increase freeboard in the haul trucks

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[9] Draft Guidance on Progress Tracking Metrics, Long-term Strategies, Reasonable Progress Goals and Other Requirements for Regional Haze State Implementation Plans for the Second Implementation Period, EPA-457/P-16-001, July 2016 ("**2016 Guidance**"). EPA has replaced the 2016 Guidance with the RH2 Guidance. However, the 2016 Guidance's measure of technical feasibility as a function of commercial availability is a distillation of positions that EPA has adopted in other technology review programs and specific cases. *See, e.g.,* 78 Fed. Reg. 16452, 16455 (March 15, 2013) ("A technology is available if it can be obtained through commercial channels . . . The BACT analysis for technical feasibility employs the same approach."); *In re Knauf Fiber Glass, GmbH*, 1999 EPA App. LEXIS 45 ("One of the elements of technical feasibility is . . . commercial availability.") (citations omitted); 40 C.F.R. Part 51 Appendix Y (Guidelines for BART Determinations Under the Regional Haze Rule), § IV.D.2 (stating for a technology to be technically feasible it must be available and that "a technology is considered 'available' if the source owner may obtain it through commercial channels, or it is otherwise available within the common sense meaning of the term."). Therefore, the 2016 Guidance has probative value in any consideration of technical feasibility for purposes of regional haze planning.

[10] Asarco endeavors to achieve safety protocols more stringent than those required by the MSHA rules.

2.1.2.1. Reduce the Speed Limit for Haul Trucks to 25 mph

Cost to Implement the Control Measure

The cost of reducing the speed limit for haul trucks to 25 mph per ton of PM_{10} reduced per year could not be determined. The calculation of a cost/ton value would necessitate decision-making on whether Asarco must accept reduced throughput at the mine as a result of the reduced speed of the haul trucks or deploy additional haul trucks to make up for the lost throughput. The extents to which Asarco might do so cannot be reasonably assessed as the grade of the ore and the market price of copper fluctuate substantially over time. As a result: (a) the cost of reduced throughput or the cost of a requirement to purchase additional haul trucks cannot be estimated; and (b) the extent to which PM_{10} emissions would increase as a result of deploying additional haul trucks cannot be reasonably anticipated. However, given the concerns that would be associated with implementing this control measure at the Mission Complex, which are further discussed in Section 2.1.1.1, implementation of this control measure would likely be cost-prohibitive.

The Time Necessary for the Control Measure to Be Implemented

Reducing the speed limit for haul trucks to 25 mph could theoretically be achieved upon EPA's approval of the RH2 SIP. However, there is no requirement that controls determined to be necessary under 40 C.F.R. § 51.308 must be installed as expeditiously as practicable; rather, such controls should be in place by 2028, unless ADEQ concludes that the control cannot reasonably be installed and become operational until after 2028.[11] Therefore, whether Asarco would need to implement this control measure before 2028 would bear further consideration, if a determination is made that the control measure is warranted contrary to this 4FA.[12]

2.1.2.2. Apply Additional Water to Haul Roads Outside the Pit

Cost to Implement the Control Measure

The PM_{10} emissions rate attributable specifically to road dust generated by haul trucks traveling on the Mission Complex haul roads outside the pit is 143 tpy, based on the following equation and calculation:

$$PM_{10}\ Emissions\ (tpy) =$$

$$\frac{\frac{2015\ emissions}{2015\ throughput} + \frac{2016\ emissions}{2016\ throughput} + \frac{2017\ emissions}{2017\ throughput}}{3} * \frac{2016\ throughput + 2017\ throughput + 2018\ throughput}{3} * (20\%)$$ [13]

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[11] RH2 Guidance §§ II.B.4(d) and II.B.5(b).

[12] A reduction of mine throughput cannot be justified under the regional haze program and Asarco reserves the right to assert this position in any proceeding.

[13] Asarco estimates that 20% of haul truck traffic occurs on haul roads outside the pit.

$$\frac{\frac{220.6\ tpy}{272{,}275\frac{miles}{yr}}+\frac{439.6\ tpy}{590{,}319\frac{miles}{yr}}+\frac{799.3\ tpy}{1{,}039{,}961\frac{miles}{yr}}}{3} * \frac{590{,}319\left(\frac{miles}{yr}\right)+1{,}039{,}961\left(\frac{miles}{yr}\right)+1{,}131{,}005\left(\frac{miles}{yr}\right)}{3} * 20\% = 143\ tpy$$

Increasing the control efficiency from 80% to 90% (see Section 2.1.1.2) would yield a reduction of 71 tons PM_{10} per year for the Mission Complex based on the following calculation:

$$143-\frac{143\ tpy}{1-80\%} * (1-90\%) = 71.5\ tpy$$

The capital cost of implementing this control measure is determined using the following equation and calculation:

$$\begin{aligned} Capital\ cost\ = &\ (\#\ of\ current\ water\ trucks) * (cost\ of\ deploying\ new\ water\ truck) \\ & * (increase\ in\ water\ application) \\ & * (proportion\ of\ haul\ roads\ that\ are\ outside\ the\ pit) \end{aligned}$$

$$Capital\ cost = (6) * (\$2{,}500{,}000) * (100\%) * (20\%) = \$3{,}000{,}000$$ [14]

To amortize the capital cost, a capital recovery factor ("**CRF**") is used:

$$CRF = \frac{i * (1+i)^n}{(1+i)^n - 1}$$

Where:

i = interest rate
n = life of the control system

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[14] Per "*Dust Suppression on Wyoming's Coal Mine Haul Roads*" (EPA, October 2004), 2.5 times the amount of water is deemed needed to increase the PM_{10} control efficiency attributable to the application of water to unpaved roads from 75% to 95%. As indicated in Section 2.1.1.2, a control efficiency of 80% is already achieved by the application of magnesium chloride and water to the haul roads outside the pit. Therefore, it is conservatively estimated that twice the amount of water would be needed to achieve a control efficiency of 90%. Asarco provided the estimated cost of a new water truck, which maximizes the life of the truck for amortization purposes. Based on engineering estimates, it was determined that purchasing a used water truck rather than a new truck would substantially increase maintenance costs which, together with the reduced life of the truck, would result in cost value substantially greater than that determined in this 4FA.

$$\frac{7\% * (1+7\%)^{12}}{(1+7\%)^{12}-1} = 12.59\%$$ [15, 16]

Multiplying the capital cost by the CRF results in an annualized capital cost of $377,700.

The annual operating cost is determined using the following equation and calculation:

$$\begin{aligned} &Annual\ operating\ cost = \\ &(Annual\ spending\ on\ water\ for\ dust\ control) * (increase\ in\ water\ application) \\ &\quad * (proportion\ of\ haul\ roads\ that\ are\ outside\ the\ pit) \\ &\quad + (admin, taxes, and\ insurance\ percentage) * (initial\ capital\ cost) \end{aligned}$$

$$\begin{aligned} Annual\ operating\ cost &= (\$1{,}267{,}129) * (100\%) * (20\%) + (4\%) * (\$3{,}000{,}000) \\ &= \$373{,}426 \end{aligned}$$ [17, 18]

Summing the annualized capital cost and the annual operating cost results in a total annual cost of $751,126.

The annual cost per ton of PM_{10} reduced is then calculated as follows:

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[15] According to Asarco: (i) the remaining useful life of the Mission Mine may be 25 years, possibly longer depending on drill data, ore reserves and the developing market price of copper; and (ii) the useful life of a water truck in its fleet is no greater than 12 years, and typically is shorter, given that a water truck typically travels 15,000 and 20,000 miles annually at the mine. *Cf.* 60 Fed. Reg. 13782, 13784 (March 14, 1995, Dep't of Labor) ("The Industrial Truck Association stated in conversations with OSHA representatives that it considers the average useful life of a powered industrial truck to be 8 years. The 8-year life cycle has been used throughout the preparation of this proposed rule and in the formulation of the Preliminary Regulatory Impact Analysis."); "Analysis of Fleet Replacement Lifecycle," South Florida Water Management District (October 2012) at p. 1 ("The District's current guidelines target vehicle replacement at approximately 12 years or 180,000 miles.") (emphasis added). *See also* "Vehicle Average Replacement Schedule" (February 24, 2017) at https://www.usf.edu › asbc-resources-field-equipment-replacement, which states that heavy trucks having a gross vehicle weight of at least 33,000 lbs and a load carrying capacity of five tons have an average useful life of 10 to 12 years. According to Asarco, the smaller water trucks at the Mission Mine weigh about 43,000 pounds without their water load and carry a water load of about 24 tons. Therefore, the cost to implement the control measure assessed in this 4FA takes into account the useful life of a new water truck, conservatively estimated at 12 years, for purposes of amortizing capital expenditures. *See* RH2 Guidance §§ II.B.4(f) and II.B.5(d). Asarco reserves the right to assert a shorter water truck life cycle in any administrative proceeding.

[16] The calculation employs a 7% interest rate for a new water truck. *See* "Air Pollution Control Cost Manual," 7th Ed. (2017), § 2.5.2.

[17] The estimated spending on water is based on the mine's 2018 actual water usage and a local water price of $0.005 per gallon. *See* https://www.tucsonaz.gov/water/industrial-rates-and-monthly-charges.

[18] Administrative expenses , taxes and insurance are assumed to be 4% of capital cost. *See* "Air Pollution Control Cost Manual," 7th Ed. (2017), § 2.6.5.8.

$$\frac{\$751{,}126}{71.5\ tpy} = \$10{,}505\ per\ ton\ PM_{10}\ reduced\ per\ year.$$

Based on precedent in the Regional Haze Program, the control measure of applying additional water to haul roads outside the pit would be cost-prohibitive.

The Time Necessary for the Control Measure to Be Implemented

The application of additional water to haul roads outside the pit could theoretically be achieved upon EPA's approval of the RH2 SIP. However, there is no requirement that controls determined to be necessary under 40 C.F.R. § 51.308 must be installed as expeditiously as practicable; rather, such controls should be in place by 2028, unless ADEQ concludes that the control cannot reasonably be installed and become operational until after 2028.[19] Therefore, whether Asarco would need to implement this control measure before 2028 would bear further consideration, if a determination is made that the control measure is warranted contrary to this 4FA.

2.1.2.3. Increase Freeboard in the Haul Trucks

Cost to Implement the Control Measure

The cost of increasing freeboard in the haul trucks per ton of PM_{10} reduced per year could not be determined for two reasons. First, no PM_{10} control efficiency has been reported for such a control measure. Second, the calculation of a cost/ton value would necessitate decision-making on whether Asarco must accept reduced throughput at the mine as a result of the increased freeboard or deploy additional haul trucks to make up for the lost throughput. The extents to which Asarco might do so cannot be reasonably assessed as the grade of the ore and the market price of copper fluctuate substantially over time. As a result: (a) the cost of the reduced throughput or the cost of a requirement to purchase additional haul trucks cannot be estimated; and (b) the extent to which PM_{10} emissions would increase as a result of deploying additional haul trucks cannot be reasonably anticipated. However, given the difficulties that would be associated with implementing this control measure at the Mission Complex, which are further discussed in Section 2.1.1.6, implementation of this control measure would likely be cost-prohibitive.

The Time Necessary for the Control Measure to Be Implemented

Increasing freeboard in the haul trucks could theoretically be achieved upon EPA's approval of the RH2 SIP. However, there is no requirement that controls determined to be necessary under 40 C.F.R. § 51.308 must be installed as expeditiously as practicable; rather, such controls should be in place by 2028, unless ADEQ concludes that the control cannot reasonably be installed and become operational until after 2028.[20] Therefore, whether Asarco would need to implement this control measure before 2028 would bear further consideration, if a determination is made that the control measure is warranted contrary to this 4FA.[21]

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[19] RH2 Guidance §§ II.B.4(d) and II.B.5(b).

[20] *Ibid*.

[21] A reduction of mine throughput cannot be justified under the regional haze program and Asarco reserves the right to assert this position in any proceeding.

2.2. PM_{10} EMISSIONS CAUSED BY RUBBER TIRE RIGS ON UNPAVED ROADS

Section 2.2.1 considers control options for PM_{10} emissions caused by rubber tire rigs on unpaved roads at the Mission Complex, in term of their effectiveness at reducing the emissions and their energy and non-air quality environmental impacts, and identifies the controls that are technically infeasible.

Section 2.2.2 evaluates the cost to implement each of the remaining controls taking into account the control measure's useful life for purposes of amortizing capital expenditures (if applicable) and the time that would be necessary for the control measure to be implemented. Section 3 evaluates the potential visibility benefits of these control measures.

2.2.1. Consideration of Control Options and Elimination of Technically Infeasible Controls

The following PM_{10} control options were identified based on a review of the RBLC database, ADEQ guidance, other technical literature, practices at other open pit copper mines, and engineering experience both generally and at the Mission Complex:

- Reduce the speed limit for rubber tire rigs
- Apply additional water to unpaved non-haul roads [22]
- Apply additional chemical dust suppressant to unpaved non-haul roads
- Apply and maintain surface gravel on unpaved non-haul roads
- Pave the unpaved non-haul roads

2.2.1.1. Reduce the Speed Limit for Rubber Tire Rigs

Even though the speed limit for all vehicles at the Mission Complex is 35 mph, the average traveling speed of rubber tire rigs at the Mission Complex is 15 mph, according to Asarco. Therefore, lowering the speed limit to 25 mph for rubber tire rigs is technically feasible. A PM_{10} control efficiency of 44% can be attributed to a speed limit of 25 mph.[23] Lowering the speed limit to 25 mph would enable Asarco to use the 44% control efficiency in its emissions inventories.

2.2.1.2. Apply Additional Water to Unpaved Non-Haul Roads

A combination of magnesium chloride (a chemical dust suppressant) and water is already applied to the unpaved non-haul roads of the Mission Complex, for which a PM_{10} control efficiency of 80% has been used in Asarco's emissions inventories. [24] ADEQ reportedly has accepted a control efficiency of up to 90% for the use of water to suppress dust from unpaved roads.

Applying more water to unpaved non-haul roads at the Mission Complex, in an effort to increase the control efficiency for unpaved non-haul roads from 80% to 90% would require Asarco to deploy additional water trucks, as there are often summer months when the current fleet is used at full capacity. The use of an expanded fleet to transport more water to the unpaved non-haul roads throughout the mine would increase PM_{10} emissions from the water truck traffic and associated fuel

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[22] All of the unpaved non-haul roads of the Mission Complex are located outside the pit.

[23] WRAP Fugitive Dust Handbook, 2006, pg. 3.

[24] *See* AP-42, Section 13.2.2 for unpaved roads.

consumption. Too much watering could also lead to traction problems between the rubber tire rigs and the roads, thus reducing the fuel economy of each rig. It has been reported that wet tires are more prone to puncture by sharp materials on the unpaved non-haul roads.

Maintenance costs associated with the above scenarios are not readily quantifiable. That said, applying additional water to the unpaved non-haul roads, in an effort to increase the control efficiency from 80% to 90%, is technically feasible.

2.2.1.3. Apply Additional Chemical Dust Suppressant to Unpaved Non-Haul Roads

As stated in Section 2.2.1.2, magnesium chloride, a chemical dust suppressant, is already applied, in combination with water, to the unpaved non-haul roads of the Mission Complex. However, the force of the rubber tire rigs substantially decreases the effectiveness of the magnesium chloride. In addition, chemical dust suppressants cause tire slippage, especially when the rubber tire rigs make turns or travel on inclines/declines. Therefore, applying additional chemical dust suppressant to the unpaved non-haul roads, beyond that which is already applied, in an effort to achieve a control efficiency above the 80% that is currently achieved by the existing combination of dust suppressant and water, would be technically infeasible.

2.2.1.4. Apply and Maintain Surface Gravel on Unpaved Non-Haul Roads

The PM_{10} control efficiency associated with graveling unpaved roads depends on the silt content of the gravel as opposed to the silt content of the unpaved roads. Asarco currently utilizes a silt content of 6.9% in its emission inventories for the unpaved roads. A silt content of 6.4% could be attributed to the addition of gravel to the unpaved roads.[25]

Application and maintenance of surface gravel on the unpaved non-haul roads of the Mission Complex would be technically feasible, given that the weight of the rubber tire rigs is substantially less than that of the haul trucks. However, the rubber tire rigs would still degrade the gravel over time, at a rate faster than normal vehicle traffic, due to the weight of the rubber tire rigs. This would necessitate periodic replacement of the gravel.

2.2.1.5. Pave the Unpaved Non-Haul Roads

It has been reported that certain other copper mines in the United States have paved some of their non-haul roads. Paving unpaved roads in an effort to reduce PM_{10} emissions from rubber tire rig traffic at the Mission Complex would require a substantial capital investment (discussed in Section 2.2.2.4). Additionally, Asarco anticipates that the non-haul roads, once paved, would be covered fairly quickly by dust, which would necessitate regular removal of the accumulated dust and make it difficult to attribute with confidence a control efficiency for the pavement. That said, paving the unpaved non-haul roads would be technically feasible.

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[25] *See* AP-42, Table 13.2.2-1, "Typical Silt Content Values of Surface Material on Industrial Unpaved Roads"; *see also* "Emission Factor Documentation for AP-42 Section 13.2.2, Unpaved Roads, Final Report," U.S. EPA Office of Air Quality Planning and Standards Emissions Factor and Inventory Group (September 1998) at p. 4-29.

2.2.2. Consideration of Technically Feasible Controls

Based on the analysis in Section 2.2.1, the following options for enhancing the control of PM_{10} emissions caused by rubber tire rigs traveling on unpaved non-haul roads at the Mission Complex are technically feasible:

- Reduce the speed limit for rubber tire rigs to 25 mph
- Apply additional water to unpaved non-haul roads
- Apply and maintain surface gravel on unpaved non-haul roads
- Pave the unpaved non-haul roads

2.2.2.1. Reduce the Speed Limit for Rubber Tire Rigs to 25 mph

Cost to Implement the Control Measure

As indicated in Section 2.2.1.1, the average traveling speed of rubber tire rigs at the Mission Complex is 15 mph. Therefore, it is reasonable to conclude that there would be relatively little cost imposed by reducing the speed limit for rubber tire rigs to 25 mph.

The Time Necessary for the Control Measure to Be Implemented

A reduction of the speed limit for rubber tire rigs to 25 mph could theoretically be achieved upon EPA's approval of the RH2 SIP. However, there is no requirement that controls determined to be necessary under 40 C.F.R. § 51.308 must be installed as expeditiously as practicable; rather, such controls should be in place by 2028, unless ADEQ concludes that the control cannot reasonably be installed and become operational until after 2028.[26] Whether/when Asarco would need to implement this control measure depends on whether the control measure is warranted. Any determination of whether the control measure is warranted should take into account the question of visibility benefits of implementing the control measure.

2.2.2.2. Apply Additional Water to Unpaved Non-Haul Roads

Cost to Implement the Control Measure

The PM_{10} emissions rate attributable specifically to road dust generated by rubber tire rigs traveling on the unpaved non-haul roads of the Mission Complex is 100 tpy, based on the following equation and calculation:

$$PM_{10}\ Emissions\ (tpy) =$$

$$\frac{\frac{2015\ emissions}{2015\ throughput} + \frac{2016\ emissions}{2016\ throughput} + \frac{2017\ emissions}{2017\ throughput}}{3} * \frac{2016\ throughput + 2017\ throughput + 2018\ throughput}{3} * (80\%)\ ^{27}$$

[26] RH2 Guidance §§ II.B.4(d) and II.B.5(b).

[27] Asarco estimates that 80% of rubber tire rig traffic occurs on non-haul roads.

$$= \frac{\frac{141\ tpy}{363{,}390\ VMT} + \frac{111\ tpy}{208{,}331\ VMT} + \frac{44\ tpy}{117{,}437\ VMT}}{3} * \frac{208{,}331\ VMT + 117{,}437\ VMT + 545{,}928\ VMT}{3} * 80\% = 100\ tpy$$

Increasing the control efficiency from 80% to 90% (see Section 2.2.1.2) would yield a reduction of 50 tons PM_{10} per year for the Mission Complex based on the following calculation:

$$100 - \frac{100\ tpy}{1 - 80\%} * (1 - 90\%) = 50\ tpy$$

The capital cost of implementing this control measure is determined using the following equation and calculation:

$$Capital\ cost = (\#\ of\ current\ water\ trucks) * (cost\ of\ deploying\ new\ water\ truck) * (increase\ in\ water\ application) * (proportion\ of\ nonhaul\ roads)$$

$$Capital\ Cost = (6) * (\$2{,}500{,}000) * (100\%) * (80\%) = \$12{,}000{,}000$$ [28]

To amortize the capital cost, a CRF is used, calculated as follows:

$$\frac{7\% * (1 + 7\%)^{12}}{(1 + 7\%)^{12} - 1} = 12.59\%$$ [29], [30]

Multiplying the capital cost by the CRF results in an annualized capital cost of $1,510,800.

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[28] Per "*Dust Suppression on Wyoming's Coal Mine Haul Roads*" (EPA, October 2004), 2.5 times the amount of water is deemed needed to increase the PM_{10} control efficiency attributable to the application of water to unpaved roads from 75% to 95%. As indicated in Section 2.2.1.2, a control efficiency of 80% is already achieved by the application of magnesium chloride and water to the unpaved non-haul roads. Therefore, it is conservatively estimated that twice the amount of water would be needed to achieve a control efficiency of 90%. Asarco provided the estimated cost of a new water truck, which maximizes the life of the truck for amortization purposes. Based on engineering estimates, it was determined that purchasing a used water truck rather than a new truck would substantially increase maintenance costs which, together with the reduced life of the truck, would result in cost value substantially greater than that determined in this 4FA.

[29] The cost to implement the control measure assessed in this 4FA takes into account the useful life of a new water truck, conservatively estimated at 12 years, for purposes of amortizing capital expenditures. *See* RH2 Guidance §§ II.B.4(f) and II.B.5(d). Asarco reserves the right to assert a shorter water truck life cycle in any administrative proceeding. (See footnote 15.)

[30] The calculation employs a 7% interest rate for a new water truck. *See* "Air Pollution Control Cost Manual," 7th Ed. (2017), § 2.5.2.

The annual operating cost is determined using the following equation and calculation:

$$\begin{aligned} &Annual\ operating\ cost \\ &\quad = (Annual\ spending\ on\ water\ for\ dust\ control) \\ &\quad * (increase\ in\ water\ application) * (proportion\ of\ nonhaul\ roads) \\ &\quad + (admin, taxes, and\ insurance\ percentage) * (initial\ capital\ cost) \end{aligned}$$

$$Annual\ operating\ cost = (\$1{,}267{,}129) * (100\%) * (80\%) + (4\%) * (\$12{,}000{,}000) = \$1{,}493{,}703$$ [31, 32]

Summing the annualized capital cost and the annual operating cost results in a total annual cost of $3,004,503.

The annual cost per ton of PM_{10} reduced is then calculated as follows:

$$\frac{\$3{,}004{,}503}{50\ tpy} = \$60{,}090\ per\ ton\ PM_{10}\ reduced\ per\ year$$

Based on precedent in the Regional Haze Program, the control measure of applying additional water to unpaved non-haul roads would be cost-prohibitive.

The Time Necessary for the Control Measure to Be Implemented

The application of additional water to unpaved non-haul roads could theoretically be achieved upon EPA's approval of the RH2 SIP. However, there is no requirement that controls determined to be necessary under 40 C.F.R. § 51.308 must be installed as expeditiously as practicable; rather, such controls should be in place by 2028, unless ADEQ concludes that the control cannot reasonably be installed and become operational until after 2028.[33] Therefore, whether Asarco would need to implement this control measure before 2028 would bear further consideration, if a determination is made that the control measure is warranted contrary to this 4FA.

2.2.2.3. Apply and Maintain Surface Gravel on Unpaved Non-Haul Roads

Cost to Implement the Control Measure

As stated in Section 2.2.2.2, the PM_{10} emissions rate attributable specifically to road dust generated by rubber tire rigs traveling on the unpaved non-haul roads of the Mission Complex is 100 tpy.

The application and maintenance of surface gravel on the unpaved non-haul roads, with an associated gravel silt content of 6.4% rather than 6.9% (see Section 2.2.1.4), would yield a reduction of 6.55 tons PM_{10} per year for the Mission Complex, based on the following equation and calculation:

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[31] The estimated spending on water is based on the mine's 2018 actual water usage and a local water price of $0.005 per gallon. *See* https://www.tucsonaz.gov/water/industrial-rates-and-monthly-charges.

[32] Administrative expenses , taxes and insurance are assumed to be 4% of capital cost. *See* "Air Pollution Control Cost Manual," 7th Ed. (2017), § 2.6.5.8.

[33] RH2 Guidance §§ II.B.4(d) and II.B.5(b).

$$E = k * \left(\frac{s}{12}\right)^a * \left(\frac{W}{3}\right)^b$$

Where:

k, a, and b = empirical constants
s = silt content (%)
W = mean vehicle weight (tons)
E = Emission factor (lb/VMT)

$$\left(1 - \frac{1.5*\left(\frac{6.4}{12}\right)^{0.9}*\left(\frac{60}{3}\right)^{0.45}}{1.5*\left(\frac{6.9}{12}\right)^{0.9}*\left(\frac{60}{3}\right)^{0.45}}\right) * 100\ tpy = 6.55\ tpy$$

The capital cost of implementing this control measure is determined using the following equation and calculation:

$$Capital\ cost\ = \left(cost\ to\ apply\ gravel\ \left(\frac{\$}{mile}\right)\right) * \left(\frac{\$2018}{\$2015}\right) * \left(length\ of\ unpaved\ nonhaul\ roads\ (miles)\right)$$

$$Capital\ Cost = \left(\$10{,}620\ \left(\frac{\$}{\text{mile}}\right)\right) * \left(\frac{603.1}{556.8}\right) * (28\text{ miles}) = \ \$322{,}087$$ [34]

To amortize the capital cost, a CRF is used, calculated as follows:

[34] The unit cost to apply gravel is taken from "Gravel Roads Construction and Maintenance Guide," U.S. Department of Transportation Federal Highway Administration (2015). The cost includes materials, equipment, labor, grading and stabilization measures. The cost is updated to 2018 dollars using the methodology stated in the Chemical Engineering Plant Cost Index for updating capital costs to a later time.

$$\frac{7\% * (1 + 7\%)^3}{(1 + 7\%)^3 - 1} = 38.11\%$$ [35, 36]

Multiplying the capital cost by the CRF yields an annualized capital cost of $122,747.

The annual operating cost is determined using the following equation and calculation:

$$\begin{aligned} &\textit{Annual operating cost} \\ &\quad = (\textit{admin, taxes, and insurance percentage}) * (\textit{initial capital cost}) \\ &\quad = (4\%) * (\$322{,}087) = \$12{,}883 \end{aligned}$$ [37]

Summing the annualized capital cost and the annual operating cost results in a total annual cost of $135,630.

The annual cost per ton of PM_{10} reduced is then calculated as follows:

$$\frac{\$135{,}630}{6.55\ tpy} = \$20{,}707\ per\ ton\ PM_{10}\ reduced\ per\ year.$$

Based on precedent in the Regional Haze Program, the control measure of applying and maintaining surface gravel on unpaved non-haul roads would be cost-prohibitive.

The Time Necessary for the Control Measure to Be Implemented

The application and maintenance of surface gravel on unpaved non-haul roads could theoretically be achieved upon EPA's approval of the RH2 SIP. However, there is no requirement that controls determined to be necessary under 40 C.F.R. § 51.308 must be installed as expeditiously as practicable; rather, such controls should be in place by 2028, unless ADEQ concludes that the control cannot reasonably be installed and become operational until after 2028.[38] Therefore, whether Asarco would need to implement this control measure before 2028 would bear further consideration, if a determination is made that the control measure is warranted contrary to this 4FA.

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[35] According to Asarco, the remaining useful life of the Mission Mine may be 25 years, possibly longer depending on drill data, ore reserves and the developing market price of copper. The useful life of surface gravel applied to the unpaved non-haul roads, before the gravel would need to be replaced, is estimated at 3 years. *See* "Gravel Roads Construction and Maintenance Guide," U.S. Department of Transportation Federal Highway Administration (2015) at Figure 17 (suggesting for estimation purposes that re-graveling is necessary every 3 years). Therefore, the cost to implement this control measure takes into account what would be the estimated useful life of the surface gravel for purposes of amortizing capital expenditures. *See* RH2 Guidance §§ II.B.4(f) and II.B.5(d).

[36] The calculation employs a 7% interest rate for the gravel. *See* "Air Pollution Control Cost Manual," 7th Ed. (2017), § 2.5.2.

[37] Administrative expenses , taxes and insurance are assumed to be 4% of capital cost. *See* "Air Pollution Control Cost Manual," 7th Ed. (2017), § 2.6.5.8.

[38] RH2 Guidance §§ II.B.4(d) and II.B.5(b).

2.2.2.4. Pave the Unpaved Non-Haul Roads

Cost to Implement the Control Measure

As stated in Section 2.2.2.2, the PM_{10} emissions rate attributable specifically to road dust generated by rubber tire rigs traveling on the unpaved non-haul roads of the Mission Complex is 100 tpy.

The pavement of the unpaved non-haul roads could yield a reduction of 95 tons PM_{10} per year for the Mission Complex, based on the following calculation:

$$100\ tpy - \frac{100\ tpy}{1-80\%} * (1-99\%) = 95\ tpy$$ [39]

The capital cost of implementing this control measure is determined using the following equation and calculation:

$$Capital\ cost = \left(cost\ to\ pave\ road\ \left(\frac{\$}{mile}\right)\right) * \left(length\ of\ unpaved\ nonhaul\ roads\ (miles)\right)$$

$$Capital\ cost = \left(\$1{,}255{,}784\ \left(\frac{\$}{mile}\right)\right) * (28\ miles) = \$35{,}161{,}952$$ [40]

To amortize the capital cost, a CRF is used, calculated as follows:

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[39] As stated in Section 2.2.1.5, Asarco anticipates that the non-haul roads, once paved, would be covered fairly quickly by dust, necessitating regular removal of the accumulated dust and making it difficult to attribute with confidence a control efficiency for the pavement. That said: (i) a control efficiency of 80% is already achieved by the application of magnesium chloride and water to the unpaved non-haul roads (see Section 2.2.1.2); and (ii) the WRAP Fugitive Dust Handbook (2006), at Table 6-6, provides that a 99% control efficiency is attributable to pavement of unpaved roads.

[40] The cost per mile of road paving is derived from the actual cost that Asarco incurred paving, compacting, grading and providing for associated drainage of Kennecott Avenue in Hayden, Arizona, pursuant to Section 14 of Appendix B of the Consent Decree in the matter of *United States of America v. ASARCO LLC*, No. CV-15-02206-PHX-DLR (D. Ariz. December 30, 2015).

$$\frac{7\% * (1 + 7\%)^{35}}{(1 + 7\%)^{35} - 1} = 7.72\%$$ [41], [42]

Multiplying the capital cost by the CRF yields an annualized capital cost of $ 2,714,503.

The annual operating cost is determined using the following equation and calculation:

$$\mathit{Annual\ operating\ cost} = (\mathit{admin, taxes, and\ insurance\ percentage}) * (\mathit{initial\ capital\ cost})$$

$$\mathit{Annual\ operating\ cost} = (4\%) * (\$35{,}161{,}952) = \$1{,}406{,}478$$ [43]

Summing the annualized capital cost and the annual operating cost results in a total annual cost of $4,120,981.

The cost per ton of PM_{10} reduced is then calculated by:

$$\frac{\$4{,}120{,}981}{95\ tpy} = \$43{,}379\ \mathit{per\ ton\ PM_{10}\ reduced\ per\ year}$$

Based on precedent in the Regional Haze Program, the control measure of paving the unpaved non-haul roads would be cost-prohibitive.

The Time Necessary for the Control Measure to Be Implemented

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[41] According to Asarco, the remaining useful life of the Mission Mine may be 25 years, possibly longer depending on drill data, ore reserves and the developing market price of copper. Asarco could not determine the useful life of pavement that is regularly traversed by rubber tire rigs (such as rubber-tired dozers). Therefore, Asarco looked to the literature on pavement life cycles, in order to develop a highly conservative estimate of the useful life of the pavement. According to Arizona Department of Transportation, highway structural designs typically employ a 20-year life of pavement, but since highways can last longer, "a minimum 35 year analysis period should be used." AZDOT Pavement Design Manual (September 29, 2017) at § 2.4. Employing a 35-year period for amortization purposes in this 4FA would be highly conservative for pavement that is regularly traversed by rubber tire rigs. Based on Asarco's experience, employing a 25-year period or even a 20-year period would also be highly conservative for pavement that is regularly traversed by rubber tire rigs. Using a 35-year period results in a CRF of 7.72%. Using a 25-year period results in a CRF of 8.58%. Using a 20-year period results in a CRF of 9.44%. This 4FA employs the most conservative of the three—a CRF of 7.72%, for a 35-year period—although this is highly conservative, and arguably over-conservative. *See* RH2 Guidance §§ II.B.4(f) and II.B.5(d).

[42] The calculation employs a 7% interest rate for the pavement. *See* "Air Pollution Control Cost Manual," 7th Ed. (2017), § 2.5.2.

[43] Administrative expenses , taxes and insurance are assumed to be 4% of capital cost. *See* "Air Pollution Control Cost Manual," 7th Ed. (2017), § 2.6.5.8. For purposes of this 4FA, this percentage is deemed to include, but not be limited to, the cost of regularly removing dust that accumulates on the pavement and the cost of repairing damage to the pavement that would be caused by the rubber tire rigs.

Pavement of the unpaved non-haul roads could theoretically be achieved upon EPA's approval of the RH2 SIP. However, there is no requirement that controls determined to be necessary under 40 C.F.R. § 51.308 must be installed as expeditiously as practicable; rather, such controls should be in place by 2028, unless ADEQ concludes that the control cannot reasonably be installed and become operational until after 2028.[44] Therefore, whether Asarco would need to implement this control measure before 2028 would bear further consideration, if a determination is made that the control measure is warranted contrary to this 4FA.

[44] RH2 Guidance §§ II.B.4(d) and II.B.5(b).

3. VISIBILITY BENEFITS

The 4FAs discussed in this report are not complete without an assessment of whether or to what extent implementation of the assessed control measures would contribute to visibility improvements in Class I areas.[45] It is, therefore, anticipated that, before the RH2 SIP is finalized for Arizona, the record of these 4FAs will be supplemented based on photochemical grid modeling of potentially associated visibility improvements to Class I areas; and that the modeling will provide an opportunity to assess the unit ($) cost of implementing any control measure that ADEQ deems to be necessary under 40 C.F.R. § 51.308 per unit (Mm^{-1}) of visibility improvement that would result in one or more Class I areas, to reflect the cost per unit of visibility benefit achieved by that control measure.[46, 47] The information derived from the modeling would be relevant to any assessment of whether the cost of a control measure would be adequately beneficial to justify its expenditure.[48]

In addition, Asarco has commissioned the preparation of a Hybrid Single Particle Lagrangian Integrated Trajectory ("**HYSPLIT**") model to determine the probability that PM_{10} emissions from processes such as those assessed in this report impact a Class I area when it experiences its 20% worst visibility days. The information derived from the HYSPLIT model would also be relevant to an assessment of whether the cost of a control measure would be adequately beneficial to justify its expenditure. Asarco anticipates that, by the end of December 2019, it will be able to supplement the information provided above with a report on the results of the HYSPLIT model. Subject to the information that will be provided in that report, the preliminary results of the HYSPLIT model indicate that the probability of emissions from the Mission Complex impacting the Saguaro National Park is between 1.0% and 2.0%.

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[45] *See* RH2 Guidance § II.B.4(g).

[46] EPA recommends that, "if a state is going to consider a metric defined as the cost per unit of visibility benefit, it [should] use light extinction units in the denominator for quantifying visibility benefits. When visibility benefits are expressed in units of light extinction, the visibility benefit can be calculated from modeling results in multiple ways. The modeled visibility benefit can be calculated by making two air quality modeling runs, with and without the [control] measure assumed to be in place. However, if a source's impacts on ambient PM species under a particular emissions scenario have been determined through source apportionment/attribution, it will generally be appropriate to estimate the reductions in ambient PM species due to pollutant-specific emission reductions from the source by assuming a proportionality between source emissions of the relevant species precursor and the ambient PM species concentration. The PM species concentrations with and without the measure can then be used to estimate the light extinction benefit of the measure." RH2 Guidance § II.B.4(g).

[47] EPA recommends that, if a state uses a cost per unit of visibility benefit metric to evaluate control measures, it should use "a cost/inverse megameter metric rather than a cost/deciview metric because the application of the deciview scale on a source- or measure-specific basis is complicated by the logarithmic nature of the deciview scale. When only one Class I area is affected by a measure under consideration, a state may calculate and consider the cost/inverse megameter metric for that one area. If multiple Class I areas would experience visibility benefits from a measure, a state may calculate and consider a metric defined as the annualized compliance cost divided by the sum of the light extinction benefit across these Class I areas. A state may use reasonable thresholds for these metrics as a way of considering the balance between compliance costs and visibility benefits." RH2 Guidance § II.B.5(a).

[48] EPA anticipates that "the balance between the cost of compliance and the visibility benefits will be an important consideration in a state's decisions" in developing an RH2 SIP. RH2 Guidance § II.B.5(a).