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# COMPARING THE BENEFITS AND COSTS OF EPA'S PROPOSED PHASEOUT OF METHYL BROMIDE

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The Methyl Bromide Working Group

# COMPARING THE BENEFITS AND COSTS OF EPA'S PROPOSED PHASEOUT OF METHYL BROMIDE

Susan E. Dudley and Brian F. Mannix


Executive Summary

Both the parties to the Montreal Protocol and the U.S. Environmental Protection have proposed to restrict the use of methyl bromide, a widely used soil, commodity, and structural fumigant. This paper analyzes the impacts of proposed restrictions on consumers and producers in the United States. It examines the likely effect of substitutes on the demand for methyl bromide, and projects annual costs and benefits of different restriction scenarios to future years.

EPA's March 18, 1993 proposal would cost $25 million in 1994 when the freeze on methyl bromide production and consumption is slated to take effect. By the year 2000, all uses would be prohibited in the United States, imposing a cost to society in that year alone of between $5.4 billion and $8.8 billion, depending on the growth in demand for methyl bromide. These estimated costs will fall largely on American consumers, who will pay higher prices for fresh fruits, vegetables, and grains, which will become less available. The costs do not include the health effects of diets that contain less of these nutritious foods, nor the environmental damage associated with increased infestations of pests that will not be effectively controlled, though these impacts are likely to be great.

The benefit of freezing U.S. consumption of methyl bromide in 1994 would be $2 million, resulting in negative net benefits of $23 million in the first year of EPA's action. The net social costs will only increase from there. The benefits of EPA's proposed ban in the year 2000 range from $19 million to $29 million, but the costs are orders of magnitude greater.

While the agreement reached by the parties to the Montreal Protocol, to freeze consumption at 1991 levels beginning in 1995 with an exemption for quarantine and some post-harvest uses, would impose significantly lower costs than EPA's approach, it too would result in negative net benefits to society. In the year 2000, the costs of a freeze on all non-quarantine uses of methyl bromide would be $401 million, compared to benefits of just $16 million: a net social cost of $375 million in that year.

## I. Introduction

### Methyl Bromide and its Uses

Methyl bromide is a gas used as a fumigant against a wide range of pests, and is the active ingredient in a number of registered pesticides. It is a simple chemical compound ($CH_3Br$) that is found in nature, is not patented, and is made by several manufacturers in the United States and abroad. In tank-car lots, methyl bromide costs between $0.50 and $1.00 per pound; smaller quantities packaged for fumigant use cost between $1.00 and $2.00 per pound. Approximately 58 million pounds of methyl bromide is used annually as a fumigant in the U.S.; another 6 million pounds is used as a chemical intermediate (and so is not released to the atmosphere).[1]

By volume, the largest use of methyl bromide is for soil fumigation. It is injected several inches below the surface, and a tarp is put in place to help retain it. Methyl bromide is effective at controlling nematodes,[2] insects, microbial pests, fungi, and weeds. Used before planting, it suppresses pests for forest seedlings, nut and fruit tree orchards, and a wide range of fruits and vegetables. It is particularly valuable in warmer climates where, absent killing frosts, plant pests can build up from one year to the next until soils are useless for planting.

Methyl bromide is also used to fumigate goods in storage or in transport—in a fumigation chamber, inside a storage facility or closed space (such as the hold of a ship), or simply under a tarp. USDA quarantine regulations require its use to control various pests on imported goods; other countries require its use on U.S. exports. Methyl bromide is safe to use on food, but is also used for many nonfood items. It easily penetrates unopened boxes, and can kill insects deeply burrowed in wood. Log exports are often treated, as are wooden palettes and other packing materials. Methyl bromide is effective at all temperatures against a wide range of pests, at all stages of their life cycle (including eggs), and it dissipates without leaving a residue. It is used as a post-harvest fumigant on interstate shipments, and not only to control agricultural pests. Hawaii, for example, relies on methyl bromide fumigation as part of its strategy for protecting island ecosystems from

[1] Data on methyl bromide use from NAPIAP, 1993.
[2] Small worms, often plant parasites. Thousands of species inhabit the soil.

invasion by alien flora and fauna. Since highly valued cargoes can be treated using only a few pounds of methyl bromide (and because effective substitutes are often unavailable), the economic value of methyl bromide in quarantine uses is many times higher than its cost.

Finally, methyl bromide is used to fumigate structures: from grain mills and food processing plants to individual residences. The United Nations Environment Programme (UNEP) observes:

> The current use of methyl bromide as a structural fumigant is widespread because of its efficacy, applicability for a wide variety of sites and pests, suitability for use on accessible and inaccessible pests, short fumigation period (about 1 day), lack of insect resistance, cost effectiveness, and because it does not damage food, structures, or equipment if used correctly.[3]

Demand for methyl bromide has been increasing recently as other fumigants have been withdrawn from the market because of concerns about toxicity or environmental hazards. A working paper prepared for EPA observed that "two U.S. producers of methyl bromide increased production capacity by approximately 42 percent" between 1988 and 1991, noting that this growth can largely be "attributed to the removal from the market in 1984 of ethylene dibromide (EDB) as a fumigant."[4]

## The UNEP and EPA Proposals

Current scientific models of atmospheric chemistry predict that methyl bromide, if it reaches the stratosphere, has the potential to contribute to the depletion of stratospheric ozone. In November, 1992, the Parties to the Montreal Protocol agreed to: include methyl bromide as a controlled substance; assign it an Ozone Depletion Potential (ODP) of 0.7 (i.e., 70 percent as potent as the reference chemical CFC-11); and freeze its production at 1991 levels beginning in 1995, with exemptions for quarantine and pre-shipment use.

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[3] UNEP, June 1992. P. 24.
[4] ICF, Incorporated, May 1992. P. 7.

In a March 18, 1993, Federal Register notice implementing the Clean Air Act and parts of the Montreal Protocol, EPA proposed to phase out the use of methyl bromide as a fumigant altogether.[5] The notice was part of a larger proposal to accelerate the phaseout of chlorofluorocarbons (CFCs); in addition, it proposed to (1) establish for methyl bromide an ODP of 0.7; (2) list methyl bromide as a Class 1 substance under the Clean Air Act; (3) freeze methyl bromide production and consumption at 1991 levels beginning on January 1, 1994; and ban methyl bromide by January 1, 2000. The preamble states that these actions are in response to a December, 1991, petition from three environmental organizations, actions taken by the parties to the Montreal protocol, and scientific data presented by UNEP.

## EPA's Economic Analyses

Despite the fact that it is embedded in the larger "accelerated phaseout" rulemaking for CFCs, the proposed ban on methyl bromide is a separate decision with distinct economic impacts that can and should be identified and analyzed. The proposed ban on methyl bromide is by itself a "major" regulatory decision,[6] costing more than $100 million per year; as such, it warrants a Regulatory Impact Analysis (RIA). While EPA issued an RIA for the phaseout of CFCs, and issued an RIA amendment covering the proposed accelerated phaseout, neither of these analyses address the proposed ban of methyl bromide. EPA has expressed the view that its decision to ban methyl bromide turns only on scientific estimates of the ODP. Nonetheless, sound public policy requires that EPA use benefit-cost analysis to inform any regulatory decision where it has discretion, and E.O. No. 12291 requires that the analysis be performed even where discretion is statutorily constrained.

Under the Regulatory Flexibility Act, EPA is also required to examine the impacts of proposed actions on small businesses. The agency published a Regulatory Flexibility analysis for its original phaseout rule, which did not include the proposal to ban methyl bromide. In the preamble to EPA's accelerated phaseout rule, Administrator Reilly certified that the acceleration would not have a significant incremental effect on small entities, so that no Regulatory Flexibility analysis would

[5] 58 *Fed Reg*. 15030-38. This public notice included only the preamble to the proposed rule; the actual regulatory language can be obtained from EPA.
[6] As defined by Executive Order No. 12291, "Federal Regulation," February 17, 1991.

be required. In this certification it appears that the Agency simply forgot about the ban on methyl bromide. The explanation and certification makes no mention of the ban, despite the fact that the rulemaking record already contains ample evidence of a very serious impact on tens of thousands of farmers, food processors, importers, and exporters, many of them small businesses.[7]

### Our analysis

In this paper, we estimate the aggregate benefits and costs of EPA's proposed ban on methyl bromide using the information available at this time. Information on costs comes primarily from USDA.[8] Information on the benefits of banning methyl bromide is derived from EPA's published RIAs for rules that cover other ozone-depleting chemicals, using relative ODP to scale the results for methyl bromide. For the purposes of this analysis, we assume that anthropogenic emissions are about 50 percent of methyl bromide use.[9]

## II. Costs of a Phaseout

### Overview

#### Soil Fumigation

The costs of a ban on methyl bromide will take several forms. Not only will the loss of methyl bromide as a soil fumigant require substitution by higher cost fumigants, but these alternatives are likely to be less effective, often necessitating increased applications of pesticides and fungicides during the growing season. More land will be required to produce affected crops, as some acres lie fallow for several years. Some crops may also demand increased labor to weed and maintain fields. Inevitably, yields will decline and crop prices will increase. For example, the use of

[7] EPA requested information from methyl bromide manufacturers and users in 1992, so that considerable documentation of the methyl bromide market is already on the record.

[8] NAPIAP, 1993.

[9] Some methyl bromide is adsorbed and degraded in the soil or on surfaces. It is also possible that the oceans act as a natural sink (as well as a natural source) of methyl bromide. The 50 percent working assumption is also used by UNEP.

methyl bromide has increased strawberry yields by a factor of 5.[10] Without it, the price consumers pay for strawberries is likely to increase dramatically.

Consumers will bear the brunt of these effects: consumption will decline, and prices will be higher for the foods and other goods that remain available. Part of the consumer costs may represent a transfer to producers, who may suffer a net loss or net gain in the short run.[11] Eventually, producers will adjust (i.e. shift resources away from unprofitable products and into more profitable ones) and long-run economic losses will be borne largely by consumers.

Imports will substitute to some extent for reduced domestic output, particularly if other countries' producers are not subject to the same restrictions as U.S. producers. These imports will mitigate consumer losses, but will lead to short run economic dislocation, as farm and related jobs are lost, forcing workers to shift to other occupations. For example, the USDA analysis predicts that imports of fresh tomatoes into the U.S. will result in a net loss of $181 million for tomato growers.

Putting U.S. businesses at a competitive disadvantage will also damage the United States' competitive position. Eventually, this decline in competitiveness will weaken the dollar, making imports (of all types) more expensive and possibly contributing to inflation. Ultimately, U.S. consumers will bear these costs, too.

The imports that arrive in the U.S. to fill consumer demand will, in many cases, be produced using methyl bromide as a soil fumigant and/or as a quarantine treatment. Thus the losses borne by U.S. producers and consumers will not necessarily be accompanied by any net reduction in global methyl bromide releases. There may be no benefits.

### Quarantine Treatment

Use of methyl bromide as a quarantine treatment is also important in the U.S. Prohibition of its use would lead to serious impacts, many of which are difficult to

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[10] U.C. Riverside Dept. of Plant Pathology, letter to EPA from A. O. Paulus, April 9, 1992.

[11] Net gains to producers will occur when demand is inelastic, so that prices increase by a greater percentage than yields decline. Consumer losses will always be greater than producer gains.

quantify. It is likely that even if methyl bromide applications for quarantine purposes are prohibited in U.S. ports, imported commodities could still be treated with methyl bromide elsewhere before being transported to the U.S. For example, Chilean grapes might be shipped to Mexico, treated with methyl bromide, and then trucked into the U.S. Because methyl bromide tends to accelerate ripening (and deterioration) of fruits and vegetables, and is currently used as late as possible in the transportation process, the quality and quantity of imported fruits and vegetables would decline.[12] This, of course, would further increase consumer costs.

U.S. producers who export commodities to countries that require methyl bromide as a condition of entry would be at a significant competitive disadvantage if methyl bromide were unilaterally banned. For example, a University of California study estimated that without the use of methyl bromide as a post-harvest fumigant, California walnut growers would suffer a decline in revenue of $36.8 million per year.[13]

Moreover, the benefits from a unilateral ban may be significantly less than expected, particularly if foreign uses for quarantine treatments not only continue, but increase to circumvent the prohibition imposed in the United States.[14] A unilateral ban might even lead to net world-wide increases in methyl bromide use. For example, assume that 5 percent of cocoa beans imported into the U.S. are currently fumigated with methyl bromide at the port after inspection detects unwelcome pests, and that without methyl bromide, the infested cocoa bean imports would have to be incinerated. The cocoa bean importer may find that it is more cost-effective simply to fumigate all cocoa bean shipments before they reach the U.S. port, rather than run the risk of losing 5 percent of his commodity. Under this hypothetical scenario, methyl bromide use on cocoa beans would increase 20-fold as a result of a U.S. ban.

If quarantine use is completely banned, either as a result of a world-wide prohibition or through U.S. restrictions on imports of commodities treated with methyl bromide, trade will be severely curtailed, causing large economic losses. The

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[12] Communication with Miguel Cea, Ag-Fume.

[13] Sunding, *et. al.* 1993. p. 32.

[14] Worldwide use could increase if other parties to the Montreal Protocol exempt quarantine uses from the freeze that would apply outside the U.S.

absence of methyl bromide as a treatment will also lessen the efficacy of quarantines, leading to greater migration of pests, causing commercial damage and consumer losses, as well as potentially serious environmental damage. Hawaii will find it more difficult to exclude pests that threaten its unique native flora and fauna, as well as its agriculture. It is not possible to put an economic value on the loss of global biodiversity that could result from a ban on methyl bromide use.

### Structural Fumigation

As UNEP noted,

> Methyl bromide is used extensively as a structural fumigant. . . . [I]ndustry is using or developing a broad-based portfolio of chemical and physical techniques enabling it to choose the most appropriate technique, taking into account environmental considerations. . . . Quarantine treatment of structures against exotic pests currently requires that all pest control options be available, including methyl bromide."[15]

Other fumigants are acceptable for some applications, but many cannot be used on structures that contain raw or processed foods or other commodities. Some corrode copper or copper bearing metals and thus cannot be used in structures containing equipment. Moreover, as the National Pest Control Association noted in its May 1992 letter to EPA, "[a]ssuming that these alternative fumigants can be used in some situations, the cost of fumigation in terms of time and material will increase 7-30X."

Most substitutes for methyl bromide require longer exposure periods. Extended closure of structures during fumigation would result in reduced productivity and lost revenues. Moreover, the lack of an effective fumigant for many uses or pests could cause considerable commercial damage as insect infestations went unchecked. Consumers would ultimately bear the costs of reduced productivity and product losses.

### Review of Existing Economic Analyses

[15] UNEP, June 1992, p. 24.

In this section, we examine existing studies of the costs to producers and consumers of restricting methyl bromide use. While EPA has not presented any analysis of the costs of its proposal, it did commission a study on the use and substitutes of methyl bromide.[16] UNEP has also made some assessments of substitutes for the different uses of methyl bromide. Other more thorough analyses of economic impact have been done by the USDA, the University of California, and several individual grower associations.

EPA Preamble and Substitutes Analysis

Neither the preamble to the proposed rule nor the accompanying RIA attempt to estimate the costs of the freeze and ban on methyl bromide, however, the preamble does address the issue of substitutes for methyl bromide's current uses.

Based on available information, EPA concludes "that substitutes for the uses of methyl bromide are currently available only on a very limited basis, but that a wide range of potential substitutes may be available prior to the year 2000."[17] EPA's optimistic projections as to the future availability of substitutes make no mention of the potential costs associated with making such substitutes available. The USDA's *Research Agenda for the 1990's* estimates that finding replacements for methyl bromide will require additional expenditures of $40 billion per year on research staff over the next five years and additional resources of $7 billion.[18] While EPA recognizes "the limited current availability of substitutes and the regulatory hurdles that must be overcome before new substances can be used as substitutes," it uses these facts only to reject environmental groups' suggested phaseout schedule for methyl bromide, not as a factor to consider in estimating the costs of its proposal.

EPA bases its predictions of the future availability of substitutes on an EPA working paper and a UNEP assessment. Under contract to EPA, ICF Incorporated prepared a draft working paper on the use and substitutes of methyl bromide.[19] It

[16] ICF Incorporated, May 1992.
[17] 58 *Fed. Reg.* 51:15035
[18] USDA *Methyl Bromide Substitutes and Alternatives*, January 1993. Totals calculated by summing individual research needs listed in the report.
[19] ICF Incorporated, May 1992

evaluates currently available and possible future substitutes for agricultural uses of methyl bromide, introducing its substitutes analysis with the statement that "alternative soil treatment methods could replace, some, if not most of the uses of methyl bromide."[20] As the substitute-by-substitute evaluation makes clear however, every registered chemical that might substitute for some of methyl bromide uses has serious drawbacks in terms of effectiveness or cost; is not allowed in certain states; or was recently or is about to be canceled. The report is not as optimistic about quarantine uses of methyl bromide, noting that "the number of available alternatives is limited."[21] The working paper also presents tables comparing the costs of methyl bromide and some possible substitutes.[22] Although these tables compare only direct application costs and ignore costs associated with other required treatments or reduced effectiveness, they do show that, in general, the cost of methyl bromide per application is less than its substitutes.

The UNEP assessment is somewhat less optimistic about the availability of substitutes:

> For the broad spectrum of applications in which it is currently used, there is no single alternative to or substitute for methyl bromide. But there are substitute chemicals and alternative procedures for specific applications that could substantially reduce anthropogenic methyl bromide emissions to the atmosphere.[23]

Many of the alternative procedures referred to by UNEP are methods for containing methyl bromide emissions during use, rather than replacements for methyl bromide. Under EPA's proposed ban, of course, such technologies would be moot. UNEP recognizes that methyl bromide is relied on more heavily in "warm climates or in areas with soils where nematodes and other soil pests pose a significant problem."[24] Yet, it uses the Netherlands and the United Kingdom, countries with cool climates, as role models for reducing dependence on methyl bromide. UNEP does note that there are "essential and unique uses of methyl bromide," which it estimates "constitute about 10 percent to 25 percent of global

[20] Ibid., p. 34.
[21] ICF Incorporated, May 1992.
[22] ICF Incorporated, May 1992, Tables 4-5, 4-9, and 4-10.
[23] UNEP, June 1992, p. 21.
[24] Ibid., p. 22.

use."[25] Even for agricultural pest situations that the report considers "easier to control [with alternatives and substitutes] than others," however, UNEP recognizes that methyl bromide has advantages, including "speed of application, pest control effect, and sometimes lower treatment costs."[26] These advantages are by no means trivial, as becomes clear when the costs of doing without methyl bromide are quantified.

### USDA's Economic Assessment of Ban

In late April 1993, the U.S. Department of Agriculture released what is probably the most complete economic assessment of a ban on methyl bromide to date.[27] This report attempts to quantify the costs to producers and consumers of banning methyl bromide for soil fumigation and quarantine uses. Based on a preliminary survey of crop specialists, USDA's National Agricultural Pesticide Impact Assessment Program (NAPIAP) focused its analysis of soil fumigation use on 21 crops in 5 states. USDA's Animal Plant Health Inspection Service (APHIS) examined the economic impact of a ban on the use of methyl bromide as a quarantine treatment for nine selected food imports.

#### Soil Fumigation

NAPIAP estimates that, in the first year of a ban on the use of methyl bromide as a soil fumigant for the 21 crops in 5 states that it analyzed, the social cost will be between $856 million and $1.081 billion. It also estimates that these 21 crops represent 80 percent of total methyl bromide use for soil fumigation. The low end of the range assumes that Vorlex will continue to be an available substitute, while the high end includes the impact of the voluntary cancellation of Vorlex.[28]

For some crops, producers are expected to gain in the short term, as prices (and consumer costs) increase. For example, NAPIAP estimates that tobacco growers will experience a net revenue gain of $103 million in the first year, although

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[25] Ibid., p. 22.
[26] Ibid., p. 22.
[27] NAPIAP "The Biologic and Economic Assessment of Methyl Bromide." 1993.
[28] While NAPIAP was performing its analysis, the producer of Vorlex petitioned EPA for voluntary cancellation of its registration to produce the fumigant.

strawberry growers would lose $31 million. An expected increase in imports of affected crops will mitigate the consumer costs, but would result in losses for all U.S. producers.

Some conservative assumptions in the NAPIAP analysis may serve to understate the impacts of a ban on the use of methyl bromide as a soil fumigant. First, it examines only first year impacts. While it is possible that in future years new substitutes will become available to mitigate the impact of the ban, past experience does not hold much hope for such an outcome. The more likely trend will be greater yield losses as the effects of losing methyl bromide as a pre-plant fumigant are compounded. The report notes that:

> A unique fumigant like methyl bromide, when withdrawn from use, can result in progressively increasing economic losses for several years, and may culminate in the total destruction of the commodity and its allied industry. This occurs because of the progressively increasing infestation of pests (pathogens, insects, nematodes, weeds) that survive consecutive plantings and are ultimately transmitted to established production fields on multiyear crops.[29]

The NAPIAP report also notes that its impact estimates do not reflect either the costs of using more of other chemicals during the growing season or the cost of increased acreage necessary to produce similar yields. These effects would have not only direct economic costs, but environmental costs as well.

### Quarantine Treatment

APHIS estimates that the impact of the ban on quarantine uses on nine selected food imports will be between $444 million and $450 million per year. Predicting that imports of these foods will essentially be banned, APHIS forecasts net gains for U.S. producers, but large losses for U.S. consumers. (Domestic producers are expected to gain from the higher prices they will receive for their products and a decline in competition from imports.) Over a five year period, domestic producers

[29] NAPIAP 1993, p. 6

of commodities that will no longer be imported are expected to gain over $3 billion, while consumers would lose close to $5 billion.[30]

The quarantine analysis is more modest in scope than the soil fumigation analysis, and does not capture as large a share of methyl bromide use. While APHIS does not estimate the quantity of methyl bromide used on the nine food imports, the value of those imports comprises about 11 percent of the total value of commodities for which methyl bromide fumigation was used in quarantine.[31] The report does not examine any examples of exports or non-food imports that would be affected by a ban on methyl bromide.

The two separate analyses, done by different staffs within USDA, address many of the same commodities, but may understate impact on those commodities because each implicitly assumed that only the only excluded use was the use under investigation. The analysis of quarantine use assumes that, to a certain extent, domestic supply will fill in the gaps in foreign supply resulting from a ban on methyl bromide as a quarantine treatment. The analysis of soil fumigation use, on the other hand, indicates that domestic supply will decline due to the loss of methyl bromide as a soil fumigant, but assumes that, in the long run, foreign suppliers will be able to replace some of the lost production. By focusing only on one use of methyl bromide and not recognizing the impacts of banning other uses of methyl bromide, these analyses probably understate the effects of the ban.

### U. Cal Berkeley Analysis

Agricultural economists at the University of California at Berkeley prepared a report on the "Economic Impacts of Methyl Bromide Cancellation" under contract to the California Department of Food and Agriculture.[32] This report examines the impacts on California producers of a ban on soil fumigation and post-harvest uses of methyl bromide, and identifies possible substitutes and alternatives.

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[30] Note that producers of *exported* commodities that depend on methyl bromide would likely suffer net losses, while consumers might be expected to gain in the short run from greater quantities of once-exported goods.

[31] Calculated from NAPIAP, 1993, Tables 11, 13, and 14.

[32] Sunding, *et. al.* February 1993.

The report relies on two measures of the short-run impacts to California growers of canceling methyl bromide for soil fumigation: (1) the change in net farm income relative to the next-best alternative, and (2) the unit value of methyl bromide as measured by the change in income per pound of applied methyl bromide. Metam sodium was found to be the most cost-effective alternative to methyl bromide for most uses, but crop rotation was found to be preferable for some crops in some California regions. State-wide, the value of methyl bromide for soil fumigation ranged from $1.80 per pound for almonds to $27.50 per pound for strawberries.

The Berkeley report discusses qualitatively the importance of methyl bromide for post-harvest uses, particularly as a quarantine treatment required before exporting California crops, and examines possible substitutes and alternatives. It also attempts to quantify the costs of a ban to California cherry and walnut growers, estimating that annual profits would fall by $7.3 million and $36.8 million, respectively. (U.S. consumers are expected to gain $44.2 million per year, due to increased supply and decreased prices of walnuts, while foreign consumers will lose $13.3 million from higher prices.) The authors note that their estimated impacts would be "more severe if California faces an exotic pest infestation or if regulators impose a ban on methyl bromide use that is not observed by producers in other parts of the U.S. or the world."[33]

### Other Analyses of Economic Impact

In addition to these broad-based economic analyses, EPA's docket contains a number of comments from methyl bromide users who estimate the costs of a ban on particular crop uses. Additional information comes from universities and from state extension services. Several trade associations have conducted surveys of their members and estimated the likely impacts of a ban on methyl bromide for particular uses or crops.

## National Impacts of Proposed Restrictions

[33] Sunding, *et al*, p. 28.

In this section, we rely on information from the above analyses, as well as independently gathered data, to impute a demand curve for methyl bromide and to estimate the total impact of banning its use as a soil, structural, post harvest, and quarantine fumigant.

While this imputed demand curve is necessarily an approximation of the true demand curve for methyl bromide, it allows us to estimate the total impact of different restriction scenarios given current demand. With assumptions about future changes in demand, we can also predict annual impacts in future years.

Different sources provide different estimates of methyl bromide production and use in the U.S. In our cost analysis, we rely on USDA statistics that put total U.S. use of methyl bromide in 1990 at 64 million pounds.[34] Of this, 44 to 49 million pounds were used for soil fumigation, 5 million pounds for quarantine and post-harvest treatments, 4 to 9 million pounds for fumigating structures, and 6 million pounds as a chemical intermediate in manufacturing.

### Method and Data

To construct the demand curve, we first estimate the unit social cost of a ban on methyl bromide, calculated as the net cost (to consumers and producers) of shifting to the next best alternative, divided by the number of pounds of methyl bromide used. Using strawberries as an example, NAPIAP estimated that the total impact (taking into account changes in yields, prices, costs, and revenues) of a ban on methyl bromide use as a soil fumigant on strawberries would be $106.6 million in the states it analyzed, which represents the net cost of shifting from methyl bromide to its next best alternatives (a combination of metam sodium, chloropicrin, Vorlex, and solarization). (See Table 1, column 1.) Dividing by the 5.7 million pounds of methyl bromide used for soil fumigation on strawberries in those states, we calculate the unit social cost of a ban to be about $19. (Table 1, columns 2 and 4.) Since most of our data on impacts represents a fraction of the total methyl bromide used for each purpose in the U.S., we adjust methyl bromide use by that fraction. For example, the NAPIAP impact estimates represent about 80 percent of methyl

[34] NAPIAP 1993, p. 1. Both the UNEP- and the EPA-proposed freeze would use 1991 as the baseline, but production data for 1991 are not yet available.

bromide use in soil fumigation, so we calculate total methyl bromide use on strawberries nation-wide to be about 7.1 million pounds (5.7 million divided by 80 percent). (See Table 1, column 3.)

It is important to note that the unit social cost is very different from the price manufacturers charge for methyl bromide—price tends to be around $1.00 per pound. The unit social cost can be thought of as the value-added downstream by a pound of methyl bromide, and is much greater than the cost of the product, or the value to manufacturers of selling it.

We have estimated unit social costs and demand curves for methyl bromide for two scenarios: one assumes that Vorlex remains available as a substitute for soil fumigation uses, and one recognizes that Vorlex will soon be canceled. Table 2 presents data on the without-Vorlex scenario.

Table 1

## Unit Social Costs of a MeBr Ban (with Vorlex)

| Crop/Use | Impact on selected uses[1] ($ mill) | MeBr use in selected states[2] (1,000 lbs) | National MeBr use[3] (1,000 lbs) | Unit Social Cost ($/lb) |
|---|---|---|---|---|
| Quarantine[4] | $447.0 | 550 | 4,873 | $813 |
| Citrus | $24.5 | 102 | 128 | $240 |
| Forest seedlings[5] | $35.0 | 320 | 840 | $109 |
| Structures[6] | N/A | 5,500 | 5,500 | $72 |
| Ornamentals | $163.4 | 3,713 | 4,641 | $44 |
| Tobacco | $125.4 | 3,682 | 4,603 | $34 |
| Peppers | $130.7 | 4,512 | 5,641 | $29 |
| Eggplant | $11.8 | 410 | 513 | $29 |
| Strawberries | $106.6 | 5,708 | 7,135 | $19 |
| Melons | $28.5 | 1,963 | 2,453 | $15 |
| Tomatoes | $164.0 | 13,111 | 16,389 | $13 |
| Apricots | $0.2 | 30 | 38 | $7 |
| Walnuts | $0.9 | 192 | 241 | $5 |
| Nectarines | $0.9 | 316 | 396 | $3 |
| Apples | $0.4 | 180 | 225 | $2 |
| Grapes | $3.2 | 1,935 | 2,419 | $2 |
| Plums/prunes | $0.4 | 296 | 370 | $1 |
| Peaches | $0.8 | 634 | 793 | $1 |
| Cucumbers | $72.1 | 0 | 0 | $0 |
| Almonds | ($0.7)[7] | 721 | 902 | $0 |
| Cherries | ($0.3)[7] | 90 | 112 | $0 |
| Sweet Potatoes | ($0.3)[7] | 9 | 11 | $0 |
| Carrots | ($0.3)[7] | 2 | 3 | $0 |
| **Total** | $1,315 | 37,927 | 58,222 | U.S. Avg.: $93 |

Notes to Table:

1. Source: NAPIAP, 1993, Table 3b (unless otherwise noted).
2. Source: NAPIAP 1993, Table 2 (unless otherwise noted).
3. National MeBr use extrapolated from volume used in NAPIAP-selected states.
4. NAPIAP impact estimate covers 9 commodities, representing 11 percent of the value of goods treated with MeBr.
5. Total MeBr use from AFPA survey, 1993.
6. Based on costs of alternatives from Industrial Fumigant Co. and National Pest Control Association; may understate total social cost.
7. Negative impacts signify that NAPIAP calculated a net gain from a MeBr ban (e.g., because higher priced exports cause transfers from non-U.S. consumers). In these cases, unit social cost is set to zero.

Table 2

## Unit Social Costs of a MeBr Ban (without Vorlex)

| Crop/Use | Impact on selected uses[1] ($ mill) | MeBr use in selected states[2] (1,000 lbs) | National MeBr use[3] (1,000 lbs) | Unit Social Cost ($/lb) |
|---|---|---|---|---|
| Quarantine[4] | $447.0 | 550 | 4,873 | $813 |
| Citrus | $24.5 | 102 | 128 | $240 |
| Forest seedlings[5] | $35.0 | 320 | 840 | $109 |
| Structures[6] | N/A | 5,500 | 5,500 | $72 |
| Ornamentals | $170.0 | 3,713 | 4,641 | $46 |
| Tobacco | $126.5 | 3,682 | 4,603 | $34 |
| Peppers | $135.3 | 4,512 | 5,641 | $30 |
| Eggplant | $11.8 | 410 | 513 | $29 |
| Tomatoes | $360.8 | 13,111 | 16,389 | $28 |
| Strawberries | $111.6 | 5,708 | 7,135 | $20 |
| Melons | $28.6 | 1,963 | 2,453 | $15 |
| Apricots | $0.2 | 30 | 38 | $7 |
| Walnuts | $0.9 | 192 | 241 | $5 |
| Nectarines | $0.9 | 316 | 396 | $3 |
| Apples | $0.4 | 180 | 225 | $2 |
| Grapes | $3.2 | 1,935 | 2,419 | $2 |
| Plums/prunes | $0.4 | 296 | 370 | $1 |
| Peaches | $0.8 | 634 | 793 | $1 |
| Cucumbers | $72.1 | 0 | 0 | $0 |
| Almonds | ($0.7)[7] | 721 | 902 | $0 |
| Cherries | ($0.3)[7] | 90 | 112 | $0 |
| Sweet Potatoes | ($0.3)[7] | 9 | 11 | $0 |
| Carrots | ($0.3)[7] | 2 | 3 | $0 |
| **Total** | $1,529.00 | 43,977 | 58,222 | U.S. Avg.: $97 |

Notes to Table:

1. Source: NAPIAP, 1993, Table 3b (unless otherwise noted).
2. Source: NAPIAP 1993, Table 2 (unless otherwise noted).
3. National MeBr use extrapolated from volume used in NAPIAP-selected states.
4. NAPIAP impact estimate covers 9 commodities, representing 11 percent of the value of goods treated with MeBr.
5. Total MeBr use from AFPA survey, 1993.
6. Based on costs of alternatives from Industrial Fumigant Co. and National Pest Control Association; may understate total social cost.
7. Negative impacts signify that NAPIAP calculated a net gain from a MeBr ban (e.g., because higher priced exports cause transfers from non-U.S. consumers). In these cases, unit social cost is set to zero.

Sources of Data

The NAPIAP report provided the most comprehensive information available on methyl bromide use and impacts. Whenever possible, we used the economic impacts reported therein and projected them to national levels by increasing them 25 percent (i.e., from NAPIAP's 80 percent coverage to 100 percent). Quarantine unit social costs were derived from data and analysis prepared by USDA's APHIS in the NAPIAP report. Because data are unavailable on the pounds of methyl bromide used on each of the nine commodities APHIS analyzed, we made estimates based on the relative value of those commodities. We assumed that on average, methyl bromide use is proportional to the value of commodities fumigated, so that APHIS's nine commodities represent 11 percent of methyl bromide use. According to Tables 11, 13, and 14 of the NAPIAP report, the nine commodities represent about 11 percent of the total value of all commodities requiring methyl bromide treatment. To estimate a unit social cost for quarantine uses, we assumed that 11 percent of the 5 million pounds of methyl bromide attributable to quarantine and post-harvest use were applied to these 9 commodities.

The bulk of the data for soil fumigation uses comes from the NAPIAP analysis. One exception is forest seedlings, where the NAPIAP data did not allow us to estimate the amount of methyl bromide used nationwide. Here we relied on the National Forest Products Association and the American Forest Council's estimate, which was based on two surveys of private and state-operated forest nurseries.[35]

The NAPIAP report did not address structural fumigation; however, information from industry sources provide sufficient data to estimate a unit social cost.[36] Based on a reported application rate of 1.25 lbs/ft$^3$, a total cost of treating with methyl bromide of \$9.50/ft$^3$, and an average cost increase for alternative treatments of \$100/ft$^3$, we calculate a unit social cost for structural fumigation of \$72/lb. (This figure represents the change in producer costs, and may understate the total social costs.)

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[35] American Forest and Paper Association Comments, May 1993.

[36] The Industrial Fumigant Company. Response to MBWG data request, 3/30/93. National Pest Control Association, Inc. Letter to David Lee, EPA. 5/13/92.

Information on non-quarantine, post-harvest uses was limited. Our only data point is based on NAPIAP's estimates of the impacts and methyl bromide application rate on citrus fruits, which are fumigated with methyl bromide before shipping. While we did include this data point in our imputed demand curve, we did not try to extrapolate from this one commodity to all non-quarantine, post-harvest uses.

### The Demand Curve

The imputed demand curve for methyl bromide (with Vorlex available as a substitute for soil fumigation uses) is presented in Figure 1. It is the (horizontal) sum of demand for methyl bromide for each of the uses listed in Table 1. A separate demand curve actually exists for each crop or use, reflecting the quantity of methyl bromide demanded for that use as a function of price. For the purpose of constructing the aggregate demand curve in Figure 1, we used a straight-line demand curve for each individual use.[37]

While it is only an approximation, the imputed demand curve can provide valuable insights into the impacts of possible restrictions on methyl bromide's use. It is particularly useful for estimating broad impacts of restriction scenarios; and, while it cannot predict the quantity of methyl bromide that would be used on strawberries if price increased to $20/lb, it can provide reasonable estimates of the impact on producers and consumers of a freeze or ban on methyl bromide use.

At current prices for methyl bromide, the entire area under the imputed demand curve represents the annual economic impact of a total ban on methyl bromide use. Alternatively, it can be thought of as the current social benefit of having methyl bromide available for soil fumigation, structural, quarantine, and other post-harvest applications. Based on the imputed demand curve, the total impact of banning methyl bromide is $5.4 billion per year, assuming Vorlex remains available.

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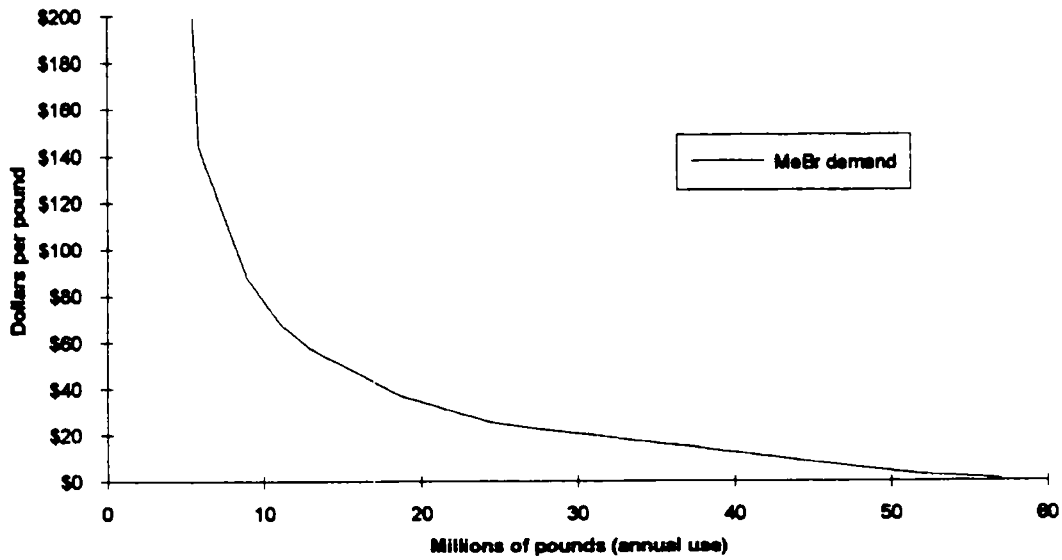
[37] For use i, with an average unit social cost of $p_i$ and a quantity used of $q_i$, the demand curve is taken as a straight line with intercepts at $q_i$ and $2p_i$. This preserves the identity between social cost and area under the demand curve. Note that the quantity used at the 1990 market price is taken as an intercept because the price on this scale is indistinguishable from zero.

Figure 1

**Imputed Demand Curve for Methyl Bromide**




The curve in Figure 1 and the $5.4 billion estimate of annual impact assumes that demand for methyl bromide remains constant over time. This is unlikely to be true for a couple reasons. First, the NAPIAP estimates of the crop losses attributable to the loss of methyl bromide as a soil fumigant, on which our estimates of impact are based, reflect only first year losses. As noted above, pest populations in the soil will often build up over several years, so that subsequent losses will be more severe. In addition, pest populations will eventually develop resistance to many substitute treatments (as they generally do not to methyl bromide), and many pests will proliferate to new areas where they are now excluded by quarantine. All of this is likely to increase the level of demand for methyl bromide, and thus the costs of going without it.

The magnitude of the impact of compounded yield losses in future years could be significant. Anecdotal data were available to estimate annual percentage yield declines for 10 of NAPIAP's 21 crops. Based on these estimates of yield reduction, the annualized five year impact on these ten crops was 156 percent larger than the impact estimated by NAPIAP in its with-Vorlex scenario.

The availability of substitutes will also effect the demand curve. The assumption that demand remains constant over time implies that the next-best alternative to methyl bromide will remain the currently available substitutes and technology alternatives. In the preamble to the proposed rule, EPA implicitly assumes that a ban on methyl bromide will be "technology forcing" and that substitutes and alternatives will emerge to replace methyl bromide before the year 2000. This would have the effect of shifting the demand curve down and to the left, reducing demand for methyl bromide and the economic impact of restrictions on its use.

Unfortunately, past history does not support this expectation nor the notion that new substitutes will rapidly become available to fill the demand for methyl bromide. The report EPA commissioned on substitutes notes:

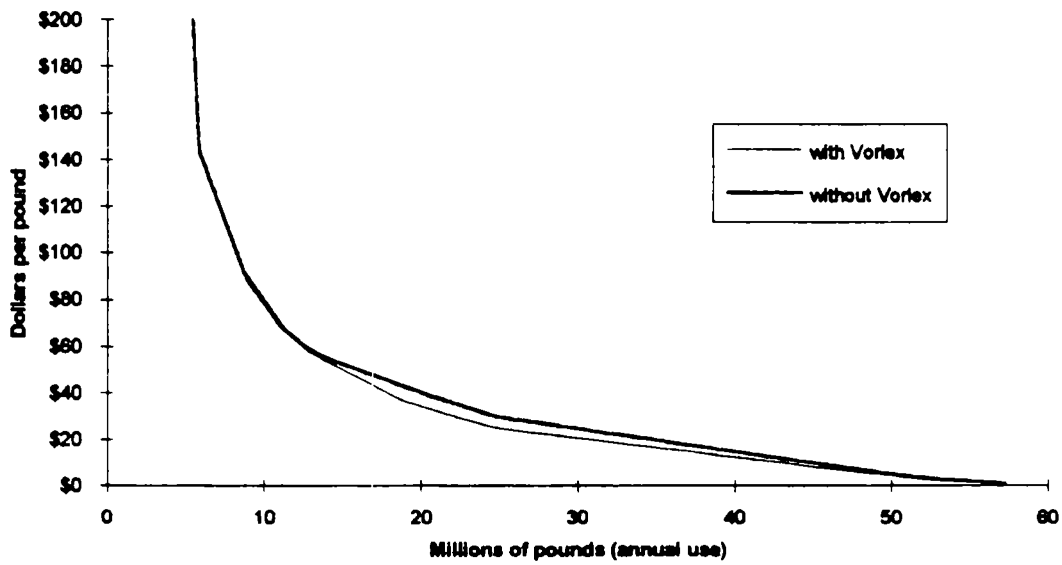
> The current use of methyl bromide is growing faster than the increase in vegetable and fruit production. This is due to both expanding grower use of methyl bromide and recent restrictions on the use of other pesticides.[38]

In other words, the ban on methyl bromide would not be as costly as it is if the majority of its substitutes had not already been withdrawn or canceled for environmental, health and safety reasons. The withdrawal of EDB, for example, substantially raised the demand for methyl bromide. The impending withdrawal of Vorlex will shift the demand curve further to the right, raising the estimated cost of a ban on methyl bromide to $5.7 billion per year. (See Figure 2.)

[38] ICF Incorporated, May 1992.

Figure 2

Imputed Demand Curve for Methyl Bromide
(with and without Vorlex available)




EPA's working paper on substitutes[39] further notes that many of the currently available fumigant substitutes for methyl bromide may have regulatory problems. Telone II and Telone-C-17 already are unavailable in Southern Florida and California (two regions in which demand for methyl bromide is the greatest) due to regulatory restrictions. Dazomet is only registered for a few of the soil uses for which methyl bromide is used and is not registered for food crops. Chloropicrin, which could be applied in greater proportions as a complement to methyl bromide, as well as a substitute in some applications, will be banned as an active ingredient in California, unless registrants meet state data requirements.[40] The report also notes that some non-fumigant chemical alternatives "might be removed from the market because of their potential to contaminate ground water.[41]

[39] ICF Incorporated, May 1992.
[40] ICF Incorporated, May 1992. pp. 36-41.
[41] ICF Incorporated, May 1992. p. 42.

One commenter noted that no new soil fumigant has been developed over the last 30 years[42] and the NAPIAP report notes that "the likelihood of developing, new effective fumigant alternatives to methyl bromide appears very remote."[43]

Biological alternatives to soil fumigation may be no more promising. Integrated pest management (IPM) has been suggested as a non-chemical alternative to methyl bromide preplant fumigation.[44] However, methyl bromide has been an important part of IPM strategies. According to one commenter:

> Without the availability of methyl bromide, IPM programs will falter because disease populations will not be initially suppressed. This will result in greater use of other pesticides in attempts to control a wide range of pests.[45]

Moreover, biological components of IPM, such as "plants with genetically selected resistance"[46] may be a long way away. Plants genetically modified to exhibit pesticidal properties are subject to extensive EPA scrutiny before they may be tested and commercialized. In a recent report to Congress, the National Biotechnology Policy Board concluded that "the lack of ability to move forward with field testing can be a major impediment to the commercialization of biotechnology products."[47]

Another trend that is likely to increase the demand for methyl bromide is the increased willingness on the part of the Japanese government to allow imports of U.S. goods, as long as they have been treated with methyl bromide to eliminate pests and alien species. EPA's report notes that "after approving the use of methyl bromide as a fumigant, the value, for example, of U.S. cherry exports has jumped from $8.3 million in 1986 to 31.1 million in 1987."[48]

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[42] University of California, Kearney Agricultural Center, letter to EPA dated April 20, 1993. M.V. McHenry, Department of Nematology.
[43] NAPIAP, 1993, p. 2.
[44] ICF Incorporated, May 1992. Pp. 44-47.
[45] U.Cal Davis, Pesticide Impact Assessment Program. Letter to Dr. Armand Padula, USDA from Rick Melnicoe. May 11, 1992
[46] ICF Incorporated, May 1992. Pp. 46-47.
[47] National Biotechnology Policy Board, 1992. P. E-9.
[48] ICF, 1992, p. 31.

Given the trend in the availability of substitutes to methyl bromide, the substantial barriers to introducing new pesticides, and the growing reliance on methyl bromide as a treatment for exports, the only reasonable assumption is that demand for methyl bromide, and therefore the annual cost of a ban, will rise for the foreseeable future.

Using a growth rate of 5 percent, we project demand for methyl bromide (assuming Vorlex is not available) to estimate annual impacts of different restrictions in future years. We examine four scenarios: (1) a total ban on methyl bromide use in the United States beginning in 2000; (2) a ban on all non-quarantine uses beginning in 2000;[49] (3) a freeze at 1991 levels; and (4) a freeze on non-quarantine uses at 1991 levels.[50] Table 3 below presents estimated impacts in current dollars for these different scenarios in future years.

Table 3
ANNUAL ECONOMIC IMPACT OF DIFFERENT RESTRICTION SCENARIOS

| | Economic Impact ($mil) | | | |
|---|---|---|---|---|
| Year | Total Ban | Ban, exempt quarantine | Freeze at '91 levels | Freeze, exempt quarantine |
| 1994 | N/A | N/A | $25 | $14 |
| 1995 | N/A | N/A | $75 | $55 |
| 2000 | $8,793 | $2,649 | $475 | $401 |
| 2005 | $11,222 | $3,381 | $1,062 | $931 |

The Montreal Protocol agreement to freeze methyl bromide uses at 1991 levels with an exemption for quarantine and some post-harvest use would take effect in 1995 and impose costs of $55 million in that first year. As demand for methyl bromide grows, annual costs would increase to $401 million in the year 2000 and $931 million in 2005.[51]

[49] The parties to the Montreal protocol agreed to exempt quarantine uses from a freeze on methyl bromide, and in the preamble to the proposed rule, EPA requests comment on whether the Clean Air Act grants it the authority to ban certain uses of Class I ozone depletors.
[50] We use sixty thousand pounds as a proxy for 1991 methyl bromide use.
[51] Our estimates of quarantine uses of methyl bromide include non-quarantine post-harvest uses which, depending on how the exemption is structured, may understate the costs of scenarios which exempt quarantine uses.

These impacts, while large, are considerably less than the projected impacts of EPA's proposal. The effect of EPA's approach would begin with its 1994 freeze, which would cost $25 million. In 1995, the annual cost of EPA's freeze without a quarantine exemption would be $75 million. By the year 2000, when the ban takes effect, costs would jump to $8.8 billion, increasing annually to $11 billion in the year 2005. As Table 4 below indicates, the cost of EPA's proposal over and above the cost of the Montreal Protocol agreement are dramatic.

Table 4
Incremental Annual Cost of EPA Proposal Over Montreal Protocol

| year: | $million |
|---:|---:|
| 1994 | $25 |
| 1995 | $20 |
| 2000 | $8,392 |
| 2005 | $10,291 |

Table 3 also provides estimates of the costs in particular years of other possible restrictions, including a complete freeze at 1991 levels (with no accompanying ban), and a ban on all non-quarantine uses. While more costly to society than the approach taken by the parties to the Montreal Protocol, these other options are significantly less costly than a complete ban.

The estimates of the impact of the freeze scenarios are likely to be overstated relative to scenarios that involve a complete ban, because they do not take into account opportunities to reduce emissions of methyl bromide. UNEP observed that "alternative procedures for specific applications . . . could substantially reduce anthropogenic methyl bromide emissions to the atmosphere."[52] Faced with a freeze on methyl bromide use, technical opportunities to reduce emissions (and thus conserve methyl bromide) will become more attractive, reducing demand for methyl bromide. These emission control technologies would not be pursued if methyl bromide were banned.

[52] UNEP June 1992.

## Conclusions

EPA's implicit assumption that a ban on methyl bromide will force new substitutes and technologies, which will minimize the effect of the ban, is overly optimistic and not supported by evidence available to the agency. It is more likely that demand for methyl bromide will continue to increase as it has historically, increasing the social costs of restricting its use.

Because of the uniqueness of methyl bromide and its importance for wide variety of crops, commodities and structures, the social cost of any restriction scenario is high. A freeze, particularly if accompanied by an exemption for quarantine uses, would impose lower impacts on consumers and producers than the outright ban proposed by EPA. We estimate that even if demand for methyl bromide does not increase, EPA's proposed phaseout of methyl bromide will cost consumers and producers $5.4 billion a year. Using a more reasonable assumption of 5 percent demand growth, these impacts will be $8.8 billion in the year 2000. In contrast, we estimate that the approach agreed to by the parties to the Montreal Protocol will impose costs of $401 million in 2000.

This is not to say that $401 million per year is a reasonable cost to impose on U.S. producers and consumers. To make that judgment, we must examine costs in the context of offsetting benefits of eliminating methyl bromide. The next two sections do that.

## III. Benefit Analysis

### EPA's Benefits Model for Ozone Protection

The economic costs of phasing out methyl bromide are large by any measure. The best criterion for deciding whether they are *too* large, however, is the magnitude of the environmental benefits that are forecast to result from reduced methyl bromide emissions.

EPA has not published an analysis of the benefits of phasing out methyl bromide; the RIAs that the agency has published focus on the benefits of reducing emissions of chlorine-containing compounds. Nonetheless, because all of the predicted benefits flow from reduced depletion of atmospheric ozone,[53] it is possible to translate the benefits of CFC reduction into benefits of methyl bromide reduction, using simple assumptions about emission rates and relative ozone depletion potential. In this section we will review the economic aspects of EPA's benefits forecasting model, and illustrate how the results can be applied to methyl bromide.

#### Sources of uncertainty

The model EPA uses to forecast benefits necessarily makes a large number of assumptions. Atmospheric chemistry models are highly uncertain, and the health and environmental effects that are predicted to result from ozone depletion are sensitive not only to the degree of ozone depletion, but to the latitudinal and seasonal distribution of depletion. Behavioral and technological uncertainties affect the dose of UV radiation, and dose-response models for UV exposure are another source of uncertainty—for ecological effects as well as human health effects.

There are additional uncertainties in translating these benefits to methyl bromide. The atmospheric chemistry of bromine is not as well characterized as that of chlorine. Methyl bromide is a natural constituent of the atmosphere, and it is not

[53] In some cases EPA alleges benefits from reduced "greenhouse" gases; this is not a significant issue for methyl bromide.

clear whether anthropogenic emissions represent an incremental stratospheric burden, or a relatively small perturbation of a natural bromine cycle. In the case of soil fumigation it is particularly difficult to estimate how much methyl bromide is emitted and how much is degraded in place.

For the purposes of this economic analysis, we will take the scientific assumptions of EPA's ozone benefits model as given. We will also assume that 50 percent of methyl bromide production is emitted, and that all of the emissions represent an additional burden on stratospheric ozone.

### Health benefits, skin cancer, and cataracts

All of the predicted benefits of controlling emissions of ozone depletors arise from reduced ultraviolet radiation on the ground. While some exposure to ultraviolet radiation is essential for good health, there are well established links between cumulative UV exposure and the two types of non-melanoma skin cancer: basal cell carcinoma and squamous cell carcinoma. More tentative evidence links UV exposure to malignant melanoma, which has a much higher fatality rate than the non-melanoma skin cancers. In addition, EPA cites evidence for an association between UV radiation and cataracts. EPA posited a dose-response relationship for each health effect, so that numbers of cases could be forecast from the predicted atmospheric ozone levels. EPA assumed no avoidance behavior: i.e., no change in consumers' use of sunblock, clothing, sunglasses, or any other response that might limit the damage.

Using focus groups, EPA assigned estimated costs for treating various health effects: $4,000 per case of basal cell carcinoma; $7,000 per case of squamous cell carcinoma; $15,000 per case of melanoma; $15,000 per cataract.[54] Roughly 2 percent of non-melanoma cancers, and 25 percent of melanomas, were predicted to be fatal; fatal cases were assigned a cost of $3 million.[55]

[54] The cataract value is from Rowe, 1987.

[55] In EPA's 1988 RIA $3 million was used as the point estimate within a range of $170,000 to $12 million; subsequently the bottom of the range has been dropped. The higher end of the range is implausible (see discussion below), so we will use EPA's $3 million per fatality.

Assigning an economic value to fatalities is a standard feature of analyses of environmental and health and safety regulations.[56] The most reliable source of market data on people's valuation of risks comes from wage-premium studies. Certain jobs—firefighter, construction worker, etc.—are known to be associated with a higher level of personal risk. People are paid more to accept these risks, and a series of studies has shown a fairly consistent pattern of wage premiums that correlate with risk level. The results are usually reported in dollars (of lifetime income) per expected fatality, and are used as a guide to evaluate the cost-effectiveness of risk-reducing regulatory programs.

EPA's 1988 RIA for ozone protection included a review of this literature, and came up with a range of $170,000 to $12 million. It used $3 million as a mid-point estimate. In the 1992 RIA, however, the bottom of the range was dropped without explanation (p. 6-14). The $12 million was retained, even though it is not within the plausible range. Among the reasons to reject a value this high is that it would have too strong an "income effect." Several authors have stressed the relationship between income and health: wealthier is statistically healthier.[57] People with higher incomes eat better, smoke less, live in safer neighborhoods, drive safer cars, buy more health care, and in countless other ways face slightly lower risks than they would if they were a little poorer. The cumulative effect is a strong correlation between life expectancy and income bracket. Similarly, average life expectancies are higher in countries with higher per capita national products. The income effect predicts that one fatality can be expected for every $7 million worth of costs imposed on an economy.[58] Thus spending $12 million per fatality prevented on any particular safety project can be expected to *cause* more fatalities, through the income effect, than it will prevent. EPA's estimate of $3 million per fatality is at the upper limit of values that economists have usually assigned to fatalities.[59]

Environmental benefits

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[56] It would be better to measure mortality benefits by examining changes in expected longevity—this is the standard measure of benefit used in medicine and in public health. However, EPA has traditionally used the more troublesome "lives saved" and "dollars per life" measures instead.

[57] See, for example, Wildavsky, 1988.

[58] OMB, "Summary of Selected Studies Relating Income and Health." April 30, 1992.

[59] The Department of Transportation, for example, recently revised its standard assumption about consumers' willingness-to-pay for safety from $1.5 million to $2.5 million per life saved. January 8, 1993.

In addition to health effects, EPA estimated reductions in crop yields due to phytotoxic effects of increased UV insolation, reductions in fish harvests, and damage to polymer products used outdoors. These effects make no noticeable contribution to the total estimated benefits, however. Throughout the various scenarios analyzed in the published RIAs, human cancer fatalities dominate the benefit forecasts. Typically 95 to 99 percent of quantified benefits are due to reduced cancer fatalities, and 90 percent of these are attributable to non-melanoma skin cancers. This is a surprising result, since non-melanoma skin cancers are so rarely fatal. The reason that fatalities dominate the reported benefits can be found in the way EPA treats discounting.

## Questionable Economic Assumptions

### Discount rates

An accurate comparison of costs that occur in different years requires an adjustment procedure known as discounting. It is done to account both for the productivity of resources over time (by investing now, we can accumulate dividends to buy more in the future) and for the preferences that people have with respect to time (for most economic goods, sooner is better; for bads—we can wait). Discounting effectively shrinks costs and benefits that occur in the future, using a standard interest rate, to calculate an equivalent "present value." The rationale for discounting as an analytical tool is well established, and it is not diminished when we are considering benefits instead of costs—even when those benefits are expressed in lives saved. We can invest resources now to save more lives in the future; at the same time people undoubtedly would prefer to save lives sooner rather than later.

OMB requires that standard discount rates be used for all benefit-cost analyses prepared to support budget initiatives and regulations.[60] Because a ban on methyl bromide will impose costs on the private sector, including capital costs and research and development expenditures, Circular A-94 requires that a 7 percent real discount

[60] OMB, Circular A-94, October 1992.

rate be used for all costs and benefits. This reflects the opportunity cost of private capital, which earns a relatively high rate of return.

EPA typically reports the results of its ozone model using real discount rates of 2, 4, and 7 percent. The agency prefers the lower rates, as a better approximation of the underlying "consumers' rate of time preference" (CRTP). While it is valid to use the CRTP for discounting cost and benefit streams, it can only be done if some other procedure is used to account for the high opportunity cost of private capital. Two techniques are available to do this: the shadow price of capital method,[61] and an equivalent amortization technique that was developed at EPA.[62] Absent either of these adjustments, 7 percent is the best discount rate to use. If EPA did make the required adjustments to capital costs, then it would be justified in using the lower rate specified in Circular A-94, which is derived from the real rate of return on risk-free 30-year Treasury bonds. This was 3.7 percent at the time Circular A-94 was issued; OMB has recently revised it upwards to 4.5 percent.[63]

The 2 percent discount rate that EPA reports cannot be justified. Moreover, this low discount rate causes serious inconsistencies and instabilities in EPA's ozone benefits model because it interacts with an *ad hoc* undiscounting factor that EPA uses to inflate the benefits attributed to fatal cancers.

Undiscounting Factor

While EPA applies a uniform discount rate (2, 4, and 7 percent) to all costs and benefits in its ozone model, it also applies an "undiscounting" factor to the benefits that it attributes to preventing fatal cancers. Those benefits, and only those, are inflated at a rate of 1.7 percent annually. Thus EPA's effective discount rate for fatality benefits is 1.7 percentage points lower than the reported rates: the 2 percent rate is actually a 0.3 percent rate when applied to fatalities. As the discount rate and the undiscount rate converge, the predicted benefits from ozone protection will approach infinity. Indeed, in some sensitivity analyses that EPA reports, the

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61 Lind, 1982.

62 Kolb, 1987.

63 Panetta, 1993.

discount rate and undiscount rate cross.[64] The model does not project infinite benefits only because EPA has built in an elaborate two-stage "truncation" procedure to limit the time horizon to 170 years. This is necessary because while the discounted costs are shrinking over time, the un-discounted benefits are growing exponentially.

EPA's rationale for the undiscounting procedure is that per capita GNP will grow in the future, so that future generations will value life more highly than the current generation. This is clearly incorrect reasoning. The price of safety, like any price, is determined by the interaction of supply and demand. The same productivity growth that will raise incomes in the future will also lower the cost of avoiding and mitigating risks. The net effect on the "value of life" is indeterminate.

Moreover, even if an adjustment for income levels were warranted, EPA has it backwards. Future generations may indeed be much wealthier than the current generation, and perhaps will be inclined to spend more of their abundant income on health and safety. But EPA is proposing to save future lives by imposing costs on the current, relatively impoverished, generation. Surely the agency does not support the general proposition that poor people are obligated to pay more to save the lives of rich people than they would pay to save themselves.

A final reason to reject EPA's undiscounting procedure is that discount rates are determined empirically from market data, and the participants in those markets are already aware of general trends in income growth. Thus observed discount rates already account for whatever future expectations people may have about income growth.

It is clear that by manipulating the discount rate and the undiscount rate, EPA's model can be made to predict arbitrarily large benefits, no matter what facts are fed to it. We have not attempted to remove the effect of the undiscounting factors. At a 7 percent discount rate its influence is limited. When EPA reports benefits

[64] 1998 RIA p. 8-6, Ex 8-3. Chapter 10 appears to use a 1.5 percent undiscounting rate (p. 10-18). It also does sensitivity analyses using one-half and double this rate. Elsewhere in Chapter 10 EPA uses 0 percent and 1 percent discount rates in conjunction with higher undiscounting rates.

discounted at 2 percent, however, most of them can be attributed to the erroneous undiscounting procedure.

## Unit Benefits and Annual Benefits

### EPA's Estimate

EPA's RIA for the recycling rule includes a sensitivity analysis that provides per kilogram benefits of reducing ozone-depleting emissions on an ODP-weighted basis (equivalents of CFC-11). ICF ran the model using (1) the baseline 1996 phaseout; and (2) the baseline 1996 phaseout with the addition of a pulse of ten million kilograms of CFC-11 emissions in 1994. The difference in total discounted benefits between scenarios was divided by the size of the pulse to arrive at the marginal benefits per kilogram of emissions.

The results were as follows:

Table 5
Unit Benefits of CFC Recycling
(Estimated value of ozone protection per kilogram of recycled CFC-11)

| Discount rate: Cost of fatal cancers: | 2 percent | 4 percent | 7 percent |
|---|---|---|---|
| \$3 m/case | \$13/kg | \$5.4/kg | \$2/kg |
| \$12 m/case | \$53/kg | \$21.3/kg | \$8/kg |

Source: Environmental Protection Agency, *Regulatory Impact Analysis for the National Recycling and Emissions Reduction Program*, March 25, 1993, p. 5-4.

Sensitivity analyses were done to confirm that these results are linear: benefits are proportional to the magnitude of the pulse when it is doubled, and that they are not very sensitive to the year of emissions, within about ten years.

Using ODP-weighting, these benefits can be applied to methyl bromide. Most of the ozone-reduction benefits EPA attributes to the phaseout of methyl bromide occur in the near term because of methyl bromide's relatively short atmospheric lifetime. Thus its effects will occur in the years that EPA used for its sensitivity analyses. The magnitude of annual methyl bromide emissions is two to three times larger than the 10 million kilogram pulse that EPA tested, and the methyl bromide emissions reductions would occur repeatedly, not simply in a single-year pulse. Even so, given the fact that anthropogenic methyl bromide is only a fraction of total methyl bromide and that total methyl bromide is only a fraction of total ozone-depleting emissions, it would be surprising if the methyl bromide rule were to cause serious non-linearities in the EPA benefits model. Therefore it is reasonable to apply EPA's unit benefits estimates to projected methyl bromide emissions.

Table 6
**Unit Benefits of Methyl Bromide Phaseout**
(Estimated value of ozone protection
per pound of methyl bromide production)

| Discount rate:<br>Cost of fatal cancers: | 2 percent | 4 percent | 7 percent |
|---|---|---|---|
| $3 m/case | $2.07/lb | $0.86/lb | $0.32/lb |
| $12 m/case | $8.42/lb | $3.38/lb | $1.27/lb |

Source: Same as Table 5. Unit values have been adjusted for methyl bromide using EPA's estimate of the ODP (0.7) and EPA's estimate of the atmospheric emission rate (50 percent of production).

As discussed above, only the $3 million per fatality cost and the 7 percent discount rate can be justified, particularly given the 1.7 percent undiscount rate that EPA has applied to the benefits stream. Thus the best estimate of unit benefits is 32 cents per pound of methyl bromide.[65] It would also be reasonable to apply a discount rate of 4 percent to benefits, but only if the amplification factor is removed, and if the costs imposed by the methyl bromide ban are adjusted to account for the shadow price of capital.

Using 32 cents per pound, annual benefits of a methyl bromide ban are about $19 million per year. If demand for methyl bromide use is assumed to grow, then obviously the magnitude of these benefits will grow as well. Table 7 below presents

[65] Removing the amplification factor would lower this estimate below 30 cents per pound.

annual benefits in future years under different restriction scenarios, using a 5 percent growth in demand, and a 7 percent discount rate.

Table 7
ANNUAL BENEFITS OF DIFFERENT RESTRICTION SCENARIOS
($mill)

| Year | Total Ban | Ban, exempt quarantine | Freeze at '91 levels | Freeze, exempt quarantine |
|---|---|---|---|---|
| 1994 | N/A | N/A | $2 | $2 |
| 1995 | N/A | N/A | $3 | $3 |
| 2000 | $29 | $26 | $10 | $9 |
| 2005 | $37 | $34 | $18 | $16 |

A couple interesting observations are apparent from this table. In the initial years, the incremental benefits of EPA's proposal (a complete freeze at 1991 levels) over the approach agreed to by the parties to the Montreal Protocol (which provides an exemption for quarantine and some post-harvest uses) is negligible. Both offer benefits of approximately $3 million in 1995. Also, commencing the freeze in 1994 rather than 1995 provides only $2 million in benefits.

As noted earlier, the benefits of unilateral U.S. actions, such as a complete freeze beginning in 1994 that does not include an exemption for quarantine uses, or a ban on methyl bromide use beginning in 2000, are likely to overstate true benefits. Other countries not subject to these restrictions will continue to use methyl bromide and perhaps even increase their use, resulting in emissions, UV radiation, and health effects that are greater than projected here.

## IV. Benefit/Cost Comparison

### Economic Costs

Comparing these benefits to the costs estimated in the previous section tells us about the net social impact (positive or negative) of EPA's proposal. Our conservative estimate of the social cost of a ban, assuming no growth in demand and that Vorlex would remain as a substitute, was $5.4 billion per year. The benefits under the no growth scenario are $19 million per year. Thus, EPA's proposal would impose enormous annual net social costs.

A comparison of Tables 3 and 7 shows that costs dwarf benefits under any of the restriction scenarios. The freeze on methyl bromide use in 1994 alone would impose net social costs of $23 million ($25 million in costs minus $2 million in benefits). A freeze that exempted quarantine uses would be less costly to society, costing $12 million (net) in 1994 ($14 million in costs minus $2 million in benefits). The cost of EPA's proposal in the year 2000, when methyl bromide would be phased out, would be $8,793 million compared to $29 million in benefits: a net social cost of $8,764 million.

Even using assumptions of $12 million per life and a 2% discount rate, which we have rejected as implausible above, the benefits of the ban in the year 2000 are only $761 million, still resulting in net social costs of $8,032 million.

Dietary effects

While we have not addressed the health and environmental effects of substitutes here, it should be noted that one of the costs of restricting methyl bromide use will be dietary. We have not estimated the magnitude of these effects, but given the predominance of cancer deaths in EPA's calculation of benefits, we believe EPA should estimate the cancer deaths that will be caused by dietary changes. Because of the importance of methyl bromide in agricultural applications, there is every reason to believe that these effects will far outweigh the fatalities predicted as a result of UV exposure.

The Public Health Service has recently published a comprehensive review of actions that promise to improve the health of Americans and reduce the incidence of disease.

Cancer Recommendation 16.9 recommends increased use of sunscreens and other methods of reducing exposure to ultraviolet light. It also notes that:

> Although latitude or distance from the equator generally determines amount of UV-B radiation in a given location, amount of ozone in the atmosphere, altitude, and sky cover are also determining factors.

But the report gives far more emphasis to the importance of diet in promoting health.

> **Increase complex carbohydrate and fiber-containing foods in the diet of adults...**
>
> Vegetables, fruits, and grains are good sources of complex carbohydrates and dietary fiber, as well as several vitamins and minerals. These foods are also generally low in fat and can be substitutes for foods high in fat. Dietary patterns with higher intakes of vegetables, fruits, and grains are associated with a variety of health benefits, including a decreased risk for some types of cancer.
>
> Populations consuming diets rich in vegetables, fruits, and grain products have significantly lower rates of cancer of the colon, breast, lung, oral cavity, larynx, esophagus, stomach, bladder, uterine cervix, and pancreas.[66]

Elsewhere, the Public Health Service notes the relative importance of different factors contributing to cancer mortality.

> The contribution of lifestyle and environmental factors to cancer mortality has been estimated as follows: diet (approximately 35 percent of cancer deaths), tobacco (30 percent), reproductive/sexual behavior (7 percent), occupation (4 percent), alcohol (3 percent), geophysical factors (3 percent), pollution (2 percent), industrial products (1 percent), and medicines and medical procedures (1 percent). Reductions in tobacco use and dietary modifications to reduce excessive fat consumption and increase consumption of fruits, vegetables, grain products, and therefore dietary fiber, hold the greatest promise as strategies to reduce cancer incidence and ultimately cancer mortality.[67]

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[66] Public Health Service, 1991, p. 118. Nutrition Recommendation 2.6. Repeated as Cancer Recommendation 16.8. See also National Research Council, 1989, and Public Health Service, 1988.
[67] DHHS 1991, p. 419. See also National Cancer Institute, 1986.

A phaseout of methyl bromide will raise the cost of fruits, vegetables, and grain, reducing consumption. It will prevent year-round availability of some fresh fruits and vegetables, making them once again only a seasonal component of consumers' diets. The effects of these changes need to be quantified and taken into account.

## V. Conclusions

Even though estimates of the benefits and costs of a methyl bromide phaseout are highly uncertain, it is clear that the costs are orders of magnitude higher than benefits. Even if EPA's assumptions about ozone depletion are correct, and demand for methyl bromide does not increase over time, the benefits of a ban are $19 million per year. The costs, on the other hand, are $5.4 billion. As demand grows, the benefits of the ban increase, but so do the costs. At a growth rate of 5 percent per year, benefits in the year 2000 are $29 million, but the costs are $8.8 billion. EPA's proposed freeze beginning in 1994 also imposes net costs on society, with benefits of $2 million and costs of $25 million. No plausible set of assumptions can make the phaseout appear justified on economic grounds.

These costs do not include the health effects of dietary changes that would result from the ban (reduced consumption of fruits, vegetables, and grains) nor the environmental damage associated with the increased migration of pests and alien invaders that will not be effectively controlled. If a complete assessment of the effects of a methyl bromide phaseout were made, it seems likely that the adverse health effects alone, without considering other economic effects, would outweigh any ozone protection benefits.

The benefits do not recognize the impact of a unilateral U.S. ban or freeze on the use of methyl bromide in other countries. Producers and exporters in countries not subject to the restrictions may increase methyl bromide use to compensate for reductions in U.S. production, reducing benefits to U.S. consumers.

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August 19, 1992

Ms. Nancy A. Ketcham-Colwill
Office of General Counsel (LE-132A)
Room 501C West Tower
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Dear Ms. Ketcham-Colwill:

This letter is a follow-up to my telephone conversation with Jonathan Martel of your office today concerning EPA's evaluation of whether to initiate a rulemaking under Section 602 of the Clean Air Act (CAA) to list methyl bromide as a controlled substance, for a phase-out in production and consumption of this chemical. This rulemaking evaluation by EPA is driven primarily by a petition, and subsequent notice of intent to sue, that the Agency has received from the Natural Resources Defense Council (NRDC), Friends of the Earth (FOE), and the Environmental Defense Fund (EDF). We are writing as counsel to the Methyl Bromide Working Group (MBWG), which is comprised of the major producers and the largest distributor of methyl bromide.

EPA is legally obligated to support any decision to list methyl bromide with a finding that the ozone depletion potential (ODP)[1] for this chemical is 0.2 or greater. Such a finding must be based upon well-established scientific evidence. In particular, both the Clean Air Act and the Administrative Procedure Act require EPA, at the time that it proposes (as well as promulgates) a rule, to provide in the rulemaking record substantial supporting information, data, and

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[1] Pursuant to Section 601(10) of the CAA, a chemical's ODP must be based upon the chemical's atmospheric lifetime; the molecular weight of bromine and chlorine; the chemical's ability to be photolytically disassociated; and other factors that are "an accurate measure of relative ozone-depletion potential."

other materials which fully demonstrate -- with a high degree of scientific certainty -- that methyl bromide has an ODP of 0.2 or greater. Without this record, the Agency may not proceed to issue such a rule.

We emphasize this point because it is unquestionable that there are numerous scientific uncertainties regarding methyl bromide's potential impact upon the stratospheric ozone layer. These uncertainties preclude calculating methyl bromide's ODP with any degree of confidence at this time.

Enclosed (as Attachment A) is a recent paper which summarizes the scientific uncertainties regarding the possible impact of methyl bromide upon the stratospheric ozone layer. Also enclosed (as Attachment B) is a letter which the MBWG previously sent to Mr. William Rosenberg, EPA's Assistant Administrator, on this subject. As these materials show, the only reasonable approach for EPA to take at this time is to deny the petition for rulemaking, and instead support an 18-36 month international research and assessment program. Upon completion of such a program, the scientific community will more likely be in a position to reach a consensus concerning methyl bromide's ODP, which might then serve as an adequate basis for making any legal judgments and risk management decisions regarding this commercially-important chemical product.

In addition, we are aware that, on July 10, 1992, NRDC, FOE and EDF served notice of their intent to sue EPA for the Agency's alleged failure to perform a non-discretionary duty. It is possible that, with respect to a Section 602 petition, EPA has one non-discretionary duty: to respond to the petition within 180 days. However, the contents of EPA's response -- here, the decision whether to list methyl bromide -- are discretionary. Therefore, EPA has no legal obligation to respond affirmatively to a Section 602 petition.

For the reasons noted above, in responding to the NRDC/FOE/EDF petition EPA cannot, at this time, make and support a credible scientific determination that methyl bromide has an ODP above 0.2. Therefore, the only legally defensible response that the Agency can make is to deny the request to list methyl bromide, pending further scientific research.

We appreciate your careful consideration of these matters. Please give me a call (at 202-872-6836) if you have any comments or questions about these or related issues. Thank you.

Very truly yours,

Blake A. Biles

Enclosures

cc: William G. Rosenberg, U.S. EPA
Eileen B. Claussen, U.S. EPA
Jonathan S. Martel, U.S. EPA

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