

**Economic Analysis of Hydrogen Sulfide Rules,
15A NCAC 02Q .0700 & 15A NCAC 02D .1100**

Final Draft - July 17, 2003

Step 1: Basic Information

1.1 Rule Reference No.	E3153 (DENR APA Rule Ref No.)
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1.6 Title of the Proposed Rule	Toxic air pollutant procedures
1.7 Citation	15A NCAC 02Q .0700 15A NCAC 02D .1100
1.8 Brief Description of the Proposed Rule	Rule amends AAL and emission rates requiring a permit to emit toxic air pollutants, provides pulp and paper wastewater treatment system exemption, and calls for testing, modeling and monitoring on a multi-year schedule.
1.9 Rule Category	Division 1 - Regulating Behavior

Step 2: Screening Analysis

Circumstances	Yes or No
2.1 Federal Rule Certification Required	No
2.2 Substantial Economic Impact Analysis - Federal Rule Exemption	No
2.3 Temporary Rules	No
2.4 Technical Corrections	No
2.5 Repeal of Regulatory Deadwood	No
2.6 Service/Financial Program	N/A

Special Circumstance Report

Identify the type of Special Circumstance, from above list.	Explain the Special Circumstance.
	NA

ECONOMIC ASSESSMENT
Final Draft - 7/17/03

I. Executive Summary

The economic assessment will evaluate the annual impact during the five-year period of rule making analysis, beginning on August 1, 2004, when the proposed rules become effective. The acceptable ambient level (AAL) concentration for hydrogen sulfide (H₂S) is currently set at 2.1 milligrams per cubic meter based on a one-hour averaging period. Five AAL options and resulting limits for hourly and daily emission rates requiring a permit to emit toxic air pollutants are being proposed, along with two exemption options regarding certain pulp and paper facilities.

Overall public health and safety are improved, despite continued exposure due to these exemptions. The rules change no expenditures or revenues of a unit of local government. There are no significant expenditures or distribution of state funds subject to the Executive Budget Act. Certain combinations of these proposed options for this rule result in ‘substantial economic impact’ in excess of an aggregate cost to all persons affected within the state totaling at least \$3,000,000 over a 12-month period. The private sector economic impact estimates range from 20 to 40 million dollars in aggregate annualized costs to industry from capital installation up to \$387,185,000 along with annual operating expenses for the control devices or systems.

II. Description of Proposed Amendment

The proposed rules would amend 15A NCAC 02D .1100, Control of Toxic Air Pollutants, and 15A NCAC 02Q .0700, Toxic Air Pollutant Procedures. Options 1, 2, or 3 incorporate a range of recommendations by the Scientific Advisory Board of the North Carolina Department of Environment and Natural Resources. Option 4 and Option 5 are a result of industry cost studies and are proposed to mitigate economic impacts on affected industries.

15A NCAC 02D .1104, Toxic Air Pollutant Guidelines, is proposed to be amended as follows: A facility shall not emit any of the following toxic air pollutants in such quantities that may cause or contribute beyond the premises (adjacent property boundary) to any significant ambient air concentration that may adversely affect human health. In determining these significant ambient air concentrations, the Division shall be guided by the following list of acceptable ambient levels in milligrams per cubic meter at 77° F (25° C) and 29.92 inches (760 mm) of mercury pressure (except for asbestos):

(Abbreviated table from 02D .1104 presenting 5 options for AAL concentrations in this rule making)

Pollutant (CAS Number)	Annual (Carcinogens)	24-hour (Chronic Toxicants)	1-hour (Acute Systemic Toxicants)	1-hour (Acute Irritants)
hydrogen sulfide (7783-06-4)				<u>2.1</u>
OPTION 1		<u>0.033</u>		
OPTION 2		<u>0.033</u>	<u>0.056</u>	
OPTION 3				
<u>New facility</u>		<u>0.033</u>	<u>0.056</u>	
<u>Old facility</u>		<u>0.12</u>		
OPTION 4		<u>0.12</u>		
OPTION 5		<u>0.12</u>	<u>0.056</u>	

15A NCAC 02Q .0711, Emission Rates Requiring A Permit, is proposed to be amended as follows: A permit to emit toxic air pollutants shall be required for any facility whose actual (or permitted if higher) rate of emissions from all sources are greater than any one of the following toxic air pollutant permitting emissions rates:

(Abbreviated table from 02Q .0711 below presents the 5 options of “emission rates requiring a permit”)

Pollutant (CAS Number)	Carcinogens lb/yr	Chronic Toxicants lb/day	Acute Systemic Toxicants lb/hr	Acute Irritants lb/hr
hydrogen sulfide (7783-06-4)				0.52
OPTION 1		0.46		
OPTION 2		0.46	0.013	
OPTION 3				
<u>New facility</u>		0.46	0.013	
<u>Old facility</u>		1.7		
OPTION 4		1.7		
OPTION 5		1.7	0.013	

The abbreviated table from 02Q.0711 has columns to identify ‘lb/day’ and/or ‘lb/hr’ as emission rates requiring a permit. Daily emission rate limits are associated with chronic toxicants, and hourly rates are related to acute systemic toxicants. Where both limits are presented, exceeding either emission rate triggers the requirement to have a permit to emit toxic air pollutants. These OPTIONS 1, 2, 3, 4, or 5 are linked to the 5 options for Acceptable Ambient Level (AAL) concentrations presented in the abbreviated table from 02D.1104 such that each AAL option has an associated emission limitation requiring a permit.

OPTION A (Air Quality Committee recommendation) and **OPTION B** (preferred by Pulp & Paper industry) are identified in this analysis. Each option has effects on two rules. An existing rule, 15A NCAC 02Q .0702, Exemptions, would be amended by adding “wastewater treatment systems at pulp and paper mills until February 1, 2007, at which time this exemption shall expire”. This exemption, **OPTION A**, has a sunset date after which these wastewater treatment systems would be included in air toxic modeling demonstrations. **OPTION B** removes the sunset date on this exemption indefinitely unless the EMC takes action in the future based on reports of modeling and monitoring.

The adoption of Rule 15A NCAC 02Q .0714, Wastewater Collection and Treatment Systems at Pulp and Paper Mills, sets out requirements for sources exempted under Rule .0702, except for facilities that employ activated sludge type wastewater treatment systems.

OPTION A proposed:

- (1) test the wastewater treatment system for emissions of hydrogen sulfide, methyl mercaptan, and total reduced sulfur and report the results of these tests to the Director by August 1, 2005; and
- (2) provide an engineering evaluation of installing an activated sludge system for wastewater treatment, including the cost of such a system, and an assessment of the environmental and health benefits to water quality and air quality of using activated sludge systems for wastewater treatment and report these evaluations and assessments to the Director by August 1, 2006.

OPTION B proposed:

- (1) submit to the Director estimates of hydrogen sulfide, total reduced sulfur, and methyl mercaptan emissions from wastewater collection and treatment systems and components using estimation methods or factors developed through industry testing and analytical studies and approved by the Director by August 1, 2005.
- (2) using the emission estimates developed under Subparagraph (b)(1), perform air dispersion modeling of all hydrogen sulfide emission sources, including all emissions associated with the wastewater collection and treatment system, as described in 15A NCAC 02D .1106 (a) through (i). If the modeling analysis demonstrates that predicted concentrations of hydrogen sulfide are below the acceptable ambient levels outlined in 15A NCAC 02D .1104, no further plan development, measurement or monitoring action is required to maintain the exemption provided by this Rule. The results of the favorable modeling demonstration must be submitted to the Director by July 1, 2006.
- (3) If the dispersion modeling performed under Subparagraph (b)(2) of this rule shows that the acceptable ambient level for hydrogen sulfide is not exceeded, submit to the Director, on or before September 30, 2006, for approval by the Director, an ambient air quality monitoring plan designed to assess actual ambient levels of hydrogen sulfide typical of pulp and paper mill operations. The monitoring plan may be undertaken at each of the individual mill sites or, at the option of the affected mill sites, it may be undertaken at a single North Carolina mill site that the Director determines to be representative of the industry.
- (4) Within 180 days of approval by the Director, implement the ambient monitoring study plan required in Subparagraph (b)(3) to determine the actual ambient levels of hydrogen sulfide near pulp and paper mills
- (5) Complete the ambient hydrogen sulfide monitoring plan and report the results to the Director and to the Chairperson of the Environmental Management Commission within 18 months of commencing ambient monitoring.

III. Motivation for the Proposed Amendment

The Scientific Advisory Board (SAB) of the North Carolina Department of Environment and Natural Resources has recommended a range of AAL options hydrogen sulfide in an effort to better protect public health under the current rules. An exemption, either with or without a sunset date, plus a couple of options for testing, modeling, and monitoring as requirements for these exemptions are proposed as a result of industry cost studies that ought to mitigate economic impacts on affected industries.

IV. Identification of Affected Sources

In an effort to provide more refined cost estimates associated with air toxics rulemaking, Division of Air Quality (DAQ) embarked upon a modified approach to estimate costs associated with this rulemaking. In some previous assessments, the agency has used a template representing the various actions, which a facility might need to take to demonstrate compliance with the program in conjunction with some general cost estimates for each of those actions, emissions inventory data, and historical information on modeling demonstrations to estimate costs. The actions a facility might take range from emission calculation and comparison to toxics permitting rates to screen or refined dispersion modeling and on to installation of controls. The rule does not mandate specific controls in order to provide flexibility to the facilities to choose the

compliance method they find most operationally and economically effective. As a result, the template approach provided a generalized cost estimate.

In this instance, DAQ engaged industry early in the process regarding costs to comply with possible levels for a revised AAL. For the purposes of the assessment, DAQ focused on those affected industries with the largest emissions contribution, the pulp and paper industry and the phosphoric acid manufacturing industry. To date industry has been able to provide aggregate cost data based on affected member facilities' anticipated approaches necessary to achieve compliance at the SAB recommended level of 0.056 milligrams/m³ for a one-hour averaging time. The bulk of cost is associated with control of wastewater processes for the Pulp and Paper industry sector.

At the request of the DAQ, Manufacturing and Chemical Industry Council (MCIC) has compiled aggregate cost estimates for control of hydrogen sulfide emissions from six (6) sites operated by four (4) MCIC member companies: Blue Ridge Paper Products, International Paper, PCS Phosphate, and Weyerhaeuser. DAQ specifically requested that MCIC identify the cost differential for two (2) emission control scenarios: (1) control of all hydrogen sulfide emissions, including emissions from wastewater collection and treatment facilities; and (2) control of all hydrogen sulfide emissions, except those from wastewater collection and treatment facilities.

V. Establishment of the Baseline

The baseline for this economic assessment is the current 15A NCAC 2Q .0700 and 15A NCAC 2Q .1100. Some facilities may have emission control requirements due to discovery that a source had been neglected in modeling procedures for NC air toxic program compliance demonstrations. It is assumed that about 20% of total estimated proposed 1-hr AAL rule impact control costs would result to meet the existing requirements based on relative emission reductions. For this analysis, the baseline aggregate industry annualized cost is about 10 million dollars. Only 22% of this total is accounted for as annual capital recovery. The remaining 78% is from annual operation, maintenance, and replacement costs. Baseline estimates are needed because "changes from the baseline" are the measure of rule impact reported in this analysis.

VI. Changes from the Baseline

A previous study, performed by the DAQ modeling staff, revealed that 76% of compliance demonstrations required permit restrictions. These restrictions included permit limits on emissions (47%), operating hours (38%), and/or limits on fuel usage (21%), in various combinations. Additional permit restrictions involve physical modification at the facility and include control devices (43%), stack modifications (11%), source relocation (2%), source design (6%) and/or reformulation (4%).

The estimated capital costs for control of all hydrogen sulfide emissions at the six (6) plant sites is \$360 million, and the estimated capital costs for control of all hydrogen sulfide emissions except for the wastewater treatment facilities is \$18.5 million, or \$2.4 million in annualized cost. Thus, the aggregate cost differential for emission controls from all sources versus control from all sources except the wastewater collection and treatment systems is \$341.5 million.

It is important to note that each of the plant sites are unique and that the capital costs for emission controls necessary to comply with the proposed AAL for hydrogen sulfide under either

of the two emission control scenarios vary widely among the six (6) sites. It is also important to note that there are significant costs that are not included in these capital cost estimates, such as the potentially major cost of de-commissioning and demolition of existing wastewater treatment systems (very large lagoons are currently in operation at four (4) of the six (6) sites), site preparation for new capital construction, production down-time during construction, etc.

For each AAL option being considered, capital costs have been broken out according to annual capital recovery and operation, maintenance, and replacement. The cost ratios are based on details provided by a few representative facilities, which were then applied to the aggregate capital investment total. The rule impact identified below adjusts for the baseline costs.

Table 1

<u>Hydrogen Sulfide AAL Alternatives</u>	<u>Baseline</u>	<u>Proposed AAL Options</u>		
Averaging Period	1-hr	1-hr	24-hr	24-hr
Milligrams per cubic meter	2.1	0.056	0.033	0.12
<u>Affected Industry Aggregate</u>				
Total Capital Installation Cost*	\$78,054,000	\$387,185,000	\$232,846,000	\$155,546,000
Annual Capital Recovery	\$2,232,000	\$11,073,000	\$6,659,000	\$4,449,000
<u>Annual OM&R</u>	<u>\$7,915,000</u>	<u>\$39,261,000</u>	<u>\$23,611,000</u>	<u>\$15,772,000</u>
Total Annualized Cost	\$10,147,000	\$50,334,000	\$30,270,000	\$20,221,000
Rule Impact		\$40,187,000	\$20,123,000	\$10,074,000

* Based on MCIC -Aggregate Cost estimates for proposed 1-hr AAL, assume pulp & paper wastewater exemption has sunset (OPTION A) and then used a template approach to simulate the costs of either 24-hr AAL Options.

OPTION A amends 15A NCAC 02Q .0702 Exemptions by adding waste water treatment systems at pulp and paper mills. This exemption remains in effect until February 1, 2007 with the adoption of requirements for the exemption in 15A NCAC 02Q .0714 that includes the reporting of emission testing and an assessment of activated sludge treatment systems.

OPTION B instead amends 15A NCAC 02Q .0702 Exemptions by indefinitely adding waste water treatment systems at pulp and paper mills. Similarly, an adoption of requirements for the exemption in 15A NCAC 02Q .0714 includes the reporting of emission estimates, dispersion modeling, and calls for ambient air quality monitoring at one or more affected mill sites if necessary.

The estimates of annualized costs shown in Table 1 are for combinations of various AAL options, in some cases adding an hourly limit to a daily emission limit and OPTION A provisions including a sunset for the wastewater treatment systems at pulp and paper mills. The exemption options have the effect of delaying some of these expenditures either temporarily or indefinitely. However, some exemption requirements (OPTION B) add costs beyond those found in Table 1. The combined result is displayed in Table 2, which attempts to distribute these costs in each State fiscal year over the five-year period of this analysis. The substantial economic impact result remains unchanged in either case, as all options exceed the threshold of \$3,000,000 in aggregate private expenditure during any 12-month period.

Table 2

**15A NCAC 02Q .0714
WASTEWATER TREATMENT
SYSTEMS AT PULP AND PAPER
MILLS**

This Rule applies to wastewater collection and treatment systems at pulp and paper mills that are exempted under Rule .0702 of this Section - Except for facilities that employ activated sludge type wastewater treatment systems

OPTION 1

0.033 mg/m3 @ 24 hr.

OPTION A - Test emissions and Assess Activated Sludge, and report results

OPTION B - Estimate emissions, report Modeling, and Monitoring

OPTION 2, OPTION 3 (New Facility), or OPTION 5

(0.033 or 0.12) mg/m3 @24-hr.
with 0.056 mg/m3 @ 1-hr.

OPTION A - Test emissions and Assess Activated Sludge, and report results

OPTION B - Estimate emissions, report Modeling, and Monitoring

OPTION 3 (Old Facility) & OPTION 4

0.12 mg/m3 @24-hr.

OPTION A - Test emissions and Assess Activated Sludge, and report results

OPTION B - Estimate emissions, report Modeling, and Monitoring

15A NCAC 02Q .0702 EXEMPTIONS

sources covered under this exemption may be covered under Rule .0714 of this Section, affects expressed in annualized control cost (million dollars)

OPTION A - wastewater treatment systems at pulp and paper mills until February 1, 2007, at which time this exemption shall expire;

<i>FY04</i>	<i>FY05</i>	<i>FY06</i>	<i>FY07</i>	<i>FY08</i>
\$0	\$3	\$3	\$20	\$20

OPTION B - wastewater treatment systems at pulp and paper mills

<i>FY04</i>	<i>FY05</i>	<i>FY06</i>	<i>FY07</i>	<i>FY08</i>
\$0	\$3	\$6	\$2.4	\$2.4

OPTION A - wastewater treatment systems at pulp and paper mills until February 1, 2007, at which time this exemption shall expire;

<i>FY04</i>	<i>FY05</i>	<i>FY06</i>	<i>FY07</i>	<i>FY08</i>
\$0	\$3	\$3	\$40	\$40

OPTION B - wastewater treatment systems at pulp and paper mills

<i>FY04</i>	<i>FY05</i>	<i>FY06</i>	<i>FY07</i>	<i>FY08</i>
\$0	\$3	\$6	\$2.4	\$2.4

OPTION A - wastewater treatment systems at pulp and paper mills until February 1, 2007, at which time this exemption shall expire;

<i>FY04</i>	<i>FY05</i>	<i>FY06</i>	<i>FY07</i>	<i>FY08</i>
\$0	\$3	\$3	\$10	\$10

OPTION B - wastewater treatment systems at pulp and paper mills

<i>FY04</i>	<i>FY05</i>	<i>FY06</i>	<i>FY07</i>	<i>FY08</i>
\$0	\$3	\$6	\$2.4	\$2.4

Background Facts

Based on the Weyerhaeuser submittal of emissions and modeling to the DAQ, the Plymouth Pulp Mill is currently operating exceeding the current H₂S AAL guideline. For instance, its modeled maximum property line concentration is 15,000 ug/m³ compared to the current AAL of 2,100 ug/m³. No other facilities have submitted models, but there is reason to believe that:

1. All NC mills (except Blue Ridge) would likewise model above the current H₂S AAL.
2. To have their wastewater treatment systems comply with any of the three proposed AALs, all NC mills (except Blue Ridge) would be forced to convert from aerated stabilization basin to activated sludge treatment, and then add covers, ducting, and an incinerator.

Data in the literature indicate that the wastewater treatment at pulp and paper mills release an equivalent amount of methyl mercaptan relative to H₂S. Assuming this similarity and given the current methyl mercaptan AAL of 50 micrograms/m³, it is likely that the wastewater treatment operations also produce conditions above the current methyl mercaptan AAL. This means that DAQ believes that modeling would estimate a level near 15 mg/m³ relative to the methyl mercaptan AAL of 50 micrograms/m³.

In addition, there are indications that a trend is developing. Wastewater discharge limits for biochemical oxygen demand, total suspended solids, nitrates, and phosphates are getting stricter for the paper industry as well other industries. Because of its superior performance, several paper mills with aerated basins releasing wastewater into sensitive waterways with stringent permit limits already have or are switching over to activated sludge. This is true at least in certain areas in Florida, Michigan, Minnesota, Washington, Wisconsin, Canada, as well as for Blue Ridge Paper on the Pigeon River here in NC.

No federal ambient air quality standards exist for hydrogen sulfide (H₂S); several states independently regulate ambient levels to protect the public from its adverse affects. There are 13 other states with 1-hour H₂S standards, ranging from 10 – 200 ppb. North Carolina's 1-hour proposal falls in the middle, with 6 rules more stringent and 7 less stringent. 12 states regulate with 24-hr standards. Likewise the NC proposals fall in the middle of the 0.6 – 200 ppb range.

The technology on the extent and control of H₂S emissions from wastewater treatment is not fully developed. This means that there is not enough known and understood about these issues for the paper industry to make a huge commitment in significantly reducing H₂S emissions from wastewater treatment. Until more information is available, DAQ recommends that the paper industry wastewater treatment operations be handled with an exemption.

Public Health Effects

Dr. Leah Devlin, State Health Director of the Department of Health and Human Services, presented several other study results, EPA's recommendations, and reported that the numbers provided by the Scientific Advisory Board are in the same range of other government entity's numbers. The current hydrogen sulfide AAL of 2.1 milligrams per cubic meter (1.5 ppm) poses a serious health concern for people with asthma and should be lowered. A 24-hour AAL for hydrogen sulfide is also needed to reduce the risk of eye-related adverse health impacts in the general public. She supports the one-hour AAL for hydrogen sulfide of 0.056 milligrams per

cubic meter (0.040 parts per million) and either 24-hour AAL 0.033 mg/m³ (same as 0.023 ppm) and 0.12 mg/m³ (same as 0.083 ppm). However, the 0.023 parts per million AAL is more health protective and based on human studies. The 0.083 parts per million 24-hour AAL is based on rat studies. Summary information can be found at the North Carolina Air Toxic Program website, under Investigation & Area Studies, <http://daq.state.nc.us/toxics/studies/H2S>.

Overall, public health and safety are improved, despite continued exposure even with the exemption of the wastewater treatment systems at pulp and paper facilities. A rule where this exemption has a sunset provision may seem more protective than Option B without one. In either case, the Environmental Management Commission will continue to gather important information upon which to base further action. These health and safety benefits are all relative to the protection provided by the current AAL. Most persons in North Carolina will realize greater protection from several combinations of these rule amendments. The most stringent would involve tightening the 1-hour AAL along with the lower 24-hour AAL. Removing the current 1-hour AAL and adding the lower 24-hour AAL provides somewhat more protection than the single AAL at the higher 24-hour averaging period.

Limitations and uncertainty of analysis

The assumptions related to regulatory alternatives are quite uncertain due to external actions that are occurring among affected source groups. The future air toxic emissions and resulting ambient concentrations will be affected by emerging control technology. Over the five-year period of analysis, the uncertainty of cost components, with respect to compliance, are impossible to predict.

Regarding regulatory requirements associated with the exemption of certain pulp and paper facilities currently without activated sludge wastewater treatment systems. The emission monitoring and cost analysis reports, identified as OPTION A, due in the 2005 and 2006, respectively may influence subsequent EMC action. OPTION B has a similar stepwise regulatory requirement; if modeling indicated a problem then ambient monitoring is required. The required reports will determine future EMC actions and subsequent costs incurred to achieve the acceptable level of ambient concentrations have uncertain schedule over the period of analysis.

New information may influence the economic realities associated with this rule, but the flexibility in this regulatory approach should allow market forces to drive the environmental solution that is more cost effective. A rule provision exists for a facility to seek approval of a variance for maximum feasible control technology, which could provide regulatory relief in cases of technical infeasibility or economic hardship. Marginal control cost estimates for each option, and costs for methods of compliance control were simulation based on general assumptions about who is affected and how for each proposed AAL levels. Conclusions about the changes in regulated behavior are equally uncertain, and are related to summarizing the information to allow economic data from other sources to be properly matched to staff cost estimates and emission sources.

Conclusion

The aggregate economic impact estimates were generated using engineering and simulation modeling considerations, and queries of DAQ emission inventory data sets to develop cost analyses and which then serve as inputs to the economic analyses. This economic analysis provided guidance to and coordinated with the engineering staff and industry representatives to develop cost estimates. MCIC did not provide aggregate cost estimates for each AAL option, because the order of magnitude nature of the basic uncertainty associated with these costs. The threshold determination for this rule making is that it results in a 'substantial economic impact' in excess of an aggregate cost to all persons affected within the state totaling at least \$3,000,000 over a 12-month period because the maximum annualized cost estimate exceeded \$40,000,000. None of the proposed rule changes are expected to cause a state or local government fiscal impact. Any of the five proposed AAL options would be filed as resulting in 'substantial economic impact', which requires 60 days for the comment period associated with the public comment process.

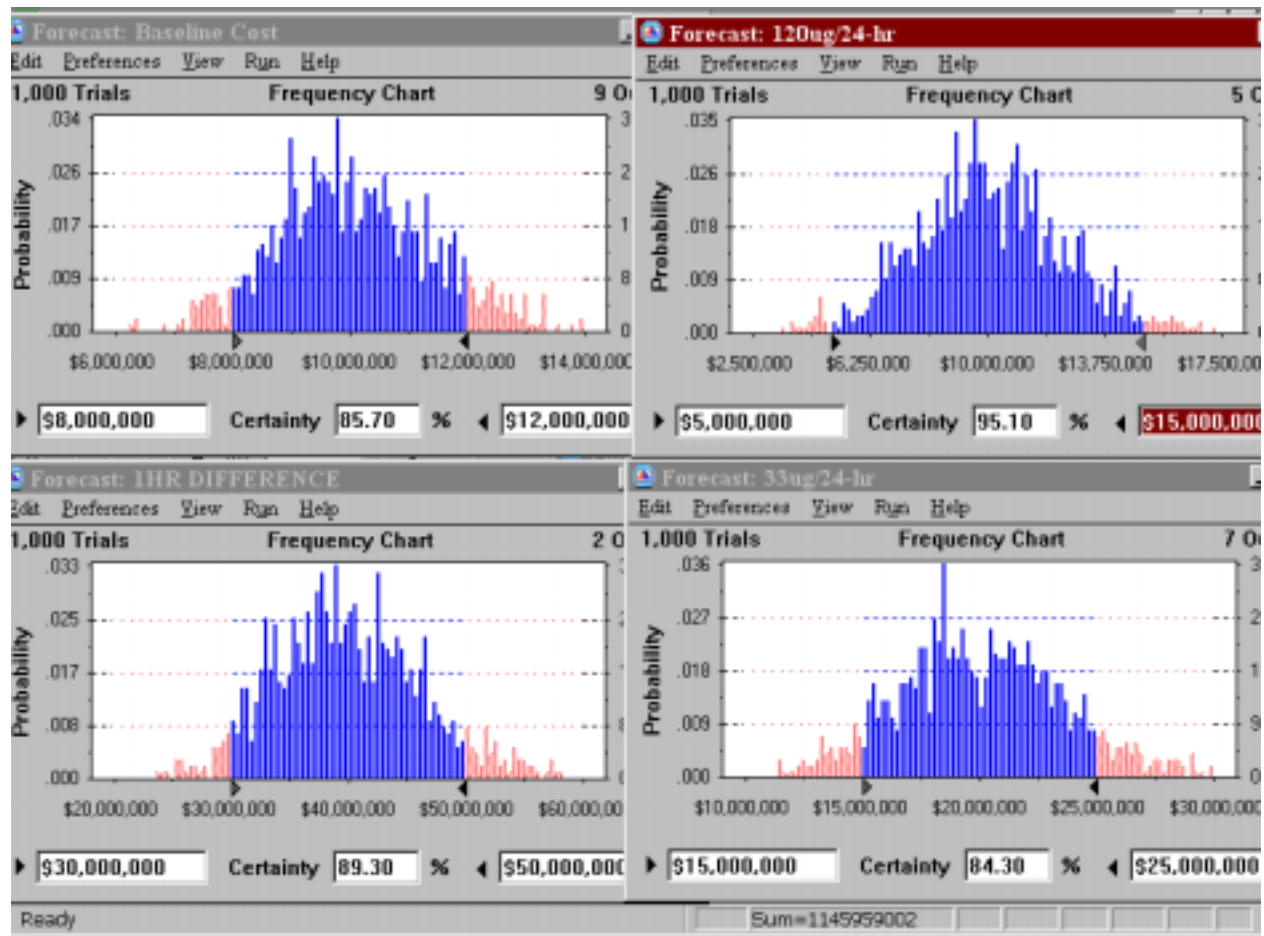
There also appear to be significant public health benefit from the various proposed AALs in terms of reduced ambient concentration limits and resulting health effects related to hydrogen sulfide exposure. Those health benefits can be reviewed in the SAB recommendation and in the full analysis by the Department of Health and Human Services. A whole series of background material can be reviewed at the DAQ website - <http://daq.state.nc.us/toxics/studies/H2S>

Economic Analysis Appendix

Cost simulation results below are based on a model of 1,000 trials showing the probability distributions for the baseline, annualized cost and estimates of rule impact for the AAL options for hydrogen sulfide. Input assumptions used lognormal distributions around previously determined average cost data. Forecasted results were rounded to central tendencies as reported in Table 1. Of course, each time these simulations are repeated the results are slightly different.

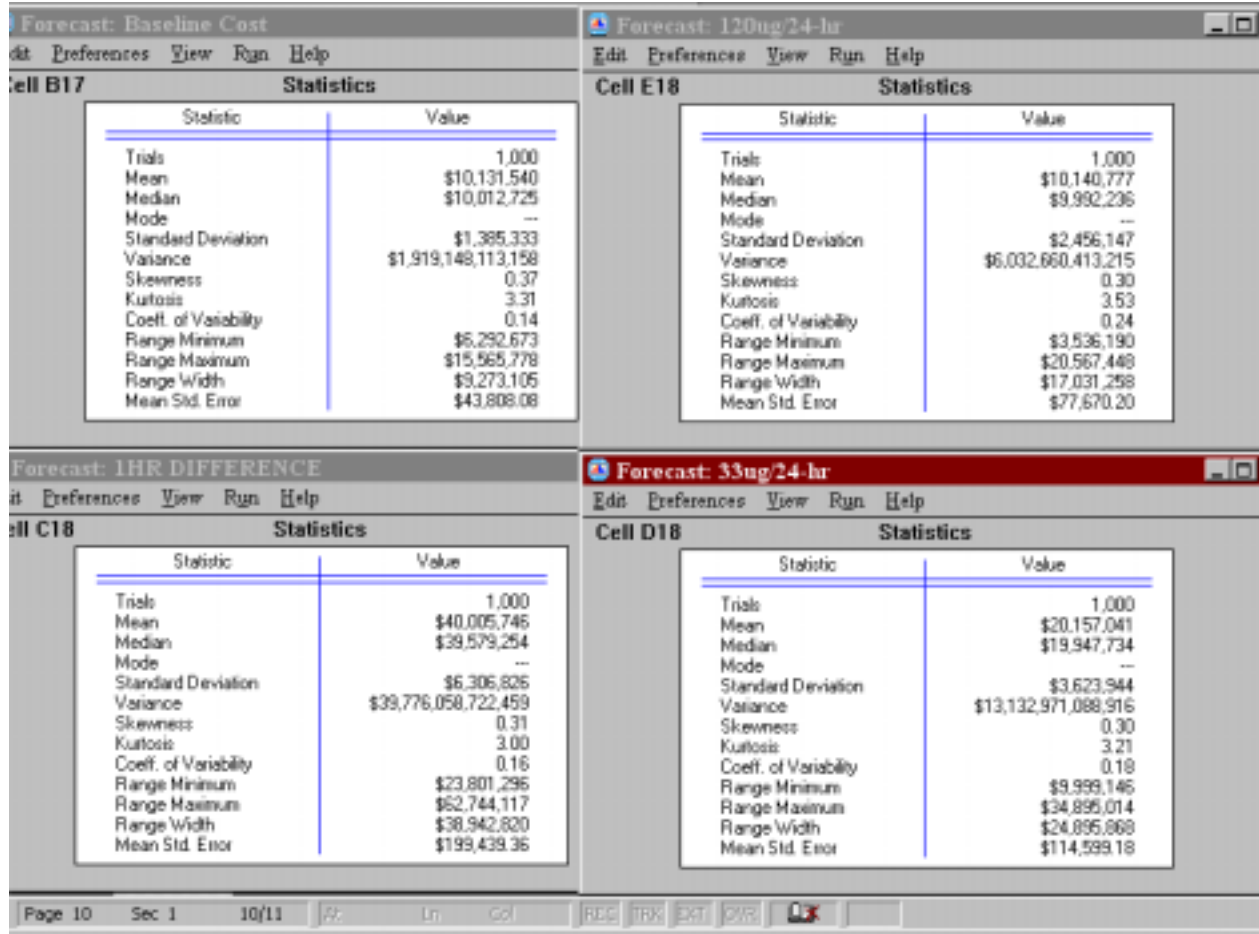
The top-left probability distribution reveals a baseline mean annualized cost estimate of \$10,147,000 to comply with the current AAL 1-hour concentration limit for H₂S of 2,100 mg/m³ of air. This estimate predicts with 86% certainty that baseline; annualized costs are in the arbitrary range between 8 and 12 million dollars.

The bottom-left distribution shows the mean rule impact for the annualized cost estimates for compliance with a 1-hour averaging period concentration limit of 56 mg/m³ of air. Estimated mean annualized costs were \$50,334,000 and the difference from the baseline is \$40,187,000 with 89% certainty in the arbitrary range from 30 to 50 million.



The top-right distribution shows 1,000 trials resulting from the differences between annualized cost estimates for compliance with a concentration limit of 120 mg/m³ of air, based on a 24-hour averaging period and the baseline annualized costs. Estimated mean annualized costs were \$20,221,000 and the mean difference from the baseline, or rule impact, is \$10,074,000 with 96% certainty in the range from 5 to 10 million dollars.

The bottom-right probability distribution show the effect of lowering the 24-hour limit to 33 mg/m³, which causes annualized cost increase to \$30,270,000. Subsequent rule impact is \$20,123,000 after accounting for baseline costs, which predict with 81% certainty within an arbitrary range from 15 to 25 million dollars.



Statistical measures for each economic result in the above graphic include the mean, median, standard deviation, along with range minimum and maximum.