NO MARGIN OF SAFETY:

A Preliminary Report on Dioxin Pollution and the Need for Emergency Action in the Pulp and Paper Industry

by Carol Van Strum and Paul Merrell

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ABOUT THE AUTHORS

Carol Van Strum, Paul Merrell, and their children live on a small farm in Five Rivers Valley, in the heart of western Oregon's Siuslaw National Forest. Both have been closely involved with toxic substance issues, particularly involving dioxin, for a decade.

Carol was a co-founder in 1976 of Citizens Against Toxic Sprays (CATS), a rural citizens group that forced dioxin issues into a national forum with educational efforts and a landmark court decision discussed in this report. She is author of A Bitter Fog: Herbicides and Human Rights (Sierra Club Books, 1983), a history of citizen efforts to halt the use of herbicides and a study of rampant fraud in the safety testing of toxic substances. Carol is a free-lance writer whose work has often appeared in national publications. She has a particular interest in toxic substances as a political phenomenon.

Paul began working full-time on toxic substance issues in 1977. He is a disabled Vietnam War veteran and the author of Toolkit: Copy It! (Citizens for Environmental Quality, 1978), a citizen's organizing guide for the herbicide issue. He won a landmark court decision without attorneys in 1983; the decision banned the use of herbicides on federal lands in the U.S. until adequate safety tests are performed. See S.O.S./Merrell v. Clark, 747 F.2d 1240 (Ninth Circuit 1984). He is now a third year law student at the University of Oregon, Eugene.

Since their marriage in 1981, Paul and Carol have been involved in an extensive study of the U.S. Environmental Protection Agency's dioxin regulatory program through records acquired under the Freedom of Information Act. Several of their related lawsuits, still pending, seek more extensive government records on subjects discussed in this report: dioxin pollution in the Great Lakes region, the National Dioxin Study, the joint EPA/Industry Pulp and Paper Mills Dioxin Study, and EPA's suppression of dioxin health studies in western Oregon.

GLOSSARY

308: Section 308 of the U.S. Federal Water Pollution Control Act Amendment to the Clean Water Act. The amendment grants EPA authority, after giving notice, to enter manufacturing sites to gather pollution-related information, including samples and records. Often referred to in government and industry documents as simply a "308 notice."

CAG: Carcinogen Assessment Group, a USEPA group formed to evaluate the cancer-causing potential of toxic substances.

CANCER INITIATOR: An agent that causes irreversible transformation of a cell into a latent tumor cell.

CANCER PROMOTER: An agent that, when applied after a cancer initiator or carcinogens are applied, increases the incidence of tumors and shortens the latency period for tumor development. This enhancement can occur even if exposure to the cancer promoter occurs long after exposure to the carcinogen or intiator.

CDC: The U.S. Centers for Disease Control. A division of the public health service, U.S. Department of Health and Human Services. Responsible for studying the occurrence of disease in the U.S. Also conducts monitoring for the introduction of chemical and biological warfare agents into the U.S.

CDWG: Chlorinated Dioxins Work Group, an internal USEPA group formed from representatives of various EPA offices involved with dioxin, to coordinate research and policy within the agency.

CHLORINE: A yellow-green gas with a pungent odor. Uses include the bleaching and delignification of wood pulp.

COCARCINOGEN: A cancer-causing substance that, when administered simultaneously with another carcinogen increases the incidence of tumors beyond what would be expected if the effects of the two compounds were merely additive.

EPA: U.S. Environmental Protection Agency.

FDA: U.S. Food and Drug Administration. Responsible for regulating pharmaceutical ingredients, food additives and contaminants, and other matters.

KRAFT PULP: Ground wood prepared for papermaking by an alkaline treatment.

MOE: Ontario Ministry of the Environment.

NCAFI: National Council for Air and Stream Improvement. A research arm of the principal trade groups of the North American pulp and paper industry, American Paper Institute/National Forest Products Association.

NDS: EPA's National Dioxin Study.

OPTS: Office of Pesticides and Toxic Substances, USEPA.

U.S.C.: United States Code, designating a federal statute.

WDNR: Wisconsin Department of Natural Resources. A state agency with responsibility for enforcing pollution laws.

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I.
INTRODUCTION & FOREWORD

From a smokescreen of government secrecy, evidence has begun to emerge that the global pulp and paper industry is a major source of chlorinated dioxin pollution. Government researchers have found extremely serious levels of the most toxic form of dioxin -- TCDD -- in fish near several mills in North America and in upstream mill wastes. The evidence suggests that pulp and paper mills are spewing hazardous levels of TCDD into the waterways and skies across North America -- and around the globe -- adding to dioxin pollution already discovered from sources such as municipal and industrial waste incinerators, hazardous waste dumps, and pesticide, chemical, plastics, and pharmaceutical manufacturing facilities.

There are no "safe" levels of TCDD. Every dose tested in laboratory animals has resulted in increased levels of cancer, birth defects and other reproductive problems, and in damage to the body's immune system. The levels of dioxin being found near pulp mills suggest a public health emergency in North America.

Information on the newly-discovered pulp mill sources is far from complete, but there is enough evidence to be certain that chlorinated dioxins are an unwanted byproduct of all pulp and

paper mill production processes using chlorine. Just as certainly, there are emergency steps that should be taken to vastly reduce the levels of dioxin emissions in the industry.

Instead of taking such steps, industry and federal government officials have conspired to conceal the problem while they carry out a leisurely research program aimed at confirming its scope.

This problem only came to light because of now-stalled action by courageous state officials in the border states of Maine, Minnesota, and Wisconsin, and because of leaked U.S. Environmental Protection Agency secrecy agreements with industry. (In Appendices.) USEPA records divulged through subsequent Freedom of Information Act litigation provide the foundation for critical portions of this report on the pulp and paper industry dioxin crisis. EPA continues to withhold crucial information while that lawsuit grinds forward.

A more expanded treatment is planned after further EPA records are released. Because of the severity of the public health problem and the scope of the government cover-up, this preliminary report has been rushed to publication in order to alert the public to the need both for emergency action and for immediate disclosure of related suppressed government records.

The report briefly summarizes the hazard of dioxin, focusing on the key studies that underly the controversy, and traces a regulatory history tainted by repeated scandals. The still-suppressed U.S. National Dioxin Study confirming the pulp mill

findings is discussed next, followed by a discussion of the secret follow-up joint-EPA/industry pulp and paper mill dioxin study. The next chapter briefly reviews relevant pulp and paper production processes, followed by a discussion of the points in those processes where dioxins could be formed. The report concludes by recommending measures to be taken and pitfalls to be avoided to vastly reduce the levels of chlorinated dioxin pollution from the industry.

The authors greatfully acknowledge the assistance of others in the preparation of this report. Particular thanks go to Greenpeace staffers Joyce McLean (Toronto), Renate Kroesa (Vancouver, B.C.), Diane Hebert (Midland, Mich.), Dick Dillman (San Francisco), Jeff Barrett-Howard (Chicago) Scott Shibley (Toronto); Ian Attridge (Toronto) Steve Sawyer (Washington, D.C.), and Dorothy Houston (Washington, D.C.); to attorneys Ralph Bradley (Eugene, Oregon) and Susan Hogg (Newport, Oregon); to Dr. John Noel (Eugene); and to family and friends who gave too much and got back far too little while this project was underway. To the unknown but obviously caring, people who leaked government and industry documents we give our heartfelt gratitude.

-- CAROL VAN STRUM, PAUL MERRELL
Five Rivers, Oregon
August 16, 1987

II.
DIOXIN: A BASIS FOR CONCERN

The most toxic known molecule made by humans is a form of dioxin, 2,3,7,8-tetrachlorodibenzo-p-dioxin (hereafter "2,3,7,8-TCDD"). 1/ "Dioxin," however, is a generic term for 75 chlorinated compounds formed from a basic nucleus of two benzene rings, bonded together by oxygen atoms. Most dioxins have not been subjected to health and safety tests with laboratory animals.

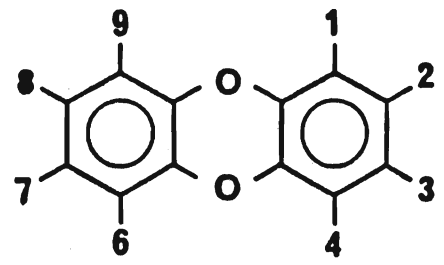

Fig. 1: Basic dioxin molecule

The numbered positions represent bonds with hydrogen or other atoms. The family of dioxin compounds that has attracted most

1. See e.g., USEPA, Dioxins. EPA Report No. 600-2-80-197 (November, 1980) at 5 ("No published reports indicate that dioxins are formed biosynthetically by living organisms; these compounds apparently are not constituents of a normal growing environment").

scientific and regulatory attention is the chlorinated dioxins, in which the chlorine atom occupies one or more of the eight numbered positions. Of these, the most studied, and most toxic known to date, is 2,3,7,8-TCDD, in which four (tetra) chlorine atoms occupy the 2,3,7, and 8 positions.

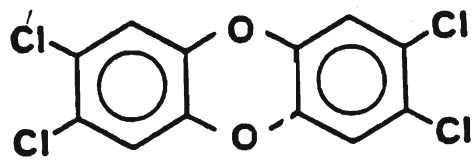

Fig. 2: 2,3,7,8-TCDD

Because so little is known about other chlorinated dioxins (e.g., octa dioxins, with chlorines in eight positions; hexa, chlorines in six positions; penta, chlorines in five positions, etc.), regulatory efforts have focused almost exclusively on the most toxic form, 2,3,7,8-TCDD. For purposes of this discussion of toxicity, "TCDD" refers to 2,3,7,8-TCDD, and "dioxin" refers to chlorinated dioxins, except as otherwise indicated. 2/

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2. J. Moore, EPA Assistant Administrator, in testimony, Dioxin--The Impact on Human Health, H. Rep. 78, Subcom. on Nat. Res., Agr. Res., & Env., Com. on Science & Tech., U.S. House of Rep., 98th Cong., 1st Sess. at 47.

"[T]he 'dioxin' we all refer to is but one member of a

A.
NO 'SAFE' LEVEL OF TCDD HAS EVER BEEN ESTABLISHED

TCDD's chronic toxicity has been compared to plutonium and is greater than aflatoxin. 3/ No "no observed effect levels" have ever been established in test animals for cancer, birth defects, and immune system effects. Test animals exposed to nearly-unimaginable doses as low as one trillionth of the animals' body weight have contracted cancer and birth defects, the lowest doses ever tested. TCDD not only may cause cancer itself, but even more seriously, it magnifies the effects of other cancer-causing

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> chemical family. . . . Members of another closely related family of chemicals, the chlorinated dibenzofurans, are frequently found as contaminants in products that contain dioxins. The pattern of disease that the other toxic dioxins and dibenzofurans produce is indistinguishable from th[at] observed with TCDD. Basic research with these chemicals indicates that a common mechanism is probably involved in their toxicity. Therefore, the public health risk should be assessed by calculating aggregate exposure to all of these chemicals, not only to TCDD."

3. For example, EPA's guidelines on handling of toxic wastes specify the same procedures for handling of plutonium and TCDD wastes. USEPA Chlorinated Dioxins Working Group meeting notes of April 25, 1980, pg. 2. This group's meeting notes from 1979 through at least 1982 repeatedly stress that there is no "no observed effect level" for TCDD and also stress the difficulties of assessing risks on dioxins. For the comparative chronic toxicity of TCDD and aflatoxin B, which was previously believed to be the strongest known cause of cancer, see detailed treatment in Direct Testimony of Dr. Roy Albert, EPA Exhibit No. 564, In Re: Dow Chemical Company, et al., USEPA FIFRA Consolidated Docket Nos. 415 et al., at pg. 15 ("TCDD is approximately three times more potent a carcinogen than aflatoxin B").

agents. It is therefore impossible to establish "safe" or "acceptable" levels of TCDD pollution. Any claims to the contrary should be subjected to close scrutiny.

TCDD is only one form of dioxin, however, and most other forms have not been subjected to an adequate range of toxicity testing. TCDD is both acutely (immediately) and chronically (long-term) toxic. The acute effects of relatively high exposures in all animal species tested are weight loss and atrophy of the thymus gland, which regulates the immune system; other symptoms of exposure are liver damage, edema (abnormal intercellular accumulation of fluid), hair loss, and suppression of immune system functions. 4/ In humans, "the symptoms of toxicity in many cases are similar to those observed in animals, with exposure leading to altered liver function and lipid metabolism, porphyria cutanea tarda (a particularly severe metabolic disorder), neurotoxicity and pathologic changes in hematologic [blood] parameters. In addition, exposure of humans to 2,3,7,8-TCDD produces skin lesions such as chloracne and hyperpigmentation." 5/ Many chronic (long-term) effects of TCDD exposure in animals have been well documented, including fetotoxicity (toxicity to the unborn) and cancer, both at almost unimaginably low doses. 6/

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4. USEPA, Health Assessment Document for Polychlorinated Dibenzo-p-Dioxins. EPA Report No. 600-8-84-014F, at pg. 4 (September, 1985).

5. Id.

6. 1 nanogram TCDD per kilogram of body weight, or one tril-

During the EPA's cancellation proceedings against the TCDD-contaminated herbicides 2,4,5-T and silvex in 1980, EPA scientific witnesses testified that TCDD is so powerful a teratogen and carcinogen that no "no-effect" level of exposure had ever been demonstrated, i.e., that the lowest measurable doses tested resulted in birth defects and cancer.

1.
REPRODUCTIVE EFFECTS AT LOWEST DOSE EVER TESTED

In those hearings, National Academy of Sciences member George Streisinger reviewed Dow's three-generation rat reproductive study on TCDD and found multi-generational reproductive effects at chronic doses of a single part per trillion in the diet per day. 7/ He concluded that TCDD at levels present in the environment from ordinary uses of 2,4,5-T poses substantial risks to human health of reproductive effects alone, without considering

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lionth of the exposed organism's body weight. Id., pg. 2-7. One trillion equals 1,000,000,000,000.

7. The Dow study was later published. F. Murray, et al, Three-Generation Reproduction Study of Rats Given 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD) in the Diet, 50 Tox. & Appl. Pharm. 241 (1979). Although Murray et al conceded that there were statistically significant differences between controls and treated animals at the lowest dose level, they felt such results should be ignored because the results were not consistent across each generation. Their confidence in that opinion apparently was not sufficient to cause them to replicate the study to determine the issue.

the substantial cancer risk. 8/

2.
CANCER PROBLEMS AT LOWEST DOSE EVER TESTED

Dr. Roy Albert, head of EPA's Carcinogen Assessment Group (CAG), reviewed CAG data on the carcinogenicity of TCDD, finding unacceptable human cancer risk at chronic dietary exposure to one part per trillion TCDD, the lowest dose tested. Dr. Albert emphasized the CAG's conclusion that TCDD is the most potent carcinogen known, with no known or assumed "safe" dose. Dr. Albert stressed evidence that TCDD is also both a cancer promoter and a cocarcinogen. 9/ (See Glossary). TCDD is thus a kind of all-purpose carcinogen; it not only may cause cancer itself, but enhances and speeds up cancers triggered by other carcinogens:

> "The human population is exposed to a large number of carcinogens in the environment.

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8. Direct Testimony of Dr. George Streisinger. EPA Exhibit No. 564, in re: The Dow Chemical Company, et al., USEPA FIFRA Docket Nos. 415, et al. at pp. 35-39. Dr. Streisinger calculated substantial risks from contaminated meat composing only 0.5 to 5 percent of the diet, depending on the age of the consumer, carefully noting that any other routes of exposure would be cumulative and raise the dose. Dr. Streisinger's discussion of Murray et al's reasons for ignoring statistically-significant results at the lowest dose level bears particular attention.

For a published critique of the Murray et al three-generation rat study by EPA contract scientists, see I. Nisbet & M. Paxton, Statistical Aspects of Three-Generation Studies of the Reproductive Toxicity of TCDD and 2,4,5-T, 36:3 Am. Statistician 290 (August 1982) (disagreeing with Dow's contention that statistically-significant effects at lowest dose level should be ignored).

9. Albert testimony, note 1 supra, at pp. 12-13.

> Therefore, it is possible that exposure to a potent promoter such as TCDD could increase the number of cancers induced by environmental carcinogens and shorten the latency period for the development of cancer. . . . There is no theoretical basis for making even ballpark estimates of the risk posed by promoters and cocarcinogens to exposed persons because the mechanism for promotion is not well understood and because the degree of total exposure of the human population to the numerous carcinogens in the environment cannot be well quantified. However, it is possible that TCDD could significantly increase human cancer as a promoter or cocarcinogen at exceedingly low levels of TCDD exposure." 10/

3.
NO 'NO-EFFECT LEVEL' IDENTIFIED FOR IMMUNE SYSTEM EFFECTS

The inability to quantify reproductive and cancer risks of TCDD exposure is compounded by similar problems with assessing its risks of impairing the body's immune system. Effects of TCDD exposure on the immune system have been well documented in animals. 11/ Immune responses are impaired in both adult and young test animals after exposure to several dioxins, including TCDD. 12/ The problem is probably more severe in infants, however, because of widespread TCDD contamination of human mother's

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10. Albert testimony, note 1 supra, pp. 29-30; see generally, EPA Dioxin Health Assessment Report, note 4 supra, pp. 14-1 through 14-17.

11. N. Kerkvliet and J. Brauner. Mechanisms of 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD-Induced Humoral Immune Suppression: Evidence of Primary Defect in T-Cell Regulation. 87 Tox. & Applied Pharm. 18 (1987), pp. 19-20.

12. Kerkvliet & Brauner, note 10 supra at 19.

milk, which comprises the entire diet of many infants for the first year of their lives. 13/

TCDD attacks several tissues affecting the body's immune system. For example, one of the target organs of TCDD in the body is the thymus gland, 14/ which regulates the body's immunologic competence, or ability to resist disease. The thymus gland is well developed and active in infants and normally degenerates with age, thus suggesting that the immune system effects on infants may be far more severe than in adults. Impaired immunity can render

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13. C. Rappe, Problems in Analysis of TCDDs and TCDFs and Presence of These Compounds in Human Milk, presented at World Health Organization Consultation on Organo-halogen Compounds in Human Milk and Related Hazards. Bilthoven, Netherlands, January 9-11, 1985 at pg. 4:

> "The levels found [are] of special interest. A five-kg baby consuming 1,000 ml. of milk a day will receive a dose of 10 pg. 2,3,7,8-tetra-CDD/kg.(-1) day(-1), which is higher than the [Allowable Daily Intake] values discussed in some countries and much higher than the virtually safe dose discussed by Kimbrough et al (1984) [see Chapter IV, this report].
>
> Contrary to the scenario discussed by Kimbrough et al, (Times Beach), the human milk is also contaminated by other toxic PCDDs and PCDFs. Some agencies and scientists now discuss 'TCDD-equivalents' and using this approach the exposure to nursing babies is even higher."

See also EPA Dioxin Health Assessment Report, note 4 supra, at pg. 4-32 (summarizing Rappe's data); M. Meselson & P. O'Keefe. January 26, 1977, letter to Hon. Jim Weaver, in U.S.D.A. Forest Service. 1 Vegetation Management With Herbicides Final Environmental Impact Statement, Pacific Northwest Region, at pp. H-18 through H-19 (1978) (transmitting preliminary results of TCDD-positive mothers' milk samples from Texas and from Oregon).

14. EPA Dioxin Health Assessment Report, note 4 supra, pp. 8-26 through 8-56; see also Kerkvliet & Brauner, note 10 supra (surveying studies on similar effects in TCDD).

an individual more susceptible to disease organisms and cancer. The presence of dioxin in human and bovine milk 15/ could therefore have long-term effects on a child's lifelong ability to withstand cancer and other disease, as well as on future reproductive capacity, particularly in light of synergistic reactions between dioxins and common environmental pollutants. 16/

Furthermore, studies on immune-system effects of various dioxins have not thus far identified a dose-response relationship or "no observed effect level," thus making quantitative risk assessment impossible. 17/ (Science is almost necessarily limited to studying immune system effects in animals, because normal medical records on exposed humans do not record the type of information required and it is unethical to conduct prospective experiments on humans.) 18/

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15. EPA Dioxin Health Assessment Report, note 4 supra, pg. 8-46.

16. See pg. 17 infra, and note 34 infra, discussing interaction between dioxins and polyaromatic hydrocarbons common in smoke from burning paper and wood, obviously applicable to pulp and paper mills.

17. R. Kimbrough, et al. Health Implications of 2,3,7,8-Tetrachlorodibenzodioxin (TCDD) Contamination of Residential Soil, 14 J. of Tox. & Env. Health 47, 61 (1984) ("Although the immunotoxicity of TCDD is a serious health effect in animals -- apparently present at low doses of TCDD exposure -- we cannot use these data in risk analysis at this point, since no adequate dose-response data exist"); see also further discussion of this publication in Chapter IV.

18. See EPA Dioxin Health Assessment Report, note 4 supra, at pg. 8-39.

4.
EPA'S 'NO SAFE LEVEL' REGULATORY POLICY

On the basis of the animal studies demonstrating TCDD's extraordinary potency as both a teratogen and a carcinogen, as well as the unfinished Alsea Study suggesting reproductive effects in humans, EPA took the position in the 2,4,5-T proceedings that because no safe level of human exposure to TCDD had ever been demonstrated, the exceedingly low levels of TCDD exposure from herbicide use posed too great a risk to justify continued use of such herbicides. A mother's exposure during critical stages of fetal gestation to a diet contaminated to 50 parts per quadrillion TCDD, Dr. Streisinger testified, would still be expected to produce adverse reproductive effects in humans, assuming humans to be as sensitive to TCDD as test animals. 19/

The toxicity of TCDD has not changed since EPA asserted its "no safe level of TCDD" policy during the 2,4,5-T hearings in 1980; 20/ what has changed is EPA regulatory policy on TCDD, as

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19. Streisinger testimony, note 7 supra, at 34-39; see also id. at 34:

> "It is difficult to estimate levels of TCDD which are likely to prove non-toxic to humans. Every dose so far examined has proven to be toxic in animal experiments. Low levels appear to be proportionally more toxic than would have been predicted from higher level tests, and considerable individual to individual variability exists in sensitivity to TCDD."

20. See generally, EPA Dioxin Health Assessment Report, note 4 supra (reviewing numerous recent animal studies confirming the toxicity of TCDD).

will be examined later in this report.

B.
DIOXIN'S FATE IN THE ENVIRONMENT

Chlorinated dioxins are remarkably stable under normal environmental conditions, although under certain conditions, chlorine atoms may be added or subtracted or may even shift positions, resulting in formation of TCDD from other dioxins. 21/ The release of even minute amounts of dioxin into the environment may therefore have severe repercussions, not only because such low levels may so profoundly affect generations of human and animal health, but because dioxin simply may not go away. Minute amounts released over time will accumulate and move in both predictable and unpredictable ways through the environment and food web.

Like many pollutants, dioxin moves through the environment largely as a hitch-hiker, attached to other, more mobile substances. The dioxin molecule may travel as a contaminant of a commercial product, e.g., a pesticide, or adhere to a soil, sediment, or ash particle, or bind to waste oil or the fatty tissue of an animal. In none of these media is it likely to stay in one place.

The characteristics of dioxin that affect its mobility are its tendency to adhere to soil and ash particles, its affinity for fats (whether waste oil or animal fat), and its low solubility in

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21. EPA Dioxin Health Assessment Report, note 4 supra, at pp. 4-17, 5-2 through 5-8.

water. The dioxin molecule can also be carried as a contaminant of another substance, e.g., a pesticide such as pentachlorophenol, or oily waste from a wood-treatment plant. In a process called "facilitated transport," dioxin will move farther and faster, and in less predictable ways, when carried in oil droplets or solvents; in such cases, the dioxin will not bind to soil particles and can much more readily contaminate ground water. 22/

How the dioxin gets from air, soil, water, or sediment into the tissues of animals and humans is largely unknown; what is known is that where dioxin pollution occurs, the dioxin ends up in the tissues of fish, wildlife, livestock, and humans. Because dioxin will remain for many years in aquatic sediments and bioaccumulates readily in aquatic plant and animal life, dioxin contamination of lakes and rivers is particularly alarming. Continuous discharges of even small amounts of dioxin build up in sediments, from which aquatic plants and fish can accumulate up to 30,000 times the sediment levels. 23/

Other routes of human and animal exposure are harder to chart or quantify. Dioxin -- in soil, dust, smoke, sprayed vegetation, or contaminated surfaces -- can be absorbed through the skin, but how much enters the body in this way is poorly studied; 24/ simi-

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22. EPA Dioxin Health Assessment Report, note 4 supra, at pg. 5-8.

23. Id., pp. 5-16 to 5-19.

24. Id., pp. 14-9.

larly, dioxin clinging to dust or smoke particles can be adsorbed through the lungs directly into the bloodstream. 25/

How quickly or slowly dioxin will break down in the environment is another unsettled question vitally important to assessing the chemical's hazard. In some laboratory experiments, dioxins seem to "disappear" or "break down" in the presence of strong sunlight and ultraviolet light. Outside the laboratory in the real world, however, dioxin does not invariably "disappear" or break down to innocuous components, as evidenced by TCDD seeping from wastes buried at Love Canal 40 years ago, by dioxin-laden soil in Arizona some twenty years after the last forest spraying projects there, 26/ and by dioxin deposits in 40-year-old sediments of Siskiwit Lake on Isle Royale in Lake Superior. 27/

In fact, chlorinated dioxins have not existed on the planet long enough to predict what will ultimately become of them. Because the chlorine atoms may dissociate from or even shift positions on the nucleus, dioxin generated in one form (e.g., an

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25. Kimbrough, et al, note 16 supra, at pg. 72; see also EPA Dioxin Health Assessment Report, note 4 supra, at pg. 14-9.

26. USEPA, The National Dioxin Study: Tiers 3,5,6, and 7 Draft Report at 30 (April 1986). For a more lively and expanded history of herbicide use at this site, see B. Shoecraft, Sue the Bastards! (Franklin Press, Phoenix, 1971); C. Van Strum, A Bitter Fog: Herbicides & Human Rights, pp. 35-46 (1983) (updated account of the Globe, Arizona damages action settled in 1981).

27. J. Czuczwa, et al, Polychlorinated Dibenzo-p-dioxins and Dibenzofurans in Sediments from Siskiwit Lake, Isle Royale, 226 Science 568 (November 2, 1984).

octa-dioxin) may in time evolve into a very different -- and perhaps more toxic -- form such as TCDD. It is therefore not only difficult to predict which dioxins will be formed under particular conditions, but also to predict which form dioxin will take in 20, 40, or 100 years. 28/

C.
CUMULATIVE EXPOSURE TO DIOXINS AND OTHER TOXINS

Unlike controlled laboratory experiments, dioxin exposure in the real world does not occur in a vacuum, isolated from other toxic exposures. Indeed, TCDD itself rarely, if ever, exists alone, but usually occurs in combination with other toxic materials e.g., other dioxins, related furans, solvents, pesticides, waste oils, smoke, ash, other universal pollutants such as PCB's, etc. Moreover, the environment in which dioxin is released is far from pristine, and dioxin simply adds to an already toxic burden of pollutants, including already-existing dioxin levels such as those discussed in the following chapters. For example, the Water

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28. USEPA Dioxin Report, note 1 supra, pp. 35-36; EPA Dioxin Health Assessment Report, note 4 supra, at pp. 4-17, 5-2 through 5-8.

The fate of the basic unchlorinated dioxin nucleus -- which may survive intact for up to 2 billion years -- is an even larger unknown, particularly with respect to the numerous opportunities for it to encounter chlorine atoms in combustion situations, thus producing chlorinated dioxins. W. Shaub & W. Tsang, Physical & Chemical Properties of Dioxins in Relation to Their Dispersal, National Bureau of Standards, Center for Chemical Physics, Chemical Kinetics Division, Washington, D.C., 1981 unpublished draft, Table III and accompanying text.

Quality Board of the International Joint Commission has identified eleven "critical pollutants in the Great Lakes ecosystem, as well as approximately 500 more chemicals "of potential concern" that need further study; the effects of TCDD levels in the Great Lakes region -- or any other region -- can not be estimated in isolation from this multitude of other pollutants. 29/

Such other pollutants -- many of them known carcinogens -- are already ubiquitous in the North American environment. Human tissues already bear a burden of chlorinated hydrocarbon pesticide residues; 99 percent of mothers' milk samples collected from across the United States in the mid-1970s contained high (up to 214,166 parts-per-billion) levels of DDT compounds, and 80-87 percent contained high levels dieldrin and benzene hexachloride; other chlorinated hydrocarbons routinely found were heptachlor epoxide (63 percent), oxychlordane (74 percent), hexachlorobenzene (46 percent), and transnonachlor (70 percent). 30/ The effects on a nursing infant of adding TCDD to such contaminants already present in human milk can not be predicted.

The effects of TCDD in combination with other chemicals may not be simply additive; in many cases, TCDD reacts synergistically

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29. National Research Council of the United States & The Royal Society of Canada, The Great Lakes Water Quality Agreement: An Evolving Instrument for Ecosystem Management, pg. 73; id., Appendix A pp. 39-45 (1985).

30. E. Savage, et al, National Study to Determine Levels of Chlorinated Hydrocarbon Insecticides in Human Milk, USEPA Contract No. 68-01-3190 (September 1976).

with other substances such as anaesthetics to produce very different effects from the sum of both individually. 31/ The fact that TCDD is also both a cancer promoter and a cocarcinogen 32/ suggests that TCDD may enhance and speed up cancers caused by other carcinogens in the environment. 33/ Similarly, TCDD's known effects on the immune system can render an individual susceptible to the effects of both other pollutants and disease organisms. 34/

For example, recent research indicates that in the body dioxins and related furans trigger production of an enzyme capable of converting organic components of smoke into active carcinogens. People breathing air contaminated with dioxins from pulp and paper mills would be inhaling such smoke components at the same time. 35/

D.
TCDD RISK ASSESSMENT CAN ONLY EXPOSE HAZARD, NOT SAFETY

There is thus, as Dr. Albert said, "no theoretical basis for

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31. USEPA Dioxin Health Assessment Report, note 4 supra at pp. 14-8, 11-39 through 11-51.

32. See discussion supra.

33. E.g., those on the lists of 511 pollutants in the Great Lakes area. See note 28 supra.

34. See discussion supra.

35. USEPA Dioxin Health Assessment Report, note 4 supra, pp. 8-71 through 8-78; P. Connett, MSW Incinerators, Dioxin, and the Hasselris Affair, Current (June 1985), pg. 2 ("The dioxins and furans are known to stimulate the production of the enzyme called cytochrome p-448. [It] has the ability to convert polyaromatic hydrocarbons and related substances into active carcinogens").

making even ballpark estimates of the risk" posed by TCDD in the environment, 36/ not only on the basis of its carcinogenic properties but also because of its potential to interact with the multitude of other environmental pollutants in unpredictable and perhaps drastic ways.

Despite the futility of making even "ball-park estimates" of TCDD risk, however, U.S. and Canadian regulatory agencies have plunged ahead with detailed, numerical "risk assessments" on TCDD exposure, replete with authoritative-looking ratios, exponents, and quantitative analyses. Such risk assessments have led to recommended "levels of concern" for TCDD contamination of soil, water, fish, meat, etc., which have been widely interpreted by the media and by the public as "safe" levels.

A look at the assumptions underlying those TCDD risk assessments and "levels of concern," however, raises grave questions about the integrity of the "science" of risk assessment, particularly in light of its political abuse discussed in the following chapters.

36. See discussion supra.

III.
REGULATORY HISTORY OF DIOXIN

The dioxin experience shows that sufficient damning information is available to justify the total elimination of TCDD wherever technologically feasible. Absolute scientific certainty is not required to regulate pollution in the United States.[1/] Government inaction on so exquisitely toxic a pollutant is difficult to comprehend without understanding TCDD's regulatory his-

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1. U.S. courts have had to grapple with such issues for more than a decade, as a body of pollution law began to emerge, severed from the traditional tort burden of proof:

> "Undoubtedly, certainty is the scientific ideal -- to the extent that even science can be certain of its truth. But certainty in the complexities of environmental medicine may be achievable only after the fact, when scientists have the opportunity for leisurely and isolated scrutiny of an entire mechanism. Awaiting certainty will often allow for only reactive, not preventive, regulation. Petitioners suggest that anything less than certainty, that any speculation, is irresponsible. But when statutes seek to avoid environmental catastrophe, can preventive, albeit uncertain, decisions legitimately be so labeled?"

Ethyl Corp. v. Environmental Protection Agency, 541 F.2d 1 (D.C. Cir. 1976) (footnote omitted) (regulation of lead fuel additives); in J. Bonine & T. McGarity, The Law of Environmental Protection 678, 684-685 (1984). See also Save Our ecoSystems/Merrell v. Clark, 747 F.2d 1240 (9th Cir. 1984) (agencies must use worst-case assumptions in assessing health effects of pollution).

tory, which demonstrates that public health concerns have given way to political and economic considerations.

With few if any exceptions, the U.S. has maintained the lead in North American dioxin regulation. Canada, with its relatively small regulatory budget, has ordinarily deferred to regulatory initiatives in the U.S., contributing primarily through occasional efforts to prod its southern neighbor into action.

A.
DIOXIN EMERGES AS A REGULATORY ISSUE

During the late Nineteenth Century, an unidentified compound was suspected as the cause of outbreaks of chloracne (a persistent, disfiguring skin condition associated with severe metabolic disorders) in certain manufacturing plants producing chemicals, notably chlorine gas, and chlorinated naphthalene. The chloracne-causing compound -- dioxin -- was not identified until the late 1950s, when methods for synthesizing it in the laboratory were developed.[2/]

Dioxin research intensified after the 1950s largely because of its presence as a contaminant of 2,4,5-T, a highly effective defoliant and weed-killer developed as a military weapon during World War II. TCDD regulatory efforts in the 1960s and 1970s focused entirely on pioneering regulatory efforts to curb the use

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2. R. Baughman, TCDD & Industrial Accidents, in, T. Whiteside, The Pendulum and the Toxic Cloud: The Course of Dioxin Contamination, pg. 145 (1978). On TCDD's early history, see C. Van Strum, A Bitter Fog: Herbicides & Human Rights, pp. 11-15. (1983).

of TCDD-contaminated herbicides 2,4,5-T and Silvex.

The 1950s saw the emergence of 2,4,5-T and Silvex[3] as commercially successful products in the agriculture, timber, lawn-care and other "vegetation management" markets, and from 1961 to 1970, 2,4,5-T and another closely-related compound, 2,4-D,[4] served as a military weapon in Vietnam under the code name Agent Orange. Consistent reports of toxic effects on Vietnam civilians, however, coupled with the release of suppressed 1965 U.S. government-sponsored studies showing both 2,4,5-T and 2,4-D to be teratogenic (causing birth defects) led the Pentagon to halt Agent Orange use in Vietnam in 1970.[5]

Nonetheless, the domestic use of TCDD-contaminated herbicides accelerated for nine years after the 1970 military ban. The U.S. Environmental Protection Agency's first attempt to cancel 2,4,5-T registrations in 1973 yielded to industry demands for further

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3. Silvex and 2,4,5-T are similar "phenoxy" chemicals both manufactured from trichlorophenol, differing only in the type of acid used in the final reaction stage of production, and both contain TCDD as an unavoidable contaminant. In the remainder of this report, they will be referred to synonymously as "2,4,5-T" or "TCDD-contaminated herbicides" for ease of reference, except where separate discussion is warranted.

4. 2,4-D is also very similar to 2,4,5-T, differing only in the substitution in 2,4-D of a carbon atom for the chlorine atom at the "5" position on the benzene ring. Because of controversy over whether 2,4-D is also contaminated with TCDD, see Chapter VIII infra, it is discussed separately in this report and not grouped generically with 2,4,5-T and silvex.

5. For an in-depth discussion, see M. Uhl & T. Ensign, GI Guinea Pigs: How the Pentagon Exposed Our Troops to Dangers More Deadly Than War (1980).

research on TCDD toxicity and on methods for detecting and measuring TCDD in the environment. Four years later, however, rural citizens of western Oregon disturbed by health effects in their community won a federal lawsuit that banned 2,4,5-T use by the U.S. Forest Service in the Siuslaw National Forest. Citizens Against Toxic Sprays v. Bergland ("CATS").[6] The citizen group won because of the government's failure to consider the effects of TCDD contamination on human health.[7]

B.
EPA TAKES EMERGENCY ACTION AGAINST TCDD-CONTAMINATED HERBICIDES

The CATS case heralded the beginning of the end of 2,4,5-T use throughout the U.S. Within two years, an EPA study correlating human miscarriages with spraying of TCDD-contaminated herbicides in a 1,600-square-mile area of western Oregon involved in the CATS case prompted EPA's emergency suspension of forestry and rights-of-way registrations of 2,4,5-T on February 28, 1979.[8] The "Alsea Study" was named after a small town in the study area.

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6. 428 F. Supp. 908 (D. Oregon 1977). The history of the CATS litigation is given in-depth treatment in Van Strum, note 3 supra. Author Carol Van Strum was a co-founder of the CATS organization and took an active role in the litigation.

7. Judge Otto Skopil's opinion in that case contains a detailed account of 2,4,5-T and TCDD's already disturbing regulatory history through 1977.

8. USEPA. Decision & Emergency Order Suspending Registrations for the Forest, Rights-of-way, and Pasture Uses of 2,4,5-Trichlorophenoxyacetic Acid (2,4,5-T). 44 Fed. Reg. 15874 (March 15, 1979).

EPA's unprecedented action was also based on a Dow Chemical Company animal study showing multigenerational reproductive effects of TCDD at the lowest dose ever tested, one-trillionth of the test animals' body weight per day.[9]

EPA's emergency suspension of 2,4,5-T triggered several years of legal and political battles with Agent Orange and 2,4,5-T manufacturers and with major herbicide users, led by Dow Chemical Co., over the hazards of 2,4,5-T and in particular of TCDD.[10] The U.S. pesticide law[11] required EPA to demonstrate that the risks of continued 2,4,5-T use outweighed any benefits the chemical might bestow on society. EPA's position, well supported by scientific evidence, was that: (a). 2,4,5-T use resulted in contamination of the environment with TCDD; (b). TCDD was extremely stable in the environment and being a lipophilic ("fat-loving") compound would bioaccumulate in living systems; (c). TCDD was extremely hazardous to human and animal health, capable of causing cancer, reproductive effects, and other harm at levels of chronic exposure at least as low as one part-per-trillion; and, (d). no safe level of TCDD exposure could be demonstrated on the

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9. Id. (Discussed in more detail in preceding chapter).

10. After an initial bout of litigation, all issues were combined in a single administrative adjudicative hearing process, In Re: Dow Chemical Company, et al., USEPA FIFRA Consolidated Docket Nos. 415 et al.

11. Federal Insecticide, Fungicide & Rodenticide Act, 7 U.S.C. §§ 136-136y.

basis of available information.[12]

Clearly, the environmental and human health risks of such a poisonous contaminant far outweighed the commercial or social "benefits" claimed by Dow and other 2,4,5-T manufacturers.

C.
THE CHLORINATED DIOXINS WORKING GROUP IS FORMED

During the summer of 1979, however, while EPA's Office of Pesticide Programs prepared to defend its dioxin position in the 2,4,5-T cancellation hearings, non-pesticide dioxin issues threatened to overwhelm EPA's regulatory effort to curb the use of TCDD-contaminated herbicides.

While the agency's position in the 2,4,5-T case was that no safe level of TCDD could be demonstrated and that levels as low as one part-per-trillion posed a significant hazard, TCDD levels thousands of times higher were being discovered in urban manufacturing areas, in waste dumps, and in pollution from both hazardous waste and municipal waste incinerators.[13] In addition, Vietnam War veterans had filed a massive class action lawsuit against chemical manufacturers, claiming damages from the dioxin-contaminated Agent Orange defoliant heavily sprayed by the military in Vietnam.[14] Dow Chemical Co. and other Agent Orange

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12. See Fed. Reg., note 8 supra; see also In Re: Dow Chemical Company, et al., note 10 supra, formal EPA Position Documents.

13. Discussed in more detail infra.

14. See generally, P. Schuck, Agent Orange on Trial (1986).

manufacturers named the U.S. Government as a third-party defendant, arguing that in the event companies were found liable, they should be indemnified by the government for all damages awarded to the hundreds of thousands of injured war veterans and their dependents.15/

EPA's dioxin regulatory dilemma arose because of the different laws the agency administers. Under the pesticide law, EPA could only cancel a product registration if the risks outweighed the benefits.16/ In theory, the pesticide law's "risk-benefit analysis" requires that a dollar's worth of economic benefits outweigh ninety-eight cents worth of cancer. Under other laws applicable to TCDD in non-pesticide settings, however, the Agency has no such discretion to engage in risk-benefit analysis, and is required to ignore economic costs to industry in protecting public health. Under those statutes, EPA must ban pollutants where no "margin of safety" can be established.17/ To set a TCDD standard in accordance with these "margin of safety" laws consistent with the agency's "no safe dose" position on TCDD in the 2,4,5-T hear-

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15. Id.

16. See Save Our ecoSystems/Merrell v. Clark, 747 F.2d 1240 (9th Cir. 1984) (Federal Insecticide, Fungicide & Rodenticide Act requires balancing of risks against benefits, not regulation based on safety).

17. See W. Ruckelshaus, Science, Risk & Public Policy, 21 Science 1026 (September 9, 1983) (calling for repeal of all statutes governing toxic substances and replacement with common statutory formula allowing risk-benefit analysis in place of margins of safety).

ings would mean setting a legal TCDD limit so low that it would result in economic havoc to a wide range of industries producing dioxin pollution, such as the chemical, pharmaceutical, waste disposal, wood treatment, and leather-tanning industries.[18] Such a safety standard would also have far-reaching implications in the Vietnam veterans' class-action lawsuit, where the U.S. government and several major chemical companies were potentially liable for billions of dollars in damages.[19]

Another facet of EPA's dioxin dilemma was posed by the Agency's efforts to deal with the U.S.'s growing "trash" problem. Charged with responsibility to implement the Resource Conservation & Recovery Act,[20] EPA officials had become the leading advocates of municipal waste incinerators as a method of reducing trash volumes and converting trash to electricity. At the same time, however, evidence had begun to mount that municipal waste incinerators were a major source of dioxin pollution. A "no safe level of dioxin" regulatory position would spell the immediate end to EPA's incinerator program under the "margin of safety" laws.

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18. Former Administrator Ruckelshaus later predicted a dire fate if the "margin of safety" statutes were not repealed. Unless they were, he said, "I fear we will have set up for ourselves a grim and unnecessary choice between the fruits of advanced technology and the blessing of democracy." 221 Science 1028.

19. Beyond the prejudicial impact alone of such a standard, any scientific evidence of dioxin hazard developed for regulatory purposes could be used by the veterans to demonstrate the validity of their claims.

20. 42 U.S.C. §§ 6901-6987.

An internal EPA reorganization ensued, with control of actions relating to TCDD transferred to officials who were more concerned with economic impacts than with protecting public health.

The evidence against TCDD being developed by EPA's Office of Pesticide Programs in the 2,4,5-T hearings created a problem not only for other branches of EPA such as its Office of Solid Waste, 21/ but also for other branches of government such as the Department of Defense (responsible for Agent Orange) and the Veterans Administration, which faced the prospect of providing care and compensation for hundreds of thousands of ailing veterans.22/ To address this dilemma, Steven D. Jellinek, EPA's Assistant Administrator for Toxic Substances, engineered the formation of EPA's

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21. See e.g., USEPA Office of Toxics Integration. Undated issue briefing document, re: "OTI's Role with Chlorinated Dioxins" (circa spring, 1981) ("while OPTS is trying to cancel the registration of 2,4,5-T because of its dioxin contamination, the Office of Solid Waste is promoting resource recovery (from trash incineration) and operating with uncertain data as to the dioxin content of the effluent"). See also note *40 infra.

22. See USEPA CDWG. January 10, 1980 Toxic Substances Priorities Committee Briefing Document on Chlorinated Dioxins, pp. 1-2:

> "While current Agency attention and resources are focused on cancellation proceedings for [2,4,5-T and Silvex], developments elsewhere concerning CD's are rapidly overtaking EPA and the Federal Government as a whole. These include: Ongoing Epidemiologic Studies. The results of studies by the Veterans Administration, Mt. Sinai Medical Center, NIOSH, USDA, and FDA, among others, will have significant ramifications for EPA's regulatory . . . activities involving [TCDD]. . . . The VA and the DoD have been named in suits brought by Vietnam veterans requesting damages for health effects attributable to exposure to Agent Orange[.]"

Chlorinated Dioxins Work Group (CDWG), an intra-agency group charged with coordinating all EPA activities and information relating to dioxins. Jellinek's stated motives in establishing CDWG were to ensure that EPA retained the lead among all federal agencies in dioxin-related actions, and to "coordinate agency activities with respect to the ongoing 2,4,5-T/Silvex proceedings . . . and other long-term activities for which the actions of one office may have policy implications for the others."[23/]

At about the time CDWG was formally established in September, 1979, Jellinek hired Dr. Donald Barnes as his special science advisor and asked him to "sit in" on CDWG meetings.[24/] Within a few months, however, Dr. Barnes was co-chairman of CDWG,[25/] which during these months had totally reversed its dioxin policy.[26/]

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23. S. Jellinek, USEPA. Undated memorandum (circa September, 1979), to CDWG members, re: identification of near-term and long-term objectives for CDWG.

24. D. Barnes, USEPA. August 26, 1983 memorandum, re: Five Rivers, DMP, and Me.

25. Id.

26. The regulatory dilemma unquestionably was foremost on CDWG's agenda:

> "While the 2,4,5-T and Silvex cancellation proceedings clearly have priority, they should neither preclude the development of a broader agency approach to the dioxins problem, nor hinder program responsiveness to issues such as the development of policies governing cleanup of contaminated waste disposal sites or the development of environmental standards. The Agency is approaching a critical juncture where certain adjudicatory positions [i.e., the 2,4,5-T and Silvex proceedings] will need to be accommodated with regulatory and technical ones, not solely the other way around."

and effectively assumed leadership of one of the most politically sensitive regulatory programs in the U.S. The public has never been advised of Barnes' extraordinary control over EPA dioxin issues.27/

Instead of coordinating other EPA actions to be consistent with its "no safe level" policy in the 2,4,5-T hearings, which was CDWG's highest priority at the outset, CDWG now emphasized the need to tailor its 2,4,5-T policy to accommodate other dioxin concerns, e.g., air and water pollution standards, which are subject to "margin of safety" requirements.28/ Dr. Barnes also

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USEPA Chlorinated Dioxins Work Group Draft Briefing Document on Chlorinated Dioxins, at 1 (October 24, 1979) (emphasis added).

27. How Barnes obtained his expertise and more importantly his far-reaching influence and power over dioxin-related issues -- extending into several other federal agencies through interagency dioxin working groups -- remains a mystery. For the nine years before he was hired by EPA in 1979, he headed the chemistry department at tiny St. Andrews Presbyterian College in Laurinberg, North Carolina, during which period he apparently neither published any dioxin research nor attracted any notice from scientists and citizens who have been involved with dioxin issues for more than a decade. The only time he was questioned by Congress on his background, he gave almost no information. U.S. H. Hearing Rept. 98-73, Hazardous Waste Contamination of Water Resources: EPA Implementation of the Superfund Program and Lead Pollution Problems in Dallas, TX. Com. on Pub. Works & Trans., Subcom. on Invest. & Oversight, 98th Cong. 1st Sess., at pp. 60, 76. American Men & Women of Science records a Chemistry Ph.D received from Florida State University in 1967, with a three-year teaching stint there, followed by his move to St. Andrews in 1970, and particular interest in identifying chemical pollutants. It also mentions concurrent employment in 1977-78 as a staff member for the EPA Assistant Administrator for Toxic Substances.

28. See discussion of statutes and implications by W. Ruckelshaus, note 17 supra. See also USEPA. April 24, 1980 CDWG Dioxin

served as "liaison" between the 2,4,5-T litigation team and the Assistant Administrator's office,[29] as well as EPA representative on federal interagency groups concerned with Agent Orange, with phenoxy herbicides, and with other dioxin-related issues, coordinated directly from the White House Office of Policy Analysis.

D.
DOW CREATES A STALEMATE

Competing factions and interests within government and new information on dioxins gave Dow Chemical Company the opportunity to create a regulatory stalemate, halting at least by 1981 any further federal regulatory pronouncements that TCDD causes unacceptable human health effects.

In 1979-1980, EPA was locked into its 2,4,5-T regulatory position and could not withdraw without major political embarrassment; but internally EPA's house was not in order. Its top administrators and many civil servants were firm in their intention to ban 2,4,5-T. Other factions, however, were just as adamantly opposed to the Agency's "no safe level" position on TCDD.

At the very time CDWG was being established, EPA researchers

Sources Subgroup draft meeting notes at pg. 2 (discussing whether EPA's Air Program would regulate dioxin emissions; issue is "Zero emission under the Clean Air Act (CAA)? Or will the problem be treated under the risk/benefit approach of TSCA and RCRA?"); note 38 infra.

29. Van Strum v. Thomas, Civil No. 84-6484-E (D. Oregon), October 28, 1986 Affidavit of Dr. Donald Barnes, pp. 5-6, 9.

were returning to Oregon to collect further samples and epidemiological data in support of the Alsea Study.

> "[I]n the Alsea Study, the EPA [was] unable to conclusively establish that the women who suffered miscarriages carry TCDD in their bodies. The link remains one of apparent cause and certain effect, absent the means of transmission. [There is no] smoking gun. . . . The EPA is just now beginning to analyze more rigorously samples of soil, water, deer and elk meat, and human mothers' milk from Alsea. If TCDD dioxin turns up in any of them, EPA will have little difficulty upholding the suspension and perhaps banning the herbicides forever."[30]

Meanwhile, EPA during 1979 and 1980 began to present its evidence of TCDD toxicity in the 2,4,5-T hearings, and CDWG became increasingly overwhelmed with work on dioxin emissions from municipal, industrial, and toxic waste incinerators.

Dow exploited new research indicating that there were far more sources of TCDD than its herbicides. Dow, major manufacturer of Agent Orange and 2,4,5-T, and chief suspect in TCDD contamination of fish downstream from its Midland, Michigan headquarters, had published a novel scientific theory that absolved Dow -- and anyone else -- of culpability for dioxin pollution. Dow's "Trace Chemistries of Fire" report suggested that dioxins are a natural product of all combustion sources (Dow's "God makes dioxin" theory) that have been present in the environment since "Prometheus

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30. J. Smith, EPA Halts Most Use of Herbicide 2,4,5-T, 203 Science 1090, 1091 (March 16, 1979).

stole fire from the gods and brought it to mankind."31/ Dow's lawyers argued that because dioxins were a naturally-occurring substance ubiquitous in the environment, impossible to regulate effectively, and because the contribution of TCDD from 2,4,5-T use was so miniscule, it would be an abuse of discretion for EPA to ban 2,4,5-T. To support this argument, Dow presented evidence of dioxin-laden fly ash and soot from European municipal incinerators.32/

To anyone familiar with the scientific and regulatory maneuvering, Dow's conclusion of a natural origin for significant amounts of TCDD pollution was preposterous. EPA scientific witnesses soundly repudiated Dow's self-serving theory in the 2,4,5-T hearings, demonstrating that combustion only of certain precursor materials could produce dioxins: chlorines, phenols (benzenes), the already notorious polychlorinated biphenyls (PCBs), polyvinyl chloride, other chlorinated hydrocarbons, and related com-

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31. R. Rawls, Dow Finds Support, Doubt for Dioxin Ideas, 57 Chem. & Engr. News 23-29 (February 12, 1979); see also Dow Chemical Co. The Trace Chemistries of Fire -- A Source of and Routes for the Entry of Chlorinated Dioxins into the Environment. 1978; later published as R. Bumb, et al. Trace Chemistries of Fire: A Source of Chlorinated Dioxins. 210 Science 385 (October 24, 1980). For an EPA rebuttal, see F. Kover, USEPA. August 8, 1978 interim status report 8EGQ-0778-0209 to J. Merenda, reprinted in U.S. H. Hearing Rept. 68, EPA Oversight On Dioxin Contamination, Com. on Science & Tech., Subcom. on Nat. Res., Agr. Res., & Env., at pg. 392 (March 23, 1983).

32. See e.g., Testimony of Dr. O. Hutzinger, Dow Exhibit No. 870, In re: The Dow Chemical Company et al, USEPA FIFRA Consolidated Docket Nos. 415 et al; see also sources cited in note 31 supra.

pounds.[33] Dow's gambit, however, led to dominance within EPA of those like Barnes who were trying to slow the regulatory onslaught against TCDD. It was now clearly established that TCDD pollution was a far broader and more serious problem than previously believed; furthermore, the economic impact of dioxin regulation would be huge. As information CDWG was amassing demonstrated, dioxin and its precursor materials are prevalent in a wide variety of industrial processes and in consumer products and wastes destined for combustion sources.

A single municipal waste incinerator at Hempstead (Long Island), N.Y., for example, was emitting TCDD at an estimated rate of seven grams per month before its management closed it down.[34] The Hempstead incinerator was located directly upwind of a Federal Aviation Administration (FAA) office building, where office workers filed 160 formal complaints in 1979 and 1980 of numerous illnesses related to the incinerator fumes.[35] The FAA formally requested EPA to investigate, but only after FAA officials announced their intent to conduct their own dioxin analyses did EPA agree to perform analyses.[36] While EPA deliberated over

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33. USEPA, Health Assessment Document for Polychlorinated Dibenzo-p-dioxins. EPA Report No. EPA/600/8-84/104F (September, 1985), pp. 4-15 through 4-17.

34. USEPA. notes of August 6, 1980 Toxic Substances Priorities Committee meeting.

35. USEPA CDWG meeting summary at 1 (May 5, 1980).

36. Id.

sampling protocols, a citizen group and local officials forced the incinerator to close down until EPA issued a safety standard for dioxin emissions.37/ (Because no EPA standard for incinerator dioxin emissions has been developed, the incinerator remains inactive.38/)

By June of 1980, the EPA pesticide division's limited facilities to analyze samples for TCDD were overwhelmed with requests for sample analyses by other offices responsible for the "new" sources of TCDD.39/ A vastly expanded effort would be needed to match the skyrocketing regulatory demand for low-level dioxin analyses with no limit in sight because "dioxin contamination of . . . the environment is also increasing," the head of the pesticide division said in a letter requesting an expanded budget

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37. USEPA Office of Toxics Integration document, note 21 supra.

38. EPA's Toxic Substances Coordinating Committee (TSPC) apparently rejected the idea of complying with any of the Agency's statutes at Hempstead. The draft agenda of the TSPC's August 6, 1980 meeting indicates that it was scheduled to decide the issue as the first agenda item:

> "1. Dioxins. Report of work of Chlorinated Dioxins Work Group and subgroups. If TCDD is present when Hempstead Resource Recovery Corp. samples are analyzed, what should EPA do? Regulate using Clean Air Act -- which could result in closing all resource recovery facilities if TCDD is added to CAA [Clean Air Act §] 112 list? Regulate using TSCA -- which may allow the benefits of using resource recovery facilities to be weighed against the damage done by TCDD?"

39. E. Johnson. June 26, 1980 memorandum to S. Jellinek, USEPA, re: Pesticides and the Dioxin Monitoring Program, pg. 4.

for dioxin monitoring.[40]

Barnes, however, blamed EPA's "no safe level" regulatory position:

> Improving analytic capability (now roughly at or near 10 parts per trillion (ppt) for most media) may be the most critical factor in the broadening scope of the 'problem,' given our legal position on health effects in the 2,4,5-T and Silvex cancellation proceedings.[41]

By the end of 1980, the magnitude of EPA's dioxin dilemma was overwhelming and Dow's ploy had succeeded. There was no question that TCDD was one of the most exquisitely deadly molecules ever released on the planet. While EPA's pesticide division reasonably desired to stop at least one major source of dioxin by cancelling 2,4,5-T use, the Agency was also reeling from the sudden discovery of vast quantities of highly contaminated dioxin wastes accumulated from decades of industrial production, exposing humans and major portions of the North American environment to high TCDD levels in addition to those resulting from 2,4,5-T. In addition EPA, in particular CDWG, was acutely aware by this time that a broad array of industrial processes and products -- including pulp and paper manufacture -- were potential sources of dioxin pollution,[42] either through direct emission of dioxins or through

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40. Id.

41. USEPA CDWG. January 10, 1980 Toxics Substances Priorities Committee Briefing Document, pg. 4.

42. USEPA, Dioxins, EPA -600/2-80-197, pg. 89 (1980). (listing potential sources). Barnes was aware of this information since he personally conducted an extensive review of the report drafts.

emission of precursor materials that would form further dioxins when exposed to kinetic energy,[43] as in waste incinerators.

To cancel 2,4,5-T's registration on the basis of a "no safe TCDD level" regulatory position would inexorably lead to economic havoc under EPA's "margin of safety" statutes. Furthermore, final EPA action upholding the validity of the Alsea Study would likely lead to a unprecedented award of damages to Vietnam veterans in the Agent Orange class action lawsuit.

The result was regulatory paralysis.

43. See Chapter VIII for discussion of dioxin formation pathways.

IV.
THE DAWNING OF THE REAGAN ERA

The dioxin regulatory stalemate continued until the Reagan Administration took over EPA's reins in 1981.

The new Administration's solution to EPA's dioxin dilemma -- indeed, to all toxic substances issues -- was simple and direct: control public opinion about dioxin and thereby relieve the pressure for any regulatory action at all. By March, 1981, the Chlorinated Dioxins Work Group had taken two major steps toward implementing this solution.

First, the entire EPA Dioxin Monitoring Program, which had been developed and administered for almost a decade by EPA's Office of Pesticide Programs, was transferred personally to Donald Barnes, co-chairman of CDWG, who was to re-establish the program under the Office of Research & Development in June, 1981.[1/] By this maneuver, all EPA dioxin research, especially all laboratory analyses of environmental samples for TCDD, was consolidated under the control of CDWG. Furthermore, all "planned or actual field sampling and analysis of 2,3,7,8-tetrachlorodibenzo-p-dioxin (or

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1. D. Barnes, August 26, 1983 memorandum, "Five Rivers, DMP & Me."

TCDD as it is sometimes called), isomers of chlorinated dioxins or related precursor materials" were to be reported in writing to Donald Barnes, who was to control public release of all such information.[2]

The second major step in the new public-relations approach to dioxin regulation occurred simultaneously with the transfer of the Dioxin Monitoring Program in March. With the "risks" phase of the 2,4,5-T hearings concluded and on the eve of the "benefits" phase, EPA suddenly reached an agreement with Dow in February, 1981, to recess the hearings indefinitely in order to conduct secret negotiations aimed at an out-of-court settlement of the 2,4,5-T controversy.[3] Timber and agricultural advocates of 2,4,5-T triumphantly predicted its imminent return to the market, and because the negotiations were closed to the public, the industry participants' prediction was distinctly plausible.[4]

With 2,4,5-T about to be exonerated, and with all TCDD studies under the tight rein of Donald Barnes and CDWG, EPA would

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2. S. Gage, USEPA Office of Research & Development. July 9, 1980 memorandum to all ORD Laboratory Directors, re: "Reporting of Dioxin Analyses by Laboratories."

3. USEPA. 2,4,5-T and Silvex Products; Intent to Cancel Registrations of Pesticide Products Containing 2,4,5-T and Silvex; Revocation of Notices of Intent to Hold a Hearing to Determine Whether Certain Uses of 2,4,5-T or Silvex should be cancelled. 48 Fed. Reg. 48434 (October 18, 1983); see also NCAP Staff, The Saga of 2,4,5-T, NCAP News, Journal of the Northwest Coalition for Alternatives to Pesticides, pp. 4-5 (Fall/Winter, 1981-82); C. Trost, Elements of Risk, pg. 195 (1984).

4. NCAP Staff, note 3 supra; see also note 34 infra.

be able to control public opinion about dioxin through tightly-controlled information releases. Instead of issuing dioxin standards for waste disposal and cleanup efforts, EPA and other involved federal agencies would merely suggest "levels of concern" as advisories to individual states, relieving EPA from responsibility for dioxin regulation and enforcement.5/

A.
THE GREAT LAKES: THE ORIGIN OF 'LEVELS OF CONCERN'

EPA's "levels of concern" strategy was particularly appealing at the time, because in late 1980 the Canadian government began pressuring the U.S. government to investigate the source of high TCDD levels found in the Great Lakes area.

On December 2, 1980, the Canadian government released a report on dioxin contamination of gull eggs in the Great Lakes area. The report included data on high levels of dioxin in gull eggs and tissue from Saginaw Bay and other areas of the Great Lakes region. "All herring gull egg and muscle tissue analyzed contained detectable levels . . . of TCDD," with by far the highest concentrations found in Saginaw Bay gull colonies.6/

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5. See testimony of S. Miller, Director, U.S. Food & Drug Administration, in, U.S. House Hearing Rept. 78, Dioxin--The Impact on Human Health, Com. on Science & Tech., Subcom. on Nat. Res., Agr. Res. & Env., 98th Cong., 1st Sess., (June 30, July 13, 28, 1983) pg. 82 (TCDD "concern level . . . was developed primarily to provide guidance to the individual States that are confronted with the problem").

6. D. Hallett & R. Norstrom, Canadian Wildlife Service, TCDD (2,3,7,8-Tetrachlorodibenzo-p-dioxin) in Great Lakes Herring Gulls

In late December, Canadian Federal Environment Minister John Roberts submitted the gull egg report to the U.S. State Department, urging the U.S. "to undertake a thorough investigation of dioxin pollution in the international waters which form the common border between the United States and Canada."[7] Officials from the Canadian federal government and Province of Ontario met that same month at the U.S. State Department with Donald Barnes of EPA and officials from the Food & Drug Administration, the Department of Interior, and New York State to discuss the gull egg study and its implications.[8]

From this meeting emerged an agreement that over the next few months the FDA and Health & Welfare Canada would jointly study the extent of TCDD contamination in Great Lakes fish, and assess the "health significance" of such findings while EPA Region 5 and Environment Canada would investigate the sources of Great Lakes dioxin pollution and what to do about it.[9] Throughout the spring and summer of 1981, Donald Barnes "served as an active

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(Dec. 2, 1980).

7. Testimony of V. Adamkus, USEPA Region 5 Administrator, in U.S. H. Hearing Rept. 98-81, EPA: Investigation of Superfund and Agency Abuses (Part I), Com. on Energy & Com., Subcom. on Oversight & Inv. at pg. 498 (February 17, March 7, March 18, March 21, 1983).

8. Statement of Donald Barnes (April 4, 1983) in USEPA Office of Inspector General report on Conflict of Interest Investigation of Deputy Administrator John Hernandez, File No. 1-83-036, pg. 120 (July 14, 1983).

9. Id.

observer in the FDA/Canadian deliberations" on risk.[10]/

Internally, EPA scientists noted that the TCDD levels in Great Lakes fish were high enough to cause a very significant increase in cancer rates among consumers.[11]/ If EPA were to announce such a conclusion, however, the U.S. Food & Drug Administration would be forced to quarantine fish from the Great Lakes, with considerable economic impact on commercial fisheries in Canada and neighboring states in the U.S., to say nothing of the public alarm such a quarantine would raise.[12]/

Instead, after several conferences between Canadian and U.S. authorities, with Barnes as an "active observer",[13]/ the FDA simply issued an "advisory" to the affected states, recommending that consumption of fish contaminated with 25-50 parts per trillion TCDD be "limited" to two meals a month and that fish contamination levels over 50 parts-per-trillion represented a

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10. Id.

11. One internal EPA report from this period predicted increased cancer rates as high as 1 out of every 100 consumers "from eating one meal per week of fish which is contaminated at the 10 ppt level -- a level which is about equal to the so-called 'background' level found in all of the Great Lakes herring gulls and some fish samples from U.S. rivers. The predicted risks would be proportionately higher in the contaminated areas and in populations which eat more than one meal of fish per week." USEPA Office of Toxics Integration, undated memorandum on "OTI's Role with Chlorinated Dioxins."

12. Testimony of S. Miller, note 5 supra, in House Report, pg. 81.

13. Statement of D. Barnes, note 8 supra.

possible hazard.[14/] Consumers, of course, would have to rely on government-determined "average" TCDD levels for particular fish and locations, and were never told of EPA's conclusion that as low as 10 parts-per-trillion TCDD in fish -- far below the Food & Drug Administration's "advisory" -- could significantly increase cancer rates.[15/] Possible reproductive effects apparently were never considered.

B.
GREAT LAKES: EPA ACTS IN DOW CHEMICAL COMPANY'S INTERESTS

During the late spring of 1981, however, the EPA Region 5 office serving the Great Lakes states prepared a draft report on dioxin contamination in the area that categorically defied the FDA's "level of concern" for TCDD levels in fish. Not suprisingly, Don Barnes played a key role in the resulting scandal. The

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14. Testimony of S. Miller, note 5 supra, in House Report at pp. 80-81.

15. FDA itself apparently lacked confidence in its "level of concern." See Testimony of S. Miller, note 5 supra, in House Report at pp. 81-82:

> "It should be recognized that these values are not tolerances or action levels[.] We did not attempt to establish a tolerance for TCDD in fish as that would force FDA to formally prepare and defend the level. Such formal action on the part of FDA would be challengeable in the courts[.] Since there is considerable uncertainty about TCDD's effects on humans, particularly with regard to the question of the sensitivity of humans to various levels of TCDD, the Agency believed that any effort to set an action level or tolerance would be premature and possibly counterproductive."

Region 5 draft report, apparently prepared in accordance with the December meeting with Canadian and Ontario officials, reviewed the extreme toxicity of dioxin, referring particularly to the EPA's Alsea Study, to the 2,4,5-T hearing evidence, and to reported ills of Agent Orange victims. The report also traced the Great Lakes TCDD pollution to Dow's doorstep in Midland, Michigan. FDA's 25 part-per-trillion "level of concern" was soundly rejected, and the report strongly concluded that dioxin levels found in Great Lakes fish presented a grave cancer hazard to consumers, recommending that "the consumption of fish from the Tittabawassee River, the Saginaw Bay, and possibly other sites in the Great Lakes should be prohibited."16/

Shortly after a draft of the Region V report was sent for review to EPA headquarters in Washington, a copy of it was "leaked" to the Globe & Mail in Toronto,17/ triggering intense media interest from both the Canadian and U.S. sides of the Great Lakes. During the months that followed, Donald Barnes and his then-immediate superior, Deputy Administrator John Hernandez, were instrumental in forcing Region 5 officials to edit the report according to a defensive Dow Chemical Company's wishes, deleting all references to the Alsea Study, to Agent Orange, to Dow as the

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16. J. M. Clark, A Review of Polychlorinated dibenzo-p-dioxins (PCDDs) and Polychlorinated dibenzofurans (PCDFs): Sources and Effects. The various drafts of the report can be found in House Report 98-81, note 7 supra.

17. M. Keating & R. Tyson, Ban fish containing dioxin, report on Great Lakes urges, Globe & Mail (June 13, 1981).

primary source of Great Lakes TCDD pollution, and deleting also the risk information and all recommendations on dioxin-contaminated fish.[18] Because the sanitized report contained no information on risks of consuming contaminated fish, the FDA advisory "levels of concern" remained unchallenged in a public forum until Congressional hearings in the spring of 1983, when Hernandez resigned in disgrace.

Since that time, EPA Region 5 has issued warnings to the public -- based on Dr. Clark's subsequent risk assessments -- that fish in several Great Lakes locations should not be consumed. Those warnings are based on a conclusion that a single part-per-trillion TCDD in fish poses an unacceptable hazard.[19]

C.
EPA SLASHES RISKS: 'LEVELS OF CONCERN' AT TIMES BEACH

The "levels of concern" policy also offered EPA an opportunity in 1982 to resolve a potentially catastrophic dioxin problem that had been festering quietly in the Times Beach area of Missouri near Saint Louis for almost a decade.[20] The illegal

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18. See generally, House Report 98-81, note 7 supra, pp. 391-542.

19. See e.g., J. M. Clark, Risk Evaluation of Data Collected During USEPA's 1984 Field Study of the Midland, Michigan Area, USEPA Region 5 (October 11, 1985).

20. B. Commoner & R. Scott, Accidental Contamination of Soil with Dioxin in Missouri: Effects & Countermeasures, unpublished report on file with Dioxin Information Project, Scientists' Institute for Public Information, N.Y., N.Y. (September 29, 1976); R. Kimbrough et al, Health Implications of 2,3,7,8-Tetrachlorodibenzodioxin

disposal of highly contaminated waste oil on roads, yards, and horse arenas had resulted in appalling dioxin levels, killing horses, pets, and songbirds, and injuring children and adults.[21] The Missouri situation had already received considerable publicity through media investigation of the Agent Orange veterans' plight. To allow continued human exposure to such levels would inevitably lead to further injuries and public alarm. EPA therefore had to take some action.

1. EPA'S 'LEVEL OF CONCERN' TRADES HEALTH FOR EXPEDIENCY

Once again, Donald Barnes played a key role in engineering EPA's policy and actions, which led to EPA's adoption of a one part-per-billion (one thousand times higher than one part-per-trillion) "level of concern" for TCDD in residential soils that would trigger cleanup operations, and in the case of Times Beach, trigger involuntary evacuation of residents. The briefing document on which Assistant Administrator Rita Lavelle's adoption of the one-part per billion "level of concern" was based, however, demonstrates that public health was not an overriding consideration in her decision. The 1 part-per-billion action level, Lavelle was advised, involved the following benefits and draw-

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(TCDD) Contamination of Residential Soil, 14 J. of Toxicology and Env. Health 47, 49-50.

21. Id.

backs if it were used as an action level in Times Beach, Missouri.

"PRO Allows immediate action for Agency, and good press.

Buys time

Allows time for reassessment of Agency risk analysis methods and policies, SAB review, and other scientific review

Allows preparation of public for possible change in policy

Intermediate cost option

* * *

Removes major source of risk

Easily implemented, sampling is relatively inexpensive and easy

CON Not the final solution, the problem will be ongoing until final resolution

* * *

Based on cost and need for immediate action, not total health protection.[22]"

The Times Beach briefing document heralded a radical shift from regulatory control of environmental hazards to control of public information and opinion. From this inauspicious beginning, the one part-per-billion "level of concern" became the baseline for EPA action on dioxin nationwide and was interpreted by the media -- with no attempt at correction by EPA -- to be a "safe" level of TCDD.

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22. September 24, 1982 Briefing Document on Region VII Dioxin Issues for Assistant EPA Administrator Rita M. Lavelle. (Emphases added.) Reprinted in appendices to this report.

2.
EPA SCIENTISTS ARE GAGGED

As the Lavelle briefing document makes clear, government scientists would be expected to tailor their risk assessments to support previously made management decisions. Moreover, as demonstrated by former Acting Administrator John Hernandez' suppression of the Great Lakes TCDD report, EPA scientists were expected not to make public statements that might alert the public to the hazard of TCDD.

The appalling evidence of dioxin hazard developed in the 2,4,5-T hearings smoldered behind the closed doors of negotiations with Dow, while the scientists who developed that evidence were forbidden by Agency lawyers and administrators to publish their dioxin studies or to discuss them in public.[23/] EPA's "preparation of [the] public" for a radical change in dioxin policy was well orchestrated and thorough; even today, the one part-per-billion "level of concern" is cited again and again as a safe level of TCDD exposure.

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23. See e.g. J. Griffith, University of Miami Dept. of Epidemiology & Public Health (lead researcher on EPA's Alsea Study on human miscarriages in Oregon linked to 2,4,5-T use) April 4, 1980 letter to Edwin L. Johnson, Deputy Assistant Administrator of EPA Office of Pesticide Programs ("I feel constrained to point out that everyone associated with the development of the Alsea study has been restrained from speaking against the negative comments on the study and on the capability and veracity of those involved in its development, conduct and interpretation . . . I believe [the gag order issued by EPA administrators] may be causing much of the negative thought and non-support expressed by [Hazard Evaluation Division] staff to [the Office of General Counsel.]").

The picture that emerges is one of an agency acting largely to protect polluting industries, rather than to protect public health and the environment. Furthermore, that focus extended to other federal agencies concerned with TCDD, through the inter-agency working groups now coordinated from the White House by Maj. Alvin Young, a U.S. Air Force scientist who had a key role in developing Agent Orange as a weapon in Vietnam.[24/]

3.
EPA'S LEVEL OF CONCERN ACQUIRES CREDENTIALS

In 1984, the 1 part-per-billion "level of concern" acquired some of the trappings of respectability with a U.S. Centers for Disease Control (CDC) published paper justifying the CDC's initial approval of the "level of concern" for Times Beach, Missouri, dioxin-tainted soils in 1982.

The CDC paper is no more than a post-hoc rationalization for EPA's economic-based decision. With the abandon of dedicated numerologists, CDC scientists juggled and excised available data on TCDD to fit Rita Lavelle's cost-effective 1 part-per-billion level to an acceptable elevated risk of one more cancer death per million exposed persons. To accomplish this feat, the CDC rejected all data on reproductive and immune system effects of TCDD because neither a "no-effect level" nor a dose-response

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24. Young coordinated most of the Air Force's research to develop techniques for aerial application of Agent Orange. He has been closely involved in dioxin issues since the issue evolved.

relationship could be determined, thereby transforming a purported lack of information itself into a no-effect level.25/ The risk assessment also assumes that TCDD does not itself cause cancer, but functions only as a cancer promoter, yet CDC proceeds to quantify the risks of cancer promotion without exploring or measuring what other carcinogens are present for the TCDD to promote.26/ Furthermore, as discussed in Chapter 1, EPA had

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25. For example, Kimbrough et al replicated Dow's arguments on why reproductive effects at the 1 part-per-trillion dose level might not be related to TCDD exposure, concluding that risk assessment was impossible for those reasons. In a somewhat startling logical leap, the CDC team then simply ignored potential reproductive effects and based the entire risk assessment on cancer studies. A similar tactic was used on immunological effects.

A major defect of current risk assessment technique is that it routinely considers only the endpoint of cancer and ignores the more immediate and pervasive nature of reproductive and immunological effects. See National Research Council of the U.S. and Royal Society of Canada, The Great Lakes Water Quality Agreement: An Evolving Instrument for Ecosystem Management, pg. 72 (1985):

> "For example, a low dose of chemical with a reproductive effect (e.g., effects on oogenesis, fertility or conception) may result in a slight impairment of fertility in all exposed individuals. With the endpoint of cancer, however, only some of the exposed individuals will contract the disease."

(Emphasis added.)

26. This is irrational for several reasons, including: First, implicit in the assumption that TCDD functions only as a cancer promoter is the assumption that in the absence of any other carcinogens to promote, TCDD will have no effect whatsoever. Second, to assume that carcinogenic effects will occur nonetheless, as the CDC researchers did, is to assume that TCDD is a carcinogen, rather than a cancer promoter. Third, any attempt to assess the effects of TCDD as a promoter would have to take account of the fact that TCDD-contaminated oils spread at Times Beach were "prob-

already recognized in the 2,4,5-T hearings that:

> "There is no theoretical basis for making even ballpark estimates of the risk posed by promoters and cocarcinogens to exposed persons because the mechanism for promotion is not well understood and because the degree of total exposure of the human population to the numerous carcinogens in the environment cannot be well quantified."[27]

Furthermore, in order to reach its 1 part-per-billion "virtually safe dose" criterion, CDC had to make the following assumptions: (1). that people would not be exposed to any source of TCDD other than the contaminated soil (e.g., fish, beef, pork, and both human and cows' milk);[28] (2). that people would only be exposed to the soil for six months of the year; and (3). that TCDD levels in all residential soils decrease with time, i.e., that no further or increasing contamination would occur from continuous manufacturing or combustion sources, pesticide applications, etc.

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ably mixed with PCB's and other pesticides," an obvious source of candidates for cancer promotion. See USEPA Chlorinated Dioxins Working Group meeting notes, January 7, 1983. Fourth, in any event, no theoretical basis exists for assessing the risks of cancer promoters. See Albert Testimony, discussed above.

27. See Chapter 1, note 10, and accompanying text.

28. See e.g., Kimbrough, note 20 supra, at pg. 82. In setting levels of concern for TCDD-tainted meat, milk, fish, etc., in the same paper, Kimbrough et al never considered the cumulative exposure from 1 part-per-billion TCDD in soils and exposure through all other routes, which was excused only by a caveat that the assessment only applied to the narrowly-defined type of site found at Times Beach. For the nursing infant, the failure to even consider exposure through contaminated mothers' milk is particularly troubling because its total diet will contain the accumulated residues from the mother's continuous exposure. See Chapter 1, note 13 supra.

Finally, the CDC paper itself acknowledged that it would be invalid if applied to any polluted media other than residential soils, or if there were any additional exposure from other sources.

It is this risk assessment that has been cited by EPA ever since to establish the "safety" of TCDD wherever it occurs.29/

4.
HEADS ROLL AT EPA

In early 1983, within a few months of the Times Beach evacuation, EPA Administrator Anne Gorsuch Burford and her assistant Rita Lavelle were forced from office, in large part for their misconduct and mishandling of the Missouri situation, but Barnes and CDWG escaped Congressional scrutiny unscathed. Shortly thereafter, Burford's successor, Acting Administrator John W. Hernandez, also resigned in disgrace following Congressional hearings into the suppression and altering of the 1981 Region V report on dioxin in the Great Lakes area, but again the role of Barnes and CDWG somehow eluded Congressional censure. In both cases, members of Congress attacked political appointees, but left the real decisionmakers, the bureaucrats, in place to continue misleading the public about the known hazards of dioxin.

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29. Id. pp. 81-82, e.g.: "If contaminated soil is close to waterways and can contaminate these waterways by way of erosion, acceptable levels may also have to be lowered, since fish can bioconcentrate TCDD 20,000-fold or more." (Citations omitted).

D.
RUCKELSHAUS CONTINUES 'LEVELS OF CONCERN' INSTEAD OF SAFETY LEVELS

Following the downfall of Dr. Hernandez, President Ronald Reagan reappointed former EPA Administrator William D. Ruckelshaus with great fanfare as the White Knight who would restore EPA's tarnished image. One of the first public acts taken by Ruckelshaus was delivery of a speech to the National Academy of Sciences in June, 1983.30/ Without ever mentioning dioxin, Ruckelshaus left a message that unequivocally described EPA's dioxin dilemma.31/

The two major obstacles to efficient toxic substance regulation, he said, were the conflicting standards demanded by different laws -- some requiring a margin of safety standard, others allowing cost-benefit analysis -- and the lack of coordination and consistency among various EPA programs and other federal agencies. "We must now deal with a class of pollutants for which it is difficult, if not impossible, to establish a safe level," Ruckelshaus said. "The administrator of EPA should not be forced to represent that a margin of safety exists for a specific substance at a specific level of exposure where none can be scientifically established," he said; "this is particularly true where the ina-

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30. W. Ruckelshaus, Science, Risk, and Public Policy, 221 Science 1026 (September 9, 1983).

31. Testimony of D. Barnes, House Report 78 note 5 supra, pp. 90, 94 (Ruckelshaus' statements applicable to TCDD).

bility to so represent forces the cessation of all use of a substance without any further evaluation."32/ Instead, Ruckelshaus proposed omnibus legislation replacing "margin of safety" laws with a "common statutory formula" for assessing and managing risks by weighing them against "benefits."33/

Ruckelshaus correctly predicted great difficulty in persuading Congress to adopt such a uniform toxic substance law, but his speech revealed that EPA had not bothered to wait for Congressional approval to engage in risk-benefit analysis. "This is what we now do at EPA and it makes sense," he said. In a flood of noble rhetoric, he served notice that EPA was to continue business as usual under his administration.

"Business as usual" at that time meant engineering public acceptance of "levels of concern" in place of safety standards, setting the stage for bringing 2,4,5-T back on the market, and

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32. Ruckelshaus thus came very close to suggesting that EPA, under his administration, would falsify risk assessments rather than take required legal action against toxic chemicals; in other words, EPA's bedroom was still open only to regulated industries.

33. Ruckelshaus has continued to stump for such legislation after he resigned as EPA Administrator to enter private practice as a lawyer in Bellingham, Washington, and at least in one instance, held legislative strategy meetings with Dow Chemical Co. board members and executives. Ruckelshaus Urges Changes in Laws, 39 Dow Today 1 (April 24, 1985) (publication of Dow Chemical Co.) ("Many of the laws that govern environmental issues today were based on flawed assumptions . . . Clear explanation of the risks versus benefits of environmental issues would help to ease the public's fear"); see also 221 Science at 1028 ("I believe such an effort touches on the maintenance of our current society, in which a democratic polity is grounded in a high-technology civilization").

sweeping under the rug all the evidence amassed by EPA of dioxin's extreme hazard. The message moving through the "grapevine" at EPA following Ruckelshaus's speech was that Dow and EPA were about to settle the 2,4,5-T proceedings and bring the herbicide back to market with a minimally qualified clean bill of health.34/ Arbitrary levels of concern -- reached in secret agreements between CDWG and the various other federal agencies with whom Donald Barnes served as liaison on dioxin matters35/ -- could then be applied to all dioxin sources, especially the new breed of hazardous waste incinerators being hailed as a solution to waste disposal.

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34. These rumors were confirmed by John Hernandez' later admission that the reason for squelching portions of the Great Lakes dioxin report was that those portions were inconsistent with the position EPA was about to take in the 2,4,5-T proceedings. See Statement of John Hernandez, in EPA Inspector General's Report, note 8 supra, at pg. 163 ("It appeared to me that what was in the first part of the report might be at odds with what kinds of conclusions we were going to draw on the basis of that large body of information" in the 2,4,5-T hearing record).

35. Barnes chaired the Interagency Regulatory Liaison Group's task group on dioxins, composed of EPA, Department of Energy, Veterans Administration, Food & Drug Administration, National Institute for Occupational Safety & Health, Occupational Safety and Health Administration, Department of Health & Human Services, and other agencies. Paul Brown, CDWG's former co-chairman, was "the EPA representative to the Interagency Work Group on the Long Term Health Effects of Phenoxy Acid Herbicides and Their Contaminants, a committee established by the White House to investigate matters surrounding the alleged effects of Agent Orange in Viet Nam veterans and the consequences of the domestic use of such herbicides." Office of Toxics Integration memorandum, note 11 supra, at 8.

E.
PLANS GO AWRY: THE END OF 2,4,5-T AND SILVEX

A likely time for announcing a settlement on 2,4,5-T was during the Congressional recess in August, 1983. On August 3, however, the "leak" of two pages of long-suppressed results from the Alsea Study samples effectively sabotaged any attempt to bring 2,4,5-T back to market. The two pages were results of TCDD analyses on the 1979 Alsea study area samples.[36/] Those results -- "Table VII" -- had been repeatedly requested by local residents since 1981, including formal discovery requests in litigation against EPA, but EPA had refused to provide them, telling the court they did not exist.[37/] The results, inadvertently released in late July, 1983, by the EPA contract chemist who performed the analyses,[38/] had been sent to EPA in 1980[39/] and were included in the Dioxin Monitoring Program records turned over to Donald Barnes

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36. In Appendices to this report. "Table VII. Analysis of TCDD in Biological and Environmental Samples ('Alsea, Oregon Phase II Project')."

37. See e.g., S. Abramson, USEPA OPTS, September 1, 1983 draft memorandum to G. Yamada, Deputy General Counsel, re: "Merrell v. Block and the Five Rivers Investigation." See also USEPA Office of Pesticide Programs, Analysis of EPA's Handling of the Five Rivers Investigation (November 22, 1983); Save Our ecoSystems/Merrell v. Clark, 747 F.2d 1240 (9th Cir. 1984) (discussing author Paul Merrell's efforts to obtain results under the Freedom of Information Act).

38. Van Strum v. Thomas, Civil No. 84-6484-E (U.S.D.C. Oregon), October 28, 1986 affidavit of Dr. Michael Gross at pp. 3-4.

39. Id., pp. 2-3; see also id., attached transmittal letters for Data Reports 10 and 12, which are referenced on Table VII.

in March, 1981.[40]

1.
THE 'SMOKING GUN' IS FOUND

Table VII put the lie to EPA's statements in court that no such study existed. Furthermore, the TCDD levels recorded suggested why EPA had covered up and denied the existence of the study. The results were in fact the "smoking gun" predicted by Science[41] in 1979: EPA had found TCDD in drinking water sediment at levels up to 5800 parts-per-trillion -- nearly six times EPA's "level of concern" for residential soils -- and had found low TCDD levels in tissues from wildlife and from a human baby born without a brain,[42] supporting the statistical correlations of the Alsea Study. Most significantly, these levels resulted not from waste dumping or from manufacturing, but from routine use of a chemical widely used in agriculture, for timber and rights-of-way management, and by the military. The missing TCDD causal link, human exposure, had been made. The implications of Table VII for the Agent Orange veterans' class action lawsuit were obvious.

Table VII electrified the media, ever alert for more scandals at EPA, particularly as Ruckelshaus had so recently been appointed

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40. See J. Conlon, USEPA. February 26, 1981 memorandum to D. Barnes (transferring DMP files to Barnes).

41. See Chapter III note 30 supra and accompanying text.

42. An interview with the father of this child before the disclosure is included in C. Van Strum, A Bitter Fog: Herbicides & Human Rights, at pp. 210-14 (1983).

with strong Administration assurances of no further EPA scandals.[43] In a televised interview outside the federal courthouse in Eugene, Dr. George Streisinger -- molecular biologist, National Academy of Sciences member, and EPA's chief witness on the reproductive hazard of TCDD in the 2,4,5-T hearings -- emphasized the significance of Table VII in light of Dow's one part-per-trillion animal study. He also expressed his outrage that EPA had concealed the critical Table VII results from him and other scientists who testified in the 2,4,5-T hearings.[44]

2. EPA'S FALLBACK POSITION: THE 'MIXUP' STORY

The following day, however, EPA issued a press statement announcing an extraordinary mistake: none of the high-level samples on Table VII were from Oregon, EPA said, but were instead from "somewhere in the upper Midwest" and had been included on the table through a clerical error.[45] Two weeks later, the Agency finally took a position on the origin of the samples: in-plant samples gathered in 1978 from Dow's facility in Midland,

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43. A New Brouhaha Over Dioxin, Chemical Week, pg. 12 (August 17, 1983); see also EPA Probes a Dioxin Mystery, pg. 12 (August 24, 1983).

44. Dr. Streisinger's televised interview is on file at Horizon Video, Newport, Oregon. He is now deceased.

45. August 17, 1983 Chemical Week, note 43 supra.

Michigan.[46]/

EPA's preposterous "mixup" story raised eyebrows in both Michigan and Oregon.[47]/ In response to demands from both citizens and members of Congress, EPA Administrator William Ruckelshaus appointed Deputy Administrator Lee Thomas to oversee a full-scale investigation.[48]/ On October 14, as two separate EPA internal investigations of the mixup drew to a close, EPA and Dow simultaneously announced the settlement of the 2,4,5-T hearings with separate press releases on the same day, revealing Dow's voluntary withdrawal from the hearings and EPA's abrupt notice of final cancellation of 2,4,5-T registrations.[49]/ According to EPA insiders, the Table VII "mixup" scandal was responsible for sud-

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46. August 24, 1983 Chemical Week, note 43 supra.

47. For example, EPA's claim that the samples were gathered from inside Dow's plant in 1978 is directly contradicted by Region 5 officials' sworn testimony in the Hernandez Congressional hearings that they had never been able to gain access to Dow's plant to gather such samples, and that this in fact was the reason they had sued Dow in 1983, to gain such access. See House Report 78, note 5, supra at pp. 151-55.

For a detailed discussion of defects in EPA's mixup story, see May 14, 1986 Affidavit of Carol Van Strum, Van Strum v. Thomas, note 38 supra, cross referencing 483 pages of EPA records.

48. EPA Administrator William Ruckelshaus disqualified himself from the issue in accordance with a promise to Congress not to involve himself with issues affecting 2,4,5-T, because of his previous employment by Weyerhaueser Corporation, which had a vested interest in the 2,4,5-T hearings. See August 24, 1983 Chemical Week, note 46 supra.

49. Dow Chemical to Quit Selling Two Herbicides, Ending EPA Battle, The Wall Street Journal, pg. 24 (October 17, 1983); see also Federal Register notice, note 3 supra.

denly scuttling the plan to bring 2,4,5-T back on the market.[50]

Within months of the 2,4,5-T settlement, Dow and EPA also settled EPA's lawsuit to gain access to Dow's Midland plant for dioxin sampling,[51] and Dow engineered the involuntary "settlement" of the Agent Orange veterans' class action lawsuit over the vehement objections of many veterans.[52] Repeatedly referring to the suppressed results of Table VII and to "widespread fraud" in herbicide health testing, in January, 1984 the Ninth U.S. Circuit Court of Appeals banned federal use of all herbicides in the Alsea Study area until they are adequately tested for human health effects.[53] In a still-pending Freedom of Information Act lawsuit filed in Oregon later that year, EPA has been unable to provide proof of its sample "mixup" story despite three years of litigation.[54]

On August 6, 1987, Dow Chemical Company announced in New Zealand that in December, it will close what is believed to be the

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50. The "grapevine" information that Table VII was responsible for the end of the 2,4,5-T battles was confirmed by The Wall Street Journal's report that Dow officials attributed their withdrawal to "renewed scrutiny" of EPA's dioxin program. See article in preceding note. The only renewed public scrutiny at the time involved Table VII and the authors' Freedom of Information Act request, now in litigation.

51. U.S. v. Dow Chemical Company, Civil No. 83-CV 7011BC (D. Mich. E.D.), Consent Decree entered March 30, 1984.

52. See generally, P. Schuck, Agent Orange on Trial (1986)

53. Save Our ecoSystems/Merrell v. Clark, 747 F.2d 1240 (9th Cir. 1984).

54. Van Strum v. Thomas, note 38 supra.

last 2,4,5-T production facility on this planet.

The final demise of 2,4,5-T, the weedkiller that sparked global research on dioxin, came with little fanfare. Ironically, the damning evidence of dioxin's hazard that ultimately doomed 2,4,5-T was effectively buried along with it, leaving federal agencies free to promote "levels of concern" as a false measure of dioxin's safety.

V.
NATIONAL DIOXIN STUDY: PULP AND PAPER MILLS PRODUCE DIOXIN

Following Congressional investigations of the John Hernandez/Rita Lavelle/Anne Burford scandals, Congress in 1983 appropriated $4 million for an EPA study of dioxin nationwide. Although the final report is nearly two years late, the National Dioxin Study's preliminary results led to the discovery that pulp and paper mills are a major source of dioxin pollution, despite EPA and industry officials' best efforts to sabotage and delay the study.

In December, 1983, EPA published its "Dioxin Strategy" outlining the protocols for the study. The strategy itself had been developed by some of the same people involved in the very scandals Congress had been investigating: the Chlorinated Dioxins Work Group, headed by Donald Barnes, and its subgroups, The same groups designated themselves to implement the overall strategy, also to function "as a steering committee dealing with policy and resource issues," and to provide technical expertise.[1/]

Under the Dioxin Strategy, seven site categories referred to as "tiers" were established for dioxin sampling, ranging from the

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1. USEPA. Dioxin Strategy. November 28, 1983.

most probable tier of dioxin contamination to the least probable. Sampling at the first two tiers would be funded through existing appropriations under the U.S. "Superfund" law.[2] The special National Dioxin Study appropriation would pay for sample analyses under tiers 3 through 7.[3] The Dioxin Strategy outlined three major components of the "study:"

a. a comprehensive investigation leading to clean-up at the most contaminated sites;

b. a national study to learn more about the extent of environmental contamination; and,

c. prevention of future contamination through development of control actions and regulations.[4]

A. 'LEVEL OF CONCERN' SABOTAGES STUDY

The entire study was to be implemented by EPA headquarters and regional offices, in coordination with states and other federal agencies. An "important aspect" of the study was to prepare risk assessments for TCDD exposure, to be developed in conjunction with the Food & Drug Administration, the Centers for Disease Control, the Federal Emergency Management Agency, and the Veterans

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2. Comprehensive Environmental Response, Compensation & Liability Act, 42 U.S.C. §§ 9601 et seq.

3. Dioxin Strategy, note 1 supra, pg. 9.

4. Id. pg. 2.

Administration.[5]

The most critical -- and damaging -- element of the National Dioxin Study was the setting of detection limits for analyzing samples. Although the Dioxin Strategy acknowledged that "national criteria or action levels for 2,3,7,8-TCDD have not yet been established," the entire study rests on the one-part-per-billion "level of concern" developed as a political expedient for Times Beach, Missouri by some of the very individuals who designed the National Dioxin Study. At all tiers except the two where the least amount of dioxin was expected (tiers 5 and 7), soil samples would generally be analyzed for dioxin levels only at or above one part-per-billion.

Sample analysis at or above one part-per-billion is far cheaper that the complex, difficult procedures for detecting dioxin at levels below that level, i.e., in the parts-per-trillion or -quadrillion range.[6] Furthermore, because of inevitable dispersion and dilution of any chemical released into the environment, far fewer sites would be contaminated at high levels above one part-per-billion than at lower but still hazardous levels, thereby reducing greatly the number and size of sites requiring regulatory action.

The one part-per-billion detection limit thus undermined the

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5. Id., pp. ii, 2-3.

6. R. Kimbrough, et al, Health Implications of 2,3,7,8-Tetrachloro-dibenzodioxin (TCDD) Contamination of Residential Soil. 14 J. of Toxicology & Env. Health 47, 85-86.

utility and ultimate credibility of the entire National Dioxin study. First, the oft-repeated level perpetuated the dangerous myth of a "safe" dose of dioxin, effectively masking all evidence of dioxin's extraordinary persistence, bioaccumulative potential, and toxicity at levels thousands of times lower than one part per billion. Second, wherever dioxin could not be detected at the one part-per-billion limit, the public could be gulled by technically accurate but misleading statements that no dioxin was detected, leaving a public perception that no dioxin is present, although up to 999 parts per trillion could escape detection or disclosure under the procedures used.[7] Through the National Dioxin Study, the false notion of a "safe" level of dioxin would therefore be compounded by the illusion that dioxin simply doesn't exist below levels of one part-per-billion.[8]

The National Dioxin Study emphasis on the magical 1 part-per-billion level not only limited the number of manufacturing and waste sites to be designated for clean-up operations, but also belittled the seriousness of dioxin contamination at the far greater number of sites where levels were lower. Far more people

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7. The one-part-per-billion detection limit may vary from sample to sample, in a range both above and below that level, and is more properly an average detection limit with a particular method than an absolute barrier to detection below 1 part-per-billion. The crucial point is that the range is far higher than previously used in most TCDD analyses, allowing a "non-detect" reading where samples would show positive under the normally-used methods.

8. See Chapter IV supra for a discussion of how EPA arrived at the 1 part-per-billion "level of concern."

risked exposure from such sources than from the relatively few manufacturing and waste sites.

B.
FISH ANALYSES POINT TO PULP AND PAPER MILL DIOXIN POLLUTION

By implication, EPA's decision nott to take action on -- or indeed even to look for -- dioxin below one part-per-billion at manufacturing and waste sites absolved the agency from any pressure to take action or to warn the public of lower dioxin levels at other sites, which the National Dioxin Study plan effectively dismissed as mere "background" or "control" sites. Preliminary results from analyses of some of these samples would make the link between dioxin pollution and pulp and paper mills. A good portion of the special appropriation for the National Dioxin Study was specifically designated for dioxin testing at a large number of sites "not suspected of being directly influenced by known sources of 2,3,7,8-TCDD."[9/] These sites, comprising Tier 7 of the study, were expected to reveal "background" concentrations of dioxin and to resolve the question whether dioxin contamination may be more widespread than previously documented,[10/] i.e., to test Dow's theory that dioxins are naturally-occuring.

Unlike the bulk of the National Dioxin Study samples, the Tier 7 samples were slated for low-parts-per-trillion analyses.

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9. Dioxin Strategy, note 1, supra, pg. 11.

10. Id., pg. 11.

Most of the samples in tier 7 were fish from streams and estuarine waters throughout the United States and from open waters of the Great Lakes.11/

Samples in Tier 5 of the study, comprising sites where dioxin-contaminated herbicides 2,4,5-T and silvex had been used, were also considered "control" or "background" samples, warranting parts-per-trillion detection limits. All soil, stream sediment and fish samples in Tiers 5 and 7 would be analyzed for dioxin at the parts-per-trillion detection limit because only "background" dioxin levels were expected.12/

EPA released the final version of its National Dioxin Strategy in December, 1983. Sampling for the National Dioxin Study was to continue through 1984, and results were be reported to the public by December 31, 1985.13/

1.
TCDD FOUND IN WISCONSIN FISH

During 1985, however, a disturbing pattern emerged in the results of dioxin analyses of fish from areas where no dioxin was expected. Results of fish samples collected downstream from pulp and paper mills consistently revealed dioxin contamination with no apparent source other than the mills. Although EPA officials

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11. Id., pg. 11.

12. Id., pg. 14.

13. Id., pg. 18.

professed great surprise at this finding, pulp and paper manufacture had been suspected as a source of dioxin pollution since at least 1980,[14] a suspicion confirmed in 1983 by the discovery of more than 50 parts-per-trillion dioxin in fish from a commercial carp fishery downstream from several pulp and paper mills on the Wisconsin River.[15] The Wisconsin Department of Natural Resources closed the commercial carp fishery in the Petenwell Flowage Reservoir that same year.[16]

Wisconsin's 1983 dioxin studies in the 35,000-acre reservoir set the stage for EPA's "surprising" pulp and paper dioxin connection three years later. As part of Tier 5 of the National Dioxin Study, EPA collected a large number of fish and other aquatic creatures from the Petenwell Flowage, as well as waste sludges from the local paper mills, to determine if dioxin contamination continued after the voluntary halt to chlorophenol-based slimi-

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14. USEPA. Dioxins. EPA-600/2-80-197, pg. 89 (1980), citing August 1978 position document on trichlorophenol, 43 Fed. Reg. 34026-34054 (1978).

15. USEPA National Dioxin Study Tiers 3,5,6, and 7 Draft Final Report, pg. 28 (1986).

At the time of the 1983 report, chlorophenol-based slimicides -- used to control slime on pulp and paper machinery -- "reportedly containing 2,3,7,8-TCDD as a contaminant," were being used by several pulp and paper mills along the Wisconsin River; use such slimicides has since been voluntarily halted. Discussed in more detail in Chapter VII, pg. 11, infra.

16. USEPA Tiers 3,5,6, and 7 Draft Report, pg. 28, note 15 supra.

cides. All fish sampled contained dioxin,[17] at levels of 9-47 parts-per-trillion in whole fish and 3-23 parts-per-trillion in the filets.[18] Aquatic sediments from both ends of the Petenwell reservoir contained 34-200 parts-per-trillion dioxin, and sludges from two of the upstream paper mills had dioxin levels over 100 parts-per-trillion,[19] "even though chlorophenol-based slimicides are no longer used."[20]

By the time of this discovery EPA had already concluded that the chlorine-bleaching process in kraft-process mills was a potential dioxin source in addition to past or present slimicide use.

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17. Unless otherwise noted, all "dioxin" results reported from the National Dioxin Study are 2,3,7,8-TCDD.

18. Another misleading practice in the NDS sampling was to skin all filets, thus removing fatty tissue under the skin; because dioxin is stored in fatty tissue, the results are consistently lower than for whole fish, and it is these lower figures that EPA commonly quotes as being the levels in "edible" portions of the fish. Some popular sportfish such as trout, however, are commonly cooked and eaten with the skin on, and the lower levels reported from skinned filets therefore do not reflect -- and likely understate -- the actual levels consumed. Furthermore, such an arbitrary distinction obviously ignores the hazard created to household pets by feeding them contaminated fish-skins.

19. H. Zar, USEPA Region 5. February 14, 1986 memorandum to Addressees, re: Results of Analyses of papermill sludges for 2,3,7,8-TCDD and attached table of results (giving 159 ppt for Consolidated and 128 for Nekoosa); but see D. Kuchl. November 22, 1985 report to R. Russo, Acting Director, OEPER, USEPA, re: Analysis of sludge samples for PCDDs and PCDFs (reporting up to 200 parts-per-trillion); see also H. Anderson, Wisconsin Department of Health & Social Services. January 27, 1986 letter to L. Fabinski, USEPA Region 5 ("we are anticipating the confirmation by the EPA laboratory of 2,3,7,8-TCDD in concentrations up to 200 ppt in sludges from at least two Wisconsin, kraft process mills").

20. Tiers 3,5,6, and 7 Draft Final Report, note 15 supra, pg. 28.

2.
TCDD FOUND IN MAINE AND MINNESOTA FISH

As part of its Tier 7 "background" or "control" sampling for the National Dioxin Study, EPA collected fish samples downstream from pulp and paper mills in Maine and Minnesota; these sites by definition were "not suspected of being directly influenced by known sources of 2,3,7,8-TCDD,"[21] despite the 1983 dioxin/pulp and paper connection earlier demonstrated in Wisconsin. Predictably, the Maine and Minnesota fish samples proved to contain dioxin at levels comparable to those found in Wisconsin, prompting EPA to collect papermill sludge samples for further analyses in all three states.[22]

C.
STATES AND ONTARIO TAKE INCONSISTENT ACTIONS

Without any guidance from EPA on the significance of the dioxin levels in fish, the states of Maine, Minnesota, and Wisconsin reacted quite differently from each other to the sample results. Wisconsin had already closed the commercial carp fishery in Petenwell Flowage in 1983; the Minnesota Department of Health warned against consumption of any fish from the Rainy River from International Falls to Sault Rapids near Birchdale, Minn.

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21. Dioxin Strategy, note 1 supra, pg. 11.

22. USEPA Tiers 2,3,6, and 7 Draft Report, note 15 supra, pg. 46.

(approximately 50 miles) after EPA reported its National Dioxin Study results showing up to 85 parts-per-trillion dioxin in Rainy River fish during 1985;[23] because the Rainy River forms the border between the U.S. and Ontario, Canada along the northern Minnesota boundary, the Ontario government was also informed of the Rainy River fish results, but chose not to issue any fish advisories;[24] and the state of Maine, despite consistent dioxin levels up to 29 parts-per-trillion in three major rivers, chose not to issue any fish consumption advisories.[25]

D.
STATES THREATEN TO TAKE ACTION AGAINST INDUSTRY

All three states and the Province of Ontario initiated further studies of the fish contamination and its sources. These studies led to proposals for state regulatory action that would eventually send industry scurrying to EPA for assistance in fending off the states.

A major concern of the states was the growing use of pulp and paper mill sludges as soil conditioners in land-reclamation projects such as strip mines and as fertilizers on agricultural and

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23. B. Schade, Minnesota Pollution Control Agency. November 6, 1985 letter to C. Sutfin, USEPA Region 5, re: fish samples.

24. Id.

25. For Maine fish levels, see Tiers 3,5,6, and 7 Draft Report, note 15 supra, pp. D-20, D-28; see also Maine Governor's Office, September 10, 1985 press release (no fish advisory).

timber land. Such use would qualify the sludge as a "usable or recyclable resource rather than a waste" -- not subject to the regulatory controls governing wastes -- and would relieve the growing burden of landfill disposal on company or public lands.[26]

In Maine, kraft mills had "voluntarily" halted application of sludge to their own land or to agricultural acreage by December of 1984, after the Maine Department of Environmental Protection raised questions about fish contamination reported by EPA.[27]

1. PULP MILL WASTES AND MORE FISH CONTAMINATED WITH TCDD

During 1985, EPA reported dioxin levels in sludges from five Maine paper companies up to 51.3 parts-per-trillion,[28] prompting extensive controversy and several public hearings over the question of "safe" dioxin levels and the potential hazards of spreading dioxin-contaminated sludge on agricultural or timber land; the following year, the Maine Department of Environmental Protection held a workshop and several public meetings in efforts to establish a statewide limit on dioxin content of sludges used in land-spreading operations.[29]

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26. Wisconsin Department of Natural Resources. January 31, 1986 press release, pg. 3.

27. Maine Governor's Office press release, note 25 supra.

28. W. Walsh, USEPA Region 1 dioxin coordinator. October 11, 1985 memorandum to H. Warren, Maine Department of Environmental Protection, re: papermill sludges.

29. Maine Department of Environmental Protection. February 4,

In early 1986, the Wisconsin Department of Natural Resources asked that spreading of pulp and paper mill sludges on agricultural lands be suspended following EPA's announcement of partial results from the National Dioxin Study showing dioxin levels of 128 and 159 parts per trillion in sludges respectively from the Nekoosa Papers and Consolidated Papers mills on the Wisconsin River. Nekoosa and Consolidated are the only two bleach kraft mills in Wisconsin; at seven other Wisconsin mills,[30] sludge samples ranged from none detected to 74 parts-per-trillion.[31]

2.
INDUSTRY PROPOSES DIOXIN STUDY

After Wisconsin DNR asked the two companies to conduct studies "to identify the sources" of dioxin in their wastes,[32] the companies in turn requested the help of a pulp and paper industry group, the National Council for Air and Stream Improvement

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1986 Record of Proceedings, Dioxin Workshop; Maine DEP March 19, 1986 Record of Proceedings, Public Hearing on Proposed Amendment to Rule 567 Dioxin Standards ("Rules for Land Application of Sludge & Residuals"); continued April 16, 1986 Record of Proceedings.

30. E.g., bleach, sulphite recycle, de-inking, and mechanical pulping mills.

31. Wisconsin DNR Press release, note 26 supra; see also note 17 supra. Query, why were these not investigated; e.g., the 74 ppt was from a tissue plant, not bleach kraft. See H. Zar February 13, 1986 memorandum, note 19 supra.

32. R. Miner, NCASI Regional Manager. April 11, 1986 letter to H. Zar, EPA Region 5, re: sampling plan at Consolidated and Nekoosa mills.

(NCASI)[33] in designing and implementing such studies. In April, 1986, NCASI sent EPA an outline of its proposed study at Consolidated and Nekoosa, suggesting that initial sampling should proceed on "the hypothesis that the bleach plants were the sources."[34] Under NCASI's proposal, samples of unbleached brownstock, bleach pulp from the final stage washer, and bleach plant effluent would be compared to samples of primary and secondary sludge, to determine whether the bleaching process accounted for the bulk of the dioxin.[35]

EPA in early 1986 also reported to the Minnesota Pollution Control Agency its results of sludge samples from the Boise Cascade mill at International Falls, where levels up to 85 parts-per-trillion had prompted Minnesota to order a fish advisory against consumption of fish from the Rainy River.[36] EPA's Boise Cascade sludge results were the highest of all the sludges sampled from the three states: 414 parts-per-trillion (the Rainy River fish were also the highest of the fish sampled near pulp and paper mills).

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33. NCASI is a technical arm of National Forest Products Association/American Paper Institute, which in turn is the lobbying arm of the industry.

34. R. Miner, letter, note 32 supra, attached NCASI study plan, pg. 2.

35. See NCASI study plan, id., pg. 2. No results of this study have been released yet.

36. See H. Zar, note 19 supra; see also Minnesota Pollution Control Agency October 29, 1985 press release, re: fish advisory.

Minnesota Pollution Control Agency followed up the EPA report with its own dioxin analyses of sludges, not from the Boise Cascade mill but from the Potlatch Corp. mill in Cloquet and from the local Western Lake Superior Sanitary District in Duluth, which accepted waste sludges from the Potlatch mill.37/ The Minnesota analyses showed from 26-34 parts-per-trillion dioxin in the Potlatch sludge, and from 51 to 53 parts-per-trillion in the Duluth sewage sludge. Sludge from both Potlatch and the sanitary district was routinely incinerated, and the state announced plans to investigate whether the incinerators were operating at proper temperatures and duration to destroy dioxin. The state also announced plans for further testing on sludge and effluent from the Potlatch mill, and a follow-up program with Wisconsin of further testing of fish from the St. Louis River and the Duluth/Superior Harbor, to "determine the need for future fish consumption advisories."38/

During this time, Minnesota Pollution Control Agency was also cooperating with the EPA's Great Lakes Regional Office in plans to conduct further studies at the Boise Cascade mill in International Falls.

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37. The Potlatch mill wastes were dumped for years into the St. Louis River, which empties into Lake Superior at Duluth; EPA had earlier reported dioxin levels up to 4 parts-per-trillion in Lake Superior fish from the vicinity. See Minnesota Pollution Control Agency, May 28, 1986 press release, re: state follow-up to dioxin study.

38. Id.

If state and regional EPA officials hoped EPA headquarters would act along with their interests, however, subsequent events must have proved very disappointing. Regional attempts to follow up on the National Dioxin Study fish sampling resulted in industry sabotage of the entire study.

VI.
PAPER TRAIL: THE EPA/INDUSTRY DIOXIN STUDY

In December, 1986, an unmarked envelope arrived in a Greenpeace office. It contained leaked EPA documents, 1/ revealing that a major secret research program on pulp and paper mill dioxin sources was underway, belying government and industry claims that no serious problem is posed by dioxin pollution from the industry.

EPA records subsequently disclosed through a Freedom of Information Act lawsuit 2/ show that nothing has changed at EPA since the Lavelle/Burford/Hernandez scandals except that the scope of dioxin secrecy has expanded. EPA has entered into secrecy

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1. The three documents, all reprinted in the Appendices to this report, are:

   P. Hill, American Paper Institute/National Forest Products Ass'n. December 11, 1986 letter to A. McBride, Chief, USEPA Water Quality & Analysis Division, re: release of information on joint pulp and paper dioxin study.

   A. McBride, USEPA. January 13, 1987 reply to P. Hill, assuring no release of information "without first discussing the situation with industry officials."

   W. Whittington, Director, USEPA Office of Water Regulations & Standards. January 13, 1987 memorandum to regional offices, emphasizing agreement "to discuss any potential data releases with the industry participants."

2. Van Strum v. EPA, Civil No. 87-6031-E (D. Oregon).

agreements with a pulp and paper industry trade organization to bar public access to critical information on contaminated plant sites and on production processes that produce dioxin.

The public might never have learned the full scope of the joint EPA-Industry effort, or its background, had the leak not occurred. EPA records relating to the secrecy agreements paint a picture of government coziness with industry beside which the conduct of Ann Burford, Rita Lavelle, and John Hernandez pale into insignificance.

In entering into the secrecy agreements with industry, EPA chose to forego regulatory action to investigate, control, or eliminate dioxin emissions from pulp and paper mills. Instead, EPA would do nothing pending further study and also gave industry control over study design, sampling plans, and pace of the study. Without public participation or oversight, EPA signed an agreement with an industry trade association substituting secret studies for regulatory action, notwithstanding that the agency already had sufficient information to take strong regulatory action as well as a string of precedents to support such action. The circumstances suggest that this agreement has delayed not only the pulp and paper dioxin study, but also the entire National Dioxin Study.

A.
EPA REGIONAL OFFICE TRIES TO TAKE ACTION

Well before beginning the National Dioxin Study, EPA was aware of dioxin emissions from pulp and paper mills in Wisconsin,

which were confirmed by early results of fish sampling downstream from mills in Maine, Minnesota, and Wisconsin. By November 1985, both EPA and industry had concluded that the bleaching process in Kraft papermills was a likely source of 2,3,7,8-TCDD, and these results were confirmed by the end of January, 1986.

In press releases, Wisconsin officials characterized results from two papermill sludges used for landfilling as "very low" or "trace" levels, saying there was "no reason for alarm." 3/ In a letter to EPA officials in the Great Lakes regional office, however, a Wisconsin official was more worried; the same samples contained "high levels of dioxin." 4/ Apparently EPA regional officials shared the Wisconsin official's alarm.

Behind the scenes, there was already considerable alarm. In November, 1985, shortly before the final report on EPA's National Dioxin Study was originally scheduled to be presented to Congress, EPA Great Lakes regional officials informed their headquarters of a serious dioxin problem. Howard Zar, the regional dioxin study manager, recommended to Alec McBride, the National Dioxin Study

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3. Compare R. Dunst, Wisconsin Dept. of Natural Resources. March 27, 1986 memorandum to M. Hora, Minnesota Pollution Control Agency and to G. Amendola, EPA REgion 5, re: Dioxin Study-Papermill Sludges ("Sludges from the two bleach-kraft mills in Wisconsin were recently found to contain high levels of dioxin") with Minnesota Dept. of Natural Resources. January 31, 1986 press release on same samples ("Dioxin detected in papermills"). The latter document is quoted in the text above.

4. The levels found were 159 and 128 parts-per-trillion. Id., Minnesota January 31, 1986 press release.

manager in Washington, D.C., that the Maine studies, "indicating that the bleaching process in Kraft papermills was a likely source of 2,3,7,8-TCDD[,] combined with findings in Petenwell Flowage [Wisconsin River], the Rainy River [Minnesota], and the Androscoggin River [Maine] provide ample reason to conclude that a significant effort to followup on these results of the National Dioxin Study is needed." 5/

1.

EPA REGIONAL OFFICE SEEKS HEADQUARTERS ASSISTANCE

The EPA Great Lakes regional office specifically requested EPA headquarters' assistance in a full-scale "paper mill effort . . . either in the context of a followup to the National Dioxin Study or as part of the Bioaccumulation Study." 6/ The

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5. H. Zar, USEPA Region 5 Dioxin Study Manager. November 5, 1985 memorandum to A. McBride, National Dioxin Study Manager, re: Headquarters support for followup on pulp and paper findings of National Dioxin Study.

6. The "bioavailability study" is another suppressed EPA portion of the National Dioxin Study. The only records provided give scant details. See USEPA Dioxin Strategy, pg. 21 (November 28, 1983) ("EPA's ORD will study the bioavailability and uptake mechanism of sorbed 2,3,7,8-TCDD. ORD will also investigate the transport and transformation processes (bioaccumulation and biomagnification) of 2,3,7,8-TCDD in fish, sediments, and plants for use in food chain models and establishment of acceptable levels"). EPA has released no results of this study this but apparently has some. See H. Zar, USEPA Region 5. March 11, 1986 notes on two meetings at International Falls (recording that he invited pro-industry scientist "to visit Duluth to view the experiments with fish involving dioxin exposures and see the very significant effects occurring at low levels"). See also USEPA. July 15, 1986 internal review draft National Dioxin Study Report to Congress, pg. III-56 ("The funding for the bioaccumulation study allows for analysis of a subset of [some 400 frozen fish samples collected

effort would involve: "(1). effluent sludge and fish sampling activities at locations on papermill rivers with positive findings in fish; (2). similar activities [at?] other locations on papermill rivers with positive selected papermill facilities, including Kraft Papermills; (3). process evaluation of mills in both an effluent guideline and NPDES permit context, and (4). appointment of agency staff to work with company, state, and Canadian officials in the studies that are now emerging." 7/ The EPA Great Lakes regional office request referred to an industry-sponsored study of similar scope already under way. 8/

Within two months, the EPA regional officials were working with headquarters "to develop an investigation of selected papermills with positive results in sludge. The investigation is intended to provide a basis for point source control efforts at the facilities." 9/ At least by the end of January, 1986, EPA Great Lakes regional officials were planning further sampling and

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from the National Dioxin Study], plus additional sampling and specific chemical analysis for a limited number of contaminants at 100-200 new sites over two years").

7. H. Zar, November 5, 1985 memorandum, note 5 supra.

8. Id.; see also API/NFPA National Council for Air & Stream Improvement October 25, 1985 memorandum, re Phase I of the NCASI Investigative Program Responding to reports of dioxin in waste treatment sludges of bleached kraft mill effluent origin. Phase I is described as "testing the hypothesis that dioxin formation in the pulping process is of chlorine based bleaching origin."

9. H. Zar, USEPA Region 5. January 31, 1986 "Background to findings of dioxin in Wisconsin papermill sludges."

regulatory action to control dioxin emissions from papermills. 10/

2. EPA REGIONAL OFFICE MOVES AGAINST BOISE CASCADE

The EPA Great Lakes regional office's next major step, on March 5, 1986, was to issue a notice under authority of the Clean Water Act 11/ to Boise Cascade Corp., requesting access to the Boise mill at International Falls, Minnesota, where the highest papermill-related dioxin levels had been found in both sludge and fish. 12/ The notice requested not only access to the mill for sampling purposes, but also information about internal manufacturing processes, raw materials, process chemicals, and waste treatment processes. 13/

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10. Id.

11. If the EPA regional office issued its Clean Water Act request to Boise Cascade without support from Headquarters, it would not have been the first time the region took such drastic action independently. From 1978 until 1983, EPA Great Lakes regional officials tried unsuccessfully to negotiate a sampling effort at Dow Chemical Company's Midland, Michigan facility, during which time headquarters sabotaged the regional office's 1981 report on dioxin contamination of fish downstream from Dow's plant. After Dow denied the EPA regional office's request to enter the plant under the Clean Water Act, regional officials filed suit against the company in early 1983. Dow settled the case out of court a year later. See Chapter 4.

12. H. Zar, USEPA Region 5. February 14, 1986 memorandum to EPA headquarters, state offices (Ohio, Wisconsin, Minnesota), and Region 5 Dioxin Task Force members, re: Results of analysis of papermill sludges for 2,3,7,8-TCDD.

13. C. Sutfin, USEPA Region 5. March 5, 1986 letter to Richard Nachbar, Boise Cascade Corp., re: study of Boise Cascade mill at International Falls, Minn., under authority of Clean Water Act § 308; H. Zar, March 5, 1986 telephone notes, conversation with

Boise Cascade's mill at International Falls, Minnesota, was already the focus of international attention because of high dioxin levels in its sludge and in Rainy River fish downstream, announced by both the state of Minnesota and the Province of Ontario. 14/ On one side of the river, Minnesota had issued an advisory recommending no fish consumption from the Rainy River, while on the other side, Ontario took no action, creating public bewilderment on both sides of the border. 15/

3.
BOISE CASCADE TRIES TO MAKE A DEAL WITH REGIONAL OFFICE

Boise Cascade predictably fought the EPA Clean Water Act notice, declaring that allowing EPA access to the mill would violate their trade secrets and benefit their competition. 16/ Because Boise Cascade was already participating in an industry-

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Richard Nachbar, concerning EPA Clean Water Act notice of same date.

14. Minnesota Pollution Control Agency. October 29, 1985 press release, "2,3,7,8-TCDD Discovered in Rainy River Fish;" see also Ontario Ministry of Environment. October 29, 1985 press release, re: Ministry testing Rainy River fish for dioxins.

15. Health & Welfare Canada later established a guideline for fish consumption based on sampling of 175 fish from four locations on the Rainy River, setting a maximum allowable level of 20 parts-per-trillion TCDD for edible portions of fish. The 1987 "Guide to Eating Ontario Sportfish," Ontario Ministry of Environment, pg. 180, recommends not eating 14-18-inch walleyes taken downstream of Fort Frances, repeating a similar warning issued in 1986.

16. R. Nachbar, Boise Cascade Corp. March 17, 1986 letter to H. Zar, re: confidentiality claim on proposed dioxin study.

sponsored study of its International Falls mill that would examine the same processes and materials EPA planned to study, EPA's proposed study would be superfluous, the company maintained. On the same day the EPA Great Lakes regional office issued its Clean Water Act notice, Boise Cascade proposed an alternative, jointly sponsored and conducted study of its mill, "incorporating a more extensive role for NCASI and the company." 17/

The alternative proposed by Boise Cascade would allow EPA to conduct "preliminary sampling" with industry assistance, after which a major study would be conducted; 18/ it would include a jointly managed program at five or six "representative" mills, including the Boise Cascade International Falls mill. 19/ Industry would test all internal process samples (chips, brown stock, blending stock, bleached stock, product, recycled material), and EPA would test only non-sensitive materials, primarily wastes (selected waste streams, additives, ashes, and sludges). 20/ A key element in Boise Cascade's proposal was that the study would result in a "joint report" and that all mills tested "would

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17. H. Zar, USEPA Region 5. March 5, 1986 telephone notes, note 13 supra; see also H. Zar. March 31, 1986 to file, re summary of March 17, 1986 meeting on proposed dioxin study of Boise Cascade papermill, International Falls, Minnesota.

18. H. Zar, March 5, 1986 telephone notes, note 13 supra.

19. H. Zar, March 31, 1986 memorandum to file, note 17 supra.

20. Id., pg. 2.

receive anonymity within the report." 21/ Thus, under Boise Cascade's proposal, the public would never be advised of problems at specific locations.

4. INDUSTRY INSISTS ON SECRECY

At a meeting among EPA Great Lakes regional officials and company and industry officials on March 17, 1986, the day before EPA's scheduled sampling at the Boise Cascade mill, the company presented a formal claim to confidentiality of "all information collected by EPA for purposes of analytical methods testing and development," forbidding EPA to disclose any data obtained from its study. 22/ The company's insistence on secrecy and its concern about adverse publicity were foremost in its arguments against EPA's Clean Water Act notice and proposed study. Richard Nachbar, Manager of Environmental Affairs for Boise Cascade, emphasized the company's intention to exert its confidentiality claim for both the preliminary sampling and the main EPA study.

Stressing the "special sensitivities" at the international boundary, Nachbar warned that singling out the Boise Cascade mill for EPA's dioxin study would limit the "general application" of the study and would "focus public reaction" and criticism on a single mill, diverting study efforts from technical to political

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21. Id.

22. R. Nachbar, Boise Cascade Corp. March 17, 1986 confidentiality claim, note 16 supra.

and legal issues. 23/

Boise Cascade's concern for secrecy also dominated Nachbar's arguments in favor of the joint EPA/industry study. Under this proposal, the company's confidentiality claim "would be handled by anonymity," and its legal opposition to the EPA study would be unnecessary. A joint study would limit "political and legal concerns," and make public relations easier; EPA, the states, Boise Cascade, and NCASI would all benefit from each others' experience, and "improved relations" between industry and EPA would result. 24/ After tentative, verbal agreement to proceed with a joint study, subject to headquarters approval, the EPA regional officials were allowed to conduct their preliminary sampling at Boise Cascade the following day. 25/

B.
INDUSTRY ASKS EPA HEADQUARTERS TO TAKE CHARGE

In subsequent negotiations with Boise Cascade and industry, EPA headquarters was represented by Alec McBride, national manager of the National Dioxin Study; industry now demanded as a condition of the joint study that EPA's share in the joint project be man-

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23. H. Zar, USEPA Region 5. March 31, 1986 memorandum to file, note 17 supra, pg. 2.

24. Id., pg. 2.

25. Id.

aged by Washington headquarters (i.e., McBride). 26/ In addition to repeating its insistence on confidentiality, industry also demanded as a condition of the joint study that there be "no more 308 [Clean Water Act] letters to participating companies, and that the 308 letter to Boise Cascade be withdrawn." 27/

EPA generally accepted industry's proposal, with some qualifications, particularly on the question of Section 308 notices; 28/ EPA Great Lakes regional officials wanted the option of Section 308 notices as a safety valve in case of prolonged delays in completing the study. 29/ EPA also qualified the confidentiality conditions imposed by industry, limiting such provisions only to internal process information; all effluent data would be disclosable, and "individual studies of effluents and fish could still lead to publicity," EPA maintained; 30/ In addition, EPA wanted all data from the study to be fully available to the states and to EPA "for regulatory purposes, e.g., NPDES." 31/ EPA and

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26. G. Amendola, USEPA Region 5. April 10, 1986 handwritten notes of "Meeting with Paper Industry;" see also H. Zar, USEPA Region 5, April 11, 1986 typed notes of same meeting.

27. Id. (Section 308 is the Clean Water Act's provision granting EPA authority to request in-plant process information and enter a facility to gather samples.) Section 308 notices are normally initiated by EPA regional offices without headquarters approval.

28. Id.

29. Id.

30. Id.

31. Id. The National Pollutant Discharge Elimination System

industry tentatively agreed to work within EPA'S limitations and to proceed with sampling at Boise Cascade's International Falls mill while industry (NCASI) chose four other volunteer mills to participate in the joint study. 32/ A lingering controversy over whether to collect all samples at once as EPA had planned, or to collect samples in stages depending on analytical results, was later resolved in EPA's favor. 33/

1.

REGIONAL OFFICIALS CONSIDER MOVING WITHOUT HEADQUARTERS

Even after this meeting and verbal agreement, however, EPA regional officials had misgivings about the joint study. After deciding internally that the regional office would prepare a revised study plan for the Boise Cascade mill and a joint study agreement, Howard Zar, EPA regional dioxin study manager, noted, "it wasn't clear that we wished to proceed at all." 34/ After the March 17 meeting, regional officials still entertained ideas for pursuing other options, including proceeding with the § 308 study at Boise Cascade, studying other mills nationwide "on a case by

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(NPDES) was established by the Federal Water Pollution Control Act of 1972. The system, administered jointly by EPA and the states, establishes a permitting system for discharge of water pollutants.

32. Id.

33. Id.; see also final joint study agreement, note 39 infra (also in Appendices).

34. Id., pg. 3.

case basis," and in general going separate ways, with industry doing its studies and EPA doing its own. 35/

2.
INDUSTRY SEEKS ASSURANCES FROM EPA HEADQUARTERS

Notwithstanding EPA Great Lakes regional officials misgivings or hopes of pursuing other options, a draft joint study plan and proposed agreement was sent to industry representatives at the end of April by Alec McBride, national dioxin study manager. 36/ Apparently industry hesitation, rather than regional office misgivings, delayed signing of a final agreement for several more months.

In subsequent correspondence between the American Paper Institute and McBride, industry made clear that it would only participate in the joint study under certain conditions: (1) that the confidentiality of the in-plant information and the anonymity of the mills be strictly maintained; (2) that EPA withdraw its Section 308 notice to Boise Cascade's International Falls mill; and (3) that EPA agree, for the duration of the joint study, not to issue any further Section 308 notices concerning dioxin to any other member company of the American Paper Institute. 37/ In

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35. Id.

36. A. McBride. April 22, 1986 letter to R. Blosser, Technical Director, NCASI, with attached proposed agreement.

37. M. Farrar, Vice President, API/NFPA Environmental Health Program. May 21, 1986 letter to A. McBride, USEPA ("Thank you for meeting with our industry delegation on Friday, May 9, to attempt

addition, industry repeatedly emphasized its intention to participate in risk assessments of any "minute" papermill dioxin levels found as a result of the study. 38/ Industry characterized these conditions and risk assessment concerns as an "impasse" that McBride played a "crucial role" in resolving. 39/

3.
EPA HEADQUARTERS GIVES INDUSTRY WHAT IT WANTS

The real "impasse," however, involved only two issues. The withdrawal of EPA's Section 308 notice to Boise Cascade and the confidentiality of in-plant information had been adequately covered in EPA's first draft of the joint study agreement, 40/ and remained virtually unchanged in the final agreement. 41/ The only issues actually involved in the "impasse" that McBride played so

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to resolve the impasse that appeared to have developed in the efforts of several companies to test for the presence of dioxin in industry processes and effluents").

38. Id., pg. 2 ("Thank you again for your conscientious efforts to work through this important matter with us. I stress, again, as we did at the meeting, that we expect the Agency to be equally conscientious in assessing whether there is any real risk associated with the minute quantities of dioxin that may be found as a result of our joint study").

39. Id. See also M. Farrar, API/NFPA. June 23, 1986 letter to A. McBride, USEPA, with attached signed copy of joint study agreement ("we want to express our appreciation for the crucial role you played in bringing this important agreement to fruition").

40. McBride April 22, 1986 proposed draft agreement, note 36 supra.

41. M. Farrar, June 23, 1986 signed agreement, note 39 supra.

crucial a role in resolving, therefore, were industry's demands for an agreement from EPA not to issue any further Section 308 notices to any API member company, 42/ and for industry participation in risk assessments on papermill dioxin. 43/

McBride's noncommittal recorded responses to industry on these two issues 44/ suggest some unwritten agreement between EPA headquarters and industry. Indeed, such "informal agreements" are recorded on both issues, effectively guaranteeing industry that it would not face further regional office demands for dioxin studies, and giving industry strong influence over risk assessments both for the joint study and for the National Dioxin Study itself.

4.
EPA PROMISES NO GOVERNMENT STUDIES OF PRODUCTION PROCESSES

Accompanying a copy of the final joint-study agreement sent to all EPA Regional offices was a letter from McBride's supervisor, 45/ instructing the regions not to initiate any investigations of dioxin in pulp and paper mills without first informing McBride. The reason he gave was that "we informally have told the

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42. M. Farrar, May 21, 1986 letter to McBride, note 31 supra.

43. Id.; see also Farrar, June 23, 1986 letter, note 39 supra, pg. 2.

44. A. McBride, USEPA. June 2, 1986 letter to M. Farrar, NFPA/API.

45. W. Whittington, USEPA, Director Office of Water Regulations & Standards. July 10, 1986 letter to regional office directors with attached final joint study agreement. (In Appendices).

industry that, during the course of the study, if EPA required information related to dioxin from any pulp and paper mill, we would attempt to collect that information in a cooperative manner prior to sending a 308 letter."

The letter reminded the regions that headquarters "assistance" was necessary for dioxin laboratory analyses, -- apparently a reminder of headquarters' tight control over dioxin sampling -- suggesting that EPA headquarters would suppress any independent action on pulp and paper dioxins contemplated by the regional offices. 46/

5.
EPA GIVES INDUSTRY INFLUENCE OVER RISK ASSESSMENTS

A similar "informal agreement" to allow industry participation in risk assessments would give industry influence over the National Dioxin Study itself.

Any risk assessment on papermill dioxin would inevitably involve fish consumption, which is also a key element of the risk assessment for the National Dioxin Study as well as a major reason for the long delay in release of the final NDS report. 47/

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46. Id.

47. EPA headquarters originally planned to include Great Lakes fish sampling in the National Dioxin Study. EPA has informed Diane Hebert, Great Lakes Toxics Coordinator for Greenpeace, that the Great Lakes fish samples now will not be addressed in the Study Report slated for release next month, but will be deferred. (All risk assessments have been purged from copies of the draft National Dioxin Study Report released so far.)

Shortly after McBride resolved industry's "impasse" and the final joint study agreement was signed, industry representatives met with EPA Administrator Lee Thomas and other EPA officials, including Michael J. Cook, 48/ coordinator of the EPA division responsible for implementing the National Dioxin Study, and addressing "policy and resource" issues. 49/

At this meeting, industry representatives stressed the need for strong national (EPA headquarters) control of dioxin risk assessments to stop individual state regulators from "acting prematurely" and setting inconsistent policies; they discussed industry studies of papermill dioxins not included in the joint study and emphasized the need for "a framework for [industry] participation in establishing extent of risk." Administrator Lee Thomas advised continuing with a "cooperative effort" on risk assessment and public relations, and Michael Cook was named as coordinator and contact for "joint work" and "contacts in other

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48. G. Amendola, USEPA Region 5, handwritten notes of September 22, 1986 meeting between industry delegation and EPA regional and headquarters officials. See also M. Farrar, June 23, 1986 to A. McBride ("we are now arranging to meet with the Administrator, and other appropriate Agency officials, to discuss issues relating to risk assessment. We have requested the meeting now, not to be critical of, but to build on, the fine efforts you have made in the area for which you are responsible").

Cook's office also was responsible for working with the EPA Office of Pesticides & Toxic Substances (Donald Barnes' office), the FDA, and the U.S. Fish & Wildlife Service "in assessing the relationship between the FDA action levels for 2,3,7,8-TCDD in fish and the proposed ambient water quality criteria"). USEPA National Dioxin Strategy, note 6 supra, pg. 21.

49. USEPA National Dioxin Strategy, note 6 supra, at pg. 70.

areas (i.e., risk assessment)." 50/ (Cook's management and policy responsibilities for the National Dioxin Study, and his specific involvement with risk assessments for fish consumption, made him a pivotal contact for industry participation in risk assessments, suggesting a further basis for industry influence in delaying release of the National Dioxin Study report.)

C.
THE DEAL IS SIGNED

The final agreement for a "Joint EPA/Paper Industry Cooperative Dioxin Screening Study," 51/ which nowhere mentions risk assessment, divided responsibility between EPA and industry for collecting and analyzing samples at five bleached kraft pulp and paper mills. Industry would choose the mills and develop sampling plans for each, subject to EPA approval; EPA would assure the confidentiality of "process related" (in-plant) information and would prepare a final report 52/ with "input" and comments

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50. G. Amendola, USEPA, September 22, 1986 notes, note 48 supra. At this meeting, John A. Moore, Assistant Administrator for the Office of Pesticides & Toxic Substances, also outlined a new, improved strategy for reducing dioxin risk: on the theory that matrix (type of sample) might critically affect the bioavailability of dioxin, and that dioxin bonding to a site "may be reversible," a new or modified risk assessment model "may be more appropriate." Administrator Thomas responded that the required models could not be ready in time.

51. See final agreement, note 45 supra. (In Appendices).

52. Id. The report would be limited to a "technical" document, apparently meaning unpublished.

from industry. 53/ Costs would be shared "on the basis of 25 percent funding by U.S. EPA and 75 percent funding by industry" for most if not all samples, possibly suggesting a corresponding ratio of control over the study.

The agreement, signed on June 20, 1986, was announced in Ontario shortly afterward by the Ontario Ministry of the Environment, which announced that results of the study "will be applicable to Ontario mills" and indicated that results were to be expected in ten months. 54/ Clearly, Ontario officials somehow became involved in the process. No mention of secrecy agreements was made in the Ontario press announcements, nor did they mention any industry involvement in preparing risk assessments for the study.

D.
THE JOINT STUDY BEGINS

The study began immediately with collection of samples from the Boise Cascade mill at International Falls, Minnesota in June, 1986. 55/ Over the next few months, while participants wrangled over analytical methods, industry drew up the list of mills to be tested, which included the James River/Crown Zellerbach mill on

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53. Id.

54. Ontario Ministry of Environment. July 17, 1986 press release. (In Appendices.)

55. G. Amendola, USEPA Region 5. October 29, 1986 Progress Report, USEPA/Paper industry study, pp. 2-3 ("full-scale" sampling completed at Boise Cascade June 26, 1986).

the Columbia River at Wauna, Oregon; the Mead mill at Chillicothe, Ohio; 56/ International Paper at Jay, Maine; and Champion International at Lufkin, Texas. Sampling at all mills except Boise Cascade was not scheduled until the end of the year. 57/

Except for the Ontario press release and a low-key mention of the study to the American trade press in August, 1986, 58/ the joint study was not publicized in in the U.S. The draft National Dioxin Study background report for Tiers 3, 5, 6, and 7, released in response to a Freedom of Information Act request in 1986, mentions only that "certain types of pulp and paper mill discharges are being investigated by EPA, the states, and the paper industry to determine the source of 2,3,7,8-TCDD within the mills." 59/ The report nowhere mentions a joint study or secrecy agreements between EPA and industry.

The only analytical records provided from the joint study are

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56. G. Amendola. July 11, 1985 letter to R. Blosser, NCASI, re: information request for "reconnaissance visits" to mills, with attached list of mills. EPA Great Lakes regional officials objected unsuccessfully to including the Mead mill in the joint study, because previous dioxin results there were so low, it would not be "a sensible choice." See also note 36 supra.

57. Id.

58. Draft Study Suggests TCDD Not Ubiquitous in Environment, Wood Treating May be Source, Chemical Regulation Reporter (BNA), pg. 575 (August 1, 1986) "EPA, states, and the paper industry are attempting cooperatively to discover where in the milling processes the [dioxin] is generated").

59. USEPA. National Dioxin Study, Tiers 3,5,6, & 7 Draft Report, pg. 49 (April 1986).

data from development of analytical methods for the study; 60/ confirmed dioxin results from the participating mills either are not completed or are being withheld. Interestingly, records disclosed indicate that Dow Chemical Company is performing sensitive TCDD analyses for the EPA/Industry study. 61/

As of this writing, the final National Dioxin Study report has not been released to Congress or the public, apparently because of paper industry involvement in risk assessment policy decisions. Had an EPA employee not leaked the documents revealing the scope of the joint EPA/Industry study, the public would not now know of it.

Former EPA Acting Administrator John Hernandez was forced to resign in disgrace because of accusations he allowed Dow Chemical Company officials to gain influence over a study on dioxin pollution in the Great Lakes region. The acts of EPA administrators and officials involved in the joint EPA/Industry pulp and paper

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60. Joint EPA/Industry study agreement, note 49 supra. (In Appendices.)

61. See e.g., G. Amendola, USEPA. September 16, 1986 memorandum to R. Blosser, NCASI (transmitting results of TCDD analyses "conducted by the Dow Chemical Company at USEPA's request"). Dow's participation seems questionable on at least two bases: First, Dow and the National Forests Products Association/American Paper Institute have a historic partnership on dioxin issues. For example, NFPA/API was an active intervenor on Dow's behalf in the 2,4,5-T cancellation hearings. See In re: Dow Chemical Company, et al, USEPA FIFRA Consolidated Docket No's. 415 et al, docket sheets. Second, Dow has a clear interest in minimizing TCDD levels at pulp mills to help maintain its chlorine/caustic sales. See H. Goltz, Dow Chemical Co. January 13, 1987 report of conference call. (In Appendices.)

mill study pale by comparison. But if John Hernandez was guilty, he left no such clear evidentiary trail of collusion with polluters to deprive the public of information vital to their health.

VII.
PULP AND PAPER PRODUCTION PROCESSES [1]

Because government and industry intend to keep secret all site-specific dioxin information involving pulp and paper mill internal production processes, the public would be left blindly to trust government and industry statements, without a basic understanding of processes used in the industry likely to produce dioxins. [2] This chapter discusses those processes and identifies

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1. The authors greatfully acknowledge the role of Renate Kroesa of Greenpeace Vancouver, whose preliminary investigation and report provided a foundation for much of this chapter. This section, however, expands upon Ms. Kroesa's work. Any errors are, of course, the responsibility of the authors and not of Ms. Kroesa.

2. The industry claims to trade secrecy for studies of dioxin formation in their particular production processes are largely spurious because process information is readily available, see e.g., Post's Pulp & Paper Directory (1987), and the fact of dioxin pollution creates no commercial advantages entitling industry to trade secrecy status. These claims represent nothing more than an effort to manipulate public opinion by creating obstacles for the public to acquire accurate information. Citizens should nonetheless be able to quickly determine what relevant processes are in use at particular mills. Such information can usually be obtained directly from mill operators or employees, and is commonly discussed openly in company publications, state regulatory agency documents, etc. Some trade publications, such as the reference materials that were used to prepare the listing of pulp mill sites and processes in North America -- in the appendices to this report --also give much helpful information. Greenpeace Toronto is developing an information base of such materials, which is available to the public.

points in which heat, chlorine, and phenols combine under ideal conditions for dioxin formation. Corresponding sections in the following chapter discuss the potential for forming dioxins in the varying processes used in the pulp and paper industry.

Since the dawn of civilization, paper has come to supplement language as a vehicle for recording and transmitting knowledge and ideas between individuals, cultures, and generations. For both writing and packaging, paper products are indispensable to modern societies; without them, education, government, and industry could not function, and paper consumption alone is often cited as a reliable standard-of-living index. 3/ So vital a product deserves a corresponding measure of care in developing safe, clean production methods.

Paper and related products such as cardboard are produced from the cellulose fibers of plants. Paper-like materials for recording information are some of the oldest products of civilization; the word "paper" itself derives from the ancient Egyptian word for papyrus, a species of reed with a tough stem that was split, spread in criss-crossed layers, soaked, beaten to form rough sheets, and pasted into long strips, which could be rolled into convenient scrolls. Until the Twelfth Century, A.D., papyrus and vellum parchments made from animal skins were the only significant writing materials in western Europe; after that time,

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3. 15 World Book Encyclopedia 114 (1983).

paper was introduced from China via the Moors in Sprain, 4/ made from other plant materials such as bamboo, flax/linen, straw, jute, etc.

Over the next few centuries, the invention of the printing press and increasing literacy swelled the demand for paper beyond the supply of linen (primarily rags) and grass fibers; "paper famines" occasionally threatened commerce. The invention of processes for making paper from wood in the middle of the Nineteenth Century not only resolved the supply and demand problem, but created new markets for related wood products. 5/

The major difficulty in making paper from wood is that the raw cellulose in tree trunks is reinforced by lignin, a tough, resinous adhesive that provides structural support to the tree. Wood solids generally consist of approximately 50 percent cellulose, 30 percent lignin, and 20 percent extractable substances such as aromatic oils and hemicellulose, an amorphous, adhesive carbohydrate in the fibrous portion of the plant. Lignin after cooking with caustic is dark-colored, and even very small residues

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4. The Moors had developed papermaking to an art, and history records that the quality of European papers quickly declined in the Twelfth Century with the Moors' fall from power in Spain when paper production passed into the hands of the "less-skilled Christians." 17 Encyclopedia Brittanica 229 (1963).

5. A shortage of raw pulp materials is again becoming a factor, as forests are denuded worldwide in part to meet pulp and paper demand. Such practices, in addition to modern intensive forestry practices such as widespread use of herbicides and fertilizers, can have serious environmental impacts. Those practices, however, are not the focus of this report.

of lignin will cause paper to yellow with age or exposure to sunlight. High quality paper contains very little lignin, whereas newsprint and packaging material such as corrugated cardboard and grocery bags contain high residues.

Some of the dissolved lignin and other organic materials removed from wood fibers in the pulping process is routinely flushed into convenient waterways -- rivers, lakes, estuaries, or the seas themselves -- as wastes. Other portions of those residues are burned in recovery boilers and recycled to produce heat, steam, and electricity to power the production process. Still other residues remain as wastes and are disposed of by methods such as landfilling, incineration, and spreading on farm or forest lands as a fertilizer. In natural waters, bacteria degrade or break down such wastes further, consuming dissolved oxygen in the process. If too great a load of biodegradable wood wastes are introduced into a waterway, oxygen levels can be depleted to the point where fish will suffocate. Once dissolved oxygen is depleted anaerobic (non-oxygen consuming) bacteria may take over, to produce highly toxic, smelly hydrogen sulphide.

Chlorine gas, when used in the first stage of the bleaching process, combines with phenols and related components of lignin to form high amounts of organochlorine compounds, many of which are dioxin precursors. 6/ These organochlorines and any accompanying

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6. Compare (both documents in Appendices) Ontario Ministry of Environment, Preliminary Investigation of Trace Contaminants in Pulp & Paper Mill Effluents, Table 7 (1986) (listing contaminants)

dioxins are responsible at least in large part for the mutagenic and carcinogenic properties and the long-term toxicity of the pulp wastes. 7/

A. PULPING

Whether the original material be papyrus, bamboo, flax, or tree trunks, the first stage in papermaking is to soak and crush the raw plant stems to break them down into their component fibers. After tree bark is removed to be burnt for steam and power generation, wood logs are "chipped" -- ground into small, relatively uniform pieces -- and broken down by either mechanical or chemical means in a process called pulping. Both chemical and mechanical methods of pulping require large quantities of water for softening the woody material and for flushing away the dissolved lignin compounds and other wastes.

Because of their need for large amounts of water, pulp and paper mills have traditionally been located along rivers or other large waterways. Increasing demand for paper products in industrialized nations and corresponding higher production, coupled with toxic processes such as chlorine gas delignification, have placed pulp and paper mills among the major sources of pollution,

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with L. Fink, USEPA. undated draft comments addressed to Howard Zar, USEPA (listing dioxin precursors)

7. Id.

particularly of freshwater lakes and rivers and their associated airsheds. 8/

There are four main pulping methods:

(a) KRAFT (or SULPHATE) (alkaline process)

(b) SULPHITE (acidic process)

(c) MECHANICAL (non-chemical)

(d) SEMI-MECHANICAL (neutral process)

1.
KRAFT (SULPHATE) PROCESS

The kraft process 9/ largely replaced the Nineteenth Century method of boiling wood chips or shavings in alkali. 10/ The addition of the sulphide reduced damage caused to the cellulose fibers in the older, now-obsolete soda method of pulping. 11/ The kraft process is suitable for almost all species and types of wood, and is preferred for resinous "softwoods" such as fir and hemlock. The kraft process has become the most widely used world-

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8. See H. R. Goltz, Dow Chemical Company. January 13, 1987 Report of Conference Call (in Appendices) (estimating North American pulp and paper mill wastewater discharges at more than 4 billion gallons a day and listing several normal pollutants).

9. The "kraft" process derives from the name given to the strong brown pulp it produces by its inventor, C. F. Dahl, who developed it in Norway in 1879. 17 Encyclopedia Brittanica 233.

10. 17 Encyclopedia Brittanica 233; K. Britt, Ed., Handbook of Pulp & Paper Technology 2d. 135-38 (1970).

11. K. Britt, note 10 supra, at 135.

wide, 12/ except in Middle Europe where stricter regulation of air pollution has produced an industry more dependent on the sulphite process. For example, ninety percent of the mills in British Columbia are kraft mills. 13/

The cooking chemicals are called the "white liquor," and the entire process takes place in a "closed loop" system that vents gases and steam to the air and unbleached pulp to the next production stage. After initial delignification, the cooking chemicals are washed from the chips; some of this spent "black liquor" is used to dilute succeeding batches of white liquor, and the rest is recovered by passing the spent black liquor through a recovery furnace, where the organic contents -- stripped lignin and other compounds -- are burned. The unburnt, inorganic residue or ash contains most of the original sodium sulphide; this smelt, or molten black ash, is dissolved in water to form the "green liquor," which is causticized with lime to produce a new batch of white liquor. After settling, the white liquor is used for another cook, and the settled calcium carbonate is burned in a large lime kiln to drive off carbon dioxide, leaving lime for another causticising operation. 14/ The recovery of the sulphur-

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12. K. Britt, note 10 supra, at 140; TAPPI Proceedings 27 (1986).

13. R. Kroesa, personal communication, based on informal survey; see also Basic Technology of the Pulp & Paper Industry and its Environmental Protection Practices Training Manual, Environment Canada, Report EPS 6-EP-83-1 (1983) pp. 38-53.

14. 17 Encyclopedia Brittanica 233; K. Britt, note 10 supra, at

containing chemicals is responsible for the characteristic foul smell of kraft mills, associated with sulphur dioxide emissions.

The kraft process produces a strong, dark-colored pulp suitable as feed stock for the manufacture of many types of paper. Because too much lignin remains in the pulp, however, further delignification is required before the pulp is suitable for products requiring long-lasting whiteness or dying to colors. 15/

2.
SULPHITE PROCESS

Whereas the kraft process uses the alkaline sulphate in the initial pulping process, the sulphite process uses sulphurous acid to delignify wood pulp, and is most effective on woods of relatively low resin content such as deciduous trees. During the early part of the Twentieth Century, sulphite was the dominant method of pulping, because it yielded the brightest unbleached pulp, removing more of the lignin than alkaline methods.

The sulphite and kraft processes are the dominant chemical pulping methods worldwide, but the kraft process, because of its suitability for a wider variety of woods, especially highly resinous species such as Pacific Northwest conifers, and because of the greater tensile strength of its final pulp, has long outstripped sulphite as the preferred process.

135-43.

15. K. Britt, note 10 supra, at 249-52.

Sulphite pulping liquor contains sulphur dioxide and a metal oxide, such as sodium, magnesium, or calcium. Some sulphite mills operate in a closed loop system, recovering the cooking chemicals and burning the organic residue, 16/ although the process chemicals in the past were inexpensive enough to discourage recovery; burning was used, if at all, only to generate heat and steam. 17/ Recycling and burning of organic material from sulphite mills is more complex and expensive than in kraft mills because the high acidity and corrosiveness of the waste require specialized equipment such as acid-proof brick or cement, or acid-resisting metals. 18/ In recent decades, the use of non-calcium bases (magnesium, ammonium, and sodium) has expanded the versatility of the sulphite process and triggered the development of sophisticated recovery systems, 19/ but many older mills, or small mills unable to afford the equipment, continue to dispose of residues directly in waterways. In Canada, for example, most sulphite mills are concentrated in the East, particularly in Quebec and in Ontario; many of these mills are old, small in size, and have few if any pollution control devices. 20/

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16. K. Britt, note 10 supra, at 172-75.

17. Id. at 159-60.

18. 17 Encyclopedia Brittanica 233.

19. K. Britt, note 10 supra, at 159.

20. Environment Canada, Report EPS 6-EP-83-1, note 13 supra, pp. 53-58.

3.
MECHANICAL PULPING

Mechanical pulp is produced without chemicals either by grinding logs with rotating stones, or by forcing wood chips between grooved, rotating steel plates called "disc refiners." These are variations on the oldest method of producing wood pulp, and even today "groundwood" continues to make the most efficient use of raw materials: wood yield from mechanical pulping approaches 95 percent, "compared with chemical and semi-chemical pulp yields in the order of 40 to 85" percent. 21/ The better opacity and printability of groundwood papers are also desired by printers, creating incentives for development of better and more efficient machinery and processes. 22/ One new technology, thermomechanical pulping (TMP), softens wood chips by steam before passing them through a disc refiner. 23/

The major use of mechanical pulp is for production of newsprint, which usually consists of more than 75 percent mechanical or thermomechanical pulp, and up to 25 percent sulphite or kraft pulp. Some mills produce newsprint from 100 percent TMP alone. Mechanical pulp and newsprint are made throughout Canada and the

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21. K. Britt, note 10 supra, at 179.

22. Id.

23. Environment Canada, Report EPS 6-EP-83-1, note 13 supra at pg. 31.

U.S. 24/

4.
SEMI-CHEMICAL PULPING

Semi-chemical methods begin the process with chemical means, but finish with mechanical means. The Neutral Sulphite Semi-chemical Process (NSSC) is carried out under neutral conditions. Basically, the process involves softening the chips with a chemical pulping agent, and then running the partially-pulped chips through grinder. 25/

The cooking material is sometimes recovered and fed into the chemical recovery system of a nearby kraft mill. The recent use of non-sulphur cooking liquors allows the NSSC mill to burn the spent cooking liquor, effectively eliminating foul smells and oxygen-depleting water pollutants from this source. 26/

Semi-chemical, and related "chemi-mechanical" pulps contain high lignin residues and are weaker in tensile strength than chemical or groundwood pulps, but are characterized by greater stiffness. They are used primarily for corrugated products.

B.
BLEACHING

The pulping process cannot remove all lignin without seri-

24. Id., pp. 28-35; K. Britt, note 10 supra, at 197-98.

25. K. Britt, note 10 supra, at 197-205.

26. Id. at 208.

ously damaging the cellulose fibers. About five to ten percent of the original lignin remains in the pulp and is responsible for the dark color.

Lignin is not water-soluble, and can only be removed by breaking down its complex structure into smaller, soluble compounds (the phenols and their chemical relatives, acetone, various alcohols, etc.). In conventional mills, residual lignin is removed by adding highly reactive chlorine gas. It is estimated that approximately ten percent of the chlorine gas employed will be discharged in an organically bound form. 27/ Typical quantities of organically-bound chlorine (TOCl) discharged by conventional bleach plants are five to eight kilograms per ton of pulp produced.

After delignification, bleaching is carried out to enhance color. The stability of the pulp is maintained by using chemicals that do not break down molecules any further. Common bleaching chemicals are chlorine dioxide and hypochlorite for Kraft and Sulphite pulp, and hydrogen peroxide or hydrosulphite for mechanical and semi-mechanical pulp. 28/

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27. See Ontario Ministry of Environment table of "Contaminants of Concern" in Appendices. See also Table 7 from same report, also in Appendices.

28. K. Britt, note 10 supra, pp. 249-257, 275-282.

1.
KRAFT BLEACHING

Kraft pulp is darkly colored, and must be bleached in a five or six-stage sequence to remove excess lignin and to achieve high brightness. 29/

The first step is chlorination of the pulp using chlorine gas; small amounts of chlorine dioxide are often added at this stage to enhance chlorination and to permit higher temperatures and shorter bleaching times. 30/ It is normal practice to sewer the filtrate.

The second step involves washing the pulp with hot caustic soda. The washer filtrate of this extraction stage also contains high amounts of organochlorines and is sewered.

After delignification, oxidative bleaching is carried out with either chlorine dioxide or with sodium hypochlorite. The most common bleaching agent in kraft mills is chlorine dioxide, although some kraft mills precede the chlorine dioxide sequence with a hypochlorite bleach. 31/

Chlorine dioxide is a yellow, toxic, explosive gas used because of its high oxidizing power. Because it is too hazardous to transport safely, chlorine dioxide is usually manufactured on

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29. Chlorine gas/hot caustic extraction/chlorine dioxide/hot caustic extraction/chlorine dioxide. In the six-stage sequence, a hypochlorite phase precedes the first chlorine dioxide phase.

30. K. Britt, note 10 supra, pp. 280-282.

31. Id. at 276.

site at pulp mills. 32/ The high cost of making chlorine dioxide is offset in kraft mills by recycling the byproducts -- sodium sulphate and sulphuric acid -- through the black liquor recovery boiler, thus saving on sulphate costs; other byproducts are sold or used elsewhere in the process. 33/ Such uses for chlorine dioxide manufacturing "wastes" make it a cost-effective bleaching agent.

Oxygen, when used in the first extraction stage, can cut down the chlorine dioxide demand considerably. Since chlorine dioxide is the most expensive of all chemicals used in pulp and paper mills, many mills are now using oxygen enriched caustic extraction. This modification, however, has no impact on the amounts of chlorine gas used or organochlorines discharged.

The filtrates of the last three to four stages are normally reused as wash water before being sewered.

2.
SULPHITE BLEACHING

Sulphite pulp is less colored than Kraft pulp and requires less bleaching. Sulphite mills usually employ a three-stage sequence of chlorination, caustic extraction, and hypochlorite or chlorine dioxide bleaching. 34/

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32. Id. at 275.

33. Id. at pp. 284, 643-49.

34. Id. at 269.

Bleaching effluents contain high quantities of organochlorines and are sewered.

3.
MECHANICAL BLEACHING

Mechanical pulp does not require a delignification stage because the lignin is left in the pulp and requires only "decolorizing" or "brightening." Hydrosulphites (sodium hydrosulphite or zinc hydrosulphite) are the most commonly used brightening agents. 35/ Hydrogen peroxide 36/ is used whenever high brightness is required but is more expensive than hydrosulphites. A combination of both has the greatest brightening potential, but is also the most expensive option.

The effluent has high Biological Oxygen Demand (BOD) values, but contains no organochlorines. Some newsprint mills are now operating in a closed loop system and burn the organic waste after using hydrogen peroxide as the brightening agent.

C.
PAPER PRODUCTION

Paper is made by blending suitable grades of pulp with a variety of additives and then forming a sheet. Most papers are "sized" with hydrocarbon resins, various polymers, and chemical reactive synthetic materials, to increase resistance to wetting

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35. Id. at 307.

36. Sodium peroxide also may be used.

and penetration by water, inks, etc. 37/ Paper is then dyed with colored pigments or water-soluble dyes and may be treated with urea-formaldehyde derivatives for "wet strength." 38/ The actual papermaking process involves pressing, shaping, and drying at high temperatures. 39/

The waste water and air emissions from the final papermaking process carries wastes accumulated from the entire pulp and paper production process, and may be particularly high in biodegradable solids, heavy metals, and other toxics from coatings, dyes, paper preservatives, etc, in addition to organochlorines and dioxins.

37. K. Britt, note 10 supra, at 355-367. Such additives can be transferred from food-wrapping papers to foodstuffs. Id. at 367.

38. Id. at 369-380.

39. Up to 190 degrees C. Id. at 440. TAPPI Proceedings (1986), pg. 49, states a higher typical temperature for new "impulse drying" roller systems of 400-1,000 degrees F.

VIII.
DIOXIN FORMATION FROM PULP AND PAPER MANUFACTURE

Because of the secrecy surrounding the joint EPA/Industry dioxin study, the public will be left to determine for themselves the potential for pulp and paper mills in their regions to produce dioxins.

Although the EPA-industry dioxin study has focused exclusively on bleach-kraft mills, available evidence from other types of mills suggests that dioxin can be produced in any pulp or paper process involving chlorine, and that differences in dioxin formation between bleach-kraft and other types of mills will be simply a matter of quantity. Furthermore, in addition to considering dioxins produced within the mills' processes themselves, dioxin-contaminated raw materials coming into the mills must also be examined.

In designing the Tier IV, or "combustion sources" phase of the National Dioxin Study, EPA developed "a study plan that identified those source categories which were believed to have the greatest potential for emitting CDDs [chlorinated dioxins] to the atmosphere." 1/ EPA's choice of source categories to be tested

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1. USEPA National Dioxin Study Tier 4 -- Combustion Sources Draft Project Summary Report, EPA-450/4-84-014g (April 1986) at 4 (emphasis added).

described many of the conditions present in pulp and paper mill production processes:

> "1. Presence of CDD in the materials being burned;
>
> 2. Presence of CDD precursors in the materials being burned (e.g., chlorinated phenols, chlorinated benzenes); and
>
> 3. Presence of chlorine, fuel and combustion conditions conducive to CDD formation, including:
>
> (a) Relatively low combustion temperature (500-800 degrees C.);
>
> (b) Short residence time of fuel in the combustion zone (less than 1-2 seconds);
>
> (c) Lack of adequate oxygen (resulting in incomplete combustion);
>
> (d) Lack of adequate processing of fuels (e.g., burning of wet garbage); and
>
> (e) Lack of supplemental fuel to promote combustion efficiency." 2/

Indeed, of the 13 reported sites that met these conditions, three were black liquor boilers from kraft paper mills. 3/ In designing its National Dioxin Study, EPA recognized the likelihood that pulp and paper manufacturing could result in "worst-case"

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2. Id.

3. Id. at 12 (a fourth was a wood-fired boiler from a wood-products facility).

dioxin emissions to the atmosphere. 4/ EPA data from the National Dioxin Study suggest that pulp and paper manufacturing is not only a major source of dioxin air pollution, but also of dioxin in the nation's waterways and its marine life. For example, Dow Chemical Company has estimated that the North American pulp and paper industry generates over 4 billion gallons of wastewater per day. 5/

Dioxin pollution from pulp and paper mills is directly related to the introduction of chlorine and chlorine compounds into the production process. Because lignin contains and breaks down to phenol compounds, chlorination of such compounds can produce not only hazardous organochlorines but dioxins as well, particularly under conditions prevalent in pulp and paper manufacture. 6/ While the amount of dioxin produced in any single process may be large or extremely small, the toxicity and persistence of dioxin indicate that dioxin production from a continuous manufacturing source -- regardless of daily amounts produced --

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4. Id. at 8.

5. H. Goltz, Dow Chemical Company. January 13, 1987 report of telephone conference (in Appendices).

6. For an extended examination of dioxin formation pathways, see M.P. Esposito, et al., Dioxins, EPA-600/2-80-197 (November 1980), at pp. 3-132; see also L. Fink, USEPA, undated draft comments addressed to Howard Zar, Water Quality Branch, EPA Region 5, on March 3, 1986 Draft Study Plan, National Dioxin Study Pulp and Paper Industry Follow-Up (Boise Cascade Corp., International Falls, Minnesota (dioxin and furan precursors known, likely, and suspected in pulp mill effluents); see also P. Connett, MSW Incinerators, Current, pp. 2-3 (June 1985).

may have long-lasting, significant effects on the environment and human health.

Overshadowing any other single source of dioxins are combustion sources, of which industrial and municipal waste incinerators are a major concern; in such incinerators, a veritable stew of dioxin precursors -- chlorines, phenols, polychlorinated biphenyls (PCBs), polyvinyl chloride (PVC) and other plastics, etc. -- is "cooked" at varying temperatures, resulting in continuous emissions of dioxin-contaminated soot and ash into the environment. 7/ Many of these conditions are mirrored in pulp and paper industry waste recovery boilers, which are probably the largest source of pulp mill dioxin air pollution.

There are numerous stages of pulp and paper manufacture capable of producing dioxins. The most obvious and likely is the bleaching stage, but other sources probably contribute.

A.
DIOXIN FORMATION IN THE PULPING STAGE

The major if not the only source of dioxin in the unbleached pulp, is contaminated feedstock, either in the wood chips themselves or in any recycled materials added.

Wood chips may be contaminated in a variety of ways. A major

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7. Connett, note 6 supra; B. Commoner et al. Paper for Presentation to Annual Meeting of Air Pollution Control Association (June 20, 185). Recent disclosures of scientific fraud in key studies of dioxin formation in waste incinerators suggest that dioxin pollution from such sources may be far more serious than believed previously. See Connett, note 6 supra.

source of wood chips in the pulp industry is the byproduct of production processes in the timber industry. Trees used for chips may come from forests sprayed with 2,4,5-T, 2,4-D, 8/ or other chlorinated pesticides containing either dioxin precursors or dioxins themselves. Furthermore, Pulp mills commonly utilize planer shavings, sawdust, and other waste wood from lumber mills and wood-products manufacturers, some of which may be treated with pentachlorophenol or other dioxin-contaminated preservatives.

Recycled process materials added to the pulp may be contaminated with dioxins and dioxin precursors from previous bleaching cycles. Secondary fibers (recycled paper products) may be contaminated in their previous life-cycles, from pulping and bleaching, from plastic coatings and inks, or from preservatives. 9/ This could prove to be a significant environmental source of

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8. Although 2,4-D is generally believed to be free of TCDD, at least one major manufacturer of this common forest-use chemical, Vertac Chemical Co., has for several years disposed of highly contaminated TCDD wastes by mixing them into its 2,4-D production processes. USEPA Chlorinated Dioxins Working Group. "Dioxin ANPR Synopsis of Comments" attached to April 2, 1982 CDWG meeting notes, pg. 4; see also USEPA Health Assessment Document for Dibenzo-p-dioxins, pp. 4-12 (1985). USEPA's acceptance of this practice raises obvious concerns as well about the purity of other chemical industry products used in the pulp and paper industry.

9. In EPA studies, one recycle mill -- Tomahawk Tissue in Tomahawk, Wisconsin -- had 75 parts per trillion 2,3,7,8-TCDD in its waste sludges. H. Zar, USEPA. January 30, 1986 memorandum to Russell Dunst, Wisconsin Dept. of Natural Resources, re: "Results of 2,3,7,8-TCDD Testing in Wisconsin Paper mill Sludges (in Appendices to this report);" see also D. Schuettpelz, Wisconsin Dept. of Natural Resources. May 5, 1986 memorandum to J. McQuire, Minnesota Pollution Control Agency, with attached notes of February 123 1986 meeting (identifying site as recycled paper mill).

dioxins; in New Jersey, for example, it is estimated that 55 percent of all paper products are recycled. 10/

A paper mill using pulp purchased elsewhere may be purchasing contaminated material unwittingly, with little or no control over the raw materials involved, because the purchased pulp may be contaminated with dioxins or precursors. Because papermaking involvesheat, the formation of dioxins from any precursors present in the raw material is likely.

B.
DIOXIN FORMATION IN THE BLEACHING STAGE

The bleaching stage is the probable source of most pulp and paper mill dioxins. The first-stage bleaching, to remove most residual lignin, is commonly performed with chlorine gas. It is at this stage that dioxin precursors are most likely to form, as the chlorine reacts with phenol compounds in the lignin. The subsequent alkaline extraction involves adding hot caustic (sodium hydroxide) to the chlorinated pulp, to remove lignin compounds rendered soluble by the chlorine. The heat from this alkaline extraction phase 11/ may trigger the formation of dioxins from the chlorinated lignin components.

Subsequent bleaching stages may use chlorine dioxide or hypo-

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10. B. Snider, Jr., Paper Recycling in the '80s -- from Pulping to Politics." TAPPI Proceedings 39 (1986).

11. K. Britt (Ed.) Handbook of Pulp & Paper Technology at (1970).(Up to 95 degrees F.)

chlorite, or both. The primary function of both chlorine dioxide and of hypochlorite is as an oxidizing agent. In both hypochlorite and chlorine dioxide oxidation, chlorine atoms are freed, however, and both processes involve some degree of chlorination of residual lignins; 12/ any subsequent hot caustic extractions should result in further dioxin formation, although far lower amounts would be involved than in the chlorination phase.

Because different types of pulping require different kinds and sequences of bleaching, the amounts of dioxin produced would likely vary from one method to another, as is suggested by the limited data EPA has disclosed. Of the chemical processes, the kraft process requires the greatest degree of bleaching, because of the high lignin content of the pulp and the chemical composition and density of the lignin, which requires more chlorine and longer first-stage chlorination time than sulphite pulp. 13/ The kraft process also takes a five- to six-stage bleaching sequence. 14/ The two subsequent hot caustic stages would increase the opportunities for dioxin formation as well. It is not surprising, therefore, that of the mills tested and reported to date, the highest dioxin levels are associated with mills that

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12. Id. at 270.

13. K. Britt, note 11 supra, at 258-59.

14. Chlorine gas/hot caustic extraction/chlorine dioxide/hot caustic extraction/chlorine dioxide. In the six-stage sequence, a hypochlorite phase precedes the first chlorine dioxide phase.

pn8
combine both kraft and bleaching processes ("bleach kraft," as opposed to kraft mills that do not operate bleaching facilities on the same site). 15/

By comparison, the sulphite pulping process requires only three or at most four bleaching stages. 16/ Sulphite pulps chlorinate much faster and require less chlorine than kraft pulp, 17/ and take only one hot caustic extraction stage instead of two. For these reasons, lower dioxin levels would likely result, although few EPA figures are yet available for comparison.

C.
DIOXINS FROM MECHANICAL AND SEMI-CHEMICAL PULPING

Mechanical and semi-chemical pulps do not require chlorination, and are brightened chiefly with hydrosulphites or hydrogen peroxide; no organochlorines or dioxins would be expected from these processes except to the extent that raw materials contaminated with dioxins or precursors are used.

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15. W. Whittington, USEPA Office of Water Regulations & Standards. July 10, 1986 memorandum to EPA Regional Water Division Directors, re: "EPA/Paper Industry Dioxin Investigation," with attached joint study agreement and plan (significant 2,3,7,8-TCDD levels found downstream from and in wastewater sludges from all bleachkraft mills sampled).

16. Chlorine gas/hot caustic extraction/hypochlorite/sometimes with a chlorine dioxide stage at the end. K. Britt, note 11 supra, at 269.

17. "[P]robably because the sulfonated lignin in the [sulphite] pulp is more swollen and easily accessible and wettable by the acidic solution of chlorine than the lignin in the kraft pulp." Id. at 259.

D.
DIOXIN FORMATION IN PAPER MILLS

Finished bleached chemical pulp, containing any organochlorine or dioxin residues not flushed away by caustic extraction, is subsequently subjected to varying chemical and heat phases in the papermaking process, which involves an array of preservatives, resinous sizing, pigments, soluble dyes, "wet strength" agents, mordants, 18/ preservatives, coatings, etc., in addition to drying sequences at relatively high temperatures.

The possibility for further dioxin formation during these processes should not be ignored. Levels of dioxin produced -- as opposed to introduced through contaminated additives -- would likely be far lower than in the bleaching sequences of the pulping process; the finished product, however, could contain a cumulative load of residual dioxins and precursors.

E.
DIOXIN FORMATION FROM RECOVERY/POWER BOILERS

Pulp and paper mill wastes, including wastes from bleach plants, may be recycled into the recovery boiler of the pulp mill where temperatures for the formation of large amounts of dioxins are ideal, 19/ adding dioxins to the smokestack pollutants.

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18. A material used to stabilize dyes.

19. Compare Environment Canada Report EPS 3/PF/1, Deposit Control Technology for Kraft Recovery Boilers (December 1984) at 11 (graph illustrating data on flue gas temperatures in lower super-

In kraft mills that operate their own on-site chlorine dioxide manufacturing facilities, chlorine wastes in the form of neutralized spent acid and by-product salt cake are routinely fed into the mills' black liquor recovery boiler; in one such mill in Georgia tested by EPA, stack gas concentrations of dioxins and furans other than 2,3,7,8-TCDD were detected. 20/ The only chlorine source identified in the EPA sampling was the chlorine dioxide production waste. 21/ EPA records do not indicate any chlorination stage in this particular bleach kraft mill process and appear to suggest that the source of the stack emissions is the salt cake from chlorine dioxide manufacture.

Liquid production wastes, particularly from bleaching stages, are routinely flushed into adjacent waterways, or at best, stored in aerated lagoons to allow biodegradation of pulp materials. Organochlorines and dioxins present in the waste, as well as any dioxins generated by the heat of waste-recovery processes, will pass into the water, where dioxins will readily accumulate in fish tissues. Lagoons must be dredged periodically to remove the

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heater region of unidentified Ontario kraft mill recovery boiler, ranging from 550 to 760 degrees C.) with EPA Report in note 1, supra.

20. M. Palazzolo et al., Test Report -- Site 05 Black Liquor Boiler BLB-B, National Dioxin Study Tier 4: Combustion Sources Report. No. DCN No. 86-222-109-02-18, pp. 2-1 thru 2-5, 3-1 and 3-2. The site is the Brunswick Pulp & Paper Company, Brunswick, Georgia.

21. Id. pg. 3-2.

accumulated settled solids. These wastes are commonly burned in "hog fuel" recovery furnaces to produce heat and steam for production processes. Another common practice is to spread to such sludge in strip-mine and other land reclamation projects, and on agricultural lands.

Finished paper products ultimately end up in the trash somewhere, and any organochlorine and dioxin residues in the products will contribute to dioxin emissions from municipal and industrial incinerators, or in leachate from ocean-dumping or landfill garbage disposal operations.

F.
DIOXIN FORMATION FROM OTHER SOURCES

Other potential sources of dioxins in pulp and paper effluents are slimicides, chemicals used to control algae and fungi that accumulate on equipment internal surfaces. Until recently, chlorophenols were preferred for this purpose. The large quantities used of such slimicides could contribute significant amounts of dioxins and precursors to the production and waste processes. 22/ Since EPA began its National Dioxin Study, some mills

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22. For example, the Nekoosa Papers, Inc. Port Edwards mill in Wisconsin has reported its total usage of chlorophenol slimicides between 1961 and 1978 as approximately 53,000 pounds. Nekoosa also reported use of 332,500 pounds of pentachlorophenol as a paper coating preservative between 1950 and 1983. ("All process losses were reported as leaving in the wastewater.") H. Zar, USEPA Region V. March 31, 1986 memorandum to R. Dunst, Wisconsin Dept. of Natural resources, re: "Information Requests to Paper mills."

in the U.S. have voluntarily discontinued their use. 23/ The use of pentachlorophenol as a slimicide has been prohibited in Canada since 1981. 24/

How much dioxin is generated at any given production or waste disposal stage of pulp and paper manufacturing has not yet been disclosed by EPA and industry. Both have separate and joint studies underway, involving samples of raw wood chips, brown (pulped) stock, final bleached pulp, influent, primary and secondary sludge, leachate, bleach effluent, and final product, to determine where in the process dioxin is generated. 25/ The studies, however, only involve five mills throughout the U.S.

Both industry and EPA have assumed that chlorine bleaching is the most likely source, and have concentrated their studies on bleach kraft mills, despite their own criteria suggesting that other production processes also produce dioxin pollution. The long delay in completing the kraft mill studies seems inexplicable in light of the urgency of the situation.

The EPA-industry studies, however, seem entirely misdirected because the production -- and reduction or elimination -- of dioxin pollution from a given plant will be a function of the

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23. USEPA. National Dioxin Study Tiers 3,5,6, & 7 final report, pg. 28 (1986)

24. See Environment Canada, Chlorinated Phenols and their Impurities in the Canadian Environment. Report EPS/3-EP-84-E (March, 1984).

25. EPA/Industry joint agreement and study plan, note 6 supra.

unique raw materials and processes used at that site.

IX.
TOWARD A DIOXIN-FREE PULP AND PAPER INDUSTRY

Society is not going to eliminate paper simply to avoid pollution, but fortunately there are alternative papermaking methods that will reduce or eliminate the worst pollutants, including dioxin. The industry itself is always looking for ways to cut costs, and some of the most promising alternatives are also highly cost-effective.

To ensure that necessary changes provide long-term, adequate environmental protection, however, it is important to be wary of cosmetic solutions that actually perpetuate pollution sources; for this reason, public awareness and oversight are essential.

To that end, appended to this report is a listing of all pulp and paper mills and their locations in North America that could be located within the short time available for research.

A.
TECHNOLOGICALLY FEASIBLE OPTIONS

To reduce dioxin pollution from the pulp and paper industry, the major goal should be the greatest possible elimination of chlorine and from all paper production cycles, from the forest to the finished product. Without chlorine, detectable quantities of

chlorinated dioxins should not result.

1.
CHLORINE-FREE BLEACHING AND DELIGNIFICATION

A most encouraging trend in worldwide industry research aims toward chlorine-free bleaching of pulp. Several new pulping processes, such as modifications in the kraft process being developed in Sweden and Japan, and most notably a new oxygen-alkali delignification process now used in some 35 mills world-wide, 1/ can reduce bleach chemical use and toxicity of bleach-plant effluent by 50 percent or more, with a 5 to 10 percent gain in yield of high quality unbleached pulp. 2/ Currently, nine out of 15 Swedish kraft mills use oxygen-delignification, and it is expected that all mills in Sweden will be retrofitted by 1990. 3/ Japan, too, is expected to operate all mills with oxygen prebleaching soon. 4/ In Germany, new pollution taxes have forced similar changes: four sulphite mills are now using oxygen-delignification, and all other mills are expected to follow soon. 5/

In North America, two mills in Wisconsin are using the new

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1. TAPPI Proceedings, pg. 29 (1986).

2. Id.

3. Anonymous, Stringent Environmental Limits Set for Swedish Pulp and Paper Mills, Pulp & Paper (April 1987).

4. R. Kroesa, personal communication.

5. M. Ducey, German Sulfite Mills Reduce Chlorine Bleaching Due to New Restrictions, Pulp & Paper (June, 1987).

technology, and conversion plans are underway at three more. 6/ Only one mill in Canada uses oxygen delignification, 7/ but conversion plans are being considered at other mills. 8/

Research into other delignification methods to reduce the need for bleaching chemicals continues. In Sweden, a pilot plant has been built to investigate the use of combined nitrous oxide and oxygen delignification, 9/ and efforts are underway in Japan, Canada, and Sweden, to assess ozone as a bleaching agent. 10/

Cost-effective pulping innovations that reduce bleaching requirements are most promising in light of new bleaching methods using oxygen and hydrogen peroxide, which are rapidly replacing some of the chlorine-dependent stages of the bleaching process. 11/ Experiments under way using ozone, oxygen, peroxide, and hyposulphite sequences hold promise for eliminating chlorine-based bleaching altogether. The new delignification processes and reductions in chlorine-based bleaching sequences have not only improved yields and cut the costs of bleaching chemicals, but have also reduced energy costs as well, quickly repaying the capital

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6. R. Kroesa, personal communication.

7. Eddy B. Forest Products, Espanola, Ontario. This facility also has an excellent secondary treatment facility.

8. R. Kroesa, personal communication.

9. TAPPI Proceedings, pg. 34 (1986).

10. Id., pp. 76-80; id., pg. 34.

11. Id., pp. 32-33.

investments required to make such changes. 12/ As one industry spokesman notes, "[i]t is always economically attractive to shut down an existing stage in a bleach plant, or better still, not build it in the first place." 13/ The combination of economic, environmental and quality factors pushing the industry toward chlorine-free bleaching methods is unique and encouraging.

Most encouraging, however, is the continued growth of mechanical (including semi-mechanical) pulping in response to increased demand for such pulps in the publication and printed paper markets. 14/ Chlorine based bleaches are not used at all on these pulps, because the goal is not to remove the lignin but only to decolorize it, usually with sodium hydrosulphite and hydrogen peroxide; the retained lignin accounts for much higher pulp yields. The growing market for such pulps has prompted development of cheaper, on-site hydrogen peroxide peroxide plants, 15/ and should spur advances in improving the "brightness stability" of mechanical pulps, thus expanding the market further. Because mechanical pulping makes such efficient use (approaching 95 percent) of forest products and requires no chlorine-based bleaching,

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12. Id., pp. 29, 32.

13. Id. at 31.

14. Id at 34.

15. Hydrogen peroxide is particularly attractive as a bleaching agent for environmental reasons; it breaks down to water immediately upon exposure to the atmosphere and therefore seems unlikely to pose the same level of environmental hazard as the persistent chlorine molecule.

thus permitting cleaner waste-recovery burning, an industry-wide shift to mechanical methods would not only drastically reduce dioxin and organochlorine emissions, but would also conserve dwindling forest resources.

Consumer education to encourage acceptance of less-bleached materials is a particularly attractive option for some products that could open new market opportunities. Tissue products, for example, are among the most highly bleached products made in the industry; yet West German consumers have been persuaded to switch to unbleached tissue. Such a switch in North America could feasibly be hastened both by government standards for bleaching in tissue production and by effective marketing techniques. Indeed, it seems likely that many consumers would respond to a "chlorine and dioxin free paper" marketing appeal with the same fervor now bestowed on recycled papers. Many printing, photocopy, and writing grade papers produced without chlorine could command a premium in the market over time, particularly with the support of public interest organizations, and even more particularly if the pulp and paper industry dioxin problem becomes widely known.

2.
CHLORINE-FREE RAW MATERIALS

Another area for particular attention is the purity of mill raw materials. Industry or government standards in this area are needed immediately. An immediate halt to the use of chips manufactured from wood treatment wastes would eliminate an obvious

source of dioxins and precursors, as would recognition of the unavoidable tendency of chlorinated pesticides used in forest management to drift even into old-growth forests.

In forest management, the use of chlorinated hydrocarbon pesticides, in particular phenoxy herbicides, has already declined drastically, largely as a result of public outcry and litigation. 16/ To assure clean raw materials, forest spraying should be limited to biologically sound materials. Use by the pulp and paper industry of any raw materials that have been exposed to chlorinated preservatives and pesticide should be discontinued immediately. Canada's 1981 ban of pentachlorophenol wood preservatives is a significant step in this direction.

Industry-wide development and implementation of chlorine-free pulp and paper methods would assure cleaner ingredients for recycled paper manufacturing, an important method for reducing municipal waste volume and conserving depleted forest reserves. Research continues on cleaner inks, preservatives, and coatings, which should be encouraged to improve the quality of recycled paper products and further reduce the toxicity of its manufacturing byproducts.

Chlorine pollution of water used in industry processes is a troubling problem, particularly for mills that are downstream from

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16. See e.g., Save Our ecoSystems/Merrell v. Clark, 747 F.2d 1240 (9th Cir. 1984) (banning use of herbicides on U.S. federal forest lands).

chlorine pollution sources such as other mills, for example on the Wisconsin River. This problem can probably be overcome only by reducing or eliminating other chlorine pollution sources.

In paper mills generally, attention to temperatures and chemicals used, as well as to sources of pulp, offer the most obvious approaches for dealing with the dioxin problem.

Political pressure in western Europe has resulted in research and development aimed at chlorine-free, less polluting manufacturing methods, demonstrating the feasibility of such a goal. North American manufacturers need more encouragement to develop and adopt the newer methods.

B.
NON-VIABLE COSMETIC SOLUTIONS

The trend toward chlorine-free bleaching is promising, but is jeopardized by several short-term approaches that will not, in the long run, lead to <u>elimination</u> of dioxin emissions, and any reduction will in time be offset by inevitable accumulation in the environment. The pulp and paper industry is a capital-intensive industry, requiring long lead times to recover investments. Expensive cosmetic solutions should therefore be avoided.
The regulatory history of TCDD teaches that perceptions of hazard can shift with political winds; a new government administration that takes environmental hazards more seriously than its predecessors may logically be expected to impose much more strict environmental controls on the industry than at present. Any cosmetic solutions may therefore result in higher long-term costs.

First, the savings realized in reduced chlorine bleaching stages, combined with a reduction -- but not elimination -- of organochlorine and dioxin effluents, may delude industry and regulators into high investments in improving present processes rather than placing such investments in production processes that can eventually eliminate dioxin pollution.

1.
HYPOCHLORITE/CHLORINE DIOXIDE: A POSSIBLE HAZARD

For example, one obvious method of reducing chlorine use would not eliminate dioxin pollution. The elimination of the chlorine gas delignification/bleaching stage would certainly reduce initial generation of organochlorines and dioxin precursors from that stage, but any such reduction would increase the use of chlorine dioxide and/or hypochlorite in subsequent bleaching stages.

> The reduction in the number of stages from 5 to 3 and the substitution of hypochlorite for chlorine dioxide decreases the total energy requirement by roughly 15 percent. The environmental impact is minimal with a small decrease in BOD and color but probably a small increase in toxicity of untreated effluent due to the increase in chlorinated phenols resulting from hypochlorite usage. [17]

This system is in use at International Paper's mill at Androscog-

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17. TAPPI Proceedings, pg. 31 (1986) (emphasis added). Chlorinated phenols, as discussed in the previous chapter, are dioxin precursors; any increase in chlorophenols would likely be accompanied by a corresponding increase in dioxin formation.

gin, Maine, where high dioxin levels have been found in fish. 18/

A further danger is that most of the new processes for eliminating the chlorine gas delignification stage involve increased use of chlorine dioxide and thereby increased chlorine dioxide production capacity at the mills. One such method proposed by industry substitutes chlorine dioxide for 75 percent of the chlorine gas in the first stage, vastly increasing both energy use and chlorine dioxide, but reducing -- not eliminating-- the toxicity of the effluent. A major problem with this apparently attractive option is that the recycling of effluents to the recovery furnace -- "as was attempted at the Thunder Bay mill of Great Lakes Paper Company" 19/ [Hall, p. 32] -- including recycling of wastes from increased chlorine dioxide manufacture, could end up generating as much or more dioxin through combustion in the recovery furnace. 20/ If the goal is to eliminate dioxin emissions, substitution of chlorine dioxide or hypochlorite for chlorine gas may be unacceptable, and immediate research should be conducted to determine its acceptability.

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18. See TAPPI Proceedings, pg. 31 (1986); see also Chapters V and VI supra (levels found in fish).

19. TAPPI Proceedings, pg. 32 (1986); see also Environment Canada, The Basic Technology of the Pulp and Paper Industry and its Environmental Protection Practices, pg. 161 (1983); K. Kringstad, K. Lindstrom, Spent Liquors from Pulp Bleaching, 18:8 Env. Science & Tech. pp. 246A-247A.

20. See Ch. VII, pg. 10 note 20 supra (in National Dioxin Study Tier IV Black Liquor Boiler, salt cake from chlorine dioxide plant only source of chlorine to the recovery boiler).

2.
ION-EXCHANGE RESIN ABSORPTION

A second dubious option is the Band-Aid solution offered by Dow Chemical Company, which is developing ion-exchange resins for removing toxic organics from pulp and paper waste streams. Beyond the fact that the safety of such resins is uncertain lies the further question of how to dispose of the waste-saturated filter resins, which will contain concentrated organochlorine, dioxin, and other wastes; this proposal would therefore merely package up pulp and papermill wastes and move them somewhere else for dispersal into the environment. The rapidly rising costs of dispose dioxin-contaminated waste disposal speaks to the long-term wisdom of Dow's approach.

Like the surgeon who takes to shooting people at night to drum up business, Dow itself has a vested interest in maintaining its near-monopoly on chlorine and caustic sales to the pulp and paper industry and therefore discouraging any chlorine-free innovations. 21/ Indeed, Dow's reason for developing the ion-exchange resin technology is that "other technical approaches to this problem [e.g., elimination of chlorine-based bleaching] could more dramatically and adversely affect Dow's existing chlor/alkali

---

21. [Caustic is a toxic byproduct of chlorine manufacture, and although there are cheaper sources of caustic soda available to pulp and paper companies, Dow has tied its sales of pulping chlorine to its caustic sales, thus avoiding stockpiles of caustic that would otherwise be a hazardous waste of chlorine production.]

business." 22/ Both industry and regulators should be wary of such self-serving, wholly cosmetic approaches to dioxin pollution, which would only increase costs to pulp and paper manufacturers and perpetuate existing polluting methods.

C.
LEGISLATION, TAXES, REGULATION & ENFORCEMENT

In Europe, strict limits on toxic emissions from pulp and paper mills are forcing process changes at a rapid rate; West Germany imposes heavy taxes on amounts of organochlorines discharged, compelling development of less chlorine-dependent pulping and bleaching processes; 23/ and in Sweden, strict discharge permits require drastic reductions in organochlorine effluent levels. 24/

In North America, less regulatory pressure exists. Canada chiefly monitors and controls biological oxygen demand (BOD) of pulp and paper effluent, and has few or no enforceable standards for toxic components beyond acute toxicity of effluents. In the United States, the EPA has the authority under the Clean Air Act, the Clean Water Act, the Toxic Substances Control Act and other

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22. H. Goltz, Dow Chemical Company. January 13, 1987 report of telephone conference. (In Appendices).

23. Michael J. Ducey, "German Sulfite Mills reduce chlorine bleaching due to new restrictions," Pulp & Paper, April 1987, pp. 102-03.

24. Anonymous, Stringent environmental limits set for Swedish Pulp and Paper mills, Pulp & Paper, April 1987, pp. 148-49.

statutes to monitor and regulate hazardous wastes, air and water emissions, and health hazards. As Dow has aptly noted, North American pulp and paper manufacturing is "a regulation-driven industry," 25/ that is unlikely to make necessary changes without compulsion.

Given industry's political power and influence over EPA -- as evidenced by pulp and paper industry subversion of the National Dioxin Study -- there is little reason to expect effective action from EPA so long as incessant "further study" can substitute.

Most if not all applicable U.S. environmental laws have citizen enforcement provisions that can be used by citizens or groups to force EPA or states to take action against polluting companies. Lawsuits are expensive, however -- especially against the combined might of government and industry -- and although some environmental laws provide for attorney fees, a lawsuit may drag on for years before lawyers can be reimbursed; few individuals or groups have the resources or time to devote to such prolonged efforts. Litigation to impose stricter effluent limits thus holds little promise of compelling change over the very short term.

Nonetheless, some such drastic means may be necessary to stir government and industry into making needed changes. For example, On March 18, 1987, EPA said in response to a Freedom of Information Act request:

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25. H. Goltz, Dow Chemical Company, report of January 13, 1987 telephone conference. (In Appendices.)

> "We have verbally speculated about possible alternatives for reducing or eliminating dioxin discharges from pulp and paper mills, but there have been no written records on this. EPA is awaiting the results of the study to identify the sources of dioxins before taking investigations of control alternatives. Therefore, there are no records responsive [to the request]." 26/

Unless the EPA official was simply being disingenuous, the Agency charged with responsibility to protect the environment from pollution has not yet developed -- despite years of study -- a single page of information on measures that could be employed by the pulp and paper industry to reduce dioxin emissions.

The most important first step toward a dioxin-free pulp and paper industry in North America is to force full disclosure of dioxin studies from industry and government. A fully informed public will be the most effective instrument for necessary political and economic changes in this vital industry.

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26. W. Whittington, USEPA, Director Office of Water Regulations & Standards. March 18, 1987 letter to Carol Van Strum.

APPENDICES

Table VII. Analysis of TCDD in Biological and Environmental Samples ("Alsea, Oregon Phase II Project").

Sample No.	Sample Type	Ngs Spike	Conc (ppt)	Det limit	% Recovery	Isotope Ratio	Data Report
UN 159	SEDIMENT	2.05	ND	19	30		10-IV
UN 160	SEDIMENT	2.05	120	15	40		10-IV
UN 160	SEDIMENT		-	8		-	10-V
UN 161	SEDIMENT	2.05	105	16	80		10-IV
UN 161	SEDIMENT		-	41		.21	10-V
UN 162	SEDIMENT	2.0	30	13	50		10-IV
UN 162	SEDIMENT		-	12		1.63	10-V
UN 163	SEDIMENT		-	680		2.00	10-V
UN 164	SEDIMENT	2.0	210	24	50		10-IV
UN 164	SEDIMENT		-	48		1.96	10-V
UN 165	SEDIMENT		-	10		-	10-V
UN 166	SLUDGE	4.0	220	140	75		10-IV
UN BLANK	SOLVENT	2.0	ND	4	50		10-IV
UN BLANK	SOLVENT	2.0	ND	1	70		10-IV
UN 166	SLUDGE		-	8		.96	10-V
UN 167	SLUDGE		-	8		.90	10-V
UN 168	SLUDGE		160	12		.78	10-V
UN 169	SLUDGE		5800	56		.78	10-V
UN 170	SLUDGE		470	10		.80	10-V
UN 171	SLUDGE		283	48		.79	10-V
UN 172	WATER		-	.25		2.16	10-V
UN 173	WATER		.38	.2		.84	10-V
UN 185	WATER FILTER	2.0	ND	5	50		10-II
UN 185	WATER FILTER		-	5		.39	10-VI
UN 186	CAT LIVER	1.85	ND	15	50		10-II
UN 187A	PRODUCTS OF CONCEPTION	2.05	ND	19	50		10-II
UN 187A	PRODUCTS OF CONCEPTION	Extracted only.		Analyzed elsewhere.			12-I
UN 188A	PRODUCTS OF CONCEPTION	2.0	3	2	50		10-II
UN BLANK	SOLVENT	10.0	ND	12	50		10-II
UN BLANK	CHARCOAL	10.0	ND	12	20		10-II
UN 188A	PRODUCTS OF CONCEPTION		-	1		-	10-VI
UN 188A	PRODUCTS OF CONCEPTION	Extracted only.		Analyzed elsewhere.			12-I
UN 191	MOUSE	2.5	ND	4	55		10-I
UN 192	SHREW	2.5	ND	3	55		10-I
UN 193	MOUSE	2.5	ND	18	6		10-I
UN 193	MOUSE	Extracted only.		Analyzed elsewhere.			12-II
UN 194	MOUSE	2.5	ND	2	50		10-I
UN 195	MOUSE	2.5	ND	3	50		10-I
UN 196	MOUSE	2.45	ND	3	55		10-I
UN 197	SHREW	Extracted only.		Analyzed elsewhere.			12-II
UN 197	SHREW	2.5	ND	8	30		10-I
UN 198	SHREW	2.45	ND	7	50		10-I
UN 199	SHREW	2.5	ND	4	65		10-I

UN 199	SHREW		ND	1		-	10-VI
UN 199	SHREW		ND	1		.98	10-VI
UN 200	BIRD	2.5	ND	5	50		10-I
UN 201	MOUSE	2.5	ND	2	60		10-I
UN 202	BIRD	2.5	ND	3	50		10-I
UN 202	BIRD	Extracted only.		Analyzed elsewhere.			12-I
UN 203	MOUSE	2.5	ND	3	30		10-I
BLANK 001	SOLVENT						12-II
BLANK 002	SOLVENT						12-II
BLANK 003	SOLVENT						12-II
UN 203	MOUSE	Extracted only.		Analyzed elsewhere.			12-II
UN 204	NEWTS	2.5	3	2	50		10-I
BLANK	SOLVENT	2.45	ND	5	50		10-I
BLANK	SOLVENT	2.4	ND	4	50		10-I
BLANK	SOLVENT	2.5	ND	3	55		10-I
UN 204	NEWTS		ND	1		-	10-VI
UN 204	NEWTS	Extracted only.		Analyzed elsewhere.			12-I

Attachment X.V.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

SEP 24 1982

MEMORANDUM

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

SUBJECT: Briefing Document for September 27, 1982, at 11:00am on Region VII, Dioxin Issues

FROM : Conrad O. Kleveno
OSWER Dioxin Coordinator

TO : Rita M. Lavelle
Assistant Administrator

The briefing package includes the following items:

1. Agenda
2. Participants
3. Assessments
   - a. Risk/Exposure Assessment of Region VII Sites
     Dr. Donald Barnes, OPTS
   - b. Risk Assessment
     Dr. Robert McGaughy, Director, CAG
   - c. Risk Assessment at other sites
     Dr. Barbara Elkus, OSWER
   - d. Non-Cancer Risk Levels
     Dr. Art Pallata, OSWER
4. Options - Barbara Elkus
   - a. .01 - .05 ppb - Pros & Cons
   - b. 1 ppb - Pros & Cons
   - c. 100 ppb - Pros & Cons
5. Background briefing material
   - a. Region status at sites - Region and ERD
   - b. Priority list issues - HSCD
   - c. Enforcement Options
   - d. Status of proposed RCRA regulation - OSW
   - e. Dioxin Task Force memorandum
6. Other (FYI)
   - a. Region management plan
   - b. OLEC concerns Memo to DTF Chairman
   - c. Sturgeon Spill

18596

Items 3 and 4 will be the major discussion issues. The other background are for your information.

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OPTION: Use 1 ppb as the cleanup level for the preliminary actions (Preliminary injunction and/or planned removal actions) and continue analysis to determine final acceptable cleanup level.

PRO: Allows immediate action for Agency, and good press.

Buys time

- Allows time for reassessment of Agency risk analysis methods and policies, SAB review, and other scientific review.
- Allows preparation of public for possible change in policy.

Intermediate cost option

Consistent with Neosho order

Removes major source of risk

Easily implemented, sampling is relatively inexpensive and easy

CON: Not the final solution, the problem will be ongoing until final resolution

If final cleanup level is 1 ppb, then still have inconsistency with cleanup levels at Hyde Park, Syntex, Vertac and Love Canal.

Based on cost and need for immediate action, not total health protection.

18598

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JAN 13 1987

OFFICE OF WATER

MEMORANDUM

SUBJECT: Release of Information from the Investigation of Dioxin in Pulp and Paper Mills

FROM: William A. Whittington, Director
Office of Water Regulations and Standards (WH-551)

TO: Water Division Directors (Regions 1, 5, 6, and 10)
Environmental Services Division Directors
(Regions 1, 5, 6, and 10)

Recently, the American Paper Institute (API) has formally raised the issue of how the data from the joint EPA/Paper industry screening study of dioxin in pulp and paper mills should be handled. In a letter to Alec McBride of my staff, who is project director for EPA on this study, Pat Hill of API describes certain concerns on the part of industry participants regarding potential premature release of the data (Attachment 1).

Our response to this letter (Attachment 2) restates what we have maintained in numerous meetings as our position on handling of the data. The major elements of our position are: 1) the data must satisfactorily complete a quality assurance review before they are provided to anyone other than the quality assurance reviewers, 2) the participating State agencies will have access to data summaries from the mills in their States when the quality assurance review is satisfactorily completed, 3) there may be circumstances where public release of certain data may be necesary prior to the completion of a final report on the study, and 4) EPA will discuss with industry representatives any release of data to the public before the data are released.

I would like to emphasize that we are in no way constraining our ability to work with State agencies or to release information which should be made public. We are only agreeing to discuss any potential data releases with the industry participants. If you have any questions or comments on this issue, please contact me or Alec McBride (382-7046).

Attachments

cc: Rebecca Hanmer

American Paper Institute
ENVIRONMENTAL & HEALTH PROGRAM
National Forest Products Association

1250 Connecticut Avenue, N.W., Washington, D.C. 20036

December 11, 1986

Patricia K. Hill
Director, Water Quality and
Waste Disposal Programs
202-463-2441

Mr. Alex McBride
Chief, Water Quality Analysis Branch (WH 533)
Monitoring & Data Support Division
Environmental Protection Agency
401 M St., S.W.
Washington, D.C. 20460

Dear Alex:

In accordance with our recent conversations, the meeting scheduled for today between representatives of the American Paper Institute/National Forest Products Association (API/NFPA) and the Environmental Protection Agency (EPA) has been postponed because of schedule conflicts. At that meeting, API/NFPA had intended to express our concerns about the possible premature release by EPA of numbers or data being generated by our joint Dioxin Screening Study.

As a result of an incident that occurred recently that potentially may have resulted in premature release, the companies that have volunteered to participate in the screening study, as well as the remaining portions of the industry, have been concerned enough to want reassurance from EPA that such information will not be released in any unforeseen fashion.

These concerns have been discussed with you in several phone conversations. When the pulp and paper industry entered into a joint Dioxin Screening Study with EPA in June 1986, we did so with the understanding that all data would be collected and analyzed first; before any information was released, EPA would develop the final report with input from NCASI and API.

We would like your assurance that, in the unlikely event that extraordinary information is developed which EPA believes to be of such critical nature that it must be released in advance of the publication of the final report, the industry will be given at least 72 hours prior notice and the opportunity to discuss the matter with you before release takes place. With that assurance, we look forward to rescheduling our meeting for sometime next month.

Sincerely,

Pat

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JAN 13 1987

OFFICE OF
WATER

Patricia K. Hill
Director, Water Quality and
Waste Disposal Programs
American Paper Institute
1250 Connecticut Avenue, N.W.
Washington, D.C. 20036

Dear Pat:

In response to your letter of December 11, I would like to describe the procedures that we at EPA have worked out with Russ Blosser of the National Council of the Paper Industry for Air and Stream Improvement (NCASI) regarding the handling of the data from our joint dioxin screening study. Since the incident you refer to involved only discussions with paper industry participants in the study agreement, we are somewhat at a loss to understand the magnitude of concern expressed regarding "release" of data. Nevertheless, the procedures outlined below will ensure that the data receive an adequate quality assurance review before they are considered.

The data are generated by the Brehm Laboratory at Wright State University under contract to NCASI and EPA. The initial analytical results for each sample or set of samples will go to Larry LaFleur of NCASI and Frank Thomas of EPA for a quality assurance review. Only after the quality assurance review is completed and the data determined to be valid will the results be given to the EPA and NCASI project directors.

As we clearly indicated during the negotiations for the agreement and have emphasized ever since, once the data have been declared valid we will provide the results to the appropriate State agency consistent with 40 CFR Part 2. Each State involved in the study will receive only the data for the mill within its jurisdiction. At that time, we anticipate that officials from the affected company, NCASI, the State agency, and EPA will discuss the results to determine whether there is a need to release them prior to publication of the final report.

This approach is consistent with our understanding of the agreement as discussed during our negotiations and in subsequent meetings. We currently have no plans to release data prior to

publication of a final report; however, we all recognized the possibility that the release of some data may be necessary in certain situations. We believe it is imperative that there be no possible appearance of a situation wherein somebody could be withholding data which indicates a potential threat to human health. We do expect that industry representatives would be involved if the circumstances are such that a release is necessary. Finally, as we have previously pointed out, we believe that certain of the results which have passed the quality assurance review are obtainable through requests under the Freedom of Information Act. We will immediately inform you if we receive any such requests.

I hope this clarifies how we propose to handle the results of the study prior to publication of the final report. While we cannot predict all possible circumstances that may arise and therefore cannot commit to a particular time frame for discussions, we can assure you that EPA will not be involved in any public release of these results without first discussing the situation with industry officials. We also suggest that company officials continue to work closely with State agency officials to ensure close coordination of any activities on their part. We look forward to meeting with you in January, at which time we expect to have some results to review.

Sincerely,

Alec

Alec McBride, Chief
Water Quality Analysis
Branch (WH-553)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION V

DATE: February 14, 1986

SUBJECT: Results Of Analysis Of Papermill Sludges For 2,3,7,8-TCDD

FROM: Howard Zar, Regional Dioxin Study Manager
Water Quality Branch

TO: See Below

As part of USEPA's National Dioxin Study Tier 5 sampling of Petenwell Flowage on the Wisconsin River, sludge samples were taken from a variety of papermills and one municipal STP by the State of Wisconsin and provided to USEPA's Duluth Environmental Research Laboratory for analysis. 2,3,7,8-TCDD results for these 12 samples and one from Minnesota were completed for USEPA Duluth by Wright State University under contract. In view of the interest in these results I have provided a summary of the findings and a description of the samples in the attached pages. A spread sheet is included which includes information on facility process, products, and pulp source when known. Maine results are included. A Wisconsin press release in the matter is also attached. We would be interested in receiving similar results from other parties when available.

Questions in regard to this information may be referred to me at 312-886-1491.

Addressees:

HQ
A. McBride (WH-553)
J. Cummings (WH-562-A)
D. Barnes (TS-788)
W. Smith (WH-552)

States
R. Dunst, WDNR
M. Hora, MPCA
C. Rogers, OEPA
J. Estenik, OEPA
J. Hesse, MDPH
J. Hochmuth, WDNR
B. Schade, MPCA

Region V Dioxin Task Force

Region V
A. Levin, 5A

Bill Walsh, Region I

C. Sutfin, D. Bryson, K. Fenner, J. Newman
Barney, Seng, 5W
W. Sanders, T. Yeates, 5S
B. Constantelos, 5H
P. Wise, 5GL
Y.J. Kim, 5HS
W. Mains, 5HE
J. Beck, 5PA

Duluth ERL
N. Jaworski
D. Kuehl

2,3,7,8 - TCDD results for Wisconsin and Minnesota papermill sludges

Results transmitted to USEPA Region V on Jan. 30, 1986 by USEPA - Duluth as part of Tier 5 = National Dioxin Study at Petenwell Flowage, Wisconsin

plant	scc #	2,3,7,8 TCDD pg/g (ppt)	% recovery
Ft Howard Paper	DE016201	to be rerun	nd @ 35
Gr Bay Metro STP	DE016301	to be rerun	nd @ 9
Tomahawk Tissue	DE016401	74	77
Owens Illinois	DE016501	ND @ 0.5	56
Owens Ill dup	DE016501	ND @ 0.4	78
Ward Paper	DE016601	10	80
Wausau Paper	DE016701	to be rerun	nd @ 24
Weyerhauser	DE016801	6	87
Mosinee Paper	DE016901	3.5	70
Consol Wisc R.	DE017001	23	90
Consol WQCenter	DE017101	159	78
Nekoosa Paper	DE017201	128	83
Rhinelander	DE017301	7.6	88
Boise Cascade*	MN000101	414	94

* Minnesota, others are Wisconsin

FACILITY AND PROCESS DESCRIPTION									WASTEWATER TREATMENT			SAMPLING DATA		
NAME/LOCATION					PULP		PAPER					WW SLUDGE		
FACILITY	CITY/TOWN	STATE	REC WATER	PROCESS	WOOD	BLCH SEQ	PRODUCTS	PURCH PULP	JNT TRTMT	TYPE TRTMT	SLUDGE DISP	WS DATE	WS RESULTS	COMMENTS
Boise Cascade	International Falls	MN	Rainy R	Bl¢¢rft	H/S	CEH/COH	Fine	?		ORS		1985	414	
Consolidated	Biron	WI	Wisconsin R	GndWd/TMP	?	?	Fine	?	Consolid	AS	LF,AgLand	1985	159	Jnt Trt - Consolid
Consolidated	Wisconsin Rapids	WI	Wisconsin R	NA	NA	NA	Fine/PapBd	?	Consolid	AS	LF,AgLand	1985	159	Jnt Trt - Consolid
Consolidated	Wisconsin Rapids	WI	Wisconsin R	Bl¢¢rft	?	?	NA	?	Consolid	AS	LF,AgLand	1985	159	Jnt Trt - Consolid
Nekoosa	Port Edwards	WI	Wisconsin R	Bl¢¢Sulf	?	?	Fine	?	Nekoosa	ORS	LF,ForLand	1985	120	Jnt Trt - Nekoosa
Nekoosa	Nekoosa	WI	Wisconsin R	Bl¢¢rft	?	?	Fine	?	Nekoosa	ORS	LF,ForLand	1985	120	Jnt Trt - Nekoosa
Tomahawk Tissue	Tomahawk	WI	Wisconsin R	NA	NA	NA	Tissue	?		ASB		1985	73.9	
Consolidated	Stevens Point	WI	Wisconsin R	NA	NA	NA	Fine	?		Prim	LF	1985	23	
Wood	Merrill	WI	Wisconsin R	Deink	NA	?	Fine	?		AS		1985	10	
Rhinelander	Rhinelander	WI	Wisconsin R	NA	NA	NA	Fine	?		AS		1985	7.6	Tortula yst from sulf
Mayerhauser	Rothschild	WI	Wisconsin R	BlchSulf	?	?	Fine	?		AS		1985	6	
Mosinee	Mosinee	WI	Wisconsin R	Bl¢¢rft-Semi	?	?	Spec	?		ORS		1985	3.5	
Fort Howard	Green Bay	WI	Fox R	Deink	NA	W	Tissue	WstPap		Prim-P/ASB	LF	1985	Rerun	ND(35)
Lmes River	Green Bay	WI	Fox R	BlchSulf/GndWd	?	?	Tissue	?	Green Bay	AS		1985	Rerun	Jnt Trt-Green Bay ND(
Procter & Gamble	Green Bay	WI	Fox R	BlchSulf	?	?	Tissue	?	Green Bay	AS		1985	Rerun	Jnt Trt-Green Bay ND(
Marsac	Brokau	WI	Wisconsin R	BlchSulf	?	?	Fine	?		AS		1985	Rerun	ND(24)
Owens Illinois	Tomahawk	WI	Wisconsin R	SemiChem	?	?	CorrMed	WstPap		ASB	LF	1985	ND(0.5)	
International	Jay	ME	Androscoggin R	Bl¢¢rft/GndWd	?	?	Fine/Tissue	?		ASB		1985	51.3	
Boise Cascade	Rumford	ME	Androscoggin R	Bl¢¢rft/GndWd/TMP	?	?	Fine	?		AS		1985	32	
S.D. Warren	Westbrook	ME	?	Bl¢¢rft	?	?	Fine	?		AS		1985	16.6	
Scott	Fairfield	ME	?	Bl¢¢rft	?	?	Fine	?		?		1985	2.8	for paper (pulp ND)
Great Northern	Millinocket	ME	?	BlchSulf/GndWd	?	?	Fine/Spec	?		ASB		1985	ND	

2/9/86

Ontario

May 2, 1986

Ministry
of the
Environment

FOR FURTHER INFORMATION:
Wally Vrooman (807) 475-1205
Ted Gorsline (416) 965-7117

2,3,7,8-TCDD DIOXIN IN FORT FRANCES PAPER MILL SLUDGE

Tests have revealed 210 parts per trillion of 2,3,7,8-TCDD, the most toxic form of dioxin, in the primary settling lagoon at Boise Cascade's pulp and paper mill in Fort Frances, Environment Minister Jim Bradley said today.

Additional tests did not detect 2,3,7,8-TCDD in the primary clarifier, the woodroom clarifier or in effluent leaving the plant and entering the Rainy River.

Initial testing made at a Fort Frances area landfill site, used by Boise Cascade as a sludge dump, have not discovered 2,3,7,8-TCDD dioxin at the site or in leachate migrating from the site. Thus, the discovery of 2,3,7,8-TCDD in the primary settling lagoon does not appear to pose a threat to Fort Frances' drinking water. Past Environment Ministry tests revealed no 2,3,7,8-TCDD in the drinking water in the communities of Fort Frances and Emo. New tests of the drinking water supplies will be made at Fort Frances, Emo and Rainy River next week.

"I treat the presence of the dioxin as a serious matter. My Ministry is acting on several fronts", the Minister said. "We are developing a guideline for 2,3,7,8-TCDD in sludge, testing to discover the source of dioxin, and expanding tests for 2,3,7,8-TCDD in other northern communities" he said.

This dioxin finding is similar to U.S. Environmental Protection Agency findings for mills in Maine, Wisconsin and Minnesota, suggesting dioxin may be a by-product of the process. The Environment Ministry, in conjunction with Boise Cascade and a U.S. industry association, has initiated in-depth analyses to discover the source of the dioxin in the pulp and paper mill process.

"My Ministry's tests will include wastes from pulp and paper mills around the province. Analyses for nine other Ontario mills will be ready by the end of May", the Minister said.

cc Sutton, Harvey, Newman, Ronson, McBride, [illegible], Klovens (HQ)
O'Farrell (HQ), Dunst-WDAR, Fabinski-SA, Beck, PAO

Ontario

July 17, 1986

Ministry of the Environment

FOR FURTHER INFORMATION:
G. Van Fleet (807) 475-1205
T. Gorsline (416) 965-7117

DIOXIN TEST RESULTS FROM ONTARIO PULP AND PAPER MILLS

The Ontario Ministry of the Environment has completed testing of sludge samples from eight Ontario pulp and paper mills for dioxins and furans.

The mills included Great Lakes Forest Products in Dryden, the Abitibi-Price Thunder Bay mill in Thunder Bay, Domtar in Red Rock, Kimberly-Clark in Terrace Bay, James River Marathon in Marathon, E. B. Eddy in Espanola, Ontario Paper in Thorold and Domtar in Cornwall.

The sampling was undertaken following detection of 2,3,7,8-TCDD dioxin in sludge from Boise Cascade's secondary treatment system in Fort Frances and other mills in Maine, Wisconsin and Minnesota.

No detectable concentrations of 2,3,7,8-TCDD were found. The detection limits for the 2,3,7,8-TCDD at the eight mills varied from 20 to 100 parts per trillion, depending on the level of chemical interference encountered in the samples.

Analyses for other forms of dioxins and related furans revealed less toxic tetra, hepta and octa dioxins and tetra and octa furans in some samples.

Octa dioxin was discovered at a level of 1,800 parts per trillion in settling basin sludge at the E. B. Eddy Mill in Espanola, at 120 and 140 ppt in sludge at the Abitibi-Price mill in Thunder Bay and at 130 ppt at the Domtar mill in Cornwall.

Hepta dioxin was discovered at a level of 360 ppt in settling basin sludge at the E. B. Eddy mill in Espanola. Tetra dioxin was found at a level of 180 ppt at the Kimberly Clark mill in Terrace Bay.

Tetra furan was revealed at a level of 1,100 ppt at the E. B. Eddy mill in Espanola, 260 ppt at the Great Lakes mill in Dryden, 280 ppt at the Domtar mill in Cornwall and 37 ppt at the James River Marathon mill in Marathon. Octa furan was found at a level of 350 ppt at E. B. Eddy in Espanola.

The sludge is disposed of at approved landfill sites. All values are below current U. S. Environmental Protection Agency cleanup criteria of one part per billion (1000 parts per trillion) 2,3,7,8-TCDD for residential soils.

Sampling of 50 fish in the Rainy River system below the Boise Cascade mill in Fort Frances revealed 2,3,7,8-TCDD in 16 of 42 fish at levels of 1 to 9 parts per trillion. These levels are below Health and Welfare Canada's guideline of 20 parts per trillion for the consumption of sport fish.

Twenty fish from Thunder Bay inner harbor and the mouth of the Mission River have also been analyzed by the environment ministry for 2,3,7,8-TCDD. None was detected.

The environment ministry also tested leachate from a closed Boise Cascade sludge disposal site located in Miscampbell Township just outside Fort Frances. No 2,3,7,8-TCDD was found at a detection level of 20 parts per quadrillion (.02 ppt). No other dioxins or furans were detected.

A 24-hour composite total mill effluent sample from Boise Cascade's Fort Frances mill revealed no 2,3,7,8-TCDD at a detection level of 70 parts per quadrillion (.07 ppt). However, tetra furan was found at levels of 210 ppq (0.21 ppt) and 230 ppq (0.23 ppt).

Environment ministry sampling of drinking water supplies downstream from Fort Frances has not revealed any dioxins or furans.

The Ministry's recently announced Municipal-Industrial Strategy for Abatement (MISA) program and strengthened regulations relating to hazardous wastes, will ensure all potential environmental impacts are considered in implementing pollution control measures. They include adequate handling, containment, recycling and/or disposal of sludge and other by-products of waste treatment processes.

An intensive in-mill sampling program, designed to pinpoint the source of dioxin, has been initiated by the U. S. Environmental Protection Agency and the pulp and paper industry. Five representative mills in the United States, including the Boise Cascade mill at International Falls, will be sampled. The results of this 10-month long study will be applicable to Ontario mills.

Environment Ontario will continue its monitoring program at Fort Frances and elsewhere in Ontario.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUN 10 1985

OFFICE OF
WATER

MEMORANDUM

SUBJECT: EPA/Paper Industry Dioxin Investigation

TO: Regional Water Division Directors
Regional Environmental Services Division Directors

Attached is a copy of an agreement which we have reached with the American Paper Institute (API) and the National Council of the Paper Industry for Air and Stream Improvement (NCASI) to perform a detailed screening investigation of possible dioxin contamination at five bleached kraft pulp and paper mills. The impetus for this investigation was the findings from our national dioxin study, which indicated the presence of dioxin (specifically 2,3,7,8-TCDD) in fish downstream from a number of paper mills. Subsequent investigations led to the detection of dioxin in wastewater treatment sludges from all six bleached kraft mills which were sampled.

The agreement calls for joint industry/EPA sampling efforts to be conducted at the five mills over the next four or five months. The samples from each mill will be analyzed following a two tiered priority system, and the results will be reported simultaneously to EPA and the industry after a joint quality assurance review. Industry will pay 75 percent of the analytical costs up to a maximum of $150,000.

One of the mills to be studied under the agreement is a Boise Cascade Corporation mill in International Falls, Minnesota. The study will provide the same information which Region V was proposing to collect under Section 308 authority; consequently, the Region agreed to withdraw its 308 letter to the company. While the formal agreement does not discuss other possible 308 activities, we informally have told the industry that, during the course of the study, if EPA required information related to dioxin from any pulp and paper mill, we would attempt to collect that information in a cooperative manner prior to sending a 308 letter. If a cooperative approach is not successful, we might then invoke Section 308 authority.

We have also indicated that we do not anticipate any other significant dioxin investigations related to water discharges from the pulp and paper industry during the course of the study. As a practical matter, we are very limited in our ability to do much additional work in the near future because of the limitations in laboratory analytical capacity to perform these complex, low level dioxin analyses. For these reasons, I ask that you inform Alec McBride (FTS 382-7046) if you are considering any investigations of dioxin in pulp and paper mills. He will be able to coordinate these activities with the national study and will also be able to assist in arranging for laboratory analytical support if necessary.

We were able to develop this agreement with the paper industry because of a shared concern over the dioxin problem and a mutual recognition that a cooperative effort would be the fastest and most efficient approach to investigating the possible sources of dioxin. However, I would like to emphasize that, while we hope to continue to work cooperatively with the industry, this agreement in no way limits our authority to collect any information we believe is necessary to protect the environment.

Please feel free to contact me or Alec if you have any questions. Thank you for your cooperation.

William A. Whittington

William A. Whittington, Director
Office of Water Regulations
and Standards (WH-551)

Attachment

cc: Larry Jensen
Susan Lepow
James Elder
Mike Cook

USEPA/PAPER INDUSTRY COOPERATIVE DIOXIN SCREENING STUDY

Background and Project Introduction

Results from the National Dioxin Study indicate that 2378-TCDD has been detected in fish and river sediments collected downstream from some pulp and paper mills located in various parts of the country. The Petenwell Flowage in Wisconsin, the Rainy River in Minnesota, and the Androscoggin River in Maine have been identified as areas containing levels of dioxin to date. Current wastewater treatment plant sludges from some Maine, Minnesota, and Wisconsin mills contain parts per trillion (ppt) levels of 2378-TCDD and other PCDDs and PCDFs. Available EPA data indicate that, within the paper industry, bleached kraft mills have the highest levels of 2378-TCDD in wastewater sludge. This would indicate that current process operations may be responsible. However, there are currently no data to document potential process sources of dioxins nor to explain the wide range of sludge concentrations at bleach kraft mills. The paper industry has initiated a sampling program for paper mill wastewater treatment plant sludges. At this writing, paper industry data are not available.

The U.S. Environmental Protection Agency (USEPA), the American Paper Institute (API) and the National Council of the Paper Industry for Air and Stream Improvement (NCASI), have decided to conduct a cooperative screening study of five bleached kraft mills to determine possible process sources of PCDDs and PCDFs and quantify raw waste, sludge, and final effluent loadings of PCDDs and PCDFs. The cooperative screening study is being conducted to determine the formation and fate of PCDDs and PCDFs in bleached kraft pulp and paper making operations and respective wastewater treatment facilities. The cooperating parties believe a screening study of this nature can most efficiently be conducted by combining the knowledge and resources of federal and state governments and industry.

On March 5, 1986, the USEPA sent a formal request for information and cooperation to the Boise-Cascade Corporation with respect to its International Falls, Minnesota, mill. Since this cooperative screening study is expected to generate information fully satisfying that asked for in USEPA's March 5, 1986, request, USEPA hereby agrees to withdraw that request pending satisfactory execution of the cooperative screening study.

Screening Study Objectives

1. Determine, if present, the source or sources of 2378-TCDD and other PCDDs and PCDFs at five bleached kraft pulp and paper mills.

2. Quantify the untreated wastewater discharge loadings, final effluent discharge loadings, sludge concentrations, and wastewater treatment system efficiency for 2378-TCDD and other PCDDs and PCDFs. Determine raw wastewater and final effluent levels of selected other organic compounds.

General Project Organization and Responsibilities

1. Joint USEPA and Industry Responsibilities

Responsible for: (1) study design; (2) field coordination of sampling collection program; (3) providing personnel and equipment for sampling; (4) providing quality assurance review of analytical data from all samples; (5) development of final report; (6) public, local government, and media relations.

2. USEPA

Responsible for: (1) approval of sampling locations; (2) contract analytical support; (3) coordination of field sampling with participating State Agencies; (4) selection and prioritization of samples for analysis; (5) providing confidential treatment of process related information in accordance with Agency regulations; (6) preparation of final report, and (7) public, local government, and media relations as necessary. For USEPA the study will be directed through the Office of Water Regulations and Standards, Industrial Technology Division and Monitoring and Data Support Division.

3. Industry

API and NCASI will each direct portions of the industry efforts, with the assistance of the five mills participating in the study.

Responsible for:

(1) providing study sites and a proposed sampling plan for each site; (Participating Mills and NCASI)

(2) contracting for analytical support; (NCASI)

(3) providing access to facilities, processes and production information to USEPA; (Participating Mills)

(4) public, local government, and media relations as necessary. (API and Participating Mills)

(5) Should a step in the kraft pulp and papermaking process be isolated as a major source of dioxin, the industry agrees to undertake a further investigation in attempt to determine its source and formation.

General Field Sampling Plan

A complete set of samples at each mill will be obtained during a single sampling event. Individual samples will be collected over a 24-hour period or other suitable composite sampling period. Where appropriate, process additives may be grab sampled. The approximate level of detail of sampling to be conducted at each mill is presented in Table 1 along with analytical requirements. The

outline presented in Table 1 will be used as a guide for developing specific sampling plans for each mill. All samples will be collected with appropriate documentation, coding, and custody procedures. Samples will be kept chilled during collection and shipment to the analytical laboratory. Process operating conditions and production records during the survey will be recorded and made available to study participants at the conclusion of each mill-specific sampling event.

General Analytical Plan

Table 1 also presents a general analytical plan, and Table 2 presents additional detail on sample prioritization. Samples and analyses are prioritized to conserve analytical resources. Priority 1 analyses will be conducted and reviewed prior to initiating Priority 2 analyses. USEPA, NCASI, and industry participants will consult to select Priority 2 samples and analyses. Analytical costs for each mill will be shared on the basis of 25 percent funding by USEPA and 75 percent funding by industry for all Priority 1 samples and up to a maximum of 15 Priority 2 samples. Industry's share of the total analytical cost for the screening study shall not exceed $150,000.

Quality Assurance Review

The coded analytical data will be forwarded from the contract laboratory simultaneously to the EPA and the NCASI quality assurance managers. The quality assurance managers will complete timely reviews of the data, consult with each other and transmit the data to the EPA and NCASI project managers. Should the quality assurance managers disagree as to whether certain samples require reanalyses or followup analyses, the matter will be referred to the USEPA and NCASI project managers for resolution. Analytical costs associated with further analyses beyond that normally conducted by the analytical laboratory to resolve analytical problems will be shared by USEPA and industry on the same basis noted above. An outline of the Quality Assurance Project Plan for this screening study is presented as Attachment 1.

Confidentiality

Section 308(b) of the Clean Water Act, 33 USC § 1318(b), provides that confidential treatment may be afforded to trade secrets which are contained in information collected by, or submitted to, USEPA except that confidential treatment is precluded for "effluent data." Information collected pursuant to this dioxin screening study can be afforded such confidential treatment in accordance with 40 CFR Part 2. The participating companies may make claims of confidentiality on information submitted to USEPA as specified in 40 CFR § 2.203(b). USEPA will treat such submitted information in accordance with its regulations found at 40 CFR Part 2.

USEPA shall choose the appropriate manner in which to release the report for this dioxin screening study after considering the confidentiality provisions in the Clean Water Act and Agency regulations and after consultation with the participating mills, NCASI, and API.

Other Matters

Any other matters regarding study design, study implementation, analytical issues, etc., will be referred to the USEPA and industry project managers in a timely fashion as they arise for resolution with other parties.

Final Report

The cooperating parties agree that the final report of this screening study will be limited to a technical document responsive to study objectives. USEPA will have primary responsibility for preparation of the final report. NCASI and API will provide input to the development of the final report and have the opportunity to provide comments on review drafts. In the event industry participants do not agree with EPA's evaluation and conclusions regarding the data resulting from this screening study, NCASI and API may provide separate views regarding the data for inclusion in the final report.

The undersigned signatories consent to, and approve this USEPA/Paper Industry Cooperative Dioxin Screening Study:

Michael C. Farrar
Vice President
Environment and Health
American Paper Institute

Isaiah Gellman
Executive Vice President
National Council
of the Paper Industry for
Air and Stream Improvement

Alexander C. McBride, Chief
Water Quality Analysis Branch
Monitoring and Data Support Division

TABLE 1

GENERAL SAMPLING PLAN AND ANALYTICAL REQUIREMENTS

	ANALYTICAL PACKAGE
A. Background Samples	
Treated River Water	2,3,4,5,6
Treated River Water Sludge	1
Wood Chips	1
B. Pulping Process	
Combined Process Wastewaters	2,5
C. Chemical Recovery Plant	
Recovery Plant Combined Wastewaters	2
Recovery Plant Waste Solids (Lime Mud)	1
D. Bleach Plant	
Pulp (Bleached and Unbleached)	1 or 2
Individual Sewered Streams from Bleachines	1 or 2
Combined Bleach Plant Process Wastewaters	2,5
Bleaching Agents Or Solutions	1
E. Paper Machines	
Combined Paper Machine Wastewaters	2,5
Process Additives (Alum, Clay, Dyes, Other Chemicals)	1
Slimicides	1 or 2
F. Utilities, Wastewater Treatment	
Powerhouse Wastewater	2,5
Powerhouse Ash to Treatment	2
Wastewater Treatment Primary Sludge	2
Wastewater Treatment Secondary Sludge	2
Wastewater Treatment Composite Sludge	2
Combined Untreated Process Wastewater	2,3,4,5,6
Final Treated Process Wastewater Effluent	2,3,4,5,6
Other Wastewater Streams to Treatment (e.g. Landfill Leachates)	1,5

Analytical Packages

1. Isomer specific analyses for TCDDs and TCDFs
2. Package 1 plus 2378-substituted and selected bioaccumulative PCDDs and PCDFs
3. Suspected precursor compounds: Chlorinated phenols, vanillins, and guaiacols
4. Non-polar compounds: HRGC scan for non-polar compounds
5. TSS: Total suspended solids
6. BOD_5: Five-Day biochemical oxygen demand

TABLE 2

ANALYTICAL PRIORITIES

PRIORITY 1 - Samples to be analyzed at all plants	Estimated Number of Samples
a. Process Related	
Pulp (in - out)	2-6
Bleach Plant Wastewaters	4-12
Powerhouse Ash to Treatment	1
Selected Additives	2
b. Effluent Related	
Combined Bleach Plant Wastewaters	1
Combined Untreated Process Wastewaters	1
Final Treated Process Wastewater Effluent	1
Composite Wastewater Sludge	1
Priority 2 - Samples to be selected from Table 1 for analysis based upon Priority 1 results	15

PRELIMINARY INVESTIGATION OF TRACE CONTAMINANTS IN PULP AND PAPER MILL EFFLUENTS

Prepared by:
Christina Cherwinsky
Great Lakes Section
Water Resources Branch
Ontario Ministry of the Environment

and

Don Murray
Industrial Abatement Section
Northwestern Region
Ontario Ministry of the Environment

July, 1986

Table 1: Preliminary List of Trace Contaminants of Concern which should be included for Monitoring Pulp and Paper Mill Effluents in Ontario*

CONTAMINANTS	CONCERN
Aluminum	criteria in development, high in waste metals
Benzene	moderately toxic(a), low bioaccumulation(b), non-persistent(c), animal and suspect human carcinogen
Bromodichloromethane	mutagen
Cadmium	extremely toxic, moderately bioaccumulative
Carbon Tetrachloride	slightly toxic, non-persistent, animal and suspect human carcinogen
Chloroacetaldehyde	mutagen
Chlorodehydroabietic Acids	toxic, persistent
Chloroform	slightly toxic, non-persistent, animal and suspect human carcinogen
Chlorofuranone	mutagen
Chloropropenal	mutagen
Copper	regulated
Dehydroabietic Acid	toxic, persistent
Dibutyl Phthalate	human health
Dichloroacetone	mutagen
Dichloroethane	slightly toxic, non-persistent, animal carcinogen
Dichloromethane	mutagen
Fatty Acids	toxic
Hexachloroacetone	mutagen
Lead	extremely toxic
Mercury	extremely toxic, highly bioaccumulative
Neoabietic Acid	mutagen
Pentachloroacetone	mutagen
Pentachlorophenol	extremely toxic, very persistent
Pentachloropropene	mutagen
Phenols	toxic, impair flavour
PCBs	high bioaccumulation, very persistent
PCDDs	animal carcinogens
PCDFs	potential animal carinogens
Resin Acids	toxic
2,3,7,8-TCDD	animal carcinogen & teratogen
Tetrachloroacetone	mutagen
Tetrachloroethene	mutagen
Tetrachloroguaiacol	toxic, persistent
Tetrachloropropene	mutagen
Toluene	moderately toxic, non-persistent, cancer promoter
Trichloroacetone	mutagen
Trichloroethane	moderately toxic, non-persistent, 1,1,1-isomer: mutagen; 1,1,2-isomer: carcinogen
Trichloroethene	mutagen
Trichloroguaiacol	toxic, persistent
Trichlorophenol	extremely toxic, persistent, 2,4,6-isomer: possible animal carcinogen
Zinc	regulated

* = prepared by Cecil Inniss, MOE (unpublished)
(a) = toxic to aquatic biota
(b) = bioaccumulates in aquatic biota
(c) = persistent in the aquatic environment
PCBs = Polychlorinated biphenyls
PCDDs = Polychlorinated dibenzodioxins

Table 7: (Cont'd)

1. Terpenes & Associated Compounds (Cont'd)
   - Octahydro-tetramethyl-naphthalenemethanol
   - Octahydrodimethyl-isopropylnaphthalenol
   - Octahydronaphthalenone derivative
   - Octahydrotetramethylmethanoazulene
   - α-Pinene
   - 7-Propylidene-bicyclo(4,1,0)heptane
   - Terpin hydrate
   - α-Terpineol (+ isomers)
   - Tetrahydro-isopropyl-pentamethylnaphthalene
   - 1,3,3-Trimethyl-bicyclo(2,2,1)heptan-2-ol
   - 3,7,7-Trimethyl-bicyclo(4,1,0)heptane
   - 1,3,3-Trimethyl-bicyclo(3,1,1)heptan-2-one
   - 1,7,7-Trimethyl-bicyclo(2,2,1)heptan-2-one?
   - 2,6,6-Trimethyl-bicyclo(3,1,1)heptan-3-one
   - 3,7,7-Trimethyl-bicyclo(4,1,0)hept-2-ene
   - Trimethylcyclopentanone
   - Trimethylcyclopentenone
   - 1,3,3-Trimethyl-2-oxabicyclo(2,2,2)octane
   - 4,11,11-Trimethyl-8-methylene-bicyclo(7,2,0)undec-4-ene
   - Triterpanes

2. Products of Chlorination
   - (2-Chloro-2-butenyl)-benzene
   - 4-Chloro-2-methylpyrimidine
   - 4-Chloro-3-methylphenol
   - Chloro-alkyne
   - Chlorodibromomethane
   - Chloroform
   - Dichloroacetone
   - Dichlorobromomethane
   - Dichloroguaiacol
   - Dichloromethoxybenzaldehyde
   - Dichloromethoxyphenol
   - Dichlorophenol
   - Hexachlorobenzene
   - Hexachlorocyclopentadiene
   - Pentachloroacetone
   - Pentachlorophenol

2. Products of Chlorination (Cont'd)
   - Tetrachloroacetone
   - Tetrachloroguaiacol
   - 2,3,4,5-Tetrachlorophenol
   - 2,3,5,6-Tetrachlorophenol
   - Trichloroguaiacol
   - 2,3,4-Trichlorophenol
   - 2,4,5-Trichlorophenol
   - 2,4,6-Trichlorophenol

3. Industrial Solvents and Additives
   - Acetone
   - Benzene
   - Bis(2-ethylhexyl)phthalate
   - Butanal
   - Butanol*
   - n-Butanol
   - t-Butanol
   - 2-Butoxyethanol
   - Carbontebrachloride
   - Chloroform
   - Di-n-butylphthalate
   - Diethylphthalate
   - (Dimethylethyl) formamide
   - Ethanol
   - Ethylbenzene
   - Isophorone
   - Isopropanol
   - Methyl acetate
   - Methyl-ethyl ketone
   - N-Methylformamide
   - Methyl-isobutyl ketone
   - Methyl-isopropyl ketone
   - Methylenechloride
   - 4-Nitrophenol
   - N-Nitrosodiphenylamine
   - Phenylbenzamine
   - n-Phenylbenzamine

Table 7: (Cont'd)

3. Industrial Solvents and Additives (Cont'd)
   - Polypropyleneglycol derivatives
   - Propanol*
   - n-Propanol
   - Silicone compound
   - Tetrachloroethylene
   - Tetrahydrofuran
   - Toluene
   - Tributylphosphate
   - 1,1,1-Trichloroethane
   - Trichloroethylene
   - m-Xylene
   - o- or p-Xylene

4. Lignin Degradation Products and Natural Products
   - Acetophenone
   - Acetosyringone
   - Acetovanillon
   - Alkyl benzenes
   - Benzaldehyde
   - Benzaldehyde derivative
   - Benzenemethanol
   - Benzenepropanoic acid
   - Benzenepropanol
   - Benzeneethanol
   - Benzoic acid
   - 2-t-Butyl-3-cresol
   - o-Cresol
   - Dihydropentyl-furanone
   - 2,3-Dihydro-2-(4-hydroxy-3-methoxyphenyl)-5-3-hydroxy-1-propenyl-7-methoxy-benzofuran-methanol?
   - Dihydro-3,4-bis-(4-hydroxy-3-methoxyphenyl) methyl-2(3H)furanone?
   - 4-(2,3-Dihydro-7-methoxy-3-methyl-5-(1-propenyl)-2-benzofuranyl)-2-methoxyphenol
   - 3,4-Dihydroxy-3-methoxypropiophenone
   - Dimethoxyphenol
   - Dimethoxypropanol
   - 1,2-Dimethoxy-4(2-propenyl)-benzene
   - Dimethoxybenzoic acid

Table 7: (Cont'd)

4. Lignin Degradation Products and Natural Products (Cont'd)

(2,2-Dimethoxyethyl) benzene
Dimethoxypropyl benzenes
Dimethylphenol
2,7-Dimethyl-3(2H)-benzofuranone
5-Ethenyl-tetrahydro-2-furanmethanol
Ethoxybenzaldehyde
Ethylbenzenediol
Ethylphenol
p-Ethylresorcinol
Eugenol
Furanylethanone
1(2-Furanyl)ethanone
Furfural
Guaiacol (+ isomers)
Hexanal
Homovanillic acid
Hydroxygenzaldehyde
Hydroxybenzeneacetic acid
Hydroxymethoxybenzaldehydes
Hydroxymethoxyethanone
Hydroxyphenylbutanone
1-(4-Hydroxy-3-methoxyphenyl)-2-propanone derivative
Isobutanal
Isomaltol?
3-Isopentyl-dihydro-2,5-furandione
p-Isopropylbenzaldehyde
2-Isopropyl-3-cresol
Methoxypropenylphenol
2-Methoxy-4-propyl-phenol
2-Methoxybenzenepropanol derivative
Methylbenzylalcohol
Methylbutanal*
Methyl-trimethylbenzoate
Methyl-3-(phenylmethyl)benzoate
Methylethylbenzoic acid
Methylfuran*
Methylphenols
3-Methyl-1,2-cyclopenthanediol
5-Methyl-5-phenyl-2-hexanone
Pentanone*
Phthalic acid
Phenol (+ unidentified phenol derivatives)
Phenylbutanone
Phenyl-ethanendiol
Phenylpropanol
Phenylpropanone
3-Phenyl-2- propenal
4-Phenyl-3-buten-2-one
2-(Phenylmethylene)-cyclohexanone
Propenylphenol
Propiovanillon
Resacetophenone + isomer
Salicylic acid
Steroids
Stigmastadieneone
Stigmastadienol
Stigmastenol
Stigmastenone
Syringaldehyde
Tetrahydro-hydroxy-dimethylbenzofuranone derivative
Tetrahydro-hydroxy-dimethyl-isobenzofuranone
Tetrahydrohydroxy-4(4-hydroxy-3-methoxy-phenyl)7-methox
naphthofuran-1(3H)one
Trimethoxybenzene
(1,2,2-Trimethoxyethyl)-benzene
Trimethylphenol
Trimethylquinolines
Vanillic acid
Vanillin
Veratrole

UNITED STATES ENVIRONMENT
REGION

2A-23

DATE:

SUBJECT: 3/03/86 Draft Study Plan, National Dioxin Study Pulp and Paper Industry Follow-Up (Boise Cascade Corp., Int'l Falls, MN.)

FROM: Larry Fink, Chemist
Remedial Programs Staff, 5GL

TO: Howard Zar
Water Quality Branch, 5WQ

I have confined my review to the "Possible Precursor Compounds" listed on pages 6 and 7 of Section 3.0.

The logic involved in developing this list is not clear. Is the intent 1) merely to confirm that polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) are present in wastewater sludge; 2) to locate the stage(s) in the process at which this is occuring; or 3) to determine the conditions of reaction which favor the formation of the most toxic PCDDs and PCDFs? This last would make it possible to recommend changes in the manufacturing process to minimize or eliminate the formation of unwanted PCDDs and PCDFs.

Based on the proposed sampling scheme, it would appear that the purpose of the study is #2. I think it would be unfortunate if useful information about why PCDDs and PCDFs are forming in the process is lost by only concerning ourselves with whether and where they are formed in the process.

If we are concerned with why the PCDDs and PCDFs are forming, then we need to refine the inquiry down to the level of the relative abundances of the PCDD and PCDF isomers forming, beginning with the unchlorinated dibenzo-p-dioxin and dibenzofurans up to octa-CDD and octa-CDF.

If the PCDDs and PCDFs are forming as a result of inadvertent chlorination of benzenes, phenols, etc., then one should expect, on kinetic grounds, that the relative abundance in the reaction mixture is mono- > di- > tri- > tetra- > .... > octa- . But if the higher chlorinated isomers are thermochemically favored (i.e., more energetically stable), then the higher chlorinated isomers might be expected to be present disproportionately in the waste streams.

Now, since the efficiency with which the various isomers are removed from the treated wastewater and sequestered in the sludge is inversely proportional to biodegradation and volatilization rates and directly proportional to the particle/water partition coefficient (which is directly proportional to the n-octanol/water partition coefficient), the current ratios in sludge might be expected to favor octa- > hepta- > hexa- ... > mono-dibenzo-p-

Don
cc Arendale 2b
Barnes 1-2-

EPA FORM 1320-6 (REV. 3-76)

DRAFT

dioxin or dibenzofurans. The actual relative abundancies in the sludge will thus reflect the balancing of these competing factors. By considering only total tetra- through octa- congeners, a great deal of information will be lost about the mechanisms of formation of the PCDDs and PCDFs. I would suggest adding mono- through tri-chlorodibenzo-p-dioxins to the analytical list.

At the isomer-specific level, much more could be learned about which raw material or resin breakdown product is the precursor of concern.

One can also speculate that precursors like chlorotoluene and chloroxylenes could form the corresponding chlrophenols via successive chlorination of the methyl group to form: chloroform or tricholoromethanol, which leaves following attack by a hydroxyl ion. If formed, trichloromethanol would be a reactive intermediate that spontaneously decomposes to yield phosgene, which further reacts with water to produce carbonic acid and HCl. This route to phenol and chlorophenol formation would also be true of other methylated molecules. Chloroform has been detected in bleached kraft paper mill effluent.

Thus, it will probably prove fruitful to identify and quantify some or all of the isomers in the mono- through tetratchloro- congener series to assist in clarifying the mechanism of formation. Such questions as whether the formation is kinetically or thermochemically controlled or which precursor is making the greatest contribution to PCDD and PCDF formation cannot be answered by the present study regime.

Further, if it is expected that $Cl_{2(aq)}$ or $ClO_{2(aq)}$ will react with bromobenzenes and bromophenols to form the corresponding chlorobenzenes and phenols by displacement, wouldn't one expect to find mixed bromochloro phenols, phenylethers, phenoxyphenols, dibenzo-p-dioxins and dibenzofurans? (Such displacement reactions are unlikely, however.) And if bromophenols are known or reasonably suspected of being present in the bleach kraft feedstock, wouldn't one also suspect the presence of brominated dibenzo-p-dioxins (PBDDs) and dibenzofurans (PBDFs)? Wouldn't one also be interested in displacement of bromine with chlorine on the PBDDs and PBDFs to again yield mixed bromochloroanalogs? If the mechanism of information is of interest, it would appear that it would be desirable to analyze for all of the above.

The direct precursors of concern for PCDDs and PCDFs are listed in Table I (attached). I have indicated those precursors known to be present in bleached kraft pulp mill waste (*) and those strongly suspect of being present (**), based on the process, chemical principles and logic.

Should you have any questions, call me at FTS: 353-0117.

Attachments

cc: A. McBride, WH-553

GLNPO:FINK:ag:5/8/86:#10

TABLE I

benzene	chlorobenzenes	
toluene	chlorotoluenes	*
xylenes	chloroxylenes	*
phenol	chlorophenols	*
anisole	chloroanisoles	
cresol	chlorocresols	
resorcinol	chlororesorcinols	
veratrol	chloroveratrols	**
diphenyl ether	chlorodiphenyl ethers	**
biphenyl	chlorobiphenyls	
phenoxyphenols	chlorophenoxyphenols	**

REPORT OF CALL

DOW CHEMICAL U.S.A

DEPARTMENT: Separation Systems

REPORT NO. 1/13/87

COPIES TO

D. Anderson, Larkin
R. Drubel, 2030
G. Fischer, 2040
J. Petricek, 458
J. Pierce, 1604
T. Radler, 2040
J. Wilson, 2040
R. Stevens, 1604
D. Baublitz, Larkin
U. Bharwada, 2040
R. Byers, Larkin
M. Kaiser, Larkin
J. Kowalczyk, 458
M. Matlock, T1500
R. Nies, 719
R. Strom, 1604
B. Harris, 1604
Y. Dhingra, 1604
H. Fravel, Larkin
S. Norman, Larkin
T. Hairston, 2040
A. Carbone, 2040
R. Stringfield, 1604
R. McCreedy, 2020

NAMES

FIRM NAME (In full, do not abbreviate)
The Dow Chemical Company

STREET	CITY	STATE	ZIP CODE
Vidal Street	Sarnia	Canada	N7T 7M1

PERSONS INTERVIEWED AND TITLES
Gordon Brown, John McIntyre, Dale Elley-Bristow, Inderjit Gill-McManus, Indresh Mathur

WRITTEN BY	FIELD	DOW PHONE	DEVELOP. SERV. OTHER	DATE CALLED	DATE WRITTEN
H. Robert Goltz HRL.	x		x	12/16/87	12/19/87

OTHER DOW PERSONNEL PRESENT
Rex Stevens

SUBJECT
Exploration of Opportunity for Adsorbent Resin in Pulp & Paper Waste Waters

SUMMARY

Background: Harold Fravel reported in his ROC to Advanced Separations Technology Inc. (AST) that they have developed and started to market a system for removal of pollutants from pulp and paper waste waters. AST would like to test alternative adsorbents to the activated carbon in their systems. In order to better understand the technology and outline a potential patent position, Rex Stevens has initiated testing of several resins for removal of color and chlorinated organics and initial results are encouraging.

REMARKS

The purpose of this visit was to explore opportunities for XUS-40285 and other adsorbent resins for wastewater treatment in the North American Pulp and Paper Industry. The Dow-Sarnia group has a high degree of expertise in this industry. The Pulp and Paper Industry discarges conventional pollutants (BOD, TSS and pH); non-conventional pollutants (ammonia, color, resin acids and bleach plant derivatives); and toxic pollutants (chloroform, zinc, trichlorophenol, PCBs, formaldehyde and certain dyes. Wastewater discharges total more than 4 billion gallons per day. Facilities have avoided strict compliance by following best practicable control technology currently available (BPT) then best available technology economically achievable (BAT) guidelines. A costly, but available approach is to redesign their process by substituting an oxygenation process for a chlorination step. This change will reduce discharge of total organic chlorides (T.O.Cl.), but starts to jeopardize existing Dow sales of chlorine and caustic ($80M in in North America of 80 million in 1986).

Rex Stevens presented preliminary data from laboratory testing. He has found that 90% of the toxic organics (chlorinated phenols, etc.) can be removed through 25 bed volumes of the solution while 90% of the color can be removed through 30 bed volumes of solution. A flow rate of 6 bed volumes per hour has been tested and regeneration does not appear to be a problem. We discussed the significance of these results and future directions.

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The group felt that the most significant effluent problem is that of total organic chloride (T.O.Cl.). We discussed the kind of testing for (T.O.Cl.) that would have to be initiated and methods for screening some new adsorption candidates. The Pulp and Paper group has equipment, that was used in a series of test done at the Pulp and Paper Research Institute of Canada (PAPRICAN) in 1984-85, to look at ion exchange resins for this same purpose. Plans are to get back together in January to formalize plans for further work.

In summary, this is primarily a regulation driven opportunity. The industry will do nothing unless the EPA forces some action. We have no idea how long it will take for this "need" to develop. This is a poor position from which to initiate a project. On the other hand, Dow does a significant amount of business in this industry. Other technical approaches to this problem could more dramatically and adversely affect Dow's existing chlor/alkai businesss. Thus, I feel that with the huge volumes involved and protection of existing Dow business that this area is worth further investigation.

APPENDIX: NORTH AMERICAN PULP AND PAPER MILLS

Key to Pulp Processes

K - kraft
S - sulphite
M - mechanical
X - semimechanical
T - thermo-mechanical
N - information not available
O - other

b - bleached
s - semibleached
u - unbleached

P - paper mill

Notes

- Numerical data indicate pulp-production capacity in tons per day (or metric tons per day, where noted). Paper-production capacity not indicated.
- Rate of production of chlorinated by-products, including dioxins, is determined by types of processes employed as well as type of input materials. Typical rates of production of Total Organically-bound Chlorine (TOCl): 5 to 8 kilograms (1.1 lbs. to 1.8 lbs.) per ton of bleached kraft pulp; 4 to 5 kilograms (0.9 lbs. to 1.1 lbs.) per ton of bleached sulfite pulp. Total "organochlorine" production (i.e., total mass of the molecules to which chlorine is attached) is considerably higher.
- Many mills not only produce pulp and/or paper but manufacture intermediate and finished paper products as well. Plants that produce only such products ("converting plants") are not listed.
- "Mechanical," "semi-mechanical," and "thermomechanical" pulp mills listed may use some chlorine bleaching.
- Some idle or closed mills may be listed; most have been omitted.

Data excerpted from: Post's Pulp & Paper Directory, 1987 Edition, Miller Freeman Publications.

ALABAMA

ALBERTVILLE	KEYES FIBRE	P	
ANNISTON	NATIONAL GYPSUM	P	
BRENTON	CONTAINER CORP. OF AM.	KP	1334
BUTLER	JAMES RIVER	KbP	1200
CLAIBORNE	ALABAMA RIVER PULP	Kb	1100
COOSA PINES	KIMBERLY-CLARK	KbuMP	1998
COURTLAND	CHAMPION INTERNATIONAL	KbP	1393
DEMOPOLIS	GULF STATES PAPER	KbP	500
JACKSON	BOISE CASCADE	KbP	600
MOBILE	GAF	MP	50
MOBILE	INTERNATIONAL PAPER	KbuTP	1105
MOBILE	MOBILE PAPERBOARD	P	
MOBILE	SCOTT PAPER	KbuP	1450
MONTGOMERY	UNION CAMP	KuP	2150
PHENIX CITY	ALABAMA KRAFT	KuP	1100
PINE HILL	MACMILLAN BLOEDEL	KuXP	1700
SELMA	HAMMERMILL PAPERS	Kb	1100
STEVENSON	MEAD	XP	650
TUSCALOOSA	TAMKO ASPHALT PRODUCTS	P	

ALASKA

KETCHIKAN	KETCHIKAN PULP	Sb	600
SITKA	ALASKA PULP	S	600

ALBERTA

CALGARY	IKO INDUSTRIES	P	
EDMONTON	BUILDING PROD. OF CAN.	P	
GRAND PRAIRIE	PROCTER & GAMBLE CELL.	Kb	840
HINTON	CHAMPION FOREST PROD.	Kbu	590

ARIZONA

SNOWFLAKE	SOUTHWEST FOREST IND.	KMROP	1440

ARKANSAS

ASHDOWN	NEXOOSA PAPERS	KbP	1400
CAMDEN	INTERNATIONAL PAPER	KuP	801
CAMDEN	CELOTEX	P	400
CROSSETT	GEORGIA-PACIFIC	KbP	1500
CYPRESS BEND	POTLATRCH	KbP	525
MORRILTON	ARKANSAS KRAFT	KuP	780
N. LITTLE ROCK	SUPERWOOD	MP	120
PINE BLUFF	MID-AMERICA PACKAGING	KP	350
PINE BLUFF	INTERNATIONAL PAPER	KbuMP	1540
STEPHENS	ELK	P	

BRITISH COLUMBIA

BRITANNIA BCH.	MAKIN PULP & PAPER	XMP	200m
BURNABY	BELKIN PAPERBOARD	P	
CAMPBELL RIV.	CROWN FOREST IND.	KbsTP	2480m
CASTLEGAR	WESTAR TIMBER	Kb	535m
CROFTON	BRITISH COLUM. FOREST	KbMP	1560M

GOLD RIVER	CIP	Kb	750a
KAMLOOPS	MEYERHAEUSER CANADA	Kb	1200a
KITIMAT	EUROCAN PULP & PAPER	KP	965a
LAKE MELLON	CANADIAN FOREST PROD.	Kb	600a
MACKENZIE	BRITISH COLUMB. FOREST	Kbu	600a
MACKENZIE	FINLAY FOREST IND.	Mb	450a
NANAIMO	MACMILLAN BLOEDEL	Kb	1100a
NEW WESTMINST.	CANFOR	NP	200a
NEW WESTMINST.	ISLAND PAPER MILLS	P	
NEW WESTMINST.	SCOTT PAPER	MP	85a
PORT ALBERNI	MACMILLAN BLOEDEL	KsuMP	1280a
PORT ALICE	WESTERN PULP	SbO	450a
POWELL RIVER	MACMILLAN BLOEDEL	KMTP	1855a
PRINCE GEORGE	NORTHWOOD PULP & TIMB.	Kb	1450a
PRINCE GEORGE	PRINCE GEORGE PULP	Kb	500a
PRINCE GEORGE	INTERCONTINENTAL PULP	Kbu	670a
PRINCE RUPERT	SKEENA CELLULOSE	Kb	1200a
QUESNEL	QUESNEL RIVER PULP	XT	500a
QUESNEL	CARIBOO PULP & PAPER	Kb	800a
SKOOKUMCHUCK	CRESTBROOK FOREST IND.	Kbu	525a
SQUAMISH	WESTERN PULP	Kb	660a

CALIFORNIA

ANDERSON	SIMPSON PAPER	KbP	240
ANTIOCH	FIBREBOARD	KbuP	750
ANTIOCH	GAYLORD CONTAINER	P	
CITY OF COMM.	FEDERAL PAPER BOARD	P	
CITY OF INDUS.	SONOCO PRODUCTS	P	
FAIRHAVEN	SIMPSON PAPER	Kb	640
FONTANA	FONTANA PAPER MILLS	P	
FRESNO	CELLULO	P	
FULLERTON	KIMBERLY-CLARK	P	
HOLLISTER	LEATHERBACK INDUSTRIES	P	
LA VERNE	PAPER-PAK PRODUCTS	P	
NEWARK	INLAND CONTAINER	P	
ONTARIO	INLAND CONTAINER	P	
OXNARD	PROCTER & GAMBLE PAPER	P	
POMONA	SIMPSON PAPER	RP	50
POMONA	GARDEN STATE PAPER	RP	400
POMONA	SIERRA TISSUE	P	
PORT HUENEME	WILLAMETTE INDUSTRIES	P	
RED BLUFF	PACKAGING CO. OF CAL.	P	
RICHMOND	PABCO ROOFING PRODUCTS	MP	30
RIPON	SIMPSON PAPER	P	
SACRAMENTO	KEYES FIBRE	P	
SAMOA	LOUISIANA-PACIFIC	Kbu	650
SAN LEANDRO	DOMTAR GYPSUM AMERICA	P	
SANTA ANA	B.J. FIBERS	R	100
SANTA CLARA	CALIFORNIA PAPERBOARD	P	
SANTA CLARA	CONTAINER CORP. OF AM.	P	
SANTA FE SPGS.	SPECIALTY PAPER MILLS	P	
SOUTH GATE	LUNDAY-THAGARD ROOFING	P	
SOUTH GATE	USG INDUSTRIES	P	
STOCKTON	NATIONAL GYPSUM	P	
VERNON	PABCO PAPER PRODUCTS	P	
VERNON	GENSTAR GYPSUM PROD.	P	
VERNON	CONTAINER CORP. OF AM.	P	

COLORADO

COMMERCE CITY	REPUBLIC PAPERBOARD	P	

CONNECTICUT

EAST HARTFORD	CELLU-TISSUE	P	
MANCHESTER	LYDALL & FOULDS	P	
MANCHESTER	ROGERS	P	
MONTVILLE	ROBERTSON PAPER BOX	P	
NEW HAVEN	SIMKINS INDUSTRIES	P	
NEW MILFORD	KIMBERLY-CLARK	P	
ROGERS	ROGERS	P	
SPRAGUE	FEDERAL PAPER BOARD	P	
UNCASVILLE	STONE CONTAINER	P	
WINDSOR	WINDSOR STEVENS	P	
WINDSOR LOCKS	DEXTER	DP	60

DELAWARE

NEWARK	JAMES RIVER	P	
NEWARK	MVF	P	

FLORIDA

BLOUNTSTOWN	SOUTHEAST FIBER	MP	210
FERNANDINA BE.	ITT RAYONIER	Sb	450
FERNANDINA BE.	CONTAINER CORP. OF AM.	KXP	1700
JACKSONVILLE	JACKSONVILLE KRAFT	KP	1400
JACKSONVILLE	JEFFERSON SMURFIT	KuP	760
JACKSONVILLE	USG INDUSTRIES	P	
MIAMI	SIMKINS INDUSTRIES	P	
PALATKA	GEORGIA-PACIFIC	KbuP	1085
PANAMA CITY	SOUTHWEST FOREST IND.	KbuP	1450
PENSACOLA	ARMSTRONG WORLD IND.	P	
PENSACOLA	CHAMPION INTERNATIONAL	KbuP	1335
PERRY	BUCKEYE CELLULOSE	Kb	1000
PORT SAINT JOE	ST. JOE PAPER	KbuP	1700

GEORGIA

ALBANY	PROCTER & GAMBLE PAPER	P	
ATLANTA	SONOCO PRODUCTS	P	
AUGUSTA	AUGUSTA NEWSPRINT	NTP	1700
AUGUSTA	PONDEROSA GEORGIA	R	100
AUGUSTA	DEERFIELD SPECIALTY	P	
AUGUSTA	FEDERAL PAPERBOARD	KbTP	1000
AUSTELL	AUSTELL BOX BOARD	P	
AUSTELL	SWEETWATER PAPER BD.	P	
BRUNSWICK	BRUNSWICK PULP & PAPER	KbP	1760
CEDAR SPRINGS	GREAT SOUTHERN PAPER	KuXP	2270
CEDARTOWN	JEFFERSON SMURFIT	P	
DUBLIN	SOUTHEAST PAPER MFT.	RTP	500
HAWKINSVILLE	PORTALS	P	
JESUP	ITT RAYONIER	KbO	1400
KRANNERT	GEORGIA KRAFT	KuP	2000
MACON	ARMSTRONG WORLD IND.	MP	927
MACON	GEORGIA KRAFT	KuP	950
MACON	PACKAGING CORP. OF AM.	P	
OGLETHORPE	BUCKEYE CELLULOSE	Kb	860
PORT WENTWORTH	STONE CONTAINER	KP	800
RICEBORO	INTERSTATE PAPER	KuP	550
RINCON	FORT HOWARD PAPER	P	
SAINT MARYS	GILMAN PAPER	KbuP	1200
SAVANNAH	GAF	MP	125
SAVANNAH	UNION CAMP	KP	2850
VALDOSTA	OWENS-ILLINOIS	KP	1015

IDAHO

LEWISTON	POTLATCH	P	
LEWISTON	POTLATCH	KbP	1100

ILLINOIS

ALSIP	FSC PAPER	RP	360
ALTON	JEFFERSON SMURFIT	P	
AURORA	DAVEY	P	
CHICAGO	WESTERN ELECTRIC	P	
CHICAGO	CHICAGO PAPERBOARD	P	
CHICAGO	IKO INDUSTRIES	P	
JOLIET	MANVILLE BUILDING MAT.	P	
JOLIET	IVEX	P	
MARSEILLES	NABISCO BRANDS	RP	200
PEKIN	QUAKER OATS	P	
PEORIA	PETRATEX PAPER	P	
QUINCY	CELOTEX	P	
ROCKTON	SONOCO PRODUCTS	P	
TAYLORVILLE	GEORGIA-PACIFIC	P	

INDIANA

BROWNSTOWN	KIEFFER PAPER MILLS	P	
CARTHAGE	CONTAINER CORP. OF AM.	P	
COLUMBIA CITY	FIBRE FORM	P	
EATON	ROCK-TENN	P	
GARY	GEORGIA-PACIFIC	RP	85
GRIFFITH	PACKAGING CORP. OF AM.	P	
HAMMOND	KEYES FIBRE	P	
INDIANAPOLIS	BEVERIDGE PAPER	P	
LAFAYETTE	JEFFERSON SMURFIT	P	
NEWPORT	INLAND CONTAINER	P	
TERRE HAUTE	WESTON PAPER & MFG.	X	300
WABASH	CONTAINER CORP. OF AM.	P	

IOWA

DUBUQUE	CELOTEX	XMP	250
FORT MADISON	CONSOLIDATED PACKAGING	XP	150
TAMA	PACKAGING CORP. OF AM.	P	

KANSAS

HUTCHINSON	REPUBLIC PAPERBOARD	P	
PHILLIPSBURG	TAMKO ASPHALT PRODUCTS	P	

KENTUCKY

HAWESVILLE	WILLAMETTE INDUSTRIES	P	
HAWESVILLE	WILLAMETTE INDUSTRIES	Kb	660
HAWESVILLE	WILLAMETTE INDUSTRIES	XOP	525
MADISONVILLE	FILTRATION SCIENCES	P	
OWENSBORO	GRACE & CO.	P	
WICKLIFFE	WESTVACO	KbP	722

LOUISIANA

BASTROP	INTERNATIONAL PAPER	XP	492
BASTROP	INTERNATIONAL PAPER	KbP	1200
BOGALUSA	GAYLORD CONTAINER	KuXP	1630
CAMPTI	WILLAMETTE INDUSTRIES	NuP	825
DE RIDDER	BOISE CASCADE	KbuMP	1995
HODGE	STONE CONTAINER	KYP	1700
LOCKPORT	VALENTINE PULP & PAPER	P	
MANSFIELD	INTERNATIONAL PAPER	KuP	2050
MARRERO	CELOTEX	MP	200
NEW ORLEANS	INTERNATIONAL BUILDING	P	
PINEVILLE	INTERNATIONAL PAPER	KuP	985
PORT HUDSON	GEORGIA-PACIFIC	Kb	1300
SHREVEPORT	GENSTAR ROOFING PROD.	MP	60
ST. FRANCISVL.	CROWN ZELLERBACH	KMP	695
WEST MONROE	MANVILLE FOREST PROD.	KuXP	1750

MAINE

AUGUSTA	STATLER TISSUE	P	
BREWER	EASTERN FINE PAPER	P	
BRUNSWICK	PEJOBSCOT PAPER	TP	160
BUCKSPORT	CHAMPION INTERNATIONAL	MTP	446
E. MILLINOCKET	GREAT NORTHERN PAPER	MP	750
GARDINER	YORKTOWNE PAPER MILLS	P	
HINCKLEY	WARREN	KbP	800
JAY	JAMES RIVER-OTIS DIV.	P	
JAY	INTERNATIONAL PAPER	KMP	1330
LINCOLN	LINCOLN PULP & PAPER	KbP	350
LISBON FALLS	USG INDUSTRIES	P	
MADAWASKA	FRASER PAPER	P	
MADISON	MADISON PAPER INDUS.	MP	280
MECHANIC FALLS	MECHANIC FALLS PAPER	P	
MILLINOCKET	GREAT NORTHERN PAPER	SuMP	1547
OLD TOWN	JAMES RIVER	KbP	600
RUMFORD	BOISE CASCADE	KbMTP	1250
SHAWMUT	KEYES FIBRE	M	120
WATERVILLE	KEYES FIBRE	P	
WESTBROOK	WARREN	KbP	295
WINSLOW	SCOTT PAPER	P	
WOODLAND	GEORGIA-PACIFIC	KbP	984

MANITOBA

PINE FALLS	ABITIBI-PRICE	SM	510a
THE PAS	MANFOR	KuP	400a
WINNIPEG	GATEWAY INDUSTRIES	P	

MARYLAND

BALTIMORE	CHESAPEAKE PAPERBOARD	P	
CATONSVILLE	SIMKINS INDUSTRIES	P	
FINKSBURG	CONGOLEUM	MP	45
LUKE	WESTVACO	SbP	907
WHITE HALL	READING&WHITE HALL	P	

MASSACHUSETTS

ADAMS	JAMES RIVER	P	
BALDWINVILLE	BALDWINVILLE PRODUCTS	P	
DALTON	BYRON WESTON	P	
DALTON	CRANE & CO.	P	
DALTON	CRANE & CO.	P	
DALTON	CRANE & CO.	P	
DALTON	CRANE & CO.	P	
EAST PEPPERELL	JAMES RIVER-PEPPERELL	P	
EAST WALPOLE	HOLLINGSWORTH & VOSE	P	
ERVING	ERVING PAPER MILLS	P	
FITCHBURG	CROCKER TECHNICAL PAP.	P	
FITCHBURG	FITCHBURG PAPER	P	
FITCHBURG	JAMES RIVER-FITCHBURG	P	
FITCHBURG	JAMES RIVER-MASS.	P	
HAVERHILL	HAVERHILL PAPERBOARD	P	
HOLYOKE	LINWEAVE FINE PAPERS	P	
HOLYOKE	PARSONS PAPER	P	
HOLYOKE	SONOCO PRODUCTS	P	
HOUSATONIC	RISING PAPER	SOP	60
HYDE PARK	JAMES RIVER	NP	
LAWRENCE	MERRIMAC PAPER	P	
LAWRENCE	ATLANTIC COAST PAPER&.	P	

LEE	KIMBERLY-CLARK	P	
LEE	WESTFIELD RIVER PAPER	P	
MATTAPAN	PERKIT FOLDING BOX	P	
MILLERS FALLS	STRATHMORE PAPER	P	
MONROE BRIDGE	DEERFIELD SPECIALTY	P	
NATICK	NATICK PAPERBOARD	R	
OTTER RIVER	SEAMAN PAPER	P	
RUSSELL	TEXON	P	
RUSSELL	WESTFIELD RIVER PAPER	P	
SOUTH HADLEY	TEXON .	P	
SOUTH LEE	MEAD	P	
THORNDIKE	DIAMOND FIBER PRODUCTS	P	
TURNERS FALLS	ESLEECK MANUFACTURING	NP	
TURNERS FALLS	STRATHMORE PAPER	P	
W. SPRINGFIELD	JAMES RIVER	P	
W. SPRINGFIELD	SOUTHWORTH	P	
WEST GROTON	HOLLINGSWORTH & VOSE	P	
WESTFIELD	STRATHMORE PAPER	P	
WORONOCO	STRATHMORE PAPER	P	

MICHIGAN

ALPENA	ABITIBI-PRICE	NP	500
ALPENA	FLETCHER PAPER	P	
BATTLE CREEK	WALDORF	P	
BATTLE CREEK	MICHIGAN PAPERBOARD	P	
BATTLE CREEK	AMERICAN FIBRIT	T	30
CHEBOYGAN	PROCTER & GAMBLE	P	
CONSTANTINE	SIMPLEX PRODUCTS	P	
DETROIT	PORT HURON PAPER	P	
ESCANABA	MEAD	KbMP	1000
FILER CITY	PACKAGING CORP. OF AM.	XP	610
KALAMAZOO	GEORGIA-PACIFIC	NP	180
KALAMAZOO	HAWTHORNE PAPER	P	
KALAMAZOO	JAMES RIVER	P	
KALAMAZOO	NATIONAL GYPSUM	P	
KALAMAZOO	ALLIED PAPER	P	
MANISTIQUE	MANISTIQUE PAPERS	P	
MENOMINEE	MENOMINEE PAPER	P	
MONROE	JEFFERSON SMURFIT	P	
MONROE	UNION CAMP	P	
MUNISING	KIMBERLY-CLARK	P	
MUSKEGON	WARREN	KbP	230
NILES	FRENCH PAPER	P	
ONTONAGON	STONE CONTAINER	XP	550
ROCHESTER	JAMES RIVER-ROCHESTER	P	
ROCKFORD	RPM PAPERBOARD	P	
VICKSBURG	SIMPSON PAPER	P	
WATERVLIET	WATERVLIET PAPER	P	
WHITE PIGEON	WHITE PIGEON PAPER	P	
YPSILANTI	JAMES RIVER	P	

MINNESOTA

BEMIDJI	SUPERWOOD	NP	100
BRAINERD	POTLATCH	P	
CLOQUET	USG ACOUSTICAL PROD.	P	
CLOQUET	POTLATCH	KbP	490
DULUTH	SUPERWOOD	NP	360
DULUTH	LAKE SUPERIOR PAPER	N	
GRAND RAPIDS	BLANDIN PAPER	TMP	298
INTER'L. FALLS	BOISE CASCADE	NbP	298
INTER'L. FALLS	BOISE CASCADE	NP	500
LITTLE FALLS	HENNEPIN PAPER	NP	82
SARTELL	CHAMPION INTERNATIONAL	TP	400
SHAKOPEE	CERTAINTEED	NP	100
ST. PAUL	WALDORF	P	

MISSISSIPPI

COLUMBUS	MEYERHAEUSER	TP	260
MERIDIAN	ATLAS ROOFING	NP	35
MONTICELLO	GEORGIA-PACIFIC	KuP	1995
MOSS POINT	INTERNATIONAL PAPER	KbP	750
NATCHEZ	INTERNATIONAL PAPER	NbN	1150
NEW AUGUSTA	LEAF RIVER FOREST	Kb	1200
PICKENS	BURROWS SOUTHERN	P	
VICKSBURG	INTERNATIONAL PAPER	KuP	1181
WIGGINS	DUNN PAPER	P	

MISSOURI

BOONVILLE	HUEBERT FIBERBOARD	NP	60
JOPLIN	TAMKO ASPHALT PRODUCTS	P	
KANSAS CITY	GAF	NP	120
N. KANSAS CITY	USG INDUSTRIES	P	

MONTANA

MISSOULA	STONE CONTAINER	KuP	1900

NEW BRUNSWICK

ATHOLVILLE	FRASER	Sb	325a
BATHURST	CONSOLIDATED-BATHURST	X	840a
DALHOUSIE	NBIP FOREST PRODUCTS	XMP	1000a
EDMUNDSTON	FRASER	SbsMP	950
NACKAWIC	ST. ANNE-NACKAWIC PULP	Kb	675a
NELSON-MIRAM.	MIRAMICHI PULP & PAPER	Nbu	375a
NEWCASTLE	MIRAMICHI PULP & PAPER	P	
NEWCASTLE	MIRAMICHI PULP & PAPER	KbuP	550a
SAINT GEORGE	LAKE UTOPIA PAPER	XP	300a
SAINT JOHN	IRVING PULP & PAPER	Kb	750a
SAINT JOHN	KIMBERLY-CLARK OF CAN.	P	
SAINT JOHN	ROTHESAY PAPER	KbTMP	1030a

NEW HAMPSHIRE

BENNINGTON	MONADNOCK PAPER MILLS	P	
BERLIN	JAMES RIVER	KbuP	800
CLAREMONT	COY PAPER	P	
CLAREMONT	CPM	P	
GORHAM	JAMES RIVER	P	
GROVETON	GROVETON PAPER BOARD	P	
GROVETON	JAMES RIVER	XP	250
HINSDALE	ASHUELOT PAPER	P	
HINSDALE	HINSDALE PRODUCTS	NP	35
HINSDALE	PAPER SERVICE MILLS	P	
HINSDALE	ROBERTSON & CO	P	
N. ROCHESTER	SPAULDING FIBRE	P	
NASHUA	BROWN PRODUCTS	P	
PENACOOK	PENACOOK FIBRE	P	
ROCHESTER	LYDALL	P	
TILTON	QUIN-T	P	
W. HENNIKER	CONTOOCOOK PAPER	P	
W. HOPKINTON	HOAGUE SPRAGUE	P	

NEW JERSEY

CAMDEN	USG INDUSTRIES	P	
CLARK	UNITED STATES GYPSUM	P	
DELAIR	GEORGIA-PACIFIC	P	
ELMWOOD PARK	MARCAL PAPER MILLS	P	
GARFIELD	GARDEN STATE PAPER	NP	700
GARWOOD	MILLEN INDUSTRIES	P	
HUGHESVILLE	JAMES RIVER	P	
JERSEY CITY	DAVEY	P	
LINDEN	CELOTEX	P	
MILFORD	JAMES RIVER	P	
NEWARK	NEWARK GROUP	P	
PATERSON	MORRIS PAPER BOARD	P	
RIDGEFIELD	LOWE PAPER	P	
RIDGEFIELD PK.	LINCOLN PAPER	P	
RIVERSIDE	CONWED BONDED FIBER	P	
SPOTSWOOD	KIMBERLY-CLARK	P	
TRENTON	HOMASOTE	P	
WARREN GLEN	JAMES RIVER	P	

NEW MEXICO

ALBUQUERQUE	LEATHERBACK INDUSTRIES	P	

NEW YORK

AMSTERDAM	SONOCO PRODUCTS	P	
ANCRAM	KIMBERLY-CLARK	P	
BATTENVILLE	BIO TECH	NP	
BEAVER FALLS	BOISE CASCADE	NP	100
BROWNVILLE	BOISE CASCADE	P	
BROWNVILLE	JAMES RIVER	P	
CARTHAGE	CROWN ZELLERBACH	RP	40
CARTHAGE	CLIMAX MANUFACTURING	P	
CAST. on HUD.	FORT ORANGE PAPER	P	
CHATHAM	COLUMBIA	P	
COHOES	MOHAWK PAPERR MILLS	P	
CORINTH	INTERNATIONAL PAPER	NP	151
CORNWALL	CORNWALL PAPER MILLS	P	
DEFERIET	CHAMPION INTERNATIONAL	NP	320
DEPOSIT	MDF TECHNOLOGY	NP	200
EASTON	HOLLINGSWORTH & VOSE	P	
FAYETTEVILLE	MCINTYRE PAPER	P	
FORT EDWARD	SCOTT PAPER	P	
FORT MILLER	FORT MILLER TISSUE	O	3
FULTON	NORTH END PAPER	P	
FULTON	ARMSTRONG WORLD INDUS.	P	
GANSEVOORT	PEARL PAPER MILLS	P	
GLENS FALLS	FINCH, PRUYN & CO.	SP	380
GOUVERNEUR	JAMES RIVER	P	
GREEN ISLAND	LYDALL	P	
GREENWICH	HOLLINGSWORTH & VOSE	P	
GREENWICH	HOLLINGSWORTH & VOSE	P	
HOOSICK FALLS	LYDALL	P	
LITTLE FALLS	MOHAWK VALLEY PAPER	P	
LITTLE FALLS	BURROWS PAPER	P	
LOCKPORT	DOMTAR INDUSTRIES	P	
LYONS FALLS	LYONS FALLS PULP	XP	120
LYONSDALE	BURROWS PAPER	P	
MARCELLUS	MARTISCO PAPER	P	
MECHANICVILLE	TAGSONS PAPERS	P	
MIDDLE FALLS	STEVENS & THOMPSON	P	
N. TONAWANDA	GATEWAY INDUSTRIES	P	
NEWTON FALLS	NEWTON FALLS PAPER	P	
NORFOLK	CHAGRIN FIBERS	P	
NORTH HOOSICK	COLUMBIA	P	
OAKFIELD	USG INDUSTRIES	P	
OSWEGO	HAMMERMILL	P	
OTSEGO	MEAD	P	
OTSEGO	MENASHA	XP	300
PALMYRA	BIG M PAPERBOARD	P	
PARCHMENT	JAMES RIVER	P	
PIERMONT	CLEVERPAK	P	
PLAINWELL	PLAINWELL PAPER	P	
PLATTSBURGH	GEORGIA-PACIFIC	XP	125
PLATTSBURGH	PACKAGING CORP. OF AM.	P	
PLATTSBURGH	IMPERIAL PAPER	P	
PORT HURON	PORT HURON PAPER	P	
PORT HURON	DUNN PAPER	P	
POTSDAM	POTSDAM PAPER MILLS	P	
PULASKI	SCHOELLER TECH. PAPERS	P	
QUINNESEC	CHAMPION INTERNATIONAL	KbP	750
RED HOOK	RED HOOK PAPER	P	
ROCHESTER	EASTMAN KODAK	P	
ROCHESTER	FLOWER CITY TISSUE	P	
ROCK CITY FLS.	COTTRELL PAPER	P	
S. GLENS FALLS	CROWN ZELLERBACH	RXP	210
TICONDEROGA	INTERNATIONAL PAPER	KbP	530
TONAWANDA	SPAULDING FIBRE	OP	25
UTICA	FOSTER PAPER	P	
WARRENSBURG	WARRENSBURG BD. & PAP.	P	
WATERFORD	MOHAWK PAPER MILLS	P	
WATERTOWN	FILTRATION SCIENCES	P	

NEWFOUNDLAND

CORNER BROOK	KRUGER	NsuTP	1030a
GRAND FALLS	ABITIBI-PRICE	STP	950a

NORTH CAROLINA

CANTON	CHAMPION INTERNATIONAL	KbP	1440
CHARLOTTE	CAROLINA PAPER BOARD	P	
CONWAY	GEORGIA-PACIFIC	NP	200
LUMBERTON	ALPHA CELLULOSE	O	140
MAXTON	LEGGETT & PLATT	P	
NEW BERN	MEYERHAEUSER PAPER	Kb	725
PATTERSON	CELLU DIVISION	P	
PISGAH FOREST	ECUSTA	OP	250
PLYMOUTH	MEYERHAEUSER	KbXP	1700
RIEGELWOOD	FEDERAL PAPER BOARD	SbP	2100
ROANOKE RAPIDS	HALIFAX PAPER BOARD	P	
ROANOKE RAPIDS	CHAMPION INTERNATIONAL	KuP	1300
ROARING RIVER	ABITIBI-PRICE	NP	375
ROCKINGHAM	CASCADES INDUSTRIES	P	
SYLVA	JACKSON PAPER MFG.	P	

NOVA SCOTIA

ABERCROMBIE P.	SCOTT MARITIMES	Kb	600a
HANTSPORT	MINAS BASIN PULP	NP	40a
HANTSPORT	CFK	P	
HUBBARDS	CANEXEL	NP	325
LIVERPOOL	BOWATER MERSEY PAPER	SuNTP	760
PORT HAWKESB.	STORA FOREST	SbMP	915a

OHIO

BALTIMORE	GAYLORD CONTAINER	P	
BRECKSVILLE	TECUMSEH CORRUGATED	P	
CHAGRIN FALLS	CHASE BAG	P	
CHILLICOTHE	MEAD	KbP	870
CINCINNATI	CINCINNATI PAPERBOARD	P	
CINCINNATI	CELOTEX	P	
CINCINNATI	MEAD	P	
CINCINNATI	OHIO PULP MILLS	R	30
CIRCLEVILLE	CONTAINER CORP OF AM.	XP	200
COLUMBUS	CHAMPION INTERNATIONAL	P	

COSHOCTON	STONE CONTAINER	XP	600
DAYTON	HOWARD PAPER MILLS	P	
FRANKLIN	FRANKLIN BOXBOARD	P	
FRANKLIN	CHENEY PULP & PAPER	O	24
FRANKLIN	IKO INDUSTRIES	P	
FRANKLIN	GEORGIA-PACIFIC	MP	50
GYPSUM	USG INDUSTRIES	P	
HAMILTON	BECKETT PAPER	P	
HAMILTON	CHAMPION INTERNATIONAL	P	
LANCASTER	SONOCO PRODUCTS	P	
LOCKLAND	ERVING PAPER MILLS	P	
LOCKLAND	JEFFERSON SMURFIT	P	
MASILLON	CLEANERS HANGER	P	
MASILLON	GREIF BOARD	P	
MIAMISBURG	AMERICAN PACKAGING	P	
MIDDLETOWN	CRYSTAL TISSUE	P	
MIDDLETOWN	JEFFERSON SMURFIT	P	
MIDDLETOWN	JEFFERSON SMURFIT	P	
MIDDLETOWN	MIDDLETOWN PAPERBOARD	P	
MIDDLETOWN	MOSINEE PAPER	P	
MIDDLETOWN	SIMPSON PAPER	P	
MILAN	CERTAINTEED	MP	135
MONROE FALLS	SONOCO PRODUCTS	P	
RITTMAN	PACKAGING CORP. OF AM.	P	
TORONTO	TORONTO PAPERBOARD	P	
URBANA	HOWARD PAPER MILLS	P	
WEST CARROLTON	APPLETON PAPERS	MP	180
WEST CARROLTON	MIAMI PAPER	MP	100

OKLAHOMA

ARDMORE	GEORGIA-PACIFIC	P	
MUSKOGEE	FORT HOWARD PAPER	MP	775
PRYOR	GEORGIA-PACIFIC	MP	50
PRYOR	NATIONAL GYPSUM	P	
PRYOR	ROBEL TISSUE MILLS	MP	125
STROUD	ALLIED MATERIALS	P	
VALLIANT	WEYERHAEUSER	KsuXP	2000

ONTARIO

BRAMPTON	IKO INDUSTRIES	MP	170m
BRANTFORD	REID-DOMINION PACKAG.	P	
BRANTFORD	SONOCO	P	
CORNWALL	DOMTAR	KbP	450m
DRYDEN	GREAT LAKES FOREST	MP	720m
ESPANOLA	EDDY FOREST PRODUCTS	KbuP	735m
FORT FRANCES	BOISE CASCADE CANADA	KbMP	1110
HUNTSVILLE	KIMBERLY-CLARK OF CAN.	P	
IROQUOIS FALLS	ABITIBI-PRICE	SMP	880m
KAPUSKASING	SPRUCE FALLS POWER	MNP	1320m
KENORA	BOISE CASCADE CANADA	SMP	820
MARATHON	JAMES RIVER-MARATHON	Kb	500m
MISSISSAUGA	DOMTAR PACKAGING	P	
NORTH BAY	NORDFIBRE	MP	120m
OTTAWA	EDDY FOREST PRODUCTS	P	
RED ROCK	DOMTAR PACKAGING	KbuMP	975m
SAU. STE. MAR.	ST. MARY'S PAPER	MP	320
SCARBOROUGH	ATLANTIC PACKAGING	RP	60m
SMOOTH ROCK F.	ABITIBI-PRICE	Kb	315m
ST. CATHERINES	KIMBERLY-CLARK OF CAN.	P	
ST. CATHERINES	DOMTAR	F	
STRATHCONA	STRATHCONA PAPER	P	
STURGEON FALLS	MACMILLAN BLOEDEL	XP	275m
TERRACE BAY	KIMBERLY-CLARK OF CAN.	Kb	1250m
THOROLD	FRASER	RP	100m
THOROLD	ONTARIO PAPER	SRTXP	946m
THOROLD	DOMTAR	MP	60m
THOROLD	BEAVER WOOD FIBRE	P	
THUNDER BAY	GREAT LAKES FOREST	KbMSP	2490m
THUNDER BAY	PROVINCIAL PAPER	MP	150
THUNDER BAY	ABITIBI-PRICE	XMP	447m
THUNDER BAY	ABITIBI-PRICE	SuMP	508m
TORONTO	DOMTAR	P	
TORONTO	DOMINION CELLULOSE	P	
TORONTO	BELKIN PAPERBOARD	P	
TRENTON	DOMTAR	XP	150m
TRENTON	TRENT VALLEY PAPERBD.	P	

OREGON

ALBANY	WILLAMETTE INDUSTRIES	KuSOP	1100
CLATSKANIE	CROWN ZELLERBACH	KbSMP	1075
CORVALLIS	EVANITE FIBER	TP	120
FOREST GROVE	FOREST FIBER PRODUCTS	MP	140
GARDINER	INTERNATIONAL PAPER	KuP	850
HALSEY	JAMES RIVER	P	
HALSEY	POPE & TALBOT PULP	Kb	420
NEWBERG	SMURFIT NEWSPRINT	MRP	1025
NORTH BEND	WEYERHAEUSER PAPER	XP	300
OREGON CITY	SMURFIT NEWSPRINT	TRP	670
PILOT ROCK	USG INDUSTRIES	MP	150
PORTLAND	MALARKEY ROOFING	MP	40
SAINT HELENS	BOISE CASCADE	KbP	1000
SAINT HELENS	CONCEL	P	
SPRINGFIELD	WEYERHEUSER PAPER	KP	1090
TOLEDO	GEORGIA-PACIFIC	KXP	1400
WEST LINN	CROWN ZELLERBACH	MP	225

PENNSYLVANIA

CHAMBERSBURG	TEXCROM PAPER	P	
CHESTER	SCOTT PAPER	P	
DELAWARE WATER	STROUDSBERG PAPERBOARD	P	
DOWNINGTON	BRANDYWINE PAPERBOARD	P	
DOWNINGTON	DAVEY	P	
DOWNINGTON	SHRYOCK BROS.	P	
DOWNINGTON	SONOCO PRODUCTS	P	
ERIE	HAMMERMILL PAPERS	MP	680
ERIE	QUIN-T	P	
EXTON	EXTON PAPER MANUF.	P	
JOHNSONBURG	PENNTECH PAPERS	KbP	220
LANCASTER	AMERICAN PAPER PROD.	P	
LEBANON	HENRY MOLDED PRODUCTS	P	
LEWISBURG	INTERNATIONAL PAPER	P	
LITITZ	WOODSTREAM	NbP	
LOCK HAVEN	HAMMERMILL PAPERS	P	
MEHOOPANY	PROCTER & GAMBLE	SP	
MILTON	NATIONAL GYPSUM	P	
MIQUON	SIMPSON PAPER	P	
MODENA	EXTON PAPER MANUF.	P	
MOUNT HOLLY S.	MH DIELECTRICS	P	
MOUNT HOLLY S.	FILTRATION SCIENCES	P	
NORRISTOWN	NICOLET	P	
OAKMONT	USG INDUSTRIES	P	
PAXINOS	CELLU DIVISION	P	
PHILADELPHIA	CONNELLY CONTAINERS	P	
PHILADELPHIA	CONTAINER CORP. OF AM.	P	
PHILADELPHIA	NEWMAN & CO.	P	
RANSOM	POTLATCH	MP	180
READING	GEORGIA-PACIFIC	P	
READING	INTERSTATE INTERCORR	P	
RIEGELSVILLE	INTERNATIONAL MILLS	P	
ROARING SPGS.	APPLETON PAPERS	KbP	180
SINKING SPGS.	READING PAPER BOARD	P	
SPRING GROVE	GLATFELTER	KbP	575
SUNBURY	CELOTEX	MP	240
TYRONE	WESTVACO	P	
WHITEHALL	TARKETT	P	
YORK	STONE CONTAINER	P	
YORK	YORKTOWNE PAPER MILLS	P	

PUERTO RICO

ARECIBO	CARIBE	DsP	125

QUEBEC

ALMA	PRICE	SMP	970m
AMOS	DONOHUE NORMICK	TP	535
BAIE COMEAU	QNS PAPER	SuMXP	1900m
BEAUHARNOIS	DOMTAR	P	
BEAUPRE	ABITIBI-PRICE	XP	550
BREAKEYVILLE	DESENCRAGE CASCADES	R	90m
BROMPTONVILLE	KRUGER	TP	800m
CABANO	PAPIER CASCADES	XP	250m
CANDIAC	PERKINS PAPERS	MP	100m
CHAMBLY	BENNETT FLEET	P	
CHANDLER	GASPESIA PULP & PAPER	SMP	636m
CHEMIN DU LAC	MOHAWK PULP	M	50m
CLERMONT	DONOHUE	SuTMP	752m
CRABTREE	SCOTT PAPER	MP	
DESBIENS	ST. RAYMOND PAPER	Su	120m
DOLBEAU	DOMTAR	SMP	460m
DOLBEAU	DOMTAR	SMP	460m
DRUMMONDVILLE	MARLBORO PAPER	P	
EAST ANGUS	CASCADES	KuP	200m
GATINEAU	CIP	MXP	1550m
GATINEAU	CANEXEL HARDBOARD	P	
GATINEAU	CANEXEL HARDBOARD	P	
GRAND MERE	CONSOLIDATED-BATHURST	SMP	550m
HULL	EDDY FOREST PRODUCTS	P	
JOLIETTE	CASCADES	MP	
JONQUIERE	ABITI-PRICE	KbXMP	150
JONQUIERE	CASCADES	KbTP	300m
KINGSEY FALLS	CASCADES	P	
KINGSEY FALLS	LES INDUSTRIES CAS.	P	
KINGSEY FALLS	PAPIER KINGSEY FALLS	P	
LA SALLE	BUILDING PROD. OF CAN.	P	
LA TUQUE	CIP	KbsP	1450m
LACHUTE	PRICE WILSON	P	
LEBEL-SUR-QUE.	DOMTAR	Kb	720m
LENNOXVILLE	SCOTT PAPER	P	
LOUISEVILLE	MATERIAUX CASCADES	MP	38m
MASSON	MACLAREN INDUSTRIES	SMP	535m
MATANE	CIP	XP	250m
MONT ROLLAND	ROLLAND	P	
MONTREAL	BELKIN PACKAGING	P	
MONTREAL	KRUGER	P	
NEW RICHMOND	CONSOLIDATED-BATHURST	KP	710m
PONT CARTIER	RAYONIER QUEBEC	SbP	750m
PONT ROUGE	BUILDING PROD. OF CAN.	MTP	220
PORTAGE-DU-FT.	CONSOLIDATED-BATHURST	KbP	625m
PORTNEUF	FORD & CO.	P	
QUEBEC CITY	GLASSINE CANADA	P	
QUEBEC CITY	REED	SuMP	1160m
RIVIERE-DU-LP.	SOUCY	TP	540m
RIVIERE-DU-LP.	SOUCY	MTP	620m
RIVIERE-DU-LP.	MOHAWK PULP	M	40m
SAINT FELICIEN	DONOHUE ST. FELICIEN	Kb	850m
SAINT JEROME	ROLLAND	P	
SAINT RAYMOND	ST. RAYMOND PAPERR	KbSMP	200m
SHAWINIGAN	CONSOLIDATED-BATHURST	SMP	1240m
TEMISCAMING	TEMBEC	SbX	800m
TERREBONNE	SONOCO	P	
THURSO	MACLAREN INDUSTRIES	Kb	336m
TROIS RIVIERES	CIP	SMP	920m
TROIS RIVIERES	KRUGER	MTP	1380m
TROIS RIVIERES	CONSOLIDATED-BATHURST	KMP	585
VILLE DE LA B.	CONSOLIDATED-BATHURST	SbsMP	1130m
WINDSOR	DOMTAR	KbuP	460m

SASKATCHEWAN

PRINCE ALBERT	WEYERHAEUSER CANADA	Kb	900m

SOUTH CAROLINA

BEECH ISLAND	KIMBERLY-CLARK	P	
CATAWBA	BOWATER CAROLINA	KbMTP	1260
CATAWBA	CATAWBA NEWSPRINT	TP	680
CHARLESTON	WESTVACO	KP	2435
EASTOVER	UNION CAMP	KbP	700
FLORENCE	STONE CONTAINER	KbP	1400
GEORGETOWN	INTERNATIONAL PAPER	KbP	1600
HARTSVILLE	SONOCO PRODUCTS	XP	280
MARION	CELOTEX	P	
TAYLORS	CAROTELL PAPER BOARD	P	

TENNESSEE

CALHOUN	BOWATER SOUTHERN PAPER	KsMXP	2010
CHATTANOOGA	ROCK-TENN	P	
CHATTANOOGA	FILTRATION SCIENCES	P	
CHATTANOOGA	SOUTHERN CELLULOSE	ND	180
CHATTANOOGA	CHATTANOOGA PAPERBOARD	P	
COUNCE	TENNESSEE RIVER PULP	KP	1600
COVINGTON	LYDALL	P	
HARRIMAN	HARRIMAN PAPERBOARD	XP	240
KINGSPORT	MEAD	OP	320
KNOXVILLE	TAMKO ASPHALT PRODUCTS	MP	80
MEMPHIS	PONDEROSA OF TENNESSEE	R	100
MEMPHIS	KIMBERLY-CLARK	P	
MEMPHIS	BUCKEYE CELLULOSE	OP	178
NEW JOHNSONVL.	INLAND CONTAINER	XP	575
NEWPORT	SONOCO PRODUCTS	P	

TEXAS

DALLAS	ROCK-TENN	P	
DIBOLL	TEMPLE-EASTEX	MP	1000
EVADALE	TEMPLE-EASTEX	KbP	1550
FORNEY	CORRUGATED SERVICES	P	
GALENA PARK	USG INDUSTRIES	P	
HOUSTON	CHAMPION INTERNATIONAL	KbuMP	1850
LA PORTE	LEXTAR	O	
LUFKIN	CHAMPION INTERNATIONAL	KsuMP	1230
ORANGE	EQUITABLE BAG	P	
ORANGE	INLAND CONTAINER	KuP	1200
PASADENA	CHAMPION INTERNATIONAL	KbP	550
TEXARKANA	INTERNATIONAL PAPER	KbP	1288

VERMONT

BELLOWS FALLS	TLR	P	
BRATTLEBORO	BOISE CASCADE	P	
EAST RYEGATE	CPM	P	
GILMAN	GEORGIA-PACIFIC	RP	30
N. BENNINGTON	VERMONT TISSUE	P	
PUTNEY	PUTNEY PAPER	P	
SHELDON SPGS.	BOISE CASCADE	MP	50
ST. JOHNSBURY	EVH-HEIDMANN	P	

VIRGINIA

ASHLAND	BEAR ISLAND PAPER	TP	620
BIG ISLAND	OWENS-ILLINOIS	XP	575
BUENA VISTA	GEORGIA-BONDED FIBERS	P	
COVINGTON	WESTVACO	KbXP	1568
DANVILLE	USG INDUSTRIES	MP	300
FRANKLIN	UNION CAMP	KbuP	1950
HOPEWELL	HERCULES	OP	250
HOPEWELL	STONE CONTAINER	KuP	1000
JARRATT	GEORGIA-PACIFIC	MTP	450
LYNCHBURG	MEAD	P	
RICHMOND	FEDERAL PAPER BOARD	P	
RICHMOND	JAMES RIVER PAPER	P	
RICHMOND	MANCHESTER BD. & PAPER	P	
RIVERVILLE	VIRGINIA FIBRE	XP	600
WEST POINT	CHESAPEAKE	KbuP	1400

WASHINGTON

BELLINGHAM	GEORGIA-PACIFIC	SbRP	1375
CAMAS	CROWN ZELLERBACH	KbOP	1400
COSMOPOLIS	WEYERHAEUSER	Sb	450
EVERETT	WEYERHAEUSER	Kb	395
EVERETT	SCOTT PAPER	SbMP	535
HOQUIAM	GRAYS JHARBOR PAPER	P	
HOQUIAM	ITT RAYONIER	Sb	550
LONGVIEW	LONGVIEW FIBRE	KbuXP	3120
LONGVIEW	NORTH PACIFIC PAPER	TP	1450m
LONGVIEW	WEUERHAEUSER	KbIOP	800
LONGVIEW	R-W PAPERS	P	
PORT ANGELES	CROWN ZELLERBACH	MP	510
PORT ANGELES	ITT RAYONIER	SbO	500
PORT TOWNSEND	PORT TOWNSEND PAPER	KuP	450
SPOKANE	INLAND EMPIRE PAPER	MP	200
STEILACOOM	BOISE CASCADE	TP	480
SUMNER	SONOCO PRODUCTS	P	
TACOMA	CONTAINER CORP. OF AM.	P	
TACOMA	SIMPSON PAPER	KbuP	1200
VANCOUVER	BOISE CASCADE	P	
WALLULA	BOISE CASCADE	KbIP	942
WENATCHEE	KEYES FIBRE	P	

WEST VIRGINIA

HALLTOWN	HALLTOWN PAPERBOARD	P	
WELLSBURG	BANNER FIBERBOARD	P	

WISCONSIN

APPLETON	FOX RIVER PAPER	P	
APPLETON	AMRICON	RP	30
ASHLAND	JAMES RIVER	RP	80
BELOIT	BELOIT BOX BOARD	P	
BROKAW	WAUSAU PAPER MILLS	SbuP	435
COMBINED LOCKS	APPLETON PAPERS	XP	200
CORNELL	GENSTAR ROOFING PROD.	XP	200
DEPERE	U.S. PAPER MILLS	P	
DEPERE	NICOLET PAPER	P	
EAU CLAIRE	POPE & TALBOT	RP	300
GREEN BAY	FORT HOWARD PAPER	RP	775
GREEN BAY	GREEN BAY PACKAGING	IuP	220
GREEN BAY	JAMES RIVER	SbP	170
GREEN BAY	PROCTOR & GAMBLE PAPER	P	
GREEN BAY	PROCTER & GAMBLE PAPER	SP	650
KAUKAUNA	THILMANY PAPER & PULP	KP	430
KIMBERLY	MIDTEC PAPER	MP	185
LADYSMITH	POPE & TALBOT	P	
MARINETTE	SCOTT PAPER	P	
MENASHA	GILBERT PAPER	P	
MENASHA	U.S. PAPER MILLS	P	
MENASHA	WHITING PAPER	P	
MENASHA	WISCONSIN TISSUE MILLS	P	
MERRILL	WARD PAPER	RP	60
MILWAUKEE	KEIDING	P	
MILWAUKEE	WISCONSIN PAPERBOARD	P	
MOSINEE	MOSINEE PAPER	KsbP	195
NEENAH	GLATFELTER	RP	260
NEENAH	KIMBERLY-CLARK	P	
NEENAH	KIMBERLY-CLARK	P	
NEKOOSA	NEKOOSA PAPERS	KbP	335
NIAGARA	NIAGARA OF WIS. PAPER	MP	210
OCONTO FALLS	SCOTT PAPER	P	
OSHKOSH	PONDEROSA PULP PROD.	P	
PARK FALLS	FLAMBEAU PAPER	NbP	120
PESHTIGO	BADGER PAPER MILLS	SbP	150
PHILLIPS	LIONITE HARDBOARD	MP	
PORT EDWARDS	NEKOOSA PAPERS	SbP	225
RHINELANDER	RHINELANDER PAPER	P	
ROTHSCHILD	WEYERHAEUSER	SbP	210
SHAWANO	SHAWANO PAPER MILLS	P	
STEVENS POINT	CONSOLIDATED PAPERS	P	
SUPERIOR	SUPERIOR FIBER PROD.	MP	275
TOMAHAWK	OWENS-ILLINOIS	XP	1200
TOMAHAWK	TOMAHAWK POWER & PULP	Mbu	30
TOMAHAWK	TOMAHAWK TISSUE	RP	30
WAUPACA	FILTER MATERIALS	P	
WHITING	KIMBERLY-CLARK	P	
WHITING	CONSOLIDATED PAPERS	MTP	256
WISC. RAPIDS	CONSOLIDATED PAPERS	MTP	536
WISC. RAPIDS	CONSOLIDATED PAPERS	Kb	667
WISC. RAPIDS	CONSOLIDATED PAPERS	P	