Public Hearing

before

ENVIRONMENTAL RISK ASSESSMENT AND RISK MANAGEMENT STUDY COMMISSION

"The scientific basis for the selection of the risk level of an additional cancer risk of one-in-one million for human carcinogens for the remediation of contaminated sites; alternative scientific standards and criteria; methodologies of risk assessment and their efficacy and applicability for the purposes of establishing remediation standards"

LOCATION:
Camden County College
Lincoln Lecture Hall
Blackwood, New Jersey

DATE:
March 9, 1994
7:00 p.m.

MEMBERS OF COMMISSION PRESENT:

Michael A. Gallo, Ph.D., Chairman
Gail Mowry Ashley, Ph.D.
Christopher P. D'Alleinne, Ph.D.
Sergio Germinario

ALSO PRESENT:

Raymond E. Cantor
Judith L. Horowitz
Office of Legislative Services
Aides, Environmental Risk Assessment and
Risk Management Study Commission

Hearing Recorded and Transcribed by
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PROTECTION AND ENERGY

REVISED

NOTICE OF PUBLIC HEARING

The Environmental Risk Assessement and Risk Management Study Commission will hold a hearing on the following topics:

The scientific basis for the selection of the risk level of an additional cancer risk of one in one million for human carcinogens for the remediation of contaminated sites; alternative scientific standards and criteria; and methodologies of risk assessment and their efficacy and applicability for the purposes of establishing remediation standards.

The hearing will be held on **Wednesday, March 9, 1994 at 7:00 PM at Camden County College, Lincoln Lecture Hall, Lincoln Theatre Complex, Blackwood, New Jersey.**

*The public may address comments and questions to Judith L. Horowitz or Raymond E. Cantor, Aides to the Commission, at (609) 292-7676. Anyone wishing to testify should contact Carol Hendryx, secretary, at (609) 292-7676. *Any person wishing to testify must send written confirmation to Judith L. Horowitz or Raymond E. Cantor by mail or fax (609) 292-6510 by close of business, March 7, 1994. Oral testimony may be limited to five minutes.*

*Those persons presenting written testimony should provide 15 copies to the commission. *Written testimony may be submitted until April 11, 1994.*

(OVER)

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(Documents available for review
at the New Jersey State Library)

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ses: 1-30

MICHAEL A. GALLO, Ph.D. (Chairman): Welcome. I'm Dr. Mike Gallo, from Robert Wood Johnson Medical School. I am the Chairman of the Industrial Site Recovery Act Commission.

We are here tonight to hear testimony and comments on the legislation. I'm going to make the assumption that everyone here is familiar with it. The law basically said that we have to have one public hearing, followed by deliberations of the Commission, then reports sent to the respective agencies and the government, and a final report after another public hearing.

I'd like you to know that as a Commission we felt that this was a little bit unfair to the citizenry of the State, and we asked the Office of Legislative Services to set up three hearings for us: one down here; one in Mid-Jersey tomorrow, on the Rutgers campus; and one on Friday at NJIT. We've been fortunate enough to get space and time on the three campuses.

Before we get started, I'd like to do two things. First, I'd like to introduce the folks here at the head table. On my far right is Judy Horowitz, from the Office of Legislative Services in the Legislature; next to Judy is Sergio Germinario, a member of the Commission; and on my immediate left is Dr. Chris D'Alleinne, another member of the Commission.

The format tonight is really for us to listen to you. There are a couple of things -- some housekeeping items:

One is that the formal submission date -- close of submission for all testimony -- is April 11. Any written testimony that you have will be welcome -- will be reviewed -- but it must be in Judy Horowitz's hands by April 11. So that gives us about a month from this week.

The second item is that to keep it brief, I want to limit the speakers to five minutes. I have a list of 14 speakers tonight, which gives us a little over an hour. I don't see a couple of the speakers who I know. However, in looking at the preliminary list, I have five speakers from one organization and two speakers from another. It's a common practice at hearings like this that if you are speaking from the same organization, that you should choose one individual to be your spokesperson, and then the written testimony will come in from all of you. I'd like to hold to that for two reasons:

1) It will leave us a little bit of time at the end for some questions and answers.

2) In looking at the list and having seen nothing written out, I would imagine that the testimonies are going to be very similar.

So for those of you-- There are a couple of organizations-- For those of you who are from those organizations, you may want to select a spokesperson. I hope that doesn't offend anyone.

Another item is: As I mentioned, I want to hold the time. Having done this a few times, I have a little laboratory timer here which I'll set for five minutes for each speaker. When the alarm goes off, I'll give you another minute or so to wrap it up. Okay? I also--

Gail, do you want to come up? (no response) You don't want to come up?

DR. ASHLEY: Sure.

This is Gail Ashley. Dr. Gail Ashley, from Rutgers, is also a member of the Commission. The more ears we have up here, I think the better it's going to be.

Okay. I mentioned we have 14 people signed up, but the first four, and also a Mr. Richard Perry, are all from the same organization. Would one of you like to speak, and then we can take the written testimony from there? None?

SHARON FINLAYSON: (from audience) Well, I have to say to you the reason-- We actually are--

DR. GALLO: Can you come up? Come on up to the mike. (witness complies)

MS. FINLAYSON: We are actually affiliated with other organizations. We simply put that down because we felt we had to give some organization. We didn't realize you would limit the speakers if we did that. So I think there are at least one or two other people who have prepared statements coming from a different approach than the others. So I don't know how you want to work that.

DR. GALLO: Okay. What do you think?

MS. FINLAYSON: None of them are long. None of them are lengthy presentations.

DR. GALLO: Okay, let's do it. We only have 14. Let's do it. And who are you?

MS. FINLAYSON: My name is Sharon Finlayson. Do you want me to go first since I'm here?

DR. GALLO: Yes.

This is Sharon Finlayson.

Go ahead. We were told to speak into the mike, because there is a transmission mike and a recording mike.

MS. FINLAYSON: My name is Sharon Finlayson. I live in Pennsauken, and I am here on behalf of South Jersey Work on Waste. Since our time is limited, I'm going to kind of read right through this and not stop to make comments or ask questions.

In assessing the degree to which we should remediate contaminated sites in our State, I would begin by making an observation. The toxins presently contained in our water, soil, air, and wildlife, as well as the tremendous increase in pollution-related diseases in humans, such as cancer and upper respiratory illnesses, would certainly indicate that risk assessments in general, and their resultant standards have failed us thus far.

One area of concern which I would like to see this Commission address is that of cumulative effect from contaminants, which can be divided into subsections:

1) The need for a risk ratio that treats the total impact of contaminants at a site, rather than a separate risk level for each source of contamination. Obviously, each toxin will have an impact. If one is dealing with only carcinogens, but more than one carcinogen exists at a site, then the risk to humans, as well as to natural resources, increases with the types and numbers present.

For example, if a site has 100 contaminants at a one-in-one million risk, then the actual cumulative risk becomes one-in-ten thousand. This increase in risk voids the very protection factor which is supposed to be contained in the risk standard. Therefore, cumulative effect must be factored into the risk standard in order for it to be truly protective of human health.

2) The total impact of carcinogens on human health: Many contaminants that cause cancer also impact health in other ways. For example, benzene is a known carcinogen. However, it is also suspected to cause fetal damage, and longer term exposure can damage the blood-forming organs enough to cause death. Benzene is also an eye, nose, throat, and skin irritant. Short-term exposure can cause symptoms of dizziness, headache, vomiting, coma, and sudden death due to irregular heart beat.

My point is that other symptoms from a known carcinogen could occur in sensitive individuals much earlier than the cancer which is being used as the risk standard. It is also possible that the onset of cancer could be premature if the body has been subjected to other known effects for a period of time, thereby weakening the immune system. Therefore, cumulative effects from carcinogens must be factored into the risk assessment.

3) The total range of potential impact on human health from remediation sites: A selection of a risk level based upon cancer does not consider the numerous health risks from

contaminants not deemed carcinogens, but which are just as lethal or debilitating. These contaminants probably far outnumber the known carcinogens, and their impact would probably be made much sooner, in greater numbers, and might more easily be attributed to the pollutant in question.

For example, mercury is not listed as a carcinogen. However, it is now known that in relatively small amounts, this metal can cause developmental effects in the fetus and young children, ranging from subtle gross motor and learning disabilities to retardation and even death. If one suspects mercury poisoning, a test will confirm the diagnosis.

Another example we can all identify with is upper respiratory irritants. There are a number of pollutants which cause upper respiratory problems. In some people, these problems can become so severe that emergency treatment must be sought in order to avoid death. Do we disregard this type of toxin because it is not listed as a carcinogen? We would likely find that people who suffer from upper respiratory problems -- aggravated by poor air quality -- will far outnumber those people who can actually be targeted as having developed cancer from a specific source.

So I would urge the Commission to tighten up its approach to risk assessment to include all toxins and their potential to impact human health.

In that same vein, I would ask the Commission to consider the relationship between all toxins found at cleanup sites and how they jointly affect human health. These toxicity levels should then be measured with existing background levels of pollution. This cumulative approach could be the more logical approach, and would afford our residents the most protective limits.

I would also ask the Commission to approach unknowns and suspect toxins in a cautious manner. By that I mean those toxins about which we have limited or conflicting information.

An example of this would be the hormone mimickers, which are chemicals that invade the body and act as hormones such as estrogen. These chemicals are linked to breast cancer and endometriosis in women, low sperm counts in men, and diminished reproduction in some wildlife. This is a relatively new area of research, with many questions unanswered. But should this information be ignored by a Commission which is formulating policy intended to protect our residents? I think not. As a resident, I would urge the Commission to consider all toxins guilty until proven innocent.

Finally, I request that-- (timer beeps)

I'm almost finished.

I request that risk standards be developed to accommodate the most sensitive receptors, specifically the developing fetus and children. It is their bodies which are most susceptible to toxins, and it is their bodies which will house these contaminants for the longest period of time.

We are a society which has barely begun to understand the true consequences of chemical production and pollution on our environment and on the health of all living species. As we attempt to address these monumental problems, we must place the life and health issues before those of industry and private gain. It is the responsibility of elected officials and government agencies to protect the health and safety of residents first and above all else. As a resident of New Jersey, I would ask you, a body appointed by our government, to apply the most stringent standards when developing a risk level, in order the protect our citizens first and above all else.

Thank you.

DR. GALLO: Thank you very much.

MS. FINLAYSON: I have copies. Do you want them?

DR. GALLO: Yes, please.

The next speaker is Chris Gass.

I'm going to give you five minutes, then the bell goes off. Okay?

CHRISTOPHER GASS: Not a problem.

DR. GALLO: Okay. Fire away.

MR. GASS: My name is Christopher Gass. I live in Collingswood, New Jersey. With regard to decontamination levels, I have the following questions and concerns:

Will the end result of our effort yield a lower risk of cancer to exposed individuals? Will the end result of our efforts make us more able to accurately predict how many cancer incidences there will be based on exposure?

When we discuss alternative scientific standards and criteria, are we anticipating a new method -- assuming the old method was inaccurate -- by as many orders of magnitude as the new method will correct? Let me expand. For example, if the current method of predicting risk has a tolerance that may be off by as much as a factor of nine or ten, the new method chosen should be accurate so that there is no greater increase in risk, but rather better predictability so that the same level of protection is achieved. This may actually result in lowering the cost of decontamination.

Will the data base used in identifying carcinogens be updated?

My last comment: Certainly I would have to say that if the shoe does not fit, certainly don't put it on. In such matters as risk assessment, the influence that industry has on public policy goes directly to campaign war chests. In that light, I ask the following questions rhetorically, with the knowledge that we will be watching:

Is this entire exercise undertaken to benefit industry at the expense of our health? What is driving this Commission? Is this a new chapter in risk assessment in New

Jersey that industry is trying to write? Will this Commission diligently execute its charter objectives, only to have some bureaucrat in the end put their findings in the bottom drawer?

Thank you.

DR. GALLO: Not bad. Thank you very much. Two minutes, that's one way to get out of here.

By the way, I want to thank everybody for coming on a night like this. It seems like this is the history of this Commission. Our very first administrative meeting was during the terrible ice storm that we had, and everybody showed up for that one. I figure if we had a Commission that was willing to take that kind of risk, we would be willing to listen to any type of testimony. (laughter)

Okay, our next speaker is Sue Marks.

UNIDENTIFIED SPEAKER FROM AUDIENCE: She's not here yet.

DR. GALLO: She's not here yet. Okay. Joan Leonard.

Oh, Mr. Gass, do you have a written testimony? Did you hand that in?

JOAN C. LEONARD: I think he gave it in. Two and a half minutes.

DR. GALLO: Two and a half? Are you guys racing now?

MS. LEONARD: No, just kidding.

I understand that the scientific basis for a risk level of an additional cancer risk of one-in-one million for human carcinogens for contaminated sites is being looked at through this Environmental Risk Assessment Commission.

I'm an occupational therapist. I'm a health care professional in this area, and I've been quite concerned about the multiple health problems that affect the lives of local residents because of my patients. It seems important that we must blend our scientific models that we use to come up with standards for risk assessments with the actual disease processes battled by patients.

It's realistic, for example, for a person to be affected by fine particulate matter in the air emitted from incinerators and industry. We have two incinerators within several miles of where I live, not to mention other industries. It's realistic for people to be affected by the fine particulate, to have lung disease such as emphysema, and to also have other conditions weakening the body's immune system.

Living in an area where the air quality is poor, such as here in this region -- known to have one of the poorest air quality levels in the nation -- we must be concerned that we give ourselves the greatest chance of survival possible. The water quality is also questionable, and many wells have been closed due to contamination. The acquifer beneath the Pennsauken landfill has contamination.

Our air is poor. Our soil grows vegetables that we ingest, and these contaminants reach our bodies in this way also. We are, in short, affected by every possible means of ingestion and contamination by all of these sources in our everyday lives at this point. Diseases will be attacking a weakened system in our body no longer equipped to fight back due to these contaminants reaching us through the air, water, soil, food chain, and lastly, through these toxic sites which you have the power to address.

I'm trying to point out that you must look at the multiple sources of pollution and the multiple contaminants causing a population to be at highest overall risk. Would this not fit into your background information when considering the risk? I know that at present this is not considered in this way. I do not mean that one or another carcinogen will cause death. I mean that persons who are having several elements causing disease affecting their body at once will be weakened and will live a shorter or lower quality of life because of it -- because of the multiple sources.

I feel that our citizens are overburdened. It could be taken into account that since our air quality is already poor due to fine particulate matter, for example, and oxides of nitrogen from industrial pollution, that we cannot tolerate further lung irritants or carcinogens. It could be that these lung problems also weaken the heart or the immune system. These are indirect problems, but are intimately connected with the body's ability to function or to resist disease. The chemicals that we clean up may be only the straw that breaks the human's back for so many people.

I do not feel that the models of the past are the correct means of dealing with our at-risk population at this time. It's time to look at the reality of interrelationships between diseases and the environment. The American Cancer Society is looking at evidence right now linking environmental contaminants with breast cancer. Breast cancer is being looked at as an epidemic because the rate has risen to one in nine nationally -- one in nine in New York. Pesticides and industrial emissions are suspected as being the cause of this rise. In this situation, too, where the numbers are rising, our role must be to be more aggressive in reducing the risk.

We must respond to the mounting evidence that each pollutant causes multiple risks to the population. We should also look at the most vulnerable population for setting our standards. For example, the unborn child, whose developing neurological system will fail and be in poor functionability throughout the life span due to contaminants. For example, mercury, where if the mother ingests mercury during fetal development, there is a chance for cerebral palsy or mental retardation.

What could we prevent by thinking this through ahead of time? Lowering our standards would not be the answer. We now have enough knowledge to be certain that caution and prudence are the only ways to safeguard our future. We know how much it costs to clean up a site that is contaminated, but do we know the cost of caring for a desperately ill child, one who will need long-term care, or one who leads a minimally productive life -- such as the people I see in my clinic -- due to our lack of responsiveness to environmental toxins in our State?

Thank you.

DR. GALLO: Thank you very much. I appreciate you folks staying to the time.

Jane? Jane Nogaki is next, an old friend. Five minutes.

JANE A. NOGAKI: Okay. I'll speak fast. I don't have prepared comments, although Delores Phillips, representing the New Jersey Environmental Federation, will be speaking on Friday at NJIT.

Briefly, my name is Jane Nogaki. I live at 223 Park Avenue, Atco, New Jersey. Thank you for coming down to this institution, which happens to be my institution right now. I'm working here.

I also want to acquaint you with the fact that not 1000 feet from this area is the GEMS Landfill. It's listed about 13 on the list of Superfund sites in the State with very serious groundwater and air pollution problems. It's now capped and so-called contained, but we have a plethora of Superfund sites in South Jersey. We seem to have been the dumping ground for every chemical company in Philadelphia, and a few of our own as well.

I want to encourage you to set standards apart from economic considerations. I think that in the setting of cleanup standards, that health of the human population and the species -- the flora, the fauna, etc. -- should be the driving force. If economic considerations cause there to be a compromising of those standards, that those standards then be called economic standards rather than cleanup standards.

Because I think that in the ideal world, you set your risk based on human health and damage to the environment. Then whether you have enough money to actually pay for that level of cleanup is another issue, but it shouldn't cloud the standards-setting issue.

Time and time again -- and citizens that are speaking tonight will provide information about this -- contaminants at low levels seem to be causing increasing problems. When people say, "Oh, it's in a part per billion. It's in a part per million. It's not going to possibly cause any harm." Time and time again we've found that that is not true. I can't think of a single contaminant that the standard has been raised for, except when it was done for political reasons. For instance, the mercury standard, where 0.5 used to be the FDA level for consumption, and then it was raised to one part per million because of the general, widespread elevating levels of mercury.

That comes to my second point.

Oh, before I go to my second point, let me just supply you with information you probably already had: A New Jersey Department of Health study done of drinking water in New Jersey found that there was an increase in stillbirths during the period of 1985 to 1988 in 75 towns that had drinking water supplies that were so-called consistent with existing contaminant levels. But nevertheless, these low levels of trihalomethanes and other kinds of chemicals cause an increase in the number of stillbirths and chromosome defects. So these so-called safe, low levels of contaminants still are causing problems. So we're concerned that the levels cannot be set low enough.

My second point is that we have to look for long-term protection. My fear is that in taking care of acute hazards, these low levels of contaminants -- you know, the parts per billion and so forth -- remain in the soil, and are going to be added to by existing production of toxics in this State and other states surrounding us. In other words, there isn't any lessening of production, use, and exposure in this State. We have not reduced chemical production in this State; it's increased.

The figures that I have, which are from a 1992 report of the Right To Know Survey, are really interesting. This is a New Jersey State report which I can leave with you. The most interesting page is the page on throughput. New Jersey is the only State that collects actual use data -- what goes out in product, as well as in emissions. While the environmental emissions are staggering enough -- the annual emissions to the environment-- Let me see if I can find this page-- (timer beeps)

Are my five minutes up?

DR. GALLO: That's five. You've got one minute left.

MS. NOGAKI: All right. I can't find the emissions.

DR. GALLO: That's okay. You can leave it with us.

MS. NOGAKI: But the throughput -- the production -- like, what was used in manufacturing in New Jersey: Ten billion pounds of chemicals, and these are just the 300 TRI chemicals. Then that what was input and then output was not 10. There was a discrepancy at 41 million pounds of what went out into the environment.

So even if we reduce emissions -- outright emissions -- there is so much production in product that is ultimately going to be winding up in a landfill or an incinerator, I just wonder what the cleanup standards of remedial sites are going to be today. I fear that there is just going to be a gradual increase in overall contamination, to the fact where we have to have background standards that are way in excess of what we consider health standards today.

So my urge to you is to not back off of standards, but make those standards drive pollution prevention, toxics use reduction, and a shift in the way that we do business in New Jersey. Okay?

DR. GALLO: Got you. Are you going to leave that with us?

MS. NOGAKI: Yes.

DR. GALLO: Thank you.

MS. NOGAKI: I also want to tell you about our conference. The keynote speaker is Bernie Goldstein, on risk assessment.

DR. GALLO: Oh, dear. I don't know if I want to go to that. That's my Chairman.

DR. D'ALLEINNE: He can't be here tonight.

MS. NOGAKI: He can't be here tonight?

DR. GALLO: He can't be here tonight. He's testifying in Congress today.

MS. NOGAKI: Here is the Right To Know report, and here is the reference to the Health Department study.

DR. GALLO: Thank you. Thanks, Jane.

Did Sue Marks come in?

UNIDENTIFIED MEMBER OF AUDIENCE: No. She's not coming.

DR. GALLO: She's not coming?

UNIDENTIFIED MEMBER OF AUDIENCE: No.

DR. GALLO: Okay. Mary Lamielle -- correct pronunciation? No? (no response) Going once, going twice, sold. Tim Bingman?

TIMOTHY S. BINGMAN, D.A.B.T.: This isn't cutting into my five minutes, is it? (distributes statement)

DR. GALLO: No, this isn't part of your five minutes.

MR. BINGMAN: Okay, good.

Good evening, Mr. Chairman. My name is Tim Bingman. I am the Senior Remediation Risk Assessment Toxicologist for the DuPont Chemicals Company, and am responsible for corporate remediation risk assessment activity nationwide. I'm a Board certified toxicologist and a Diplomat of the American Board of Toxicology.

I am very pleased to be with you tonight, and to have the opportunity to speak before this Commission on behalf of the New Jersey Chemical Council regarding the proper application of risk assessment in the evaluation of waste sites and the development of remediation standards. In addition to this oral testimony, I have just given you a detailed write-up of a white paper that expands on several of the points from this discussion.

We begin by commending the Commission for its efforts to critically evaluate risk assessment methods and their applicability for establishing remediation standards. In New Jersey, the CIC believes that risk assessment is absolutely fundamental to effective decision-making regarding hazardous waste site remediation. As clearly recognized by the language in the New Jersey Industrial Site Recovery Act, risk assessment is a tool which can be used to establish the need for remediation, determine the extent of remediation necessary, and evaluate the effectiveness of implementing a particular remedial measure. However, just as we embrace this technology as a keystone in our decision-making, we also must recognize the importance of applying site-specific information, reasonable judgements, and the best available scientific information to this process.

As you are no doubt aware, risk assessment is a discipline that contains some uncertainties. Like any process which attempts to describe a probabilistic phenomenon, there are certain aspects of risk assessment that are inherently variable. However, the manner in which this Commission addresses this variability will ultimately determine the utility of the resulting risk assessment methodologies. There is a tendency to attempt to offset uncertainty in any process with conservatism. Some would suggest that the only way to assure that a risk assessment will not underestimate risk is to be conservative at every turn.

I would submit to you, however, that there is another course that should be considered in addressing the uncertainty issue. That approach is to encourage, to the extent possible, the development and application of site-specific information. For example, site-specific information on groundwater flow, contaminant fate, and potentially exposed populations all dramatically impact the validity of the resulting risk assessment as a decision-making tool. To the extent that we can limit uncertainty through application of site-specific information, we can also increase our degree of comfort with the results and implications of the risk assessment.

Of course, situations will always arise where our knowledge is less than complete. This is particularly true in the case where risk assessment is being used to help develop remediation standards. In these instances, we must apply reasonable estimates in our calculations, as opposed to worst-case, what-if types of approaches.

For example, in setting a remediation standard, it would be inappropriate to apply worst-case exposure assumptions to every variable. Rather, since the goal of the remediation standards is to be protective for a potentially exposed population, ideally one should examine a range of exposure conditions to account for the various exposure patterns that may be represented in that population. One tool available for this task is a Monte Carlo simulation -- a computer simulation which uses probability density functions to describe the various parameter values used to estimate exposure and risk. A Monte Carlo simulation can also be used to derive cleanup standards that will be assured of being protective of a diverse population under a broad range of exposure conditions.

The New Jersey CIC believes it is vital that the Commission consider reasonable assumptions, which ideally will represent a range of exposures, in refining the performance and application of risk assessment in the State of New Jersey. Being overly conservative in the development of input assumptions will only serve to limit the utility of the risk assessment as a decision-making and criteria-setting tool.

I've mentioned site specificity and reasonable assumptions. Now I'd like to take a moment and talk about best available science. The entire field of risk assessment is evolving at a breakneck pace. When the practice of waste site risk assessment began roughly a decade ago, there was virtually no guidance and even less consensus on how a risk assessment should be conducted. Today, volumes are written on the subject. Risk assessment has its own professional societies, conferences, and scientific journals. As a result of this rapid evolution, there are significant advances being made in the technology of risk assessment on almost a daily basis.

For example, the efforts of research teams -- many within my own company -- are advancing our understanding of the mechanisms of chemical carcinogenesis and noncancer effects. Significant breakthroughs in fate and transport modeling, and exposure assessment also are occurring rapidly. The New Jersey Legislature clearly recognized the importance of such new scientific information when it developed the Industrial Site Recovery Act, stating that, "Risk assessment may consider exposure scenarios and assumptions that take into account the form of the contaminant present--" (timer beeps)

I have just maybe 30 seconds more.

"--natural biodegredation, fate and transport of the contaminant, and available toxicological data that are based upon generally accepted, peer-reviewed, and scientific evidence or methodologies."

In order for a risk assessment to provide the most scientifically defensible evaluation of a given site's conditions, or to serve as the basis for a credible remediation standard, the Commission should incorporate a mechanism to keep risk assessment in New Jersey "evergreen". The CIC strongly recommends that periodic reviews of methodologies, toxicity criteria, and exposure assumptions be undertaken, so that as new information becomes available, it can be brought to bear in remediating our waste sites.

In closing, let me say that I believe that without the use of risk assessment, we are left with only impassioned perceptions and supposition as tools to guide us in our decision-making. I'm sure that you would agree that neither of these represent a meaningful way to direct the allocation of the limited resources available to address this critical issue.

As you move ahead with your charge to evaluate risk assessment methodologies, the New Jersey CIC strongly encourages this Commission to exercise the full latitude recognized in its legislative charter. The Commission has before it an enormous opportunity to enhance the process of waste site remediation in this State. By applying the concepts of site-specific information and reasonable assumptions in the face of uncertainty, and best available scientific information, the findings of this Commission can steer the development and application of risk assessment technologies to their fullest in a way that is both protective and financially responsible.

DR. GALLO: Thank you.

MR. BINGMAN: Thank you.

DR. GALLO: Does the Recorder also have a copy?

MR. BINGMAN: Yes, the Recorder has a copy as well.

DR. GALLO: Thank you very much.

Okay. Give me a chance to turn the page here. I hope I'm going to be able to read all these notes I'm writing so fast. I'm not so sure. I guess we'll get everything down.

The next speaker is Randy Blume.

RANDALL BLUME: I don't have a real professional handout for you. I'm Randy Blume, and I live in Evesham Township. I'm a member of the Evesham Township Zoning Board, the Evesham Township Environmental Commission, and the Ellis Site Task Force. The Ellis Site is one of the Superfund sites here in South Jersey.

We don't know a whole lot about what is going to be the future of the area around that Ellis Site, because the master plan in New Jersey municipalities changes on such a regular basis. So when you think about -- as I'm sure you will, since the CIC brought it up -- site-specific risk assessment, what's specific about the site? What crystal ball are you going to use? Keep that in mind, because you can't predict it.

The institutional controls that people have proposed aren't really going to work unless you put great, big fences up. Even then-- If you come down here in the daytime, look at the GEMS Landfill. It's fenced, with new homes built near it. People are being exposed on a regular basis to all kinds of chemicals. You need to consider what the health basis of those risks are going to be.

Carcinogens are one thing. You're obviously going to look at that. Whether one-in-a-million or some higher risk -- ten-in-a-million -- who knows what's going to happen there. You're going to look at that. But there are risks other than cancer that need to be considered -- birth defects for one. But there is just a whole host, and people have mentioned the multiple factors that go on. Things that now we're agreeing cause birth defects--

Ten, twenty years ago, when guys came back from Vietnam and had kids with funny hands and funny legs, it wasn't Agent Orange. Agent Orange just caused skin rashes. We know better now. Guys are coming back from Desert Storm, and it's the same kind of issue going on. Chemicals in combination cause a whole lot of different effects than chemicals when they're looked at one at a time. So there is an awful lot of crystal-balling you have to do.

I think you need to look at the issues around land use, future land use, and the knowledge that land use in New Jersey is going to be heavier and heavier in terms of residential land use. The questions that you are going to use are going to have a real impact on the answers that you get. I just ask that you consider much more than the economic issue; that the risks and standards be health-based; that they be protective of the environment, and the environment beyond -- more than just the people, but all the things that are then going to go into the food chain -- the plants and animals that are going to be involved.

Be conservative. Protect my health; protect the health of my kids. There are studies that indicate that over the last 50 years in industrialized nations sperm production in men has decreased by half. If you trend that out, by 2020 or there about you're not going to have to worry about our future. If that's related to chemicals, as is a very strong likelihood, then that is an issue that has to be looked at also.

So it's a big issue. You're going to get lots of fancy information. Maybe we should get some conservative thought processes here.

Thank you very much

DR. GALLO: You're welcome. Thank you.

Okay, the next speaker is Faith Stetson.

FAITH B. STETSON: Good evening, I'm Faith Stetson. I'm also from Evesham Township, and I sit on the Ellis Site Superfund site. I've been listening to you all -- very interested in what's going on. However, just a few things:

Randy, who preceded me, happened to indicate about how land use changes. The CIC said that they would -- the representative -- would be reviewing their statistics every so often. Well, when Randy said that land changes in our town, every six years our master plan is updated. Right now, our Superfund site happens to be in a rural area. But, you know, if in six years -- less than six years -- that could be a possible school site. What we don't know today can be a danger tomorrow with the chemicals.

I'm very concerned that this Commission listen and try to be as conservative as possible. What we thought was very safe just a few years ago we know today is a danger. My husband served in Vietnam. Some of the people that we know who served with him are no longer with us because they thought they were using chemicals that were safe.

I think you have to be very careful about your judgements and what you're going to do here. I don't envy you your job; however, I ask you to proceed and try to be very careful in what you're doing when you're considering people's health. I know there are economics that come to bear, but when people are becoming ill, there is also an economic problem that they face in paying for bills to get well. So I really hope that you will be very, very careful in what you do, because what you do here affects all of us in this State.

Thank you very much.

DR. GALLO: You're welcome. Thank you.

The next speaker is Bob Stetson. Is he here?

ROBERT J. STETSON: Good evening. I am also from Evesham Township. My name is Robert Stetson, and I am here representing the Coalition Against Toxics.

The EPA currently uses the guidance of one additional cancer risk of one-in-one million for an additional chemical at a Superfund site, or one-in-ten thousand for all the chemicals at a site. How was the decision made that any additional risks should be incurred after its cleanup of a contaminated site? Shouldn't the goal be to restore the site to its original state?

Clean up contamination to the level that there is no risk to human health, or to the flora and fauna at the site. Any less indicates a willingness to tolerate levels of contamination that will make someone sick.

An environmental group in the Midwest has only half-jokingly enlisted Adopt A Chemical volunteers -- people who will willingly offer themselves up to be that one-in-a-million additional cancer risk for benzene; that one-in-a-million cancer risk for chlordane. So far no one has volunteered.

There is a Superfund site in Evesham Township known as the Ellis Site. Several of our group members serve on the Ellis Site Task Force, an advisory body appointed by our Township government to oversee the progress of the cleanup of this site. In answer to our requests for a return of the site to background levels of contamination, which are extremely low in the rural site, we were told that the cleanup would be done according to applicable standards. Our members are not convinced that the standards are sufficient protection of human health, as well as the ecology of the site, particularly when we learned that cleanup standards for sediment don't exist. Therefore, there will be no cleanup of contaminated sediments in the drainage ditches at the Ellis Site.

What is the impediment to setting cleanup standards that impose no risk? Is it cost, and should cost of cleanup affect the setting of standards? These questions raise ethical consideration, as well as scientific ones, that demand public scrutiny. If the public decides that it will assume some risk in order to reduce the very expensive cost of cleanup of contaminated sites, it needs to be a participant in the decision-making process, and not informed after the fact that cleanup standards were set that will protect the public, when in fact the standards are compromised by economic considerations and/or technological considerations. Maybe they should be called levels of residual contamination standards instead of cleanup standards.

One of the Ellis Site Task Force members who could not be present here tonight summed up the dilemma when he said, "From the public's point of view, remediation of sites should get as close to no risk as you can get. From a commercial point of view, remediation should cause as little risk as economically feasible." Who decides what is economically feasible -- the scientists, the politician, the public, or the polluter?

From the public's perspective, the disincentive to pollute has to be very strong in order to prevent future contaminated sites from occurring. The cost of polluting has been too cheap in this country when you consider the damage that has been done to human health, our waterways, our air, and our land. Tough cleanup standards coupled with toxics use reduction and pollution prevention are the only hopes we have of preventing the next generation of Superfund sites.

The public tends to be skeptical of risk assessment because it has been misused against us so many times. Our hope is that scientists who use risk assessment will use it in the public interest, and that the frailties will be expressed along with the determinations, so that decision-makers -- which must include the public -- are fully informed, not merely massaged.

Thank you.

DR. GALLO: Thank you very much.

The next speaker is Michael Kwasnik.

MICHAEL W. KWASNIK: (from audience) I decline to comment.

DR. GALLO: Pardon?

MR. KWASNIK: I decline to comment at this time.

DR. GALLO: Oh, okay.

Richard Perry, or Rich Perry, is he here? No? (no response) We'll leave that in the box for now.

Edwin Crowell, is he here?

EDWIN P. CROWELL: Good evening, I'm Ned Crowell -- also known as Edwin -- Assistant Director of Research and Development for Union Camp Corporation, Lawrenceville, New Jersey. In addition to representing Union Camp, I am speaking on behalf of the R & D Council of New Jersey, which represents about 100 of the leading research organizations in the State. Our membership comprises most of the Fortune 500 companies who do research in New Jersey, as well as the leading universities of New Jersey.

Most important-- Better yet, my plea -- is that I want to leave you tonight-- I want to leave you with tonight with a-- Oh, boy, I'm sorry.

Better yet, I want to leave you with tonight that it is critical for the well-being of the State that the product of your deliberations reflects current scientific research in the field of risk assessment.

We frequently hear the question: "Has the DEPE gone beyond the U.S. EPA in its regulations?" In the case of site remediation standards, DEPE has not gone beyond that, but is working with concepts that are many years behind current U.S. EPA positions, and with science and technology which is outdated.

Your mission is to critique the proposed procedures which will determine the extent of remediation required for contaminated soil. We hear most about the one-in-a-million -- the 10 to the minus 6 (10^{-6}) -- cancer risk factor, but that's only one part of the many factors in the equation. The algorithm used by the Department also includes consideration of cancer slope factors, soil ingestion rates, body weight factors, and time correction factors. All of these factors include redundant, conservative assumptions based on the lack of quality research information, but that is all that was available in the early years of risk assessment technology. Since that time, much high-quality research has been reported in the scientific peer-reviewed literature on these matters.

For example, in the area of ingestion rates, Calabrese and his coworkers, and more recently, de Silva of Australia, have done some very elegant work using real-life contaminated soil situations and tracer techniques to demonstrate that the more appropriate ingestion rates are actually on the order of 10 times less than the value proposed by the DEPE.

In addition to the factors in the DEPE equation, I believe that factors such as oral bioavailability and half-lives of chemicals in soils should be incorporated into the equation. More important, the computational approach should be expanded to include probabilistic techniques, such as the Monte Carlo simulations.

Public Service Electric and Gas has commissioned TERRA, Incorporated, of Tallahassee, Florida, to do a technical assessment of the New Jersey Department of Environmental Protection and Energy's proposed procedures. I have reviewed a draft of that report, which will be offered to you in Public Service's testimony. The TERRA report contains significant scientific and regulatory reference material that supports our contention that a major update of DEPE's approach to risk assessment and management is in order. The report will provide you with technical and scientific information you can use to spearhead that update and influence the Department to improve its scientific approach.

I implore you to take the Public Service report very seriously, and to use this very valuable information to bring reasonableness to the regulatory process. You have a very important role, with ramifications well beyond the science of site cleanup. Your input can affect the Department's use of good science in its other programs, and the Department's credibility both in the scientific community and the public at large.

Thank you for the opportunity of sharing my thoughts with you.

DR. GALLO: Thank you very much.

Michael Egenton?

MICHAEL A. EGENTON: Good evening. I'm Michael A. Egenton, Manager of Governmental Relations for the New Jersey Chamber of Commerce. On behalf of the New Jersey Chamber of Commerce, I would like to thank the Environmental Risk Assessment and Risk Management Study Commission for this opportunity to comment and share our views on issues concerning the establishment of remediation standards.

Prior to the convening of the Commission, the New Jersey Department of Environmental Protection and Energy in 1992 proposed and then, based upon comments received, withdrew cleanup standards that were based upon a one-in-one million cancer risk. A review of the criteria that the DEPE used in developing those proposed cleanup standards showed that the methods and criteria used by the DEPE were redundant and conservative in nature. It is on the redundancy and conservativeness of the DEPE's withdrawn proposal that I will base my testimony on.

Along with its 110 affiliated local and regional chambers of commerce, the New Jersey Chamber of Commerce represents more than 45,000 businesses throughout New Jersey. Since I do not have a scientific background, my comments will not be technical in nature, but they will address the concerns of the Chamber's membership concerning the one-in-one million cancer risk, along with the methodologies that were used.

To begin with, there is no scientific basis for the one-in-one million cancer risk. This risk level, which is also conservative in nature, will unnecessarily put the Chamber's members at a competitive disadvantage. To demonstrate the conservative nature of the one-in-one million cancer risk, I am going to briefly compare this theoretical risk level to actual risks that are commonly encountered in our daily activities.

For example, drinking one diet soda or drinking one pint of milk a day gives us a lifetime cancer risk of 70 per 100,000. Natural radiation at sea level gives us a cancer risk of 105 per 100,000. Other risks associated with our daily activities, such as driving a car, are 15,400 per 100,000. Even in the home the risk of having an accident is 98 per 100,000. All of these before mentioned risks -- activities that we are exposed to in our daily lives -- are orders of magnitude higher than the conservative one-in-one million risk factor. Even California, the state that New Jersey seems to be in competition with for the strictest environmental laws and regulations, has adopted a higher risk level -- a one-in-one hundred thousand -- as the no significant risk level for the implementation of their Proposition 65.

These examples illustrate two significant points:

One is that the theoretical one-in-one million risk that the Commission is directed to address is far more conservative than a number of risks that are normally associated with in the course of our daily activities.

Second, it must be remembered that unlike the examples above, the theoretical cancer risk of one-in-one million is not a true or measured risk, but rather it is an assumed risk calculated from animal data; data which was developed when the animals were injected with high doses of chemicals in concentrations that far exceed anything that we would come into contact with in our daily activities.

It is recommended that a risk value be developed that would be more in line with the daily activities that we are associated with, say, one-in-ten thousand (10^{-4}), or one-in-one hundred thousand (10^{-5}), or something in between.

One-in-one million cancer risk is not the only component that the Chamber's membership has a concern about. Soil ingestion is also of a concern to our members. The DEPE, when they proposed their cleanup standards back in 1992, used an ingestion rate of 200 milligrams per day for children, and 100 milligrams per day for adults. These numbers were based on studies that were done many years ago, and in most likelihood, developed by using methodologies that are not now considered state-of-the-art, or less accurate than those used today. There are many recent studies out there that show these numbers to be conservative in nature, an aspect that the Legislature directed the Commission to remove.

For children, these recent studies shows an ingestion rate in the range of less than 9 milligrams a day, up to a maximum of 104 milligrams a day. For adults, recent studies suggest that ingestion rates in residential settings range from as little as 1 milligram a day to 50 milligrams a day. In regard to occupational settings, even the U.S. EPA in 1991 developed a default value of 50 milligrams a day. All of these numbers that were developed in recent studies are less than the 200 and 100 milligrams a day proposed by the DEPE.

It is recommended that the Commission reevaluate these ingestion rates proposed by the DEPE in light of more recent data and studies, as mentioned above, and come to a number that is not only protective of human health, but is also realistic and not overly conservative as the numbers proposed by the

DEPE. The Chamber is confident that the ingestion rates, when looked at in a scientific manner and based on recent data, would be less than those proposed by the DEPE.

Another issue the Commission should look at is the time correction factor. The TCF accounts for the number of days per week, weeks per year, and years per lifetime a person would be exposed at a site. In regard to nonresidential, the DEPE assumed that a person would be exposed to chemicals in the soil on the site for five days per week, 49 weeks per year, for 25 years. In the age of transportation, where it is easy to move from one job to another -- including company downsizing, along with recent demographic information -- it is highly unlikely that the average worker would not only be at the same site for 25 years, but would also be exposed to a contaminated area of that site for 25 years.

In addition, the Department of Labor, in all probability, would also be able to supply documentation that would depict DEPE's criteria that an individual stays at the same job as overly conservative. (timer beeps)

I'm just going to skip around. You can read the--

DR. GALLO: You've got about 40 seconds.

MR. EGENTON: Okay.

DR. GALLO: You want to go to your bottom.

MR. EGENTON: Yes.

Furthermore, the Chamber recommends that the Commission calculate the numeric remediation standards. Although this is not currently the Commission's task, the benefits would be twofold: Since it is the Commission that is doing the in-depth scientific study for developing the risk criteria, they would be most familiar with the applicability of the data as it relates to the risk process. Second, since the Commission is an uncompensated panel that will be dissolved after this task is complete, they would not have to be concerned to the political ramifications.

In closing, New Jersey always likes to consider itself a leader. Let's use this process to do just that. Let us be the leader in developing safe yet practical remediation standards. Let us not use data and concepts that were developed many years ago. Let us not use outdated data just because it's there. Let us take a proactive approach. Use the most recent scientifically justifiable data and apply it in a practical way, so as to make New Jersey a safe State, but yet a State that businesses can thrive in once again.

Thank you.

DR. GALLO: Thank you very much. You said you're going to be submitting some of these data. Is that what I heard?

MR. EGENTON: Yes.

DR. GALLO: Okay. Thank you.

I'm just thinking about the rain out there. Two people that were on the list didn't show. Is Mary Lamielle here? No? (no response) And I guess, Rich Perry -- No? (no response) That's it.

I want to thank everybody for coming. We were just about an hour, and I was hoping it was going to be an hour to two. We're going to do this again tomorrow, and again on Friday. Maybe by Friday we'll get it right.

Tomorrow will be up at Cook College, and for any of you who-- Let me just give you-- You may have it. It's going to be at the College Farm Road, at Cook College, and we'll be going on about the same time. Then on Friday it will be the afternoon up at NJIT, at 2:30 p.m. NJIT is in lovely downtown Newark, and easy enough to reach by train from just about anywhere in the State. So you are more than welcome.

I want to thank everybody for coming and for their comments.

Yes, sir?

UNIDENTIFIED SPEAKER FROM AUDIENCE: I had only heard about this conference about a day or so ago. I was wondering if it's either possible to make a comment now, or if I could get my name on the list for the NJIT time?

DR. GALLO: I think it would be fair enough-- If you want to put your name on for NJIT, that would be better. Okay?

UNIDENTIFIED MEMBER OF AUDIENCE: Very good.

DR. GALLO: If you want to give that to Judy before you leave, that would be great.

Again, any written material that we can use, we will be reviewing all of it and your comments. I would like to have it as soon as possible. It's my understanding that when the original ECRA was written, there were 48 inches of paper. I would hope that there aren't another 48 inches of paper, but let's see what happens.

Thanks again for coming. I hope you make it home tonight on a wet, windy night.

(HEARING CONCLUDED)

APPENDIX

NJ Environmental Federation
94 Church Street, 2nd Floor
New Brunswick, NJ 08901

9th Annual Conference
Saturday, April 16, 1994

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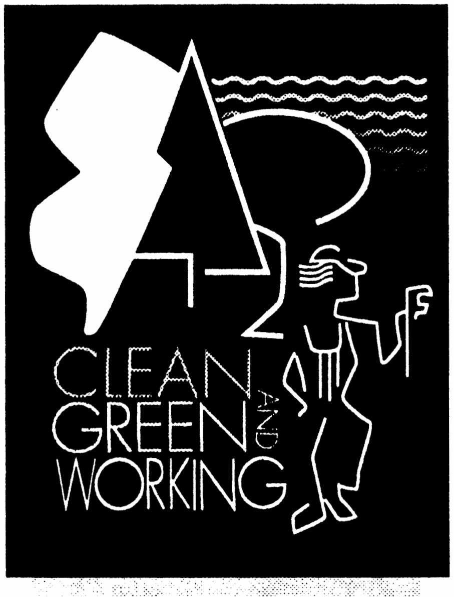

9th Annual
CONFERENCE

Saturday, April 16, 1994
8am to 4:30 pm

Rutgers University
Douglass Campus
Hickman Hall
New Brunswick, NJ

PROGRAM

8:00 - 9:00 am	REGISTRATION
9:00 - 11:00 am	ISSUE WORKSHOPS: panel discussion and small group participatory exercise on NJEF's "Clean, Green and Working" campaign
11:00 - 12:00 pm	PLENARY: recommendations for action on "Clean, Green and Working" from the issue workshops
NOON - 2:00 pm	LUNCH GOVERNOR CHRISTINE TODD WHITMAN (Invited) to speak on "Clean, Green and Working" as well as listen to our concerns and goals
2:00 - 3:30 pm	KEYNOTE SPEAKERS BERNARD D. GOLDSTEIN, MD ELLEN K. SILBERGELD, PhD (invited) Risk Assessments: The Hidden Rules (includes question and answer session)
3:30 - 4:00 pm	AWARDS
4:00 - 4:30 pm	WRAP-UP, NEXT STEPS
4:30 pm	SOCIAL HOUR Legislators and other special guests to be invited.

For more information, call NJEF at (908) 846-4224

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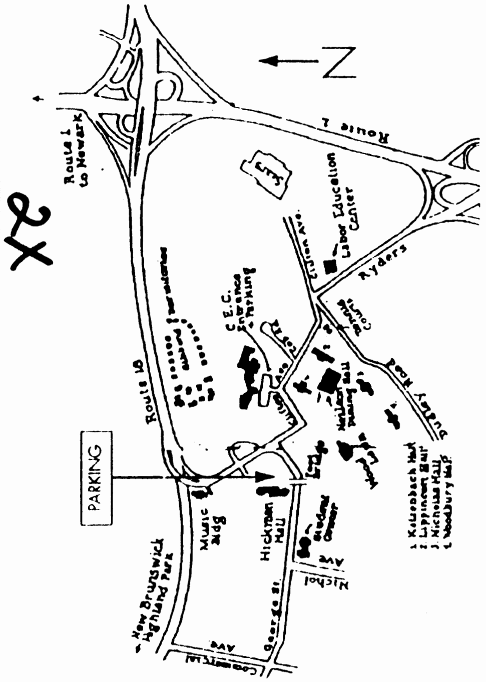
. . . and to the more than 94,000 individual and 69 organizational members and contributors of the New Jersey Environmental Federation

XI

CLEAN GREEN WORKING

Now, more than ever, environmentalists, community leaders and labor need to work together to protect hard-won victories, such as Right to Know and pollution prevention, as well as develop new initiatives for a securer and greener economy. Join us on April 16th! Acquire critical information and access to decision makers, network, and share your ideas for making NJEF's new campaign "Clean, Green and Working" a success.



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BY CAR • From NJ Turnpike Take Exit 9 to Route 18 North toward New Brunswick. Bear left crossing over Rte 1 to next exit ramp to Cook/Douglass Campus. • From Route 1: Take exit to Ryders Lane. Follow Ryders Lane to Clifton Avenue, turn left on Clifton Avenue to Hickman Hall.

BY TRAIN or BUS New Brunswick is on the main line of the Amtrak and the NJ Transit NE Corridor Railroads and is a regular stop for intercity bus lines. Take a cab from the bus or train station to Hickman Hall.

WORKSHOP DESCRIPTIONS

Each of the four morning workshops consists of a brief (30-45 minutes) panel discussion followed by a 1 to 1 ½ hour small group participatory exercise designed to get YOU involved in shaping NJEF's "Clean, Green and Working" campaign. Discussions will focus on strategies for achieving environmental and health protections while building a stronger economy and employment base.

Each workshop is only offered once from 9-11 am.

PESTICIDES: Reducing the Risk

Successful strategies for reducing pesticide use in the home, school, community and workplace through least toxic alternatives."

Moderator:	Maria Sepulte, PhD, Chair, Cedar Grove Environmental Advisory Committee
Panelists:	Dr. Christopher Paul Milne, NJ Dept. of Health
	Mary Lamielle, President, National Center for Environmental Health Strategies
	John Hall, Chair, Safety & Health Committee, Chemical Workers Association
	Nancy Coleman, licensed Pesticide Applicator and Owner, ORGANIC LAWNS

TOXICS: Making Less and Working More

Issues and options for forging ahead towards greener economic and employment opportunities.

Moderator:	Rick Engler, Vice President, NJ Industrial Union Council, AFL-CIO
Panelists:	Robert Beck, Oil, Chemical & Atomic Workers Union, Local 8-397
	Joan Cook Luckhardt, PhD, Director, Lead Poisoning Prevention Education and Training Program, UMDNJ-SOM

SOLID WASTES: The Next Generation

How changing the life cycle of a material and promoting materials efficiency will affect the environment, our communities and businesses.

Moderator:	Dolores Phillips Legislative and Policy Director, NJEF
Panelists:	Brenda Platt, Engineer, Institute for Local Self-Reliance
	Rob Young, President, American Soil Composting, Inc.
	American Forest and Paper Association representative

JOBS & THE ENVIRONMENT: Developing New Jersey the Right Way

Rebuilding New Jersey's infrastructure while putting people back to work cleaning up our air, soil and water.

Moderator:	David Pringle, Campaign Coordinator, NJEF
Panelists:	Candace Ashmun, member of State Planning Commission and President, Association of NJ Environmental Commissions (ANJEC)
	Gerald Stockman, former State Senator and author of the State Plan
	NJ Building Trades representative

LUNCHEON SPEAKER

CHRISTINE TODD WHITMAN
Governor
State of New Jersey
(invited)

Opportunity for the Governor to share her plans for achieving a "Clean, Green and Working" future for the State of New Jersey. You will also have the opportunity to express your concerns to her.

KEYNOTE SPEAKERS

BERNARD D. GOLDSTEIN, MD
Professor & Chairperson,
EOHSI, UMDNJ

ELLEN K. SILBERGELD, PhD (invited)
Environmental Defense Fund,
University of Maryland,
Dept. of Epidemiology

Risk Assessment: the hidden rules of determining "acceptable" risk to our health—what it means and how it will affect us.

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New Brunswick, New Jersey 08901
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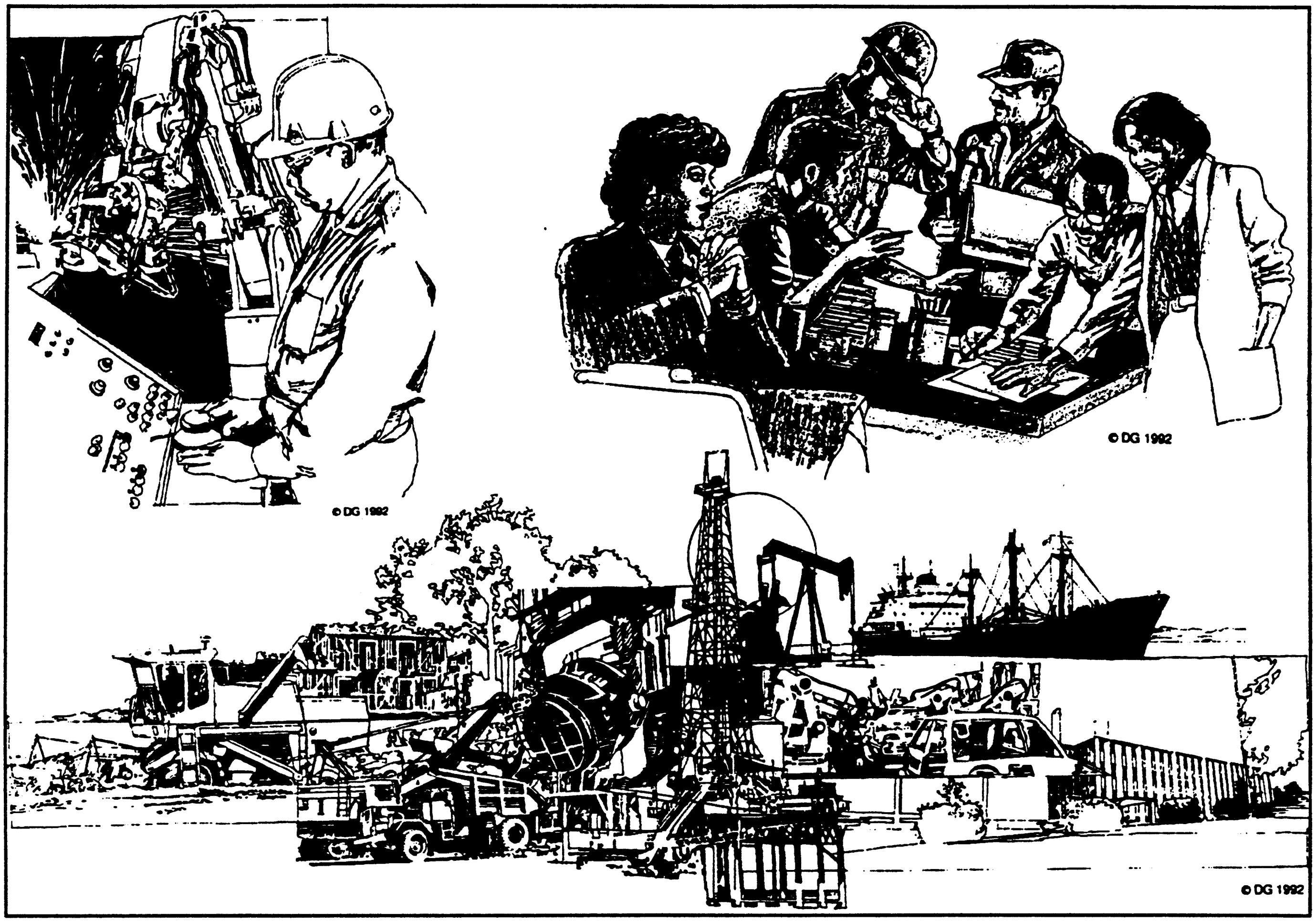
THE COMMUNITY RIGHT TO KNOW ANNUAL REPORT FOR SURVEY YEAR 1990



NEW JERSEY DEPARTMENT OF
ENVIRONMENTAL PROTECTION AND ENERGY

Bureau of Hazardous Substances Information

Jim Florio, Governor
Scott Weiner, Commissioner

November, 1992

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THE COMMUNITY RIGHT TO KNOW ANNUAL REPORT

for Reporting Year 1990

New Jersey Department of Environmental Protection and Energy
Bureau of Hazardous Substances Information
Trenton, New Jersey
(609) 292-6714

November, 1992

Jim Florio, Governor
Scott Weiner, Commissioner

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THE COMMUNITY RIGHT TO KNOW ANNUAL REPORT

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State of New Jersey
Department of Environmental Protection and Energy
CN 402
Trenton, NJ 08625-0402

Scott A. Weiner
Commissioner

Dear Friend:

I am pleased to provide to you the Department of Environmental Protection and Energy's (DEPE) Community Right to Know Annual Report for the 1990 survey year. This report is a summary of chemical inventory, environmental release, waste transfer, facility throughput and pollution prevention data reported in New Jersey pursuant to state and federal Right to Know laws for calendar year 1990.

More than 30,000 Community Right to Know Surveys were sent to employers covered by the New Jersey Worker and Community Right to Know Act in late 1990. These employers were required to report to us the hazardous substances used, produced or stored at their places of business by March 1, 1991. This information was subsequently computerized and those computerized data were used as a basis for this report.

In addition, New Jersey manufacturers that meet federally established thresholds must provide certain information about environmental releases and waste transfers of toxic chemicals to the United States Environmental Protection Agency. This reporting requirement is pursuant to Section 313 of the federal Superfund Amendments and Reauthorization Act of 1986. Copies of these submissions, known as the Toxic Chemical Release Inventory forms, and due by July 1, 1991, were sent to the DEPE. These manufacturers were also required to report throughput and pollution prevention information on the DEPE's Release and Source Reduction Report by July 1, 1991. This information is also summarized in this report.

During the past year we have begun two projects that will expedite the assimilation, analysis and distribution of this information. The first is a computerized imaging system that is now on-line, processing the Community Right to Know Surveys for calendar year 1992. This system will enable the DEPE to get the original submissions computerized more quickly than was previously possible. The second, an on-line computerized data access system being developed in cooperation with the Department of Health and the Division of State Police, will enable interested persons with access to a personal computer and a modem to obtain chemical hazard and inventory information for all employers required to report under state and federal Right to Know laws. This system will be ready by August of 1993.

I hope that this information is of interest to you and that it enhances your awareness of the presence and use of hazardous substances in New Jersey. The information presented in past Community Right to Know Annual Reports has already led to reduction in the use and generation of hazardous substances in our state. I believe that the information contained in this report will contribute to making New Jersey an even better place to work and live.

Sincerely,

Scott A. Weiner
Commissioner

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The Community Right to Know Annual Report

Introduction

Business owners and operators in New Jersey who are regulated by the New Jersey Worker and Community Right to Know (W&CRTK) Act and the federal Superfund Amendments and Reauthorization Act of 1986 (SARA), Title III are required to report inventories of the hazardous substances present at their places of business. Additionally, certain manufacturing facilities are required to report their environmental releases and waste transfers. The information collected under these laws is required to be accessible for the public's review and use.

The data summarized in the report represents the fourth full year of information that was collected under the combined federal and state Community Right to Know programs. The fourth year data was collected using: 1) the Community Right to Know Survey (DEQ-094), 2) the federal Toxic Chemical Release Inventory (TRI) Reporting Form (Form R), and 3) the Release and Source Reduction Report (DEQ-114).

Hazardous Substances Inventory

Every year by March 1, covered businesses are required to report their hazardous substances inventories of the previous year on the Community Right to Know Survey (DEQ-094). The hazardous substance inventory data which is summarized in this report was due on March 1, 1991 for calendar year 1990.

Both manufacturing and non-manufacturing industry classifications are covered under the laws. The Standard Industrial Classification (SIC) code of a business determines its coverage under the New Jersey Community Right to Know program. Facilities not covered under the state law may still be required under federal SARA Title III, the Emergency Planning and Community Right to Know Act, to file inventory reporting forms based upon chemical thresholds at the facility. For the 1990 reporting year, more than 33,000 regulated businesses were identified and were mailed a survey form in 1991. See Table 1 for a listing of Standard Industrial Classification (SIC) codes for businesses that are required to report Community Right to Know data under New Jersey's law.

Toxic Chemical Release Inventory

The Superfund Amendments and Reauthorization Act of 1986 (SARA), Title III, Section 313, requires certain manufacturers to report environmental releases and waste transfers for more than 300 toxic chemicals and chemical groups. All manufacturing sector employers (SICs 20 through 39) who have 10 or more full- time employees, and manufacture (including import), process, or otherwise use any of the reportable toxic chemicals or chemical groups above established thresholds must comply with Section 313.

12X

Facilities covered by Section 313 must submit the Toxic Chemical Release Inventory Reporting Form (Form R), which includes information about annual on-site releases to air, water, and land, and off-site transfers to publicly owned treatment works (POTWs), landfills, and other treatment locations. Manufacturers send the completed original forms to the U.S. Environmental Protection Agency (USEPA) and a copy to the N.J. Department of Environmental Protection and Energy (NJDEPE).

Form R is due July 1 of every year and contains information for the previous calendar year. The environmental release data summarized in this report are for calendar year 1990.

Release and Source Reduction Report

New Jersey requires additional information from those facilities mandated to complete the federal Form R. Previously, the information was collected on the Supplemental Information Report (DEQ-100). Commencing with the 1990 reporting year, the additional information was submitted on the Release and Source Reduction Report (DEQ-114). The Release and Source Reduction Report was conducted by the Department pursuant to the Worker and Community Right to Know Act (P.L. 1983, C:315, N.J.S.A. 34:5A-1.1 et seq.).

The DEQ-114 must be completed for each New Jersey Environmental Hazardous Substance (EHS) which meets the reporting thresholds under SARA, Title III, Section 313. For the 1990 reporting year, the EHS list included 167 individual chemicals and 11 chemical compound categories.

The Release and Source Reduction Report contained two parts: information pertaining to the facility site and its overall operations was required to be submitted on Section A; Section B provided information pertaining to reportable Environmental Hazardous Substances. One complete Section B form must be submitted for each Environmental Hazardous Substance meeting the threshold requirements of SARA Section 313. The additional information for each EHS reported in Section B included beginning and ending inventory for the reporting year; the quantities produced on site, brought on site, consumed on site and shipped off-site as (or in) a product; and waste hauler information. Also required to be reported are air emissions, waste water discharges, waste transfers, including those sent off-site for recycling purposes, and source reduction/pollution prevention information. The Release and Source Reduction Report is due by July 1 of each year. This report incorporates data collected on New Jersey's Release and Source Reduction Report (DEQ-114) for calendar year 1990. This is the first annual report to summarize materials balance and related information collected under New Jersey's law.

General Discussion

The data presented in this annual report represent maximum daily inventories or annual quantities of releases and transfers, and are not a direct indicator of exposure, if any, of the public to the chemicals. This information is provided to promote awareness of the hazardous substances produced, used, stored and released in New Jersey and at what quantities. The requirement of facilities to disclose the amounts of hazardous substances

13X

which are stored or released has encouraged many facilities to reduce the production, use, storage, and/or emissions of those substances. Other potential benefits of Right to Know data are:

- encouraging dialogue between citizens and facility managers to increase understanding of hazardous substance uses in businesses;
- identifying particular needs for better regulation of hazardous substances, both locally and statewide;
- identifying locations of concentrated hazardous substances inventories or environmental releases in the state;
- identifying businesses that may be subject to other environmental protection requirements, such as permit programs;
- making hazardous substances inventories available to state and local emergency responders so that they may plan for and respond effectively to emergency incidents;
- using the information for land use planning decisions;
- providing direction for the development of monitoring and surveillance studies regarding hazardous substances.

If you are interested in finding out more about hazardous substances at an individual facility or in your community, we recommend that you request CRTK information using the request form found on page 88 of this report. Or, contact the Right to Know coordinator for your county; a list of county agencies and their addresses is included on page 87. If you are not certain what information you want or what the request would entail, contact the Bureau of Hazardous Substances Information directly, at 609-292-6714.

Comments

The Department welcomes your comments and suggestions about this annual report. We hope that with your assistance and recommendations, we will be able to present the information in a form that is most useful by the public. You may submit your comments to the Bureau of Hazardous Substances Information, CN-405, Trenton, New Jersey 08625-0405.

14X

Table 1. Standard Industrial Classification Codes: New Jersey Employer Groups and Activities Subject to Hazardous Substances Inventory Reporting.

SIC Code	ACTIVITY
07	AGRICULTURAL SERVICES
0782	Lawn and Garden Services
20 - 39	MANUFACTURING ESTABLISHMENTS (Entire Major Groups)
20	FOOD AND KINDRED PRODUCTS
21	TOBACCO MANUFACTURING
22	TEXTILE MILL PRODUCTS
23	APPAREL AND OTHER TEXTILE PRODUCTS
24	LUMBER AND WOOD PRODUCTS
25	FURNITURE AND FIXTURES
26	PAPER AND ALLIED PRODUCTS
27	PRINTING AND PUBLISHING
28	CHEMICALS AND ALLIED PRODUCTS
29	PETROLEUM AND COAL PRODUCTS
30	RUBBER AND MISCELLANEOUS PLASTIC PRODUCTS
31	LEATHER AND LEATHER PRODUCTS
32	STONE, CLAY, AND GLASS PRODUCTS
33	PRIMARY METAL INDUSTRIES
34	FABRICATED METAL PRODUCTS
35	MACHINERY, EXCEPT ELECTRICAL
36	ELECTRICAL AND ELECTRONIC EQUIPMENT
37	TRANSPORTATION EQUIPMENT
38	INSTRUMENTS AND RELATED PRODUCTS
39	MISCELLANEOUS MANUFACTURING INDUSTRIES

15X

Table 1. Standard Industrial Classification Codes, Continued.

SIC Code	ACTIVITY
45	TRANSPORTATION BY AIR
4511	Certificated Air Transportation
(4512)	(Scheduled Air Transport)[1]
(4513)	(Air Courier Services)[1]
4582	Airports and Flying Fields
(4581)	(Airports, Flying Fields, & Airport Terminal Services)[1]
4583	Airport Terminal Services (see 4581)[1]
46	PIPELINES, EXCEPT NATURAL GAS (Entire Major Group)
47	TRANSPORTATION SERVICES
4712	Freight Forwarding
(4731)	(Arrangement of Transportation of Freight and Cargo)[1]
4742	Rental of Railroad Cars, with Care of Lading
(4741)	(Rental of Railroad Cars)[1]
4743	Rental of Railroad Cars, without Care of Lading (see 4741)[1]
4782	Inspection and Weighing
(4785)	(Fixed Facilities, Handling Motor Vehicle Transport, including Inspection and Weighing)[1]
4783	Packing and Crating
4784	Fixed Facilities, Handling Motor Vehicle Transport (see 4785)[1]
4789	Transport Services, n.e.c.[2]
48	COMMUNICATIONS
4811	Telephone Communication (Radio or Wire)
(4812)	(Radiotelephone Communication)[1]
(4813)	(Telephone, except Radiotelephone)[1]
4821	Telegraph Communication (Radio or Wire)
(4822)	(Telegraph Communication (Radio or Wire))[1]
49	ELECTRIC, GAS, AND SANITARY SERVICES (Entire Major Group)

Table 1. Standard Industrial Classification Codes, Continued.

SIC Code	ACTIVITY
50	WHOLESALE TRADE - DURABLE GOODS
5085	Machinery, Equipment, and Supplies - Industrial
5087	Machinery, Equipment, and Supplies - Service Establishments
5093	Miscellaneous Durable Goods - Scraps and Waste
51	WHOLESALE TRADE - NONDURABLE GOODS
5122	Drugs, Drug Proprietaries, and Druggists' Sundries
5161	Chemicals and Allied Products
(5162)	(Plastics Materials, Basic Forms and Shapes)[1]
(5169)	(Chemicals and Allied Products, n.e.c.)[1,2]
5171	Petroleum Bulk Stations and Terminals
5172	Petroleum and Petroleum Product Wholesalers, except Bulk Stations and Terminals
5181	Beer and Ale
5182	Wines and Distilled Alcoholic Beverages
5191	Farm Supplies
5192	Books, Periodicals, and Newspapers
5193	Flowers, Nursery Stock and Florists Supplies
5194	Tobacco and Tobacco Products
5198	Paints, Varnishes, and Supplies
5199	Nondurable Goods, n.e.c.[2]
55	AUTOMOTIVE DEALERS AND GASOLINE SERVICE STATIONS
5511	Motor Vehicle Dealers (New and Used)
5521	Motor Vehicle Dealers (Used only)
5541	Gasoline Service Stations - Retail
72	PERSONAL SERVICES
7216	Dry Cleaning Plants, except Rug Cleaning
7217	Carpet and Upholstery Cleaning
7218	Industrial Launderers
73	BUSINESS SERVICES
7397	Commercial Testing Labs
(8734)	(Testing Labs)

Table 1. Standard Industrial Classification Codes, Continued.

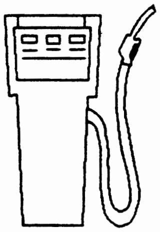
SIC Code	ACTIVITY
75	AUTOMOTIVE REPAIR, SERVICES, AND GARAGES
7531	Top and Body Repair
(7532)	(Top, Body, and Upholstery Repair, and Paint)[1]
7533	Automotive Exhaust System Repair
7534	Tire Retreading and Repair
7535	Paint (see 7532)[1]
7536	Automotive Glass Replacement
7537	Automotive Transmission Repair
7538	General Automotive Repair
7539	Automotive Repair, n.e.c.[2]
76	MISCELLANEOUS REPAIR
7692	Welding Repair
80	HEALTH SERVICES
8062	General Medical and Surgical Hospitals[3]
8063	Psychiatric Hospitals[3]
8069	Specialty Hospitals, except Psychiatric[3]
82	EDUCATIONAL SERVICES
8211	Elementary and Secondary Schools[3]
8221	Colleges, Universities, and Professional Schools[3]
8222	Junior Colleges and Technical Institutes[3]
8249	Vocational Schools, except Vocational Schools n.e.c.[2,3]
91 - 96	PUBLIC ADMINISTRATION
	All State, County, and Local Governments[3]

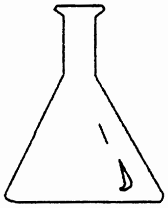
1. Activity as currently described, "Standard Industrial Classification Manual, Revised," (PB87-100012), National Technical Information Service, Springfield, VA, 1987.

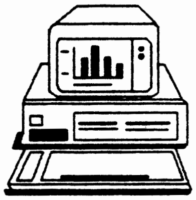
2. n.e.c. means "not elsewhere classified."

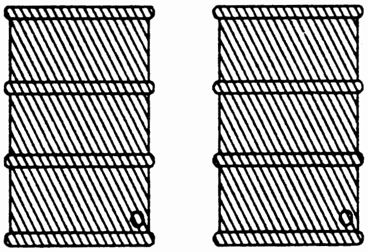
3. Public sector employers receive the Right to Know Survey from the NJ Department of Health (NJDOH). It combines the hazardous substances inventory reporting requirements of both NJDEPE and NJDOH.

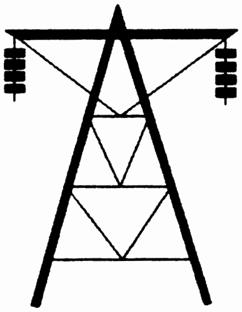
COMMUNITY RIGHT TO KNOW SURVEY
FOR 1990
HAZARDOUS SUBSTANCES INVENTORY SUMMARY











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THE COMMUNITY RIGHT TO KNOW SURVEY FOR 1990

The New Jersey Community Right to Know Survey (DEQ-094) was mailed to approximately 33,300 facilities to collect information regarding the production, use, or storage of hazardous substances in reporting year 1990. More than 28,000 facilities returned a completed survey or updated the information regarding their status (such as the facility is only a sales office and not subject to reporting, is no longer in business, or has relocated).

Figures 1 and 2 show 1990 and 1989 compliance by industry group for both manufacturing and non-manufacturing sectors, respectively. Compliance rates are presented only for the industry groups regulated by the New Jersey Worker and Community Right to Know Act (see Table 1); several other industry groups report on the Community Right to Know Survey as a result of their coverage under the federal SARA Title III, although they are exempt under the state Act. An example of such a group is the Fuel Oil Dealers. The difference in coverage between the state and federal statutes is in the non-manufacturing sector; both laws cover all manufacturers.

Within the manufacturing sector, the only industrial categories with compliance rates below 80% were the Apparel and Other Finished Products group (SIC 23xx) and Lumber and Wood Products (SIC 24xx). Many groups had a compliance rate of 90% or better, including Chemicals and Allied Products, Petroleum and Coal Products, and industries in Rubber and Miscellaneous Plastics Products, Leather and Leather Products, and Primary Metals. Figure 1 shows that all industries increased in compliance except the Petroleum and Coal Products group, which dropped to a compliance rate of 91.4% from 98% for the 1989 reporting year.

The Tobacco Manufacturing group (SIC 21xx) demonstrated the highest compliance rate for 1990, 100%, with four facilities responding. In contrast, the Apparel and Other Textile Products industry (SIC 23xx) had the lowest compliance rate, 75.1%, with 953 of 1,269 facilities responding. Compliance rates, in themselves, do not present the complete picture of industry activity in the state nor the size of subpopulations within the regulated community. For numerical contrast, more than 2,300 facilities within the Printing and Publishing industry (SIC 27xx) were surveyed while only four facilities were in the Tobacco Manufacturing industry (SIC 21xx).

Within the non-manufacturing sector, some industry groups are regulated in their entirety (e.g. 46 and 49) while only specific business activities are regulated in others (e.g. 0782, Lawn and Garden Services, within Agricultural Services). Only those businesses, including educational services, which are in the private sector report to NJDEPE; public sector employers report to the N.J. Department of Health.

Three groups in the regulated non-manufacturing sector had a compliance rate of less than 80% - Lawn and Garden Services, Personal Services, and Welding Repair. As for 1989, all Pipeline facilities (SIC 46xx) in the state were in compliance for 1990. Many groups demonstrated a dramatic increase in compliance, such as Transportation (SICs 45xx and 47xx), Utilities (SIC 49xx), Wholesale Trades (SICs 50xx and 51xx), Health Services, and Educational Services. Despite this fact, the non-manufacturing industries overall still lagged slightly behind the manufacturers in compliance for survey year 1990, as has been the case in the past. While the manufacturing industries had an 89% return rate for the Community Right to Know Survey for 1990, the non-manufacturers had an 83% rate of return.

20X

The 31 facilities in the Pipelines, except Natural Gas industry (SIC 46xx) again had a 100% compliance rate for 1990. The Lawn and Garden Services sector (SIC 0782) had the lowest compliance rate, 68.4%, with 1,792 responses from its 2,619 employers. Again, for numerical contrast, there were 86 facilities surveyed in the Testing Laboratories industry (SIC 8734), while more than 4,700 facilities in the Automotive Dealers and Gasoline Service Stations industry (SIC 55xx) received the DEQ-094 for 1990. All SIC codes in the non-manufacturing sector showed an increase in compliance when compared to 1989. Overall compliance increased from 75% to 83%.

An evaluation of survey response by county (Figure 3) yielded a somewhat consistent response in the range of 79% to 90% (up from 69% to 81% for 1989). Hudson County had the lowest compliance rate for the second year in a row while Cumberland County was the highest. The greatest increase was observed in Gloucester County which increased 14 percentage points. It should be noted that in addition to completed surveys, "returned surveys" include companies which have notified DEPE that they are no longer in business, or have no facilities in the state, and surveys which have been returned to DEPE as undeliverable.

Figure 4 presents a qualitative analysis of the number of facilities by county reporting any inventories of hazardous substances at their locations for the 1990 reporting year. Five counties - Camden, Gloucester, Hudson, Passaic, and Union - showed an increase in the number of facilities reporting over the 1989 survey year which caused them to be represented by the next higher range as shown in Figure 4. No county has less than 100 facilities with chemical inventories and no county moved into a lower group when compared to 1989.

The number of facilities by county reporting any individual hazardous substance in a maximum daily amount above 50,000 pounds is presented in Figure 5. When a facility reported a hazardous substance which was not pure (that is the hazardous substance was contained in a mixture), the reportable substance had to comprise at least 50% of a mixture for the facility to be included in Figure 5. The number of facilities (3,332) reporting any individual hazardous substance in a maximum daily amount above 50,000 pounds for 1990 is significantly greater than the number presented in the annual reports for 1989 (2,582) and 1988 (1,423). This is not necessarily due to an actual increase in the number of facilities with large quantities of chemical inventories, however. The data are retrieved from a chemical inventory database and the amount of data in the database is a time-related factor. The 1988 data were summarized by mid-March of 1990. The 1989 data were summarized by July of 1991. The 1990 data were summarized by June of 1992. Possible explanations for this observation include:

- the increased compliance rate achieved for the 1990 survey year;
- better reporting by industry;
- additional time for data entry; and,
- the CRTK program's focus on expediting data entry.

Data presented in Figures 4 and 5 may be used to identify areas of the state where chemical usage by industry is the heaviest. It is quickly evident that the northeast portion of the state contains a large number of facilities with chemical inventories and a large number of facilities with large maximum daily inventories. It is important to note that these data do not necessarily indicate increased health risks or greater individual exposures to hazardous substances compared to any other region in the state.

21X

422

1990 Surveys Mailed = 13,217 **1990 Surveys Returned = 11,755** **1990 Compliance = 89%**

1989 Surveys Mailed = 14,610 **1989 Surveys Returned = 11,675** **1989 Compliance = 80%**

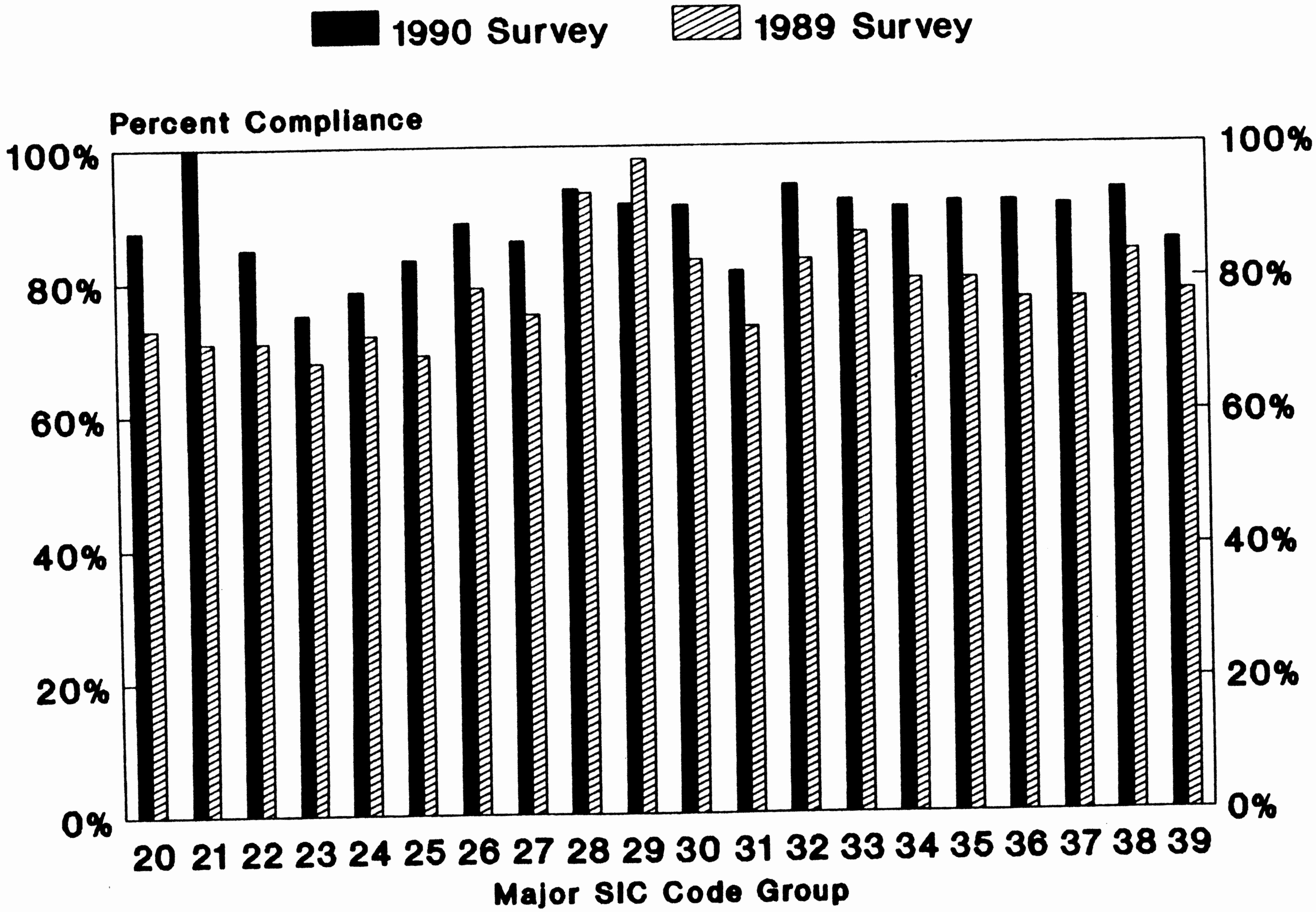


Figure 1. Community RTK Survey Compliance, 1990 & 1989 (Manufacturing SIC Codes).

23X

1990 Surveys Mailed = 20,086 **1990 Surveys Returned = 16,631** **1990 Compliance = 83%**

1989 Surveys Mailed = 22,294 **1989 Surveys Returned = 16,632** **1989 Compliance = 75%**

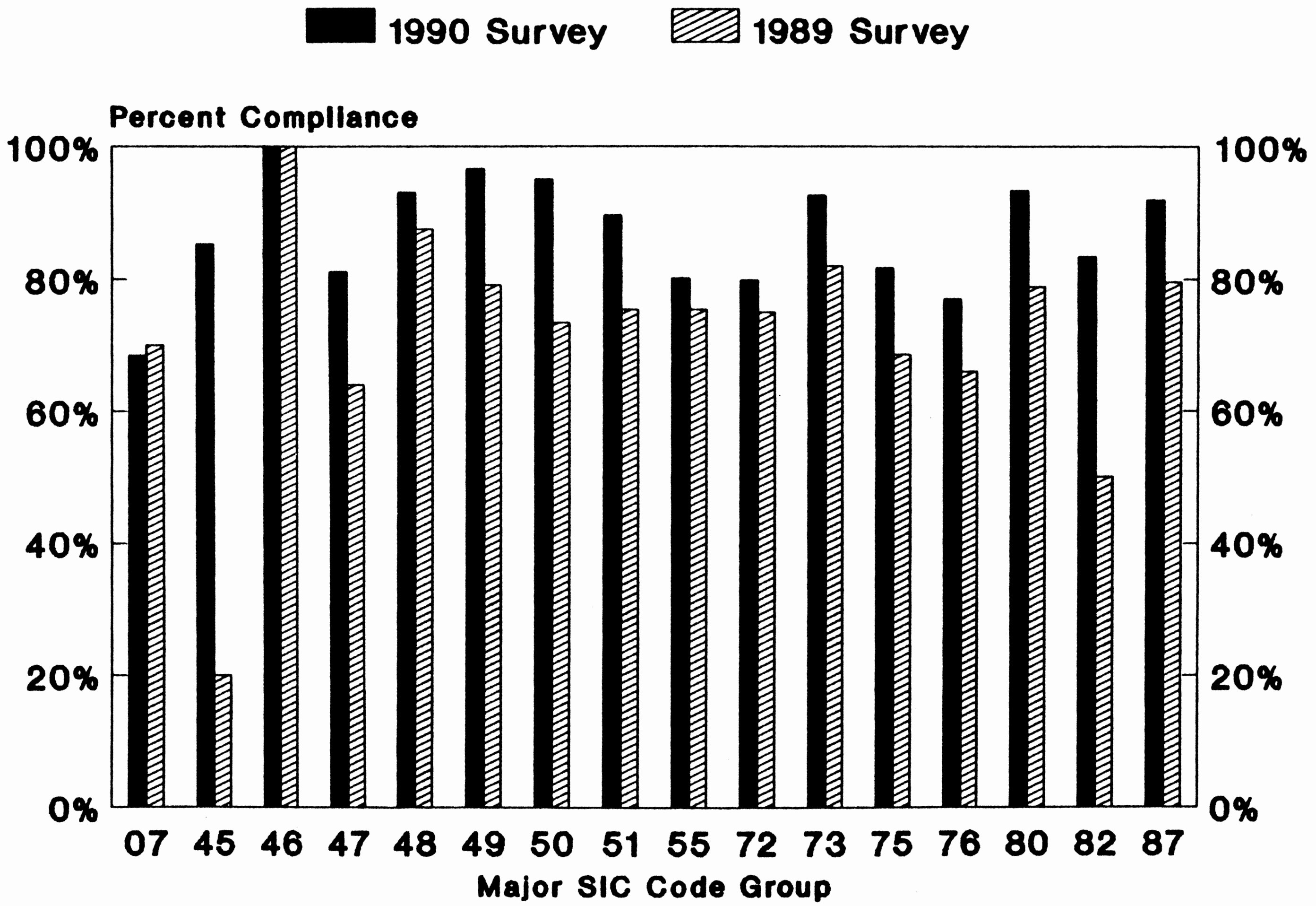
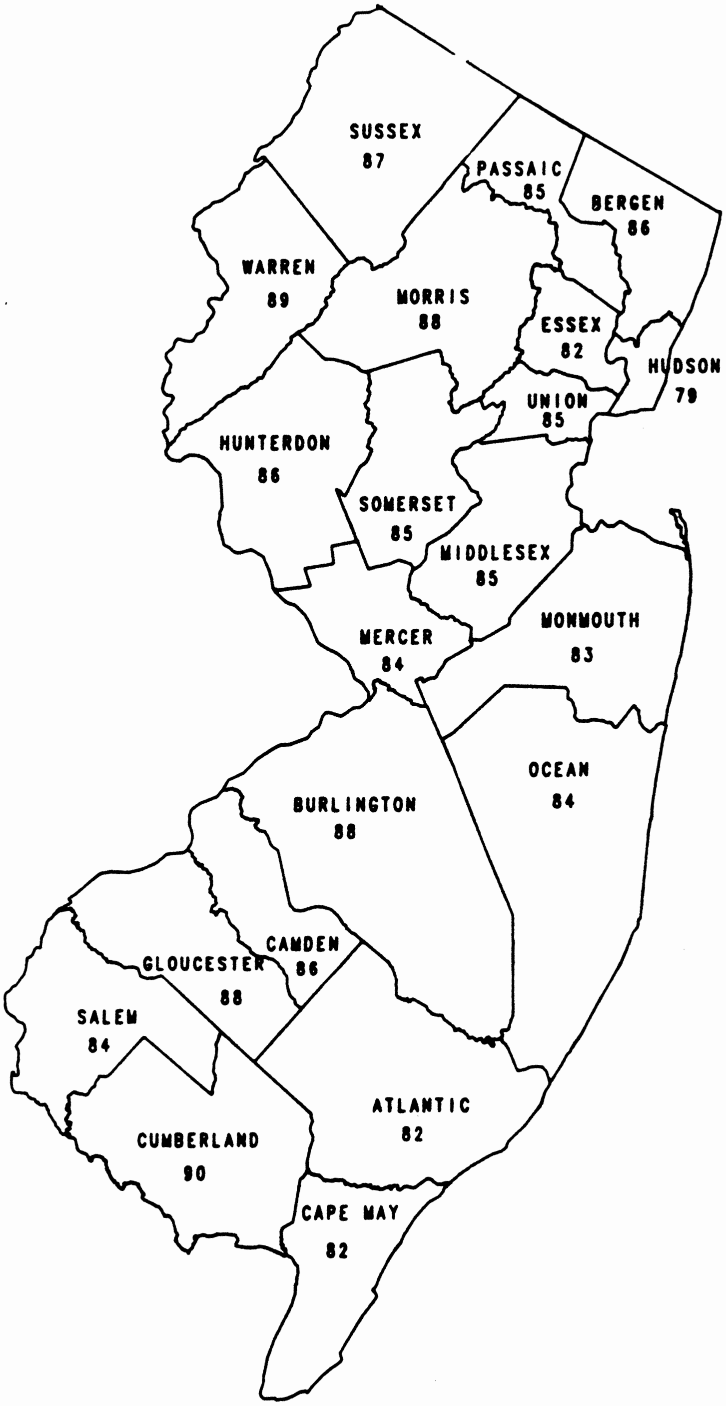


Figure 2. Community RTK Survey Compliance, 1990 & 1989 (Non-manufacturing SIC Codes).



COUNTY	PERCENTAGE
ATLANTIC	82
BERGEN	86
BURLINGTON	88
CAMDEN	86
CAPE MAY	82
CUMBERLAND	90
ESSEX	82
GLOUCESTER	88
HUDSON	79
HUNTERDON	86
MERCER	84
MIDDLESEX	85
MONMOUTH	83
MORRIS	88
OCEAN	84
PASSAIC	85
SALEM	84
SOMERSET	85
SUSSEX	87
UNION	85
WARREN	89

Figure 3. Community Right To Know Surveys Returned by County (by percentage).

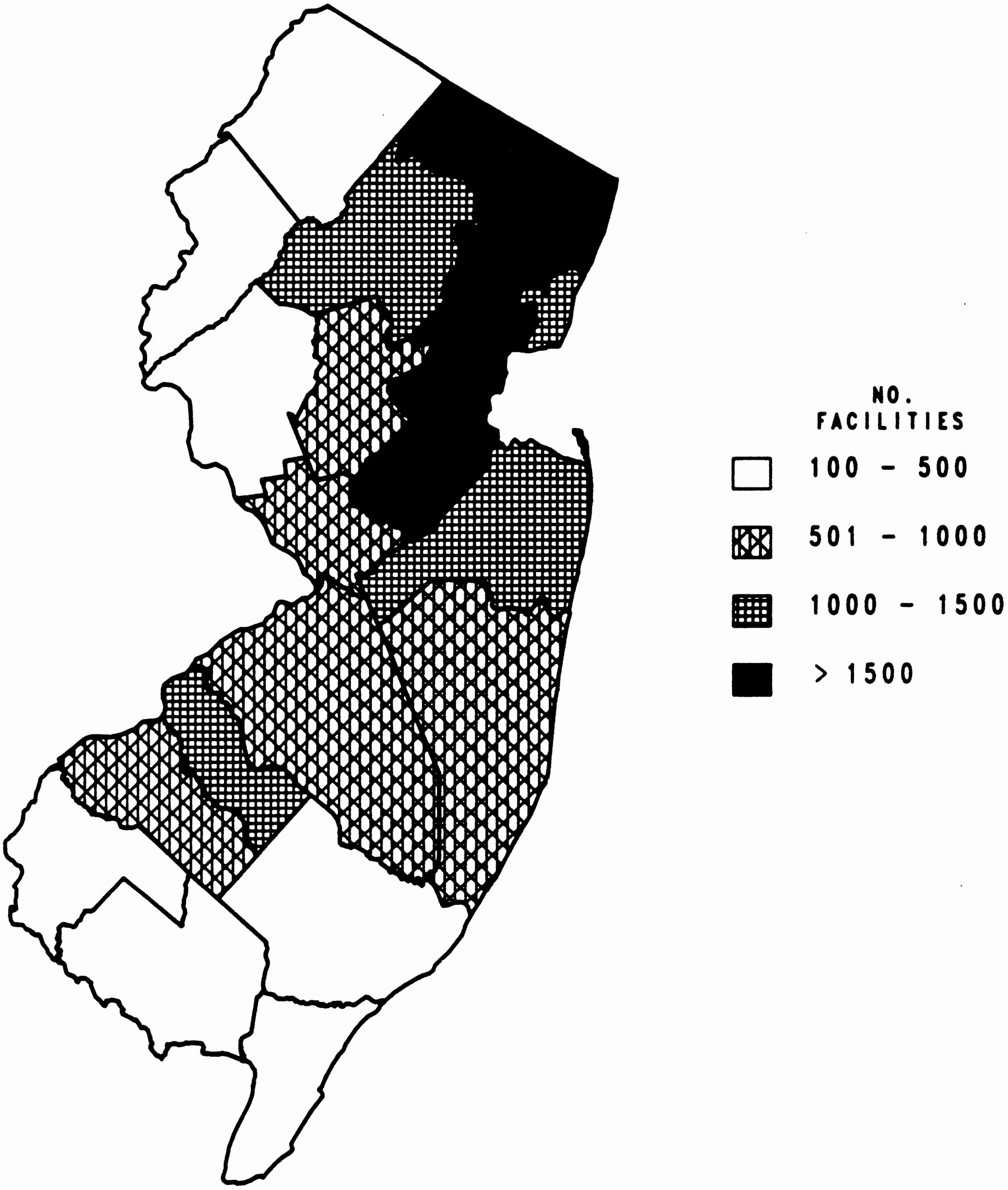
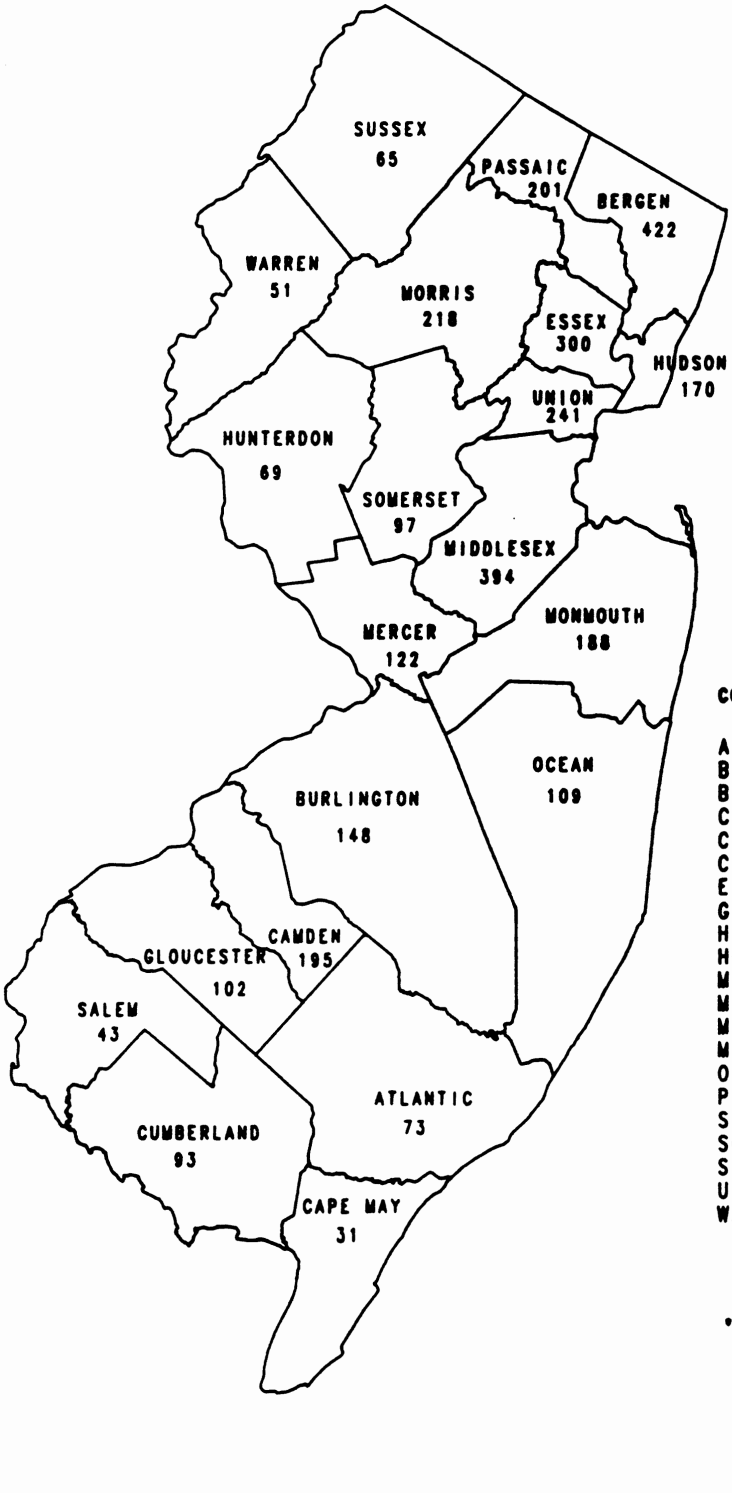


Figure 4. Number of Facilities Reporting Chemical Inventories on the CRTK Survey for 1990 by County.

25X



COUNTY	NO. FACILITIES	NO. SUBSTANCES
ATLANTIC	73	151
BERGEN	422	1,200
BURLINGTON	148	448
CAMDEN	195	538
CAPE MAY	31	55
CUMBERLAND	93	208
ESSEX	300	992
GLOUCESTER	102	530
HUDSON	170	795
HUNTERDON	69	183
MERCER	122	299
MIDDLESEX	394	1,790
MONMOUTH	188	474
MORRIS	218	555
OCEAN	109	205
PASSAIC	201	632
SALEM	43	233
SOMERSET	97	237
SUSSEX	65	145
UNION	241	1,540
WARREN	51	266
	----	----
TOTAL =	3,332	11,476

*mixtures greater than 50% per substance

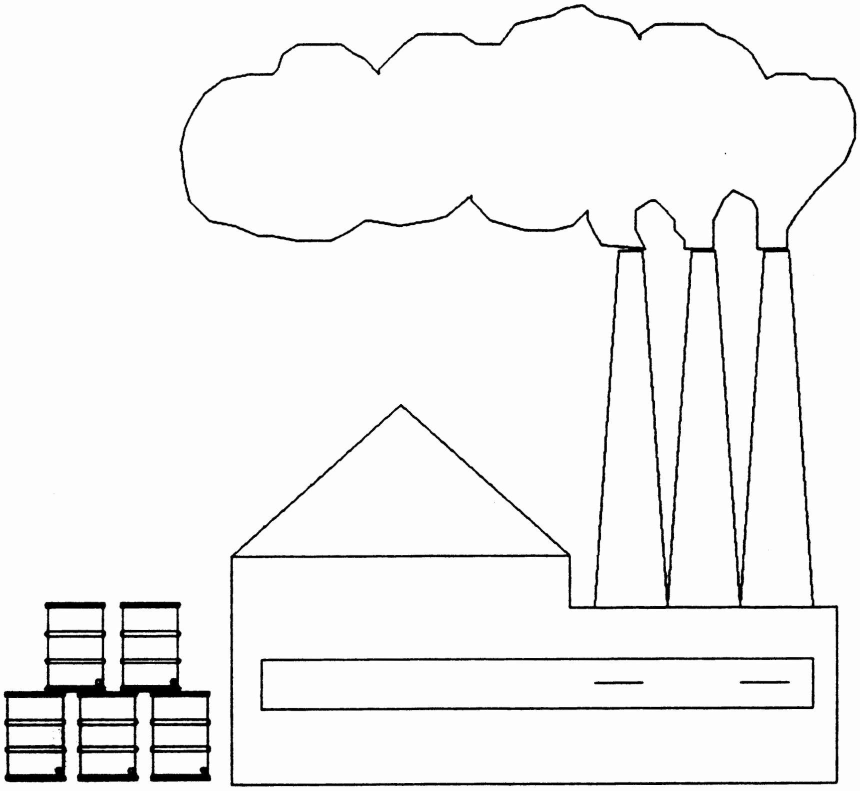
Figure 5. Number of Facilities Reporting Greater Than 50,000 Pounds of Maximum Daily Inventory for Individual Substances* on the CRTK Survey for 1990.

26X

SARA TITLE III, SECTION 313

TOXIC CHEMICAL RELEASE INVENTORY

FOR 1990



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THE 1990 TOXIC CHEMICAL RELEASE INVENTORY

Introduction

Section 313 of SARA Title III requires that Form R*s* be filed by owners and operators of facilities that meet all three of the following criteria:

- the facility's business activity is included in Standard Industrial Classification codes 20 through 39; and
- the facility has 10 or more full-time employees; and
- the facility manufactured (defined to include imported), processed, or otherwise used any listed chemical in quantities equal to or greater than the established thresholds in the course of a calendar year.

Covered facilities are required to provide, along with a variety of other information, estimates of releases and transfers to the following environmental media for each chemical which meets the manufacture, process, or use threshold:

- air emissions
  [both fugitive (or non-point), and stack (or point)];
- surface waters discharges;
- on-site land releases (i.e. at the facility);
- underground injection;
- discharges to publicly owned treatment works (POTWs); and,
- transfers to other off-site locations.

The Section 313 Toxic Chemical List for 1990 included 310 individual chemicals and 20 chemical categories. The toxic effects on human health and the environment of the listed chemicals vary widely. Some of the chemicals are known or suspected carcinogens (cause cancer), some are mutagens (cause changes in genetic material), some are teratogens (cause defects in fetal development), some affect the central nervous system, others are irritants, some are environmental toxins, while still others are relatively harmless. Table 2 presents a summary of the more common uses of and the hazards posed by the chemicals reported as "Largest Total Quantities" or "Most Frequently Reported" (as identified in Tables 7 through 15).

The information presented here is a summary of the 1990 data as received on the Toxic Chemical Release Inventory (TRI) Reporting Form (Form R) by the NJDEPE through July 31, 1992. This is the fourth annual summary of New Jersey SARA Section 313 data. New Jersey facilities reported information for 202 of the 330 chemicals and chemical categories covered in 1990.

Data Applications and Limitations

There are many potential uses, and misuses, of this very interesting and valuable data. Many factors must be taken into consideration when evaluating and interpreting the meaning of the reported data. These factors are discussed below.

There are several caveats which affect the data reported by facility owners or operators. Facilities are not required to monitor, measure, or sample their waste streams to any extent beyond that required by existing federal or state laws, permits, etc., governing the covered chemicals and the media to which they are discharged. Thus, much of the data reported on the Form R are estimates.

Only manufacturing sector employers meeting the reporting criteria (see page 18 of this report) are subject to the Section 313 reporting requirements. While these facilities may be large generators and emitters of hazardous chemicals, there are certainly other facilities in the manufacturing sector and also non-manufacturing sector businesses which have the potential to release hazardous substances into the environment. Additionally, motor vehicles (cars, trucks, buses, etc.) have been implicated as a significant source of toxic air contaminants, particularly in urban areas. Non-point sources, such as farm water runoff and contaminated sediments, are major sources of water pollution. Therefore, the data reported under Section 313 may represent the largest releases of these substances but are certainly not the only sources of release for them.

Environmental releases are reported as total annual quantities without reference to the frequency, duration or peak rates of release. The total annual release quantities alone are not sufficient to conduct human health and environmental impact assessments. Numerous factors influence the nature and extent to which any TRI release or transfer cause adverse human health or environmental effects, including the following:

- the dose to which the individual is exposed;
- the degree of toxicity of the chemical;
- the route(s) of release;
- the route(s) of exposure;
- the persistence, bioconcentration, transport, and nature of the environmental degradation of the chemical; and
- various local factors, such as human and wildlife population patterns, atmospheric and climatic conditions, patterns of drinking water use, and sources of the food supply.

Consequently, a few pounds of a highly toxic chemical released to the environment may be of far greater concern than thousands of pounds of a less toxic chemical. Likewise, the same number of pounds of a chemical released by different facilities may have different effects due to differing local conditions.

Since the manufacturers estimate the releases and transfers to a variety of environmental media, and, in some cases, very large facilities with many sources of releases, the accuracy of the reported quantities may be questionable and not easily verified. Some facilities have staff devoted entirely to the task of preparing environmental surveys while at other facilities the plant manager, supervisor, accountant, or office staff prepare the forms in addition to performing their other duties. The methods of estimation also vary widely. Direct measurements are by far the best method to determine releases and transfers. The use of engineering calculations, emission factors, and other engineering approaches are equally acceptable, however may produce significantly different estimated quantities of releases. Additionally, any estimate may be rounded off to two significant digits (for example, if a stack air release is estimated to be 1,444,000 pounds, the entry on the Form R may be 1,400,000 pounds).

It is important to note that some discharges to publicly owned treatment works are removed, either partially or completely, or rendered innocuous at the treatment plant. Also, waste transfers to off-site locations are subjected to proper disposal techniques at permitted waste treatment or disposal facilities, as assessed by the information provided on the Forms. Therefore, the presence of a discharge does not imply any illegal activity since many discharges are permitted or regulated under state and/or federal programs.

Quantities of a chemical sent off-site to be recycled or reprocessed are not required to be reported. Discussions with several submitters have indicated that this exemption was not clear. Some submitters did report quantities shipped off-site for recycling or reprocessing even though they were not required to be reported. Therefore, off-site transfers included quantities which were not required to be reported on Form R. This is not to imply that wastes were not generated. However, the wastes which are recycled or reprocessed often become resources which make their way back into the manufacturing loop or are reused in some manner, thereby reducing the need for waste disposal and the potential for release to the environment. The recycling exemption will be eliminated by the USEPA in the 1991 reporting year.

For reporting year 1990, there were four chemicals delisted from Section 313 reporting: terephthalic acid; and three members of the copper compounds category - C.I. Pigment Blue 15, C.I. Pigment Green 7, and C.I. Pigment Green 36. Additionally, nine substances were added to the list and subject to reporting for the first time: allyl alcohol, creosote, 2,3-dichloropropene, m-dinitrobenzene, o-dinitrobenzene, p-dinitrobenzene, dinitrotoluene (mixed isomers), isosafrole, and toluenediisocyanate (mixed isomers).

General Findings

The NJDEPE has made no assessment of the accuracy of the reported figures at this time. Some of the Department's programs have integrated this information into a routine inspection program for facilities with large quantities of toxic releases or transfers. Therefore, the information is presently best used to evaluate potential human health and environmental problems, to prioritize environmental efforts in areas where high release density coincides with high population density, and to identify pollution prevention potential.

For 1990, 844 manufacturing-sector facilities submitted 3,092 Form R*s* (i.e. one Form R for each reportable chemical per facility), reporting on 202 of the 330 TRI chemicals and chemical groups. Figure 6 is a map of New Jersey showing the number of reporting facilities by county. The northeastern section of the state contains the highest number and density of facilities, with 139 facilities (submitting 622 Form R*s*) reporting in Middlesex County.

Total Statewide Releases - Approximately 114 million pounds of chemicals were reported as having been released to the environment or transferred off-site for treatment or disposal in 1990. About 26.3 million pounds were released on-site at the reporting facilities and 87.7 million pounds were transferred off-site. Figure 7 presents two pie charts depicting the 1990 releases and 1990 transfers, respectively, by reporting media. Table 3 presents the reported releases and transfers for each individual chemical (ordered alphabetically by chemical name).

30X

County Summary - Table 4 presents a detailed analysis of 1990 quantities by reporting media for each county. Middlesex County had the highest total quantity of releases and transfers of approximately 26 million pounds. Cumberland County had the lowest quantity of reported releases and transfers, with the exception of Cape May County which had no facilities reporting for the fourth consecutive year.

An analysis of direct releases within each county (i.e. air, water, and on-site land) is presented in Table 5. The analysis summarized the release density (pounds per square mile) and population density for each county. The density of direct TRI releases within a county represents the average number of pounds of TRI chemicals released per square mile for the 1990 reporting year. Four counties - Essex, Hudson, Middlesex, and Union - had release densities greater than 19,000 pounds per square mile. All but Middlesex are in the top five counties ranked by population density. Hudson, Essex and Union are the top three, respectively. Since release densities are averaged over both space and time, they are not an accurate indicator of the actual release density in any given geographic area. Additionally, no average measure, such as release density, should be confused with exposure - the amount of chemicals that an individual citizen may actually come into contact with. Overall, the high density counties reflect the same pattern observed in data on chemical inventories (see Figures 4 and 5) and data on quantities of releases and transfers (Table 4). The best application of this information is to focus environmental efforts in the areas of overlap of high release density and high population density.

Manufacturing Industry Summary - Table 6 and Figure 8 present the reported data by Standard Industrial Classification (SIC) code. By far, the Chemicals and Allied Products industry (SIC 28xx) reported the largest total quantity of chemical releases and transfers, approximately 80.3 million pounds. The Primary Metals industry (SIC 33xx) and the Fabricated Metal Products industry (SIC 34xx) were second and third with total releases and transfers of approximately 8.6 and 6.9 million pounds respectively. Note in Table 6 the inclusion of data as reported by six non-manufacturing sector facilities which submitted 15 Form R*s*.

31X

Table 2. Hazardous Substances Reference Sheet: Common Uses of Toxic Chemicals and Their Potential Hazards.

The following material is presented as a quick-reference summary of information for the chemicals presented in Tables 9 through 17 as "Largest Total Quantities" or "Most Frequently Reported." It is not a detailed discussion on the uses of and/or potential hazards posed by the chemicals. The reader should consult chemical or toxicology reference materials when there is interest in knowing more about any or all of the substances presented in this report. The New Jersey Department of Health - Right to Know Program has prepared a series of "Hazardous Substance Fact Sheets" for most of the following substances as well as a large number of others. These fact sheets are available through the NJ Department of Health, Right to Know Program, CN-368, Trenton, NJ 08625-0368.

Acetone: In paints, varnishes and lacquers; solvent for cements in the leather and rubber industries. <u>Hazard:</u> flammable; moderately toxic if inhaled; can irritate eyes, nose and throat.

Aluminum (fume or dust): In paint, metal products (alloys, electronics, packaging), protective coatings, and rocket fuels. <u>Hazard:</u> flammable and explosive; mildly toxic if inhaled; fine dust can cause scarring of the lungs.

Aluminum oxide (fibrous forms only): In manufacture of alloys, cements, paints and ceramics; by-product of aluminum processing. <u>Hazard:</u> inhalation of finely divided particles may cause lung damage.

Ammonia: Used in making fertilizers, explosives, and plastics, dyes and textiles. <u>Hazard:</u> moderately flammable; inhalation may irritate lungs; can irritate eyes, nose, mouth and throat; exposure to concentrated fumes can be fatal.

Ammonium sulfate (solution): In fertilizers, water treatment, fire proofing, and rayon. <u>Hazard:</u> moderately toxic by several routes; can be toxic if swallowed.

Barium and compounds: In vacuum and X-ray tubes, and spark plugs. <u>Hazard:</u> powder is flammable at room temperature; can irritate eyes, nose and throat.

n-Butyl alcohol: Solvent for fats, resins, waxes, gums, shellac, varnish; also in manufacture of rayon, lacquers, detergents, and hydraulic fluids. <u>Hazard:</u> flammable; toxic by prolonged inhalation; can irritate eyes, nose, throat and skin.

Chlorine: Widely used ingredient in disinfectants, cleaners, and other chemicals; in waste water treatment; and in publicly owned treatment works. <u>Hazard:</u> extremely poisonous; moderately toxic and very irritating by inhalation; can cause respiratory problems in small doses.

Chloroethane: Used in making certain other chemicals, in refrigeration, and as a solvent and local anesthetic. <u>Hazard:</u> a highly flammable liquid/gas and a dangerous fire hazard; vapor can irritate the eyes, nose, and throat; may cause lightheadedness and fainting; long-term exposure may damage the liver and kidneys.

32X

Table 2. Hazardous Substances Reference Sheet, Continued.

Chromium and compounds: In protective coatings, nuclear research, and metal plating. Hazard: some compounds are *carcinogenic*; prolonged exposure can damage tissue; human poison by ingestion.

Copper and compounds: Manufacture of electrical wiring, plumbing, heating, and roofing materials; used in electroplating, and in pesticides. Hazard: copper dust is flammable; an experimental *tumorigen* and *teratogen*; hazards of individual compounds may vary according to chemical and physical characteristics.

1,2-Dichlorobenzene: In dry cleaning, as a degreasing agent, and insecticide. Hazard: can irritate eyes, throat and skin; inhalation may cause headaches and nausea.

1,2-Dichloroethane: Used in making vinyl chloride, as a solvent, and in many other industrial processes. Hazard: *carcinogen*; can irritate nose, throat, lungs and skin; flammable.

Dichloromethane: Industrial solvent and paint stripper; in aerosol and pesticide products; used in photographic film production, and in food, furniture and plastics processing. Hazard: *carcinogen*; lung irritant; inhalation can cause headaches, fatigue and "drunk behavior."

Di(2-ethylhexyl) phthalate: Used as a plasticizer. Hazard: suspected human *carcinogen* and experimental *teratogen*; may damage the testes; mild skin and eye irritant; prolonged exposure may affect the kidneys and liver.

Dinitrotoluenes: Used in making plastics and explosives. Hazards: poisons; highly reactive, flammable and/or explosive; experimental *carcinogens*, *tumorigens* and *teratogens*; prolonged exposure may cause liver damage.

Ethylene glycol: In anti-freeze, paints, laminates, auto brake fluids, ink, tobacco, and wood stains, and to de-ice aircraft wings. Hazard: *teratogen*; highly toxic by ingestion or inhalation.

Freon 113: Common solvent used for electronic components; refrigerant. Hazard: depletes Earth's ozone layer; can irritate eyes, nose, throat, and skin; toxic effects by inhalation.

Glycol ethers: Solvents. Hazard: toxic by inhalation, ingestion or skin absorption; irritating to eyes, nose, throat and skin.

Hydrochloric acid: Metal cleaning and pickling, food processing, and general cleaners. Hazard: very corrosive; toxic by ingestion or inhalation, can irritate the mouth, nose and throat.

Lead and compounds: In batteries, gasoline additives, ammunition, piping, and radiation shielding. Hazard: poison by ingestion; can cause brain damage, particularly in children; suspected *carcinogen* of the lungs and kidneys.

33X

Table 2. Hazardous Substances Reference Sheet, Continued.

Manganese and compounds: In aluminum production, steel making, and metal purification, and in dry cell batteries. Compounds used for varnishes, fertilizers, food additives. Hazard: manganese dust is flammable and moderately explosive; toxic by inhalation.

Methanol: Solvent, cleaner, and fuel. Hazard: highly flammable; ingestion can cause blindness; mildly toxic by inhalation.

Methyl ethyl ketone: Solvent in making plastics, textiles, paint and paint removers, and adhesives. Hazard: flammable, explosive; toxic by inhalation, a strong irritant; moderately toxic by ingestion.

Phenol: Widely used for disinfectants, pharmaceuticals, paints; also used to refine lubricating oils. Hazard: *mutagen*; human poison by ingestion; toxic if inhaled or through skin contact; a severe eye and skin irritant.

Sulfuric acid: In fertilizers, chemicals, dyes, rayon, and film; widely used by the metals industry. Hazard: moderately toxic by ingestion; a severe eye irritant; extremely irritating, corrosive and toxic to tissue.

Toluene: Solvent for perfumes, medicines, dyes, explosives, detergents, aviation gasoline and other chemicals. Hazard: highly flammable and explosive; toxic by ingestion, inhalation, skin contact.

1,1,1-Trichloroethane: Solvent for cleaning precision instruments, also in pesticides, and textiles. Hazard: suspected *carcinogen*; irritating to eyes and skin; moderately toxic by ingestion, inhalation, and skin contact.

Trichloroethylene: For cleaning electronic parts, diluting paints; also used in degreasers, fumigants; aerospace industries use it to flush liquid oxygen. Hazard: *carcinogen*; mildly toxic by ingestion and inhalation.

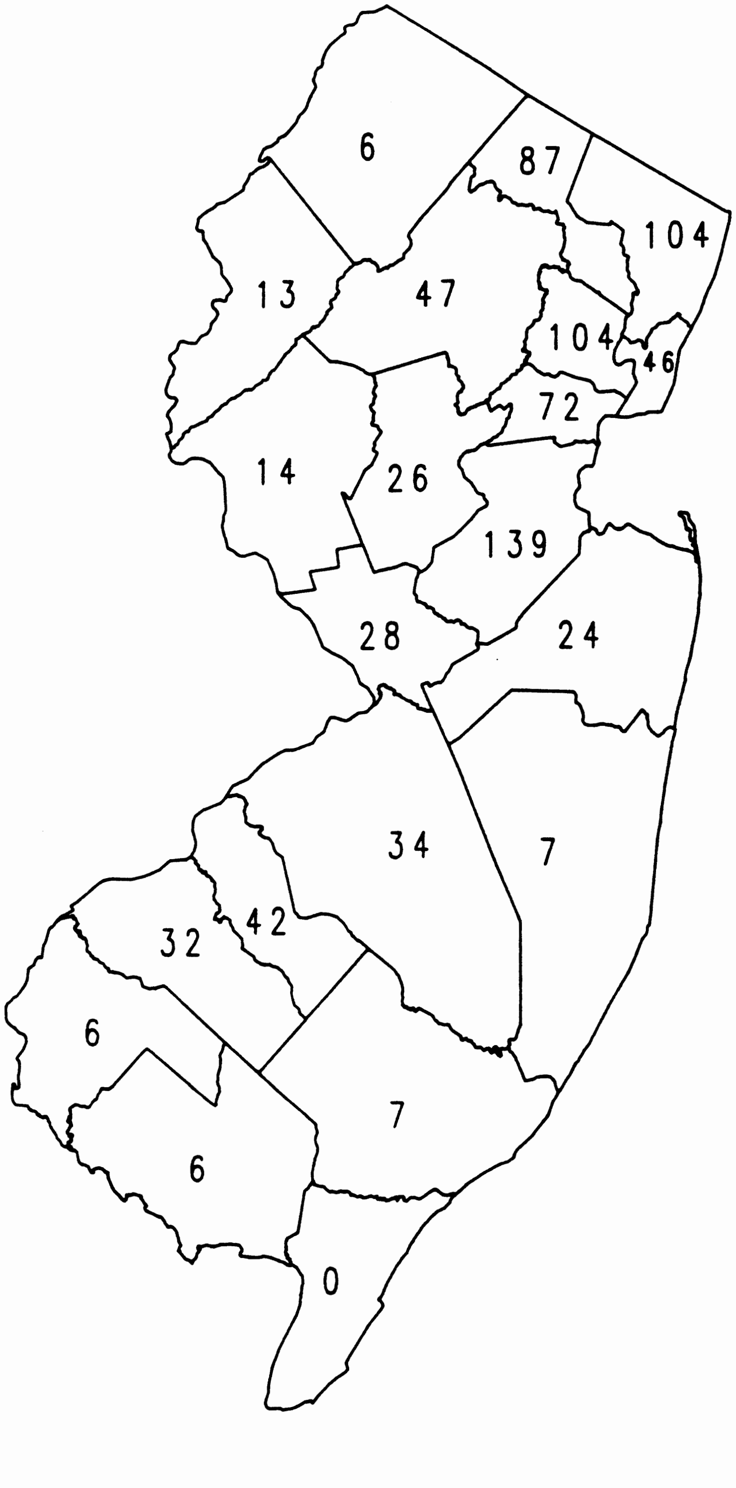
Xylenes: Used as solvents and in making drugs, dyes, insecticides and gasoline. Hazard: flammable; mildly toxic by ingestion and inhalation.

Zinc and compounds: Uses as a coating on iron and steel, in making brass metal alloys, car parts, electroplating, batteries, electrical products, paints and fungicides. Hazard: zinc dust is flammable and a human skin irritant.

References:

New Jersey Department of Health, Right to Know Program, Hazardous Substance Fact Sheets, Trenton, NJ.

Sax, N. Irving, and Richard J. Lewis, Sr., editors, Dangerous Properties of Industrial Materials, Seventh Edition, Van Nostrand Reinhold, New York, NY, 1989.



COUNTY	NO. FACILITIES
ATLANTIC	7
BERGEN	104
BURLINGTON	34
CAMDEN	42
CAPE MAY	0
CUMBERLAND	6
ESSEX	104
GLOUCESTER	32
HUDSON	46
HUNTERDON	14
MERCER	28
MIDDLESEX	139
MONMOUTH	24
MORRIS	47
OCEAN	7
PASSAIC	87
SALEM	6
SOMERSET	26
SUSSEX	6
UNION	72
WARREN	13

TOTAL =	844

Figure 6. Number of Facilities Reporting Form Rs for 1990 by County.

35X

36X

1990 TRI Releases & Transfers = 113,988,596 Pounds

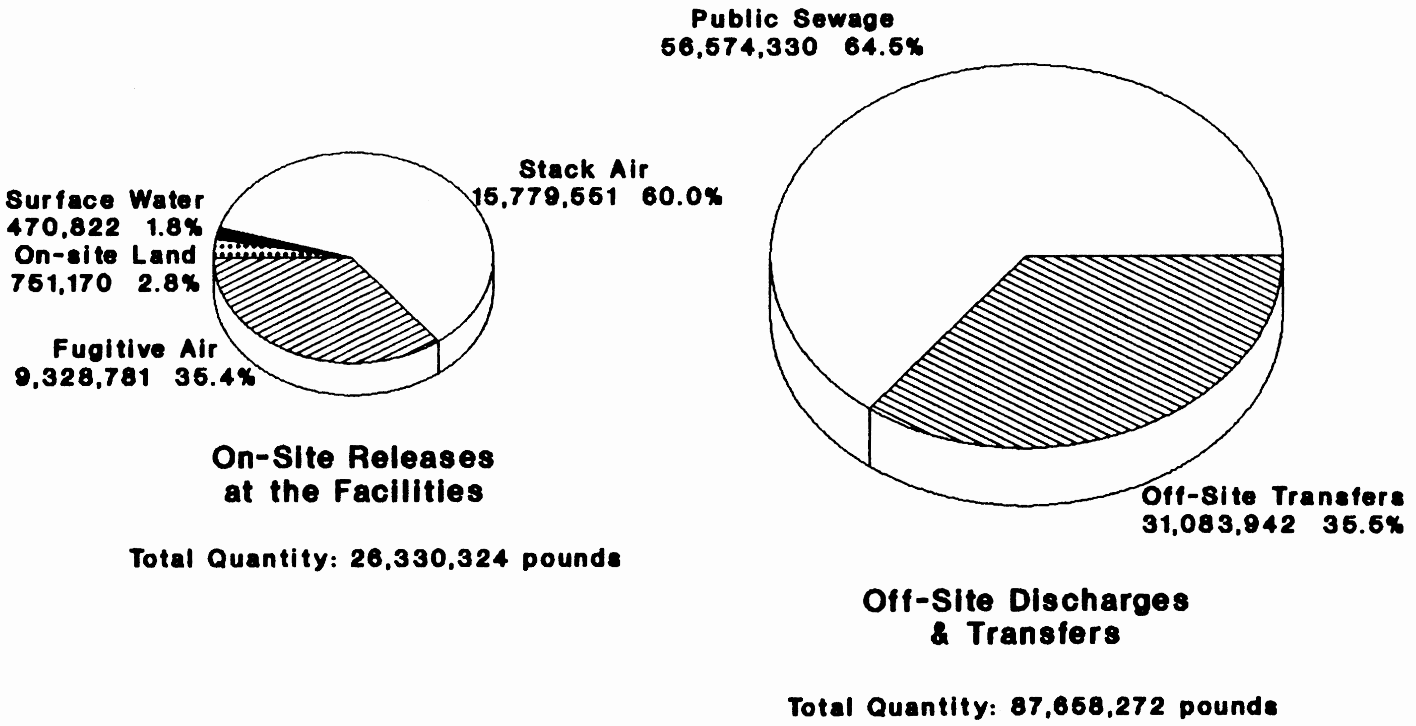


Figure 7. 1990 TRI Releases & Transfers, distributed by Reporting Media.

Table 3. 1990 TRI Releases and Transfers Reported by New Jersey Facilities[1] (Ordered Alphabetically by Chemical).
(Environmental Releases & Transfers are reported in pounds for the calendar year)

CAS #	Chemical Name	Fugitive Air Emissions	Stack Air Emissions	Total[2] Air Emissions	Surface Water Discharges	On-Site Releases to Land	Discharges to POTWs[3]	Other Off-Site Transfers	Total[4] Releases & Transfers	Total TRI Forms (1990)	Total TRI Forms (1989)
75-07-0	Acetaldehyde	5	0	5	0	0	0	0	5	1	2
67-64-1	Acetone	1,590,190	1,748,195	3,338,385	1,616	896	1,543,203	2,394,502	7,278,602	101	103
75-05-8	Acetonitrile	10,335	12,152	22,487	0	0	341,450	79,900	443,837	5	5
79-06-1	Acrylamide	127	8	135	0	0	16	295	446	5	6
79-10-7	Acrylic acid	4,731	5,003	9,734	0	0	1,793	7,825	19,352	17	14
107-13-1	Acrylonitrile	2,350	4,417	6,767	3	0	5	2,358	9,133	9	8
107-18-6	Allyl alcohol	255	395	650	0	0	750	5,344	6,744	2	0
107-05-1	Allyl chloride	1,036	1,000	2,036	0	0	46	10,131	12,213	2	1
7429-90-5	Aluminum (fume or dust)	2,706	11,000	13,706	0	0	250	1,477,949	1,491,905	8	11
1344-28-1	Aluminum oxide	1,000	250	1,250	0	0	0	1,169,150	1,170,400	4	12
7664-41-7	Ammonia	227,234	455,733	682,967	245,978	16	3,565,795	27,761	4,522,517	103	99
6484-52-2	Ammonium nitrate (solution)	0	0	0	0	0	320,000	0	320,000	1	2
7783-20-2	Ammonium sulfate (solution)	121	260	381	0	0	12,101,738	200,158	12,302,277	16	20
62-53-3	Aniline	1,695	1,733	3,428	0	0	21,000	1	24,429	10	10
90-04-0	o-Anisidine	0	0	0	0	0	0	0	0	1	2
104-94-9	p-Anisidine	0	0	0	0	0	0	0	0	1	0
120-12-7	Anthracene	250	253	503	47	241	0	262	1,053	2	4
7440-36-0	Antimony	505	555	1,060	255	250	255	500	2,320	5	5
	Antimony compounds	1,583	1,324	2,907	792	0	30	59,278	63,007	28	25
7440-38-2	Arsenic	5	5	10	0	0	0	255	265	1	1
	Arsenic compounds	5	6	11	0	0	10	1,280	1,301	8	7
1332-21-4	Asbestos (friable)	250	10	260	0	0	250	331	841	3	3
7440-39-3	Barium	8,350	0	8,350	0	8,100	0	500	16,950	2	4
	Barium compounds	5,337	8,151	13,488	8,684	134,340	98,711	155,099	410,322	57	48
98-87-3	Benzal chloride	0	6	6	0	0	0	37,000	37,006	1	1
71-43-2	Benzene	82,354	45,990	128,244	804	83	120,186	22,024	271,341	16	14
98-88-4	Benzoyl chloride	0	3	3	0	0	0	0	3	2	2
94-36-0	Benzoyl peroxide	5	0	5	0	0	0	212	217	2	2
100-44-7	Benzyl chloride	2,765	3,855	6,620	0	0	6,358	231,500	244,478	7	6
7440-41-7	Beryllium	0	0	0	0	0	0	0	0	1	0
92-52-4	Biphenyl	2,882	0	2,882	5	0	25,787	0	28,674	5	5
542-88-1	Bis(chloromethyl) ether	0	3	3	0	0	0	0	3	1	0
103-23-1	Bis(2-ethylhexyl) adipate	6,230	6,611	12,841	0	0	4,503	11,798	29,142	9	12
74-83-9	Bromomethane	15,500	0	15,500	0	0	0	0	15,500	1	1
106-99-0	1,3-Butadiene	324	27	351	0	0	0	0	351	3	3
141-32-2	Butyl acrylate	7,876	3,839	11,715	3	0	804	6,623	19,145	14	13
71-36-3	n-Butyl alcohol	168,328	949,101	1,117,429	7,136	11,281	513,073	2,036,662	3,685,581	69	73
78-92-2	sec-Butyl alcohol	3,306	4,615	7,921	380	0	929	9,483	18,713	5	6
75-65-0	tert-Butyl alcohol	19,690	1,029	20,719	0	0	80,659	1,201	102,579	5	4
85-68-7	Butyl benzyl phthalate	1,775	9,850	11,625	252	1,900	215	107,968	121,960	17	18

37X

Table 3. 1990 TRI Releases and Transfers Reported by New Jersey Facilities[1] (Ordered Alphabetically by Chemical), Continued.
(Environmental Releases & Transfers are reported in pounds for the calendar year)

CAS #	Chemical Name	Fugitive Air Emissions	Stack Air Emissions	Total[2] Air Emissions	Surface Water Discharges	On-Site Releases to Land	Discharges to POTWs[3]	Other Off-Site Transfers	Total[4] Releases & Transfers	Total TRI Forms (1990)	Total TRI Forms (1989)
123-72-8	Butyraldehyde	250	250	500	0	0	250	0	750	1	1
569-64-2	C.I. Basic green 4	6	1	7	0	0	641	0	648	2	4
81-88-9	C.I. Food red 15	0	0	0	0	0	0	0	0	2	2
97-56-3	C.I. Solvent yellow 3	0	0	0	0	0	0	0	0	1	1
7440-43-9	Cadmium	255	0	255	0	0	5	0	260	2	3
	Cadmium compounds	1,252	1,306	2,558	5	0	600	7,947	11,110	13	12
63-25-2	Carbaryl	250	0	250	0	0	0	250	500	1	0
75-15-0	Carbon disulfide	9,300	15,275	24,575	0	0	1,102	8,300	33,977	2	3
56-23-5	Carbon tetrachloride	2,841	1,832	4,673	322	0	0	0	4,995	4	3
120-80-9	Catechol	0	0	0	0	0	46,000	0	46,000	1	1
7782-50-5	Chlorine	23,575	40,571	64,146	16,099	0	18,285	37,210	135,740	24	29
79-11-8	Chloroacetic acid	17	1,942	1,959	0	0	748	3,650	6,357	4	4
108-90-7	Chlorobenzene	360	497	857	3,229	3,222	1,123	44,711	53,142	3	6
75-00-3	Chloroethane (Ethyl chloride)	3,090	64,054	67,144	35,728	54	0	0	102,926	2	2
67-66-3	Chloroform	118,420	2,840	121,260	586	0	21,986	118,351	262,183	6	5
74-87-3	Chloromethane	7,450	750	8,200	0	0	250	0	8,450	2	2
107-30-2	Chloromethyl methyl ether	0	91	91	0	0	0	0	91	1	1
	Chlorophenols	250	250	500	0	0	750	0	1,250	1	1
126-99-8	Chloroprene	250	250	500	0	0	0	1,779	2,279	1	1
7440-47-3	Chromium	1,775	2,380	4,155	257	250	1,202	58,333	64,197	28	24
	Chromium compounds	3,592	4,616	8,208	6,579	69,595	70,403	141,175	295,960	41	43
7440-48-4	Cobalt	505	1,256	1,761	250	0	3,321	22,038	27,370	9	8
	Cobalt compounds	760	1,010	1,770	362	5	642	9,473	12,252	10	9
7440-50-8	Copper	28,162	60,247	88,409	335	5	1,707	692,321	782,777	50	45
	Copper compounds	4,579	9,502	14,081	1,170	0	12,359	72,331	99,941	52	54
8001-58-9	Creosote	6,279	5,166	11,445	0	5	707	55,331	67,488	2	0
120-71-8	p-Cresidine	0	0	0	0	0	0	0	0	1	1
1319-77-3	Cresol (mixed isomers)	9,703	1,917	11,620	0	700	1,015	1,037	14,372	5	6
95-48-7	o-Cresol	5	67	72	31	5	0	11,506	11,614	1	2
106-44-5	p-Cresol	250	750	1,000	0	0	0	1,043	2,043	2	2
98-82-8	Cumene	22,583	79,957	102,540	259	750	13	2,313	105,875	7	9
80-15-9	Cumene hydroperoxide	0	0	0	0	250	0	250	500	1	1
	Cyanide compounds	600	1,251	1,851	250	250	2,492	750	5,593	10	8
110-82-7	Cyclohexane	22,768	34,827	57,595	128	5	260	13,690	71,678	11	11
1163-19-5	Decabromodiphenyl oxide	238	6	244	250	0	0	26,831	27,325	7	8
101-80-4	4,4′-Diaminodiphenyl ether	0	150	150	163	0	0	0	313	2	2
95-80-7	2,4-Diaminotoluene	1	1	2	0	0	501	0	503	2	2
132-64-9	Dibenzofuran	250	250	500	0	0	0	250	750	1	3
106-93-4	1,2-Dibromoethane	241	20,072	20,313	0	0	0	0	20,313	1	1
84-74-2	Dibutyl phthalate	546	799	1,345	260	135	1,985	71,041	74,766	12	13

Table 3. 1990 TRI Releases and Transfers Reported by New Jersey Facilities[1] (Ordered Alphabetically by Chemical), Continued.
(Environmental Releases & Transfers are reported in pounds for the calendar year)

CAS #	Chemical Name	Fugitive Air Emissions	Stack Air Emissions	Total[2] Air Emissions	Surface Water Discharges	On-Site Releases to Land	Discharges to POTWs[3]	Other Off-Site Transfers	Total[4] Releases & Transfers	Total TRI Forms (1990)	Total TRI Forms (1989)
25321-22-6	Dichlorobenzene (mixed isomers)	2,300	2,300	4,600	0	0	20,000	156,850	181,450	2	3
95-50-1	1,2-Dichlorobenzene	2,135	3,231	5,366	3,915	32,578	23,219	2,827	67,905	5	6
106-46-7	1,4-Dichlorobenzene	250	0	250	0	0	0	0	250	1	0
91-94-1	3,3'-Dichlorobenzidine	5	5	10	0	0	0	0	10	3	4
107-06-2	1,2-Dichloroethane	278	44,812	45,090	22,772	3	2,254	1,500	71,619	3	3
75-09-2	Dichloromethane	403,216	524,946	928,162	17,329	2,900	298,243	776,126	2,022,760	54	62
78-87-5	1,2-Dichloropropane	1,860	6,439	8,299	587	0	0	1,139	10,025	1	1
111-42-2	Diethanolamine	1,659	1,335	2,994	5	0	211,119	639	214,757	23	37
117-81-7	Di-(2-ethylhexyl) phthalate (DEHP)	3,351	8,030	11,381	789	11,835	72,531	112,068	208,604	23	23
84-66-2	Diethyl phthalate	3,051	4,480	7,531	251	5	46,105	30,545	84,437	16	15
64-67-5	Diethyl sulfate	261	261	522	0	0	266	0	788	7	6
119-90-4	3,3'-Dimethoxybenzidine	3	1	4	0	0	37	0	41	3	2
119-93-7	3,3'-Dimethylbenzidine	0	0	0	0	0	5	0	5	1	1
105-67-9	2,4-Dimethylphenol	288	251	539	0	0	237	12	788	2	1
77-78-1	Dimethyl sulfate	295	290	585	375	0	0	0	960	5	6
99-65-0	m-Dinitrobenzene	500	7,360	7,860	0	358	0	0	8,218	1	0
528-29-0	o-Dinitrobenzene	50	1,039	1,089	0	49	0	0	1,138	1	0
100-25-4	p-Dinitrobenzene	50	759	809	0	14	0	0	823	1	0
25321-14-6	Dinitrotoluene (mixed isomers)	75	114	189	7,081	363	0	0	7,633	1	0
121-14-2	2,4-Dinitrotoluene	11	16	27	2,253	2,148	0	0	4,428	1	1
117-84-0	N-Dioctyl phthalate	515	2,255	2,770	0	0	15	17,012	19,797	9	11
123-91-1	1,4-Dioxane	5	0	5	0	0	0	0	5	1	1
106-89-8	Epichlorohydrin	5,774	10,449	16,223	10	4	6,770	45,375	68,382	9	9
110-80-5	2-Ethoxyethanol	880	4,280	5,160	0	0	7,800	930	13,890	2	2
140-88-5	Ethyl acrylate	6,107	4,246	10,353	4	0	1,758	4,043	16,158	8	7
100-41-4	Ethylbenzene	23,734	38,306	62,040	220	226	4,997	85,556	153,039	25	23
74-85-1	Ethylene	47,097	129,301	176,398	0	0	11	0	176,409	8	8
107-21-1	Ethylene glycol	72,389	46,675	119,064	318	0	2,925,499	80,783	3,125,664	77	75
75-21-8	Ethylene oxide	21,940	11,958	33,898	0	2	10	3,490	37,405	11	12
96-45-7	Ethylene thiourea	0	1	1	0	0	0	8,235	8,236	1	1
50-00-0	Formaldehyde	21,609	109,072	130,681	4,078	4	80,429	130,851	346,043	34	37
76-13-1	Freon 113	507,089	330,037	837,126	9,333	9,475	36,885	54,225	947,044	33	38
	Glycol ethers	174,716	826,068	1,000,784	5,522	320	1,766,391	65,307	2,838,324	87	93
67-72-1	Hexachloroethane	5	5	10	0	0	0	0	10	1	1
302-01-2	Hydrazine	1,005	1,005	2,010	13	5	500	747	3,275	3	3
10034-93-2	Hydrazine sulfate	5	252	257	0	0	250	0	507	2	2
7647-01-0	Hydrochloric acid	63,455	197,325	260,780	431	0	141,169	21,320	423,700	130	137
74-90-8	Hydrogen cyanide	0	750	750	0	0	0	0	750	1	1
7664-39-3	Hydrogen fluoride	6,138	1,983	8,121	49	0	0	88,236	96,406	17	15
123-31-9	Hydroquinone	34	255	289	0	0	1,374	6,943	8,606	7	7

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Table 3. 1990 TRI Releases and Transfers Reported by New Jersey Facilities[1] (Ordered Alphabetically by Chemical), Continued.
(Environmental Releases & Transfers are reported in pounds for the calendar year)

CAS #	Chemical Name	Fugitive Air Emissions	Stack Air Emissions	Total[2] Air Emissions	Surface Water Discharges	On-Site Releases to Land	Discharges to POTWs[3]	Other Off-Site Transfers	Total[4] Releases & Transfers	Total TRI Forms (1990)	Total TRI Forms (1989)
78-84-2	Isobutyraldehyde	0	250	250	0	0	35,649	13,987	49,886	1	1
67-63-0	Isopropyl alcohol (mfg. only)[5]	255	1,847	2,102	5	0	31,208	24,254	57,569	6	2
80-05-7	4,4'-Isopropylidenediphenol	267	259	526	10	5	0	22,127	22,668	4	4
7439-92-1	Lead	2,270	4,062	6,332	11	0	260	35,079	41,682	27	24
	Lead compounds	4,832	56,124	60,956	19,387	159,706	104,961	970,598	1,315,608	50	53
58-89-9	Lindane	0	0	0	0	0	0	5	5	1	0
108-31-6	Maleic anhydride	1,516	1,966	3,482	10	2,500	1,244	8,128	15,364	18	20
7439-96-5	Manganese	5,515	756	6,271	259	5	518	343,769	350,822	16	14
	Manganese compounds	5,077	3,805	8,882	804	58,854	6,064,597	4,737	6,137,874	19	14
7439-97-6	Mercury	38	1	39	1	0	5	11	56	1	0
	Mercury compounds	5	6	11	0	0	261	14,848	15,120	5	5
67-56-1	Methanol	457,110	1,927,830	2,384,940	14,166	2,223	22,662,432	4,502,951	29,566,712	116	110
109-86-4	2-Methoxyethanol	2,361	8,990	11,351	0	0	4,339	17,830	33,520	3	3
96-33-3	Methyl acrylate	4,025	3,361	7,386	0	0	2,650	365	10,401	6	7
1634-04-4	Methyl tert-butyl ether	10,625	150,611	161,236	3,209	0	663	1,790	166,898	8	8
101-14-4	4,4'-Methylenebis (2-chloro aniline)	0	0	0	0	0	0	0	0	2	2
101-68-8	Methylenebis (phenylisocyanate)	7,453	2,375	9,828	0	0	0	62,839	72,667	19	12
101-77-9	4,4'-Methylenedianiline	160	451	611	18	5	0	3,417	4,051	2	1
78-93-3	Methyl ethyl ketone	895,458	1,140,535	2,035,993	1,062	4	73,850	1,087,047	3,197,956	104	108
108-10-1	Methyl isobutyl ketone	214,583	489,806	704,389	1,165	255	248,994	196,735	1,151,538	53	55
624-83-9	Methyl isocyanate	5	5	10	0	0	0	0	10	1	1
80-62-6	Methyl methacrylate	3,537	8,041	11,578	1,135	0	646	10,474	23,833	15	17
90-94-8	Michler's ketone	0	0	0	0	0	0	27,591	27,591	1	1
1313-27-5	Molybdenum trioxide	7,316	3,043	10,359	250	0	0	750	11,359	2	3
91-20-3	Naphthalene	11,699	4,201	15,900	956	7,209	280	3,001	27,346	17	16
7440-02-0	Nickel	1,010	1,201	2,211	250	0	5,007	4,204	11,672	25	25
	Nickel compounds	1,520	5,278	6,798	817	5,150	1,567	62,706	77,038	20	18
7697-37-2	Nitric acid	28,489	133,632	162,121	0	5	127,186	1,034,414	1,323,726	48	53
99-59-2	5-Nitro-o-anisidine	5	5	10	0	0	5	0	15	1	1
98-95-3	Nitrobenzene	750	250	1,000	0	0	0	0	1,000	1	1
55-63-0	Nitroglycerin	250	13,621	13,871	0	0	0	10,400	24,271	1	1
100-02-7	4-Nitrophenol	0	0	0	0	0	750	0	750	1	1
79-46-9	2-Nitropropane	2,943	250	3,193	0	0	0	500	3,693	1	1
121-69-7	N,N-Dimethylaniline	416	358	774	0	0	12,172	4,657	17,603	5	4
79-21-0	Peracetic acid	1	1	2	0	0	0	0	2	1	1
108-95-2	Phenol	28,662	14,171	42,833	2,359	19,337	1,024,023	146,544	1,235,096	23	23
106-50-3	p-Phenylenediamine	58	0	58	0	0	0	0	58	1	2
90-43-7	2-Phenylphenol	250	5	255	0	0	2,322	0	2,577	2	2
75-44-5	Phosgene	2	724	726	0	0	0	0	726	4	4
7664-38-2	Phosphoric acid	5,821	16,002	21,823	2,078	767	216,869	202,307	443,844	74	81

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Table 3. 1990 TRI Releases and Transfers Reported by New Jersey Facilities[1] (Ordered Alphabetically by Chemical), Continued.
(Environmental Releases & Transfers are reported in pounds for the calendar year)

CAS #	Chemical Name	Fugitive Air Emissions	Stack Air Emissions	Total[2] Air Emissions	Surface Water Discharges	On-Site Releases to Land	Discharges to POTWs[3]	Other Off-Site Transfers	Total[4] Releases & Transfers	Total TRI Forms (1990)	Total TRI Forms (1989)
7440-66-6	Zinc	2,555	6,492	9,047	5	250	1,010	2,882,638	2,892,950	14	16
	Zinc compounds	17,637	12,539	30,176	4,751	164,347	554,230	609,804	1,363,308	80	82
	*** Total ***	9,328,781	15,779,551	25,108,332	470,822	751,170	56,574,330	31,083,942	113,988,596	3,092	3,124

43x

Footnotes:

1. Manufacturing sector facilities only (SIC codes 20 through 39).
2. TOTAL AIR EMISSIONS = fugitive air emissions + stack air emissions.
3. "POTW" means publicly owned treatment works (municipal or public sewage system).
4. TOTAL RELEASES & TRANSFERS = total air + water + land + potw + off-site transfers.
5. Isopropyl alcohol manufactured by the strong acid manufacturing process only.

Table 3. 1990 TRI Releases and Transfers Reported by New Jersey Facilities[1] (Ordered Alphabetically by Chemical), Continued.
(Environmental Releases & Transfers are reported in pounds for the calendar year)

CAS #	Chemical Name	Fugitive Air Emissions	Stack Air Emissions	Total[2] Air Emissions	Surface Water Discharges	On-Site Releases to Land	Discharges to POTWs[3]	Other Off-Site Transfers	Total[4] Releases & Transfers	Total TRI Forms (1990)	Total TRI Forms (1989)
7723-14-0	Phosphorus	0	0	0	0	0	0	0	0	1	1
85-44-9	Phthalic anhydride	3,978	16,471	20,449	27	3,405	1,473	364,021	389,375	20	19
	Polychlorinated biphenyls (PCBs)	0	0	0	0	5	0	22,183	22,188	2	0
123-38-6	Propionaldehyde	505	2,190	2,695	0	0	1,500	4,195	3	2	
115-07-1	Propylene	168,090	60,953	229,043	0	0	0	0	229,043	9	12
75-55-8	Propyleneimine	250	313	563	0	0	250	0	813	2	1
75-56-9	Propylene oxide	9,757	115,341	125,098	0	5	4,255	15	129,373	9	9
81-07-2	Saccharin	6	5	11	0	0	421	243	675	1	1
7782-49-2	Selenium	5	5	10	0	0	5	0	15	1	0
	Selenium compounds	505	505	1,010	0	0	5	1,012	2,027	5	3
7440-22-4	Silver	760	510	1,270	0	0	10	250	1,530	8	6
	Silver compounds	250	2,180	2,430	15	0	1,351	6,102	9,898	4	3
100-42-5	Styrene	23,501	63,514	87,015	260	5	576	19,371	107,227	27	27
96-09-3	Styrene oxide	260	5	265	0	0	0	0	265	3	3
7664-93-9	Sulfuric acid	67,700	137,994	205,694	1,567	18,770	143,646	1,683,894	2,053,571	165	175
79-34-5	1,1,2,2-Tetrachloroethane	17	30	47	0	0	119	22,000	22,166	1	1
127-18-4	Tetrachloroethylene	140,805	129,936	270,741	113	0	63	34,170	305,087	14	12
961-11-5	Tetrachlorvinphos	0	0	0	0	0	4,300	4,300		1	1
62-56-6	Thiourea	5	5	10	1	0	750	945	1,706	3	4
7550-45-0	Titanium tetrachloride	1,225	250	1,475	0	0	0	13,361	14,836	3	3
108-88-3	Toluene	1,354,875	2,839,454	4,194,329	4,145	3,973	475,043	3,104,163	7,781,653	178	176
26471-62-5	Toluene diisocyanate (mixed isomers)	59	783	842	0	0	5	68	915	6	0
584-84-9	Toluene-2,4-diisocyanate	1,851	829	2,680	0	0	0	5	2,685	7	13
91-08-7	Toluene-2,6-diisocyanate	1	17	18	0	0	0	0	18	3	11
95-53-4	o-Toluidine	424	6	430	0	0	8,411	0	8,841	4	3
120-82-1	1,2,4-Trichlorobenzene	250	0	250	0	0	11,500	27,786	39,536	2	2
71-55-6	1,1,1-Trichloroethane	894,929	567,368	1,462,297	286	2,400	17,303	696,621	2,178,907	112	112
79-01-6	Trichloroethylene	456,612	215,026	671,638	59	0	1,755	84,698	758,150	15	20
1582-09-8	Trifluralin	750	0	750	0		5	0	755	1	0
95-63-6	1,2,4-Trimethylbenzene	17,894	7,330	25,224	239	255	365	1,503	27,586	18	17
51-79-6	Urethane	250	250	500	0	0	0	2,529	3,029	3	1
7440-62-2	Vanadium	250	250	500	0	0	0	0	500	1	1
108-05-4	Vinyl acetate	21,139	124,777	145,916	13	0	53,213	21,777	220,919	14	12
75-01-4	Vinyl chloride	25,300	117,400	142,700	39	0	0	264	143,003	4	6
75-35-4	Vinylidene chloride	12	3	15	0	0	14	1,988	2,017	1	1
1330-20-7	Xylene (mixed isomers)	596,042	1,412,291	2,008,333	1,876	9,053	88,056	1,438,586	3,545,904	137	134
108-38-3	m-Xylene	644	117	761	5	5	250	25	1,046	2	1
95-47-6	o-Xylene	3,414	1,218	4,632	5	40	271	69,505	74,453	3	3
106-42-3	p-Xylene	347	50	397	5	5	0	5	412	1	1
87-62-7	2,6-Xylidene	0	17	17	1,906	0	0	0	1,923	1	1

Table 4. 1990 TRI Releases and Transfers by New Jersey County[1]
(Environmental Releases & Transfers are reported in pounds for the calendar year)

County	Number of Facilities	Number of Form R's	Fugitive Air Emissions	Stack Air Emissions	Total[2] Air Emissions	Surface Water Discharges	On-Site Releases to Land	Discharges to POTWs[3]	Other Off-Site Transfers	Total[4] Releases & Transfers	1990 Rank for Total Releases & Transfers
ATLANTIC	7	13	36,905	104,159	141,064	5	0	440	81,527	223,036	19
BERGEN	104	392	1,025,923	1,181,965	2,207,888	1,339	500	6,702,978	2,458,641	11,371,346	5
BURLINGTON	34	121	248,543	538,369	786,912	18,684	428,914	9,307	407,069	1,650,886	11
CAMDEN	42	112	242,319	950,890	1,193,209	250	1,015	129,621	2,849,568	4,173,663	7
CAPE MAY	0	0	0	0	0	0	0	0	0	0	N/A[5]
CUMBERLAND	6	9	14,955	250	15,205	0	0	0	9,580	24,785	20
ESSEX	104	388	738,885	2,102,423	2,841,308	0	1,515	16,735,247	3,677,570	23,255,640	2
GLOUCESTER	32	135	389,209	620,847	1,010,056	162,622	10,570	15,834	1,320,798	2,519,880	10
HUDSON	46	152	412,181	718,319	1,130,500	5,939	20,265	2,546,242	1,628,365	5,331,311	6
HUNTERDON	14	33	104,194	107,899	212,093	9	0	5	235,096	447,203	17
MERCER	28	58	103,439	293,719	397,158	316	0	9,778	375,470	782,722	15
MIDDLESEX	139	622	2,486,922	3,389,224	6,599,224	3,837	5,474	12,318,766	7,281,403	25,998,704	1
MONMOUTH	24	67	191,770	240,776	432,546	250	770	412,271	441,707	1,287,544	12
MORRIS	47	116	1,053,962	546,167	1,600,129	276	0	26,534	1,093,990	2,720,929	9
OCEAN	7	26	25,120	118,498	143,618	7,631	99	0	326,604	477,952	16
PASSAIC	87	246	552,343	671,838	1,224,181	3,833	0	10,674,923	2,382,951	14,285,888	3
SALEM	6	89	77,348	924,959	1,002,307	166,944	277,633	55	1,740,141	3,187,080	8
SOMERSET	26	125	63,124	177,476	240,600	14	500	494,611	481,143	1,216,868	13
SUSSEX	6	11	80,658	123,311	203,969	0	0	0	80,000	283,969	18
UNION	72	310	1,150,840	2,035,832	3,186,672	72,892	3,160	6,494,395	4,078,002	13,835,121	4
WARREN	13	67	330,141	419,552	749,693	25,981	755	3,323	134,317	914,069	14
** Total **	844	3,092	9,328,781	15,779,551	25,108,332	470,822	751,170	56,574,330	31,083,942	113,988,596	

1. Includes manufacturing sector facilities only (SIC codes 20 through 39).
2. TOTAL AIR EMISSIONS = fugitive air emissions + stack air emissions.
3. "POTW" means publicly owned treatment works (municipal or public sewage system).
4. TOTAL RELEASES & TRANSFERS = total air + water + land + potw + off-site transfers.
5. "N/A" means not applicable.

Table 5. 1990 TRI Releases and Population Density by County

County	Direct Releases (pounds)[1]	Land Area[2] (sq. miles)	Population[2]	Release Density Density [3]	Release Density Rank	Population Density[4]	Population Rank
Atlantic	141,069	609	224,327	232	19	368	15
Bergen	2,209,727	246	825,380	8,983	5	3,355	4
Burlington	1,234,510	827	395,066	1,493	13	478	14
Camden	1,194,474	225	502,284	5,309	7	2,232	6
Cape May	0	454	95,089	0	n/a	209	19
Cumberland	15,205	669	138,053	23	20	206	20
Essex	2,842,823	129	778,206	22,037	2	6,033	2
Gloucester	1,183,248	339	230,082	3,490	9	679	12
Hudson	1,156,704	60	553,099	19,278	4	9,218	1
Hunterdon	212,102	439	107,776	483	16	246	17
Mercer	397,474	228	325,824	1,743	12	1,429	8
Middlesex	6,608,535	324	671,780	20,397	3	2,073	7
Monmouth	433,556	538	553,124	806	14	1,028	9
Morris	1,600,405	480	421,353	3,334	10	878	10
Ocean	151,348	750	433,203	202	19	578	13
Passaic	1,228,014	198	453,060	6,202	6	2,288	5
Salem	1,446,884	373	65,294	3,879	8	175	21
Somerset	241,114	304	240,279	793	15	790	11
Sussex	203,969	535	130,943	381	17	245	18
Union	3,262,724	104	493,819	31,372	1	4,748	3
Warren	776,429	364	91,607	2,133	11	252	16
Totals	26,330,324	8,195	7,729,648	3,213[5]		1,820[5]	

1. Direct Releases include total air emissions, surface water discharges and on-site land releases, i.e direct releases at the facility.
2. Land area and population statistics are from the 1990 U.S. Census Data.
3. Release density refers to pounds per square mile.
4. Population density refers to people per square mile.
5. Statewide Release Density and Population Density.

Table 6. TRI Releases and Transfers by Standard Industrial Classification.
(Environmental Releases & Transfers are reported in pounds for the calendar year)

SIC	Category	Number of Facilities	Number of Form R's	Fugitive Air Emissions	Stack Air Emissions	Total[1] Air Emissions	Surface Water Discharges	On-Site Releases to Land	Discharges to POTWs[2]	Other Off-Site Transfers	Total[3] Releases & Transfers	1990 Rank for Total Releases & Transfers
20	FOOD & KINDRED PRODUCTS	34	71	95,433	326,692	422,125	0	755	750,440	840,868	2,014,188	7
21	TOBACCO MANUFACTURING	0	0	0	0	0	0	0	0	0	0	N/A[4]
22	TEXTILE MILL PRODUCTS	20	34	124,970	380,504	505,474	10	0	348,755	24,713	878,952	13
23	APPAREL & OTHER TEXTILE PRODUCTS	0	0	0	0	0	0	0	0	0	0	N/A
24	LUMBER & WOOD PRODUCTS	5	9	11,293	100,162	111,455	0	5	707	57,831	169,998	16
25	FURNITURE & FIXTURES	3	13	9,841	75,159	85,000	0	0	0	45,296	130,296	18
26	PAPER & ALLIED PRODUCTS	25	53	545,835	1,277,516	1,823,351	0	0	701,600	275,364	2,800,315	4
27	PRINTING & PUBLISHING	19	44	284,139	475,897	760,036	14	0	15	184,958	945,023	12
28	CHEMICALS & ALLIED PRODUCTS	332	1,705	3,325,362	5,915,336	9,240,698	327,649	307,497	52,465,348	17,941,704	80,282,986	1
29	PETROLEUM & COAL PRODUCTS	21	127	473,750	425,369	899,119	132,203	4,354	1,750	204,489	1,241,915	10
30	RUBBER & MISC. PLASTIC PRODUCTS	64	169	536,192	900,130	1,436,322	1,761	0	222,402	589,360	2,249,845	6
31	LEATHER & LEATHER PRODUCTS	5	18	7,755	782,419	790,174	0	750	38,458	47,535	876,917	14
32	STONE, CLAY & GLASS PRODUCTS	23	39	55,486	159,846	215,332	10	815	5,250	246,691	468,098	15
33	PRIMARY METAL INDUSTRIES	69	205	347,216	338,620	685,836	2,082	434,089	991,757	6,525,870	8,639,634	2
34	FABRICATED METAL PRODUCTS	107	298	2,267,588	2,222,170	4,489,758	552	2,905	277,828	2,103,454	6,874,497	3
35	MACHINERY, except ELECTRICAL	27	64	266,091	334,212	600,303	0	0	14,108	822,363	1,436,774	8
36	ELECTRICAL & ELECTRONIC EQUIPMENT	41	72	491,085	141,639	632,724	525	0	28,535	327,874	989,658	11
37	TRANSPORTATION EQUIPMENT	12	48	130,651	1,130,180	1,260,831	250	0	7,540	155,147	1,423,768	9
38	INSTRUMENTS & RELATED PRODUCTS	27	90	346,225	718,828	1,065,053	10	0	719,834	619,322	2,404,219	5
39	MISCELLANEOUS MANUFACTURING	10	33	9,869	74,872	84,741	5,756	0	3	71,103	161,603	17
	TOTALS (Manufacturing Sector)	844	3,092	9,328,781	15,779,551	25,108,332	470,822	751,170	56,574,330	31,083,942	113,988,596	
	Non-Manufacturing	6	15	16,730	765	17,495	2	0	1,005	16,165	34,667	
	1990 TOTALS	850	3,107	9,345,511	15,780,316	25,125,827	470,824	751,170	56,575,335	31,100,107	114,023,263	

45X

1. TOTAL AIR EMISSIONS = fugitive air emissions + stack air emissions.
2. "POTW" means publicly owned treatment works (municipal or public sewage system).
3. TOTAL RELEASES & TRANSFERS = total air + water + land + potw + off-site transfers.
4. "N/A" means not applicable.

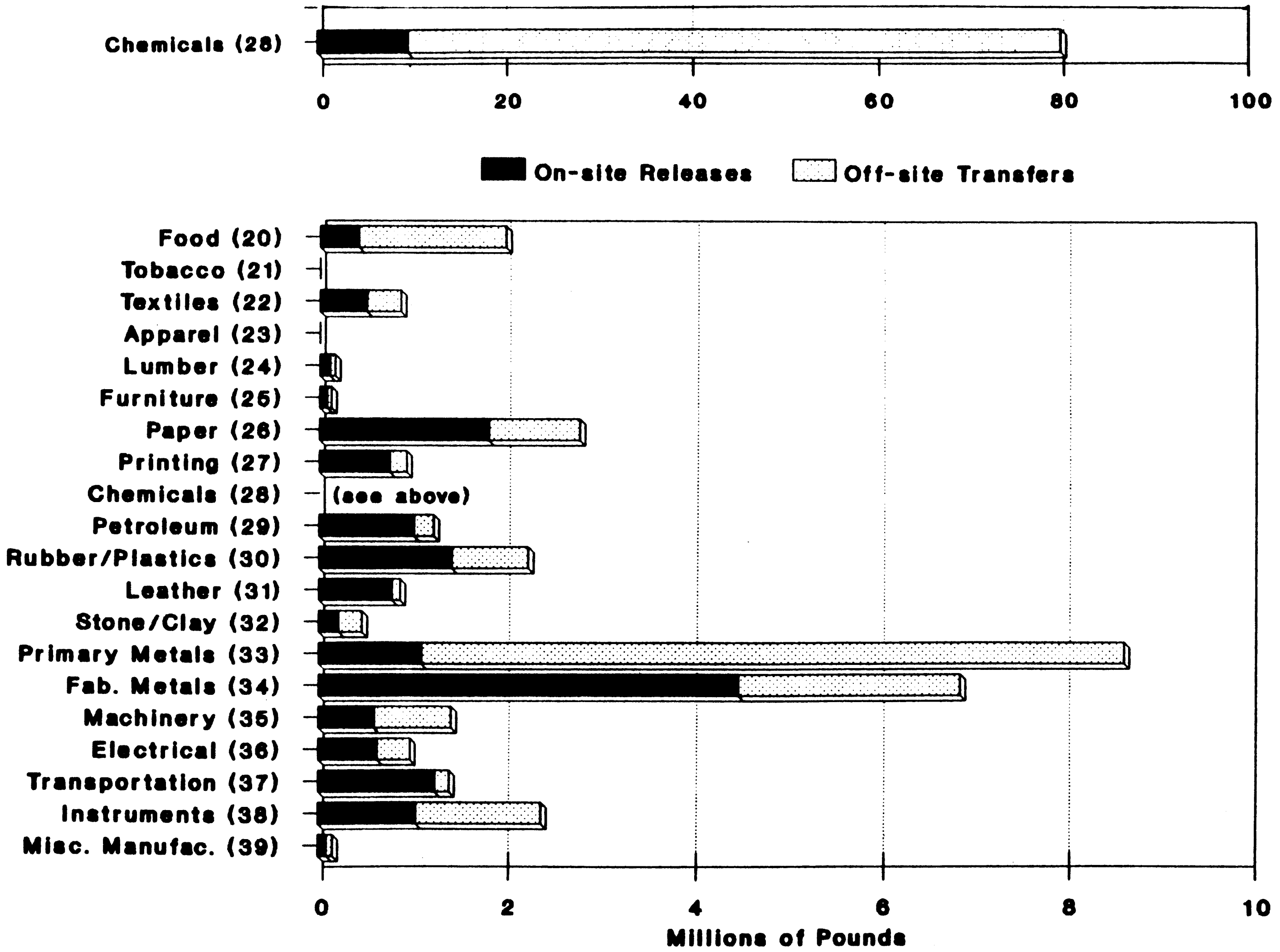

Figure 8. 1990 TRI Releases & Transfers, distributed by Industrial Classification.

Most Commonly Reported Chemicals - Table 7 presents information for the largest reported total TRI quantities for the top 10 chemicals and the top 10 most frequently reported chemicals. As in previous years, methanol was reported in the largest total quantity, over 29.5 million pounds. The most frequently reported chemical was toluene, reported by 178 facilities.

Top Ten Facilities - Table 8 presents information for the top 10 TRI facilities in New Jersey with the largest total facility-wide on-site environmental releases for reportable chemicals and the top 10 TRI facilities with the largest total facility-wide off-site transfers for reportable chemicals. The top facilities in each category were Permacel in North Brunswick, Middlesex County, which reported more than 1.2 million pounds of on-site environmental releases, and Merck & Company, in Rahway, Union County, which reported more than 6.7 million pounds of off-site transfers.

Chemical Emissions to Air - Form R reports of releases to air include both fugitive (non-point) and stack (point) emissions. Tables 9 and 10 present the top 10 chemicals by quantity emitted as fugitive and stack air releases, respectively, and each chemical's percent contribution to the total for that medium. Also, the 10 TRI facilities reporting the largest fugitive and stack emissions of any single chemical are presented. In general, most substances listed in these tables are chemicals of moderate to low human toxicity; however, three known or suspected carcinogens - dichloromethane, 1,1,1-trichloroethane, and trichloroethylene - appear on the fugitive emissions list, and two known or suspected carcinogens - dichloromethane and 1,1,1-trichloroethane - are on the stack emissions list. Table 11 presents the top 10 chemicals for combined fugitive and stack air releases and the 10 TRI facilities reporting the largest total air emissions of a single chemical.

Discharges to Surface Waters - Form R covers point source releases as well as storm water runoff of chemicals to surface waters. Table 12 presents the top 10 chemicals reported as largest quantities of releases to surface waters and the top 10 TRI facilities discharging the largest quantities of a single chemical. Again, these chemicals are considered to be moderate to low human toxicity chemicals; however, three chemicals - 1,2-dichloroethane, dichloromethane and dinitrotoluenes - are known or suspected oral route (ingestion) carcinogens. Ammonia accounts for 52.2% of the total surface water discharges reported for 1990.

On-Site Releases to Land - Section 313 requires reporting of releases to landfills, land treatment or application farming, surface impoundments, and "other" land disposals on site at the reporting facility. Table 13 presents the top 10 chemicals reported as largest quantities of on-site releases and the top 10 TRI facilities releasing the largest quantities of a single chemical on site. This group is dominated by the metals and compounds categories.

Discharges to Publicly Owned Treatment Works - Table 14 presents the Form R data for toxic chemicals transferred in waste water to publicly owned treatment works (POTW), also known as municipal sewage or waste water treatment facilities. The top 10 chemicals reported as largest quantities of POTW transfers and the top 10 TRI facilities transferring the largest quantities of a single chemical are listed. Methanol dominates this group of waste transfers, accounting for 40.1% of this category.

Transfers to Off-Site Locations - The quantity of toxic chemicals in wastes transferred to off-site locations, other than POTWs, are required to be reported on Form R. Off-site locations include facilities designed for treatment, storage or disposal of chemical wastes. Through the 1990 reporting year, quantities of chemical wastes transferred off-site for recycling or reprocessing have not been required to be reported by Section 313. However quantities reported here certainly include some amount of wastes which were recycled or reprocessed. Table 15 presents the top 10 chemicals reported as largest quantities of off-site transfers and the top 10 TRI facilities transferring the largest quantities of a single chemical.

Discussion

The Toxic Chemical Release Inventory is a dynamic set of environmental release data. For the 1990 reporting year, four chemicals were removed from the reporting requirements while nine were added to the list of reportable chemicals. Additionally, USEPA qualified the reporting of aluminum oxide to include only fibrous forms of the chemical. Also, USEPA revised Form R with respect to reporting ranges for releases or transfers of less than 1,000 pounds. Where previously there were two ranges: 1-499 pounds and 500-999 pounds, the 1990 form had three ranges: 1-10 pounds, 11-499 pounds, and 500-999 pounds. This change was made to the form to account for very small estimated releases or transfers. Data management practices require a quantitative entry and, therefore, the following numbers are entered into the database for the three estimate ranges: *5* (1-10), *250* (11-499), and *750* (500-999). Therefore, it is important to recognize that the public is dealing with an ever-changing database, and interpretation of any data set and comparisons between data sets must be performed with considerable caution.

While the Department has made no assessment of the accuracy of reported quantities of releases and transfers, numerous contacts with reporting facilities were made to clarify information presented on Form R. For example, underground injection, the disposal of toxic or hazardous wastes into underground wells, is not a common practice in New Jersey. Therefore, any facility which reported quantities in this data field was contacted to verify or correct this reporting. As it turned out, there were no facilities that disposed of wastes into injection wells under TRI reporting. Also, facilities were contacted when extremely large quantities of releases or transfers were reported in 1990 and not in previous years.

The 1990 data set, following the trend set in previous reporting years, is dominated by off-site transfers. Approximately 50% of the total quantity of releases and transfers, more than 56 million pounds, were discharged to POTWs. Another 27%, 31 million pounds, were transferred to other off-site locations for treatment, storage or disposal. The remainder, 26.3 million pounds, were reported as on-site releases. Once again, Middlesex County is first with the number of reporting facilities, number of Form Rs, and the total quantity of releases and transfers. The Chemicals and Allied Products industry continues to overshadow the rest of the manufacturing sector, certainly an indicator of the nature of New Jersey's manufacturing base. A review of Tables 7 through 15 demonstrate a relatively constant ranking of the "top ten" reported chemicals and reporting facilities, however, a few newcomers to the previous year's report can be noted in almost every table.

Conclusion

The federal Emergency Planning and Community Right To Know Act (EPCRA), also known as SARA Title III, requires covered manufacturing facilities to report environmental releases and waste transfers of more than 300 chemicals and 20 chemical categories on the Toxic Chemical Release Inventory Reporting Form (Form R). The 1990 TRI data presented in this section represents the fourth year of reporting under Section 313. As mentioned, the Toxic Release Inventory is a dynamic set of data. This report summarizes the 1990 as reported through July 31, 1992. While this report represents the bulk of the TRI data, additional Form R*s* with new data, revisions, and withdrawals have been received.

The need for information regarding hazardous substances within the community has increased with its availability under the state and federal Right to Know laws. Also, the usefulness of the data is increasing with each subsequent year's submission. It is the goal of the Community Right to Know program to establish a comprehensive database of hazardous substance production, use, storage, and environmental release and waste transfer. The New Jersey TRI data along with hazardous chemical inventory and throughput information gathered under the state and federal Community Right To Know (CRTK) acts will assist the NJDEPE in prioritizing its environmental protection efforts.

Some of the NJDEPE's programs are currently using the TRI and CRTK data to identify facilities for further investigations. Assessments have been, and are being, conducted to determine compliance with existing state and federal permit requirements. Facilities which are not in compliance with state emissions or discharge regulations have been identified. Other state programs are being encouraged to use the TRI data as best suit their needs. And finally, the information is available to the public. The data presented in this report, plus information available through the Department, will assist citizens in identifying toxic chemical releases in the community, generate an interest in knowing more about those substances, and allow for the making of informed decisions about community planning, emergency management, and pollution prevention. It is our goal to assemble and make available the necessary information that will help the citizens, government, and industry of the state to plan for and work toward a safer, cleaner New Jersey.

Table 7. 1990 TOXIC RELEASE INVENTORY REPORT

MOST COMMONLY REPORTED CHEMICALS

TOP TEN CHEMICALS: LARGEST TOTAL QUANTITIES REPORTED[1] (in pounds)

RANK 90	89	CAS #[2]	CHEMICAL NAME	Lbs./Yr.	# of Forms
1	1	67-56-1	Methanol	29,566,712	116
2	2	7783-20-2	Ammonium sulfate (solution)	12,302,277	16
3	3	108-88-3	Toluene	7,781,653	178
4	4	67-64-1	Acetone	7,278,602	101
5	5		Manganese and compounds[3]	6,488,696	35
6	11	7664-41-7	Ammonia	4,522,517	103
7	14		Zinc and compounds[4]	4,256,258	94
8	12	71-36-3	n-Butyl alcohol	3,685,581	69
9	7		Xylenes[5]	3,621,815	143
10	6	78-93-3	Methyl ethyl ketone	3,197,956	104
				82,702,067[6]	

TOP TEN CHEMICALS MOST FREQUENTLY REPORTED

RANK 90	89	CAS #	CHEMICAL NAME	Lbs./Yr.	# of Forms
1	2	108-88-3	Toluene	7,781,653	178
2	1	7664-93-9	Sulfuric acid	2,053,571	165
3	3		Xylenes[5]	3,621,815	143
4	4	7647-01-0	Hydrochloric acid	435,700	130
5	5	67-56-1	Methanol	29,566,712	116
6	6	71-55-6	1,1,1-Trichloroethane	2,178,907	112
7	7	78-93-3	Methyl ethyl ketone	3,197,956	104
8	9	7664-41-7	Ammonia	4,522,517	103
9	11		Copper and compounds[7]	882,718	102
10	8	67-64-1	Acetone	7,278,602	101
					1,254[8]

1. Quantity includes all reported releases to the environment and transfers in waste to publicly owned treatment works and other off-site locations.
2. Chemical Abstracts Service Registry Number.
3. Includes both manganese (CAS# 7439-96-5) and "manganese compounds."
4. Includes both zinc (CAS# 7440-66-6) and "zinc compounds."
5. Includes xylene (mixed isomers) (CAS# 1330-20-7), m-xylene (CAS# 108-38-3), o-xylene (CAS# 95-47-6), and p-xylene (CAS# 106-42-3).
6. This quantity is 72.6% of the total quantity of releases and transfers reported.
7. Includes both copper (CAS# 7440-50-8) and "copper compounds."
8. This quantity accounts for 40.6% of the total number of reports submitted.

50X

Table 8. 1990 TOXIC RELEASE INVENTORY

TOP TEN FACILITIES FOR ON-SITE RELEASES (reported in pounds)

RANK 90	RANK 89	FACILITY NAME	CITY, COUNTY	Air Emissions (pounds)	Surface Water Discharges (pounds)	Releases to Land (pounds)	Total Releases (pounds)
1	1	Permacel, a Nitto Denko Co	North Brunswick, Middlesex	1,251,339	0	0	1,251,399
2	3	E I DuPont de Nemours & Co Inc	Deepwater, Salem	765,963	166,637	277,633	1,210,233
3	10	Hercules Inc	Kenvil, Morris	945,337	0	0	945,337
4	18	Transfer Print Foils Inc	East Brunswick, Middlesex	723,429	0	0	723,429
5	6	Seton Co/Radel Leather Div	Newark, Essex	708,069		750	708,819
6	174	Arsynco Inc	Carlstadt, Bergen	702,220	0	0	702,220
7	4	General Motors Corp	Linden, Union	637,670	250	0	637,920
8	11	Kleer Kast	Kearny, Hudson	575,950	500	0	576,450
9	16	US Pipe and Foundry Co	Burlington, Burlington	74,255	0	425,914	500,169
10	12	Hoffmann-La Roche Inc	Belvidere, Warren	457,201	3940	0	461,141

TOP TEN FACILITIES FOR OFF-SITE TRANSFERS (reported in pounds)

RANK 90	RANK 89	FACILITY NAME	CITY, COUNTY	Discharges to POTWs (pounds)	Other Off-Site Transfers (pounds)	Total Transfers (pounds)
1	1	Merck and Co, Inc	Rahway, Union	5,049,216	1,663,950	6,713,166
2	3	Givaudan Corp	Clifton, Passaic	6,582,411	35,176	6,617,587
3	5	Hoffmann-La Roche Inc	Nutley, Essex	3,843,242	2,034,481	5,877,723
4	4	Old Bridge Chemicals, Inc	Old Bridge, Middlesex	5,526,935	0	5,526,935
5	2	Sun Chemical Corp	Newark, Essex	4,500,000	0	4,500,000
6	31	New Jersey Steel Corp	Sayreville, Middlesex	0	3,250,593	3,250,593
7	15	Mobay Corp	Haledon, Passaic	3,209,272	325	3,209,597
8	6	Alliance Chemical Inc	Newark, Essex	2,875,105	0	2,875,105
9	7	Aluminum Smelters of NJ	Pennsauken, Camden	0	2,706,885	2,706,885
10	8	Hercules Inc	Sayreville, Middlesex	2,543,980	0	2,543,980

5/X

Table 9. 1990 TOXIC RELEASE INVENTORY REPORT

FUGITIVE[1] EMISSIONS TO THE AIR (reported in pounds)

TOP TEN CHEMICALS EMITTED IN THE LARGEST QUANTITIES

RANK 90	89	CAS #[2]	CHEMICAL NAME	Lbs./Yr.	% of Total
1	1	67-64-1	Acetone	1,590,190	17.1
2	2	108-88-3	Toluene	1,354,875	14.5
3	5	78-93-3	Methyl ethyl ketone	895,458	9.6
4	3	71-55-6	1,1,1-Trichloroethane	894,929	9.6
5	6		Xylenes[3]	600,447	6.4
6	4	76-13-1	Freon 113	507,089	5.4
7	8	67-56-1	Methanol	457,110	4.9
8	9	79-01-6	Trichloroethylene	456,612	4.9
9	10	75-09-2	Dichloromethane	403,216	4.3
10	11	7664-41-7	Ammonia	227,234	2.4
				7,387,160	79.2

TOP TEN REPORTED FUGITIVE AIR EMISSIONS OF A SINGLE CHEMICAL

RANK 90	89	FACILITY NAME	COUNTY	CHEMICAL NAME	Lbs./Yr.
1	2	Hercules Inc	Morris	Acetone	791,561
2	45	Transfer Print Foils Inc	Middlesex	Methyl ethyl ketone	397,923
3	3	Permacel, a Nitto Denko Co	Middlesex	Toluene	289,260
4	7	Kleer Kast	Hudson	Acetone	220,000
5	5	Peerless Tube Company	Essex	Trichloroethylene	200,000
6	17	WCI Home Comfort Div	Middlesex	Trichloroethylene	154,409
7	10	Transfer Print Foils Inc	Middlesex	Toluene	154,169
8	11	Dri-Print Foils Inc	Union	Methyl ethyl ketone	132,079
9	366	Arsynco Inc	Bergen	Xylene (mixed isomers)	131,816
10	230	Arsynco Inc	Bergen	Toluene	131,395

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1. Fugitive emissions are those releases to the air that are not releases through stack, vents, ducts, pipes, or any other confined air stream.
2. Chemical Abstracts Service Registry Number.
3. Includes xylene (mixed isomers) (CAS# 1330-20-7), m-xylene (CAS# 108-38-3), o-xylene (CAS# 95-47-6), and p-xylene (CAS# 106-42-3).

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Table 10. 1990 TOXIC RELEASE INVENTORY REPORT

STACK[1] EMISSIONS TO THE AIR (reported in pounds)

TOP TEN CHEMICALS EMITTED IN THE LARGEST QUANTITIES

RANK 90	RANK 89	CAS # [2]	CHEMICAL NAME	Lbs./Yr.	% of Total
1	1	108-88-3	Toluene	2,839,454	18.0
2	2	67-56-1	Methanol	1,927,830	12.2
3	5	67-64-1	Acetone	1,748,195	11.1
4	4		Xylenes[3]	1,413,676	9.0
5	3	78-93-3	Methyl ethyl ketone	1,140,535	7.2
6	7	71-36-3	n-Butyl alcohol	949,101	6.0
7	6		Glycol ethers	826,068	5.2
8	11	71-55-6	1,1,1-Trichloroethane	567,368	3.6
9	8	75-09-2	Dichloromethane	524,946	3.3
10	10	7664-41-7	Ammonia	455,733	2.9
				12,392,906	78.5

TOP TEN REPORTED STACK AIR EMISSIONS OF A SINGLE CHEMICAL

RANK 90	RANK 89	FACILITY NAME	COUNTY	CHEMICAL NAME	Lbs./Yr.
1	1	Permacel, a Nitto Denko Co	Middlesex	Toluene	871,500
2	7	Kleer Kast	Hudson	Acetone	350,000
3	9	Seton Co./Radel Leather Div	Essex	Toluene	302,800
4	4	Penick Corporation	Essex	Methanol	258,506
5	2	Lehigh Press Lithographers	Camden	Methyl ethyl ketone	218,849
6	13	E I DuPont de Nemours & Co Inc	Salem	n-Butyl alcohol	211,902
7	21	Kalama Chemical Inc	Bergen	Methanol	208,183
8	11	National Can Company	Middlesex	Glycol ethers	203,263
9	3	General Motors Corp	Union	Xylene (mixed isomers)	197,000
10	6	Seton Co./Radel Leather Div	Essex	Methyl ethyl ketone	192,000

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1. Stack emissions are those releases to the air that occur through stack, vents, ducts, pipes, or any other confined air stream.
2. Chemical Abstracts Service Registry Number.
3. Includes xylene (mixed isomers) (CAS# 1330-20-7), m-xylene (CAS# 108-38-3), o-xylene (CAS# 95-47-6), and p-xylene (CAS# 106-42-3).

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Table 11. 1990 TOXIC RELEASE INVENTORY REPORT

TOTAL EMISSIONS TO THE AIR[1] (reported in pounds)

TOP TEN CHEMICALS EMITTED IN THE LARGEST QUANTITIES

RANK 90	89	CAS #[2]	CHEMICAL NAME	Lbs./Yr.	% of Total
1	1	108-88-3	Toluene	4,194,329	16.7
2	2	67-64-1	Acetone	3,338,385	13.3
3	3	67-56-1	Methanol	2,384,940	9.5
4	4	78-93-3	Methyl ethyl ketone	2,035,993	8.1
5	5		Xylenes[3]	2,014,123	8.0
6	6	71-55-6	1,1,1-Trichloroethane	1,462,297	5.8
7	8	71-36-3	n-Butyl alcohol	1,117,429	4.5
8	7		Glycol ethers	1,000,784	4.0
9	9	75-09-2	Dichloromethane	928,162	3.7
10	10	76-13-1	Freon 113	827,136	3.3
				19,303,578	76.9

TOP TEN REPORTED TOTAL AIR EMISSIONS OF A SINGLE CHEMICAL

RANK 90	89	FACILITY NAME	COUNTY	CHEMICAL NAME	Lbs./Yr.
1	1	Permacel, a Nitto Denko Co	Middlesex	Toluene	1,160,760
2	5	Hercules Inc	Morris	Acetone	931,466
3	6	Kleer Kast	Hudson	Acetone	570,000
4	18	National Can Company	Middlesex	Glycol ethers	435,848
5	154	Transfer Print Foils Inc	Middlesex	Methyl ethyl ketone	400,769
6	11	Seton Co./Radel Leather Div	Essex	Toluene	303,550
7	366	Arsynco Inc	Bergen	Toluene	292,375
8	4	Penick Corporation	Essex	Methanol	287,467
9	12	Hoffmann-La Roche Inc	Warren	Acetone	229,000
10	25	Kalama Chemical Inc	Bergen	Methanol	226,613

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1. TOTAL EMISSIONS = fugitive air emissions + stack air emissions.
2. Chemical Abstracts Service Registry Number.
3. Includes xylene (mixed isomers) (CAS# 1330-20-7), m-xylene (CAS# 108-38-3), o-xylene (CAS# 95-47-6), and p-xylene (CAS# 106-42-3).

Table 12. 1990 TOXIC RELEASE INVENTORY REPORT

SURFACE WATER DISCHARGES (reported in pounds)

TOP TEN CHEMICALS DISCHARGED IN THE LARGEST QUANTITIES

RANK					
90	89	CAS #[1]	CHEMICAL NAME	Lbs./Yr.	% of Total
1	1	7664-41-7	Ammonia	245,978	52.2
2	4	75-00-3	Chloroethane (ethyl chloride)	35,728	7.6
3	2	107-06-2	1,2-Dichloroethane	22,772	4.9
4	7		Lead and compounds[2]	19,398	4.1
5	5	75-09-2	Dichloromethane	17,329	3.7
6	9	7782-50-5	Chlorine	16,099	3.4
7	8	67-56-1	Methanol	14,166	3.0
8[3]	13[4]		Dinitrotoluenes[3]	9,334	2.0
9	12	76-13-1	Freon 113	9,333	2.0
10	14		Barium and compounds[5]	8,684	1.8
				398,821	84.7

TOP TEN REPORTED SURFACE WATER DISCHARGES OF A SINGLE CHEMICAL

RANK					
90	89	FACILITY NAME	COUNTY	CHEMICAL NAME	Lbs./Yr.
1	5	Coastal Eagle Point Oil Company	Gloucester	Ammonia	111,300
2	3	E I DuPont de Nemours & Co Inc	Union	Ammonia	53,600
3	5	Monsanto Company	Gloucester	Ammonia	44,000
4	4	E I DuPont de Nemours & Co Inc	Salem	Chloroethane	35,728
5	1	E I DuPont de Nemours & Co Inc	Salem	1,2-Dichloroethane	22,772
6	9	E I DuPont de Nemours & Co Inc	Salem	Lead compounds	18,767
7	6	E I DuPont de Nemours & Co Inc	Salem	Dichloromethane	17,220
8	10	J T Baker Inc.	Warren	Ammonia	15,050
9	7	Exxon Company, USA	Union	Ammonia	11,000
10	17	E I DuPont de Nemours & Co Inc	Salem	Chlorine	10,369

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1. Chemical Abstracts Service Registry Number.
2. Includes both lead (CAS# 7439-92-1) and "lead compounds."
3. Includes dinitrotoluene (mixed isomers) (CAS# 25321-14-6) which was added as a reportable substance for the 1990 reporting year, as well as 2,4-dinitrotoluene (CAS# 121-14-2).
4. Includes 2,4-dinitrotoluene (CAS# 121-14-2) only.
5. Includes both barium (CAS# 7440-39-3) and "barium compounds."

Table 13. 1990 TOXIC RELEASE INVENTORY REPORT

ON-SITE RELEASES TO LAND[1] (reported in pounds)

TOP TEN CHEMICALS RELEASED IN THE LARGEST QUANTITIES

RANK 90	89	CAS # [2]	CHEMICAL NAME	Lbs./Yr.	% of Total
1	4		Zinc and compounds[3]	164,597	21.9
2	5		Lead and compounds[4]	159,706	21.3
3	2		Barium and compounds[5]	142,440	19.0
4	3		Chromium and compounds[6]	69,845	9.3
5	8		Manganese and compounds[7]	58,859	7.8
6	6		Dichlorobenzenes[8]	32,578	4.3
7	15	108-95-2	Phenol	19,337	2.6
8	23	7664-93-9	Sulfuric acid	18,770	2.5
9	20	117-81-7	Di-(2-ethylhexyl) phthalate (DEHP)	11,835	1.5
10	9	71-36-3	n-Butyl alcohol	11,281	1.5
				689,248	91.7

TOP TEN REPORTED ON-SITE LAND RELEASES OF A SINGLE CHEMICAL

RANK 90	89	FACILITY NAME	COUNTY	CHEMICAL NAME	Lbs./Yr.
1	4	United States Pipe and Foundry	Burlington	Zinc compounds	163,847
2	2	United States Pipe and Foundry	Burlington	Barium and compounds[5]	134,310
3	7	E I DuPont de Nemours & Co Inc	Salem	Lead compounds	89,803
4	6	United States Pipe and Foundry	Burlington	Lead compounds	69,653
5	12	E I DuPont de Nemours & Co Inc	Salem	Chromium compounds	67,845
6	9	United States Pipe and Foundry	Burlington	Manganese compounds	58,104
7	5	E I DuPont de Nemours & Co Inc	Salem	1,2-Dichlorobenzene	32,578
8	17	E I DuPont de Nemours & Co Inc	Salem	Phenol	19,332
9	45	Standard Chlorine Chemical Co	Hudson	Sulfuric acid	17,000
10	26	E I DuPont de Nemours & Co Inc	Salem	Di-(2-ethylhexyl) phthalate	11,635

1. Includes quantities which were landfilled, treated or applied in farming, impounded, or otherwise disposed of at the facility.
2. Chemical Abstracts Service Registry Number.
3. Includes both zinc (CAS# 7440-66-6) and "zinc compounds."
4. Includes both lead (CAS# 7439-92-1) and "lead compounds."
5. Includes both barium (CAS# 7440-39-3) and "barium compounds."
6. Includes both chromium (CAS# 7440-47-3) and "chromium compounds."
7. Includes both manganese (CAS# 7439-96-5) and "manganese compounds."
8. Includes dichlorobenzene (mixed isomers) (CAS# 25321-22-6), 1,2-dichlorobenzene (CAS# 95-50-1), and 1,4-dichlorobenzene (CAS# 106-46-7).

56X

Table 14. 1990 TOXIC RELEASE INVENTORY REPORT

DISCHARGES TO PUBLICLY OWNED TREATMENT WORKS[1] (reported in pounds)

TOP TEN CHEMICALS DISCHARGED IN THE LARGEST QUANTITIES

RANK 90	RANK 89	CAS #[2]	CHEMICAL NAME	Lbs./Yr.	% of Total
1	1	67-56-1	Methanol	22,662,432	40.1
2	2	7783-20-2	Ammonium sulfate (solution)	12,101,738	21.4
3	3		Manganese and compounds[3]	6,065,115	10.7
4	7	7664-41-7	Ammonia	3,565,795	6.3
5	4	107-21-1	Ethylene glycol	2,925,499	5.2
6	6		Glycol ethers	1,766,391	3.1
7	5	67-64-1	Acetone	1,543,203	2.7
8	8	108-95-2	Phenol	1,024,023	1.8
9	9		Zinc and compounds[4]	555,240	1.0
10	11	71-36-3	n-Butyl alcohol	513,073	0.9
				52,722,509	93.2

TOP TEN REPORTED POTW DISCHARGES OF A SINGLE CHEMICAL

RANK 90	RANK 89	FACILITY NAME	COUNTY	CHEMICAL NAME	Lbs./Yr.
1	2	Givaudan Corporation	Passaic	Manganese compounds	6,063,868
2	3	Old Bridge Chemicals, Inc	Middlesex	Ammonium sulfate	5,526,685
3	1	Sun Chemical Corp	Essex	Methanol	4,500,000
4	4	Merck & Co, Inc	Union	Methanol	3,940,000
5	10	Mobay Corp	Passaic	Methanol	3,183,300
6	7	Hilton Davis Co	Essex	Ammonium sulfate	2,530,800
7	6	Hercules, Inc	Middlesex	Ethylene glycol	2,482,481
8	174	ICI Americas	Hudson	Ammonia	2,300,000
9	5	Hoffmann-La Roche Inc	Essex	Methanol	2,126,790
10	9	Alliance Chemical Inc	Essex	Ammonium sulfate	2,017,800

1. The term includes publicly owned treatment works (POTW), and public sewage or municipal sewage treatment plant.
2. Chemical Abstracts Service Registry Number.
3. Includes both zinc (CAS# 7440-66-6) and "zinc compounds."
4. Includes both manganese (CAS# 7439-96-5) and "manganese compounds."
5. Includes xylene (mixed isomers) (CAS# 1330-20-7), m-xylene (CAS# 108-38-3), o-xylene (CAS# 95-47-6), and p-xylene (CAS# 106-42-3).

57X

Table 15. 1990 TOXIC RELEASE INVENTORY REPORT

TRANSFERS IN WASTES TO OTHER OFF-SITE LOCATIONS[1] (reported in pounds)

TOP TEN CHEMICALS TRANSFERRED OFF-SITE IN THE LARGEST QUANTITIES

RANK 90	RANK 89	CAS # [2]	CHEMICAL NAME	Lbs./Yr.	% of Total
1	2	67-56-1	Methanol	4,502,951	14.5
2	11		Zinc and compounds[3]	3,492,442	11.2
3	1	108-88-3	Toluene	3,104,163	10.0
4	5	67-64-1	Acetone	2,394,502	7.7
5	7	71-36-3	n-Butyl alcohol	2,036,662	6.6
6	9	7664-93-9	Sulfuric acid	1,683,894	5.4
7	10		Xylenes[4]	1,508,126	4.6
8	3	7429-90-5	Aluminum (fume or dust)	1,477,949	4.6
9	4	1344-28-1	Aluminum oxide (fibrous forms)	1,169,150	3.8
10	6	78-93-3	Methyl ethyl ketone	1,087,047	3.5
				22,456,886	72.3

TOP TEN REPORTED OFF-SITE TRANSFERS OF A SINGLE CHEMICAL

RANK 90	RANK 89	FACILITY NAME	COUNTY	CHEMICAL NAME	Lbs./Yr.
1	*[5]	New Jersey Steel Corporation	Middlesex	Zinc	2,833,177
2	1	Aluminum Smelters of NJ	Camden	Aluminum	1,335,312
3	6	Reichhold Chemicals Inc	Union	n-Butyl alcohol	1,175,000
4	*[5]	Stepan Company/Maywood Div	Bergen	Methanol	1,171,040
5	2	Aluminum Smelters of NJ	Camden	Aluminum oxide	1,168,400
6	3	Merck & Co, Inc	Union	Methanol	800,000
7	11	Ganes Chemicals, Inc	Salem	Methanol	789,359
8	80	E I DuPont de Nemours & Co Inc	Passaic	Lead compounds	769,693
9	57	Ganes Chemicals, Inc	Salem	Sulfuric acid	649,888
10	183	E I DuPont de Nemours & Co Inc	Passaic	Copper	631,517

1. "Other Off-site Locations" means locations, other than POTWs, to which wastes containing reportable toxic chemicals are shipped or transferred.
2. Chemical Abstracts Service Registry Number.
3. Includes both zinc (CAS# 7440-66-6) and "zinc compounds."
4. Includes xylene (mixed isomers) (CAS# 1330-20-7), m-xylene (CAS# 108-38-3), o-xylene (CAS# 95-47-6), and p-xylene (CAS# 106-42-3).
5. One of 1,890 chemical records where either "zero" or "not applicable" was reported for 1989.

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Comparison of TRI Releases and Transfers, 1987 - 1990

Introduction

Valid comparisons between the first four years of TRI reporting are possible, however some adjustments must be made to each year's data set based upon chemical reporting requirements for those years. It is important to note that the TRI is a dynamic and ever-changing set of data. On a continuing basis, facilities are submitting new forms for past reporting years, submitting revisions to environmental release and waste transfer estimates previously reported (which can include both increases and decreases to quantities reported), and withdrawing submissions for chemicals previously reported.

There have been changes in the reporting requirements each year which significantly affect chemical reporting, the data submitted, and potential comparisons of the four databases. First, the threshold for the manufacture or processing of chemicals was reduced from 75,000 pounds for 1987 to 50,000 pounds for 1988 to 25,000 pounds for 1989 and subsequent reporting years. This increases the potential number of facilities subject to the reporting requirements of this statute. Furthermore, facilities that reported a chemical in 1987 or 1988 that was subsequently deleted may not have had to report in 1989 or 1990.

Second, ten chemicals - titanium dioxide, C.I. acid blue 9 diammonium salt, C.I. acid blue 9 disodium salt, melamine, sodium hydroxide (solution), sodium sulfate (sulfate), terephthalic acid, C.I. pigment blue 15, C.I. pigment green 7, and C.I. pigment green 37 - have been deleted from the list of toxic chemicals because they do not meet USEPA's toxicity criteria to warrant further reporting. Third, USEPA removed non-fibrous forms of aluminum oxide from the TRI list after concluding that non-fibrous forms of compound did not cause, nor could be reasonably anticipated to cause, significant adverse human health or environmental effects under normal conditions. Fourth, nine chemicals were added to the list for 1990 and made subject to the Section 313 reporting requirements for the first time.

Additionally, facilities may be substituting chemicals that are not on the TRI list for chemicals previously reported. Facilities may intentionally, or due to market demands, reduce quantities below the reporting thresholds; and, particularly in the case of changing market demands, certain facilities' reporting statuses may change from year to year. Further, facilities may be making more knowledgeable estimates of their releases so that quantities reported last year may be much different than the quantities reported this year.

Consequently, this section contains information on all reported chemicals on the Section 313 Toxic Chemical List except those chemicals that were first reportable in the 1990 reporting year:

59X

Allyl alcohol
Creosote
2,3-Dichloropropene
m-Dinitrobenzene
o-Dinitrobenzene
p-Dinitrobenzene
Dinitrotoluene (mixed isomers)
Isosafrole
Toluenediisocyanate (mixed isomers)
and
Aluminum oxide (fibrous forms)[1]

Additionally, those chemicals that have been deleted from the Toxic Chemical List have been summarized in a separate table to present the effect of the delisting:

Aluminum oxide (non-fibrous forms)[1]
Color Index (C.I.) Acid Blue 9 disodium salt
C.I. Acid Blue 9 diammonium salt
Melamine
Sodium hydroxide (solution)
Sodium sulfate (solution)
Terephthalic acid
Titanium dioxide

Discussion

As mentioned earlier, there have been some changes in the reporting requirements which have significantly affected the reported data and potential comparisons between the four years' databases. First, in June 1989, USEPA delisted sodium sulfate (solution) thereby relieving facilities of their 1988, and subsequent, reporting obligations. For reporting year 1987, sodium sulfate was reported by 52 facilities which quantified almost 113 million pounds of total releases and transfers. Sodium sulfate accounted for 35% of the total quantity for 1987. Additionally, due to the late date of this rule's promulgation (Form Rs are due July 1), many facilities had already submitted their 1988 forms. Second, in December 1989, sodium hydroxide (solution) was delisted by the USEPA thereby relieving facilities of their 1989, and subsequent, reporting obligations. For 1987, 265 facilities reported more than 9 million pounds of sodium hydroxide releases and transfers. Third, in February 1990, USEPA revised the reporting criteria for aluminum oxide to include fibrous forms only. More than 12 million pounds of aluminum oxide releases and transfers were reported by 39 facilities for 1987, while only 4 facilities reported slightly more than one million pounds for 1990. See Table 16 for a summary of releases and transfers

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[1] Non-fibrous forms of aluminum oxide were deleted from EPCRA Section 313 beginning with the 1989 reporting year. TRI data indicate that facilities continued to report both the non-fibrous and fibrous forms of aluminum oxide for the 1989 reporting year, but reported only fibrous forms of aluminum oxide in the 1990 reporting year. In New Jersey, 39 facilities reported aluminum oxide for 1987 and 1988, 12 for 1989, and four for 1990. Thus, aluminum oxide (fibrous forms) is treated as if it were a newly added chemical reportable beginning with the 1990 reporting year.

for delisted substances. Additionally, Allied Signal of Elizabeth, Union County, reduced through process terminations, their 1988 TRI total facility reportable quantities of 28,329,620 pounds (including 26,320,360 pounds of hydrochloric acid alone) to a total of 80,433 pounds for 1989, and 63,404 pounds for 1990.

From its inception, the exemption from TRI reporting for off-site transfers of wastes for recycling or reprocessing has not been clear to Form R submitters. In some cases, due to the nature of off-site processing, recyclable quantities are not readily identifiable nor readily separated from quantities which must be reported. In other cases, it is simply easier for facilities to quantify all wastes transferred off-site rather than to distinguish between those wastes which are recycled/reprocessed and other wastes. Therefore, the TRI-estimated quantities of transfers subject to reporting can not be determined from the existing databases. Conversations with Form R submitters indicate that recyclables, etc., have been reported for all years. The recycling exemption will be eliminated in the 1991 reporting year with the inclusion of pollution prevention data reporting.

With this information in mind, some general comparisons can be drawn from the first four years of TRI reporting. These comparisons are made by adjusting the data sets for all four years. First of all, the 1990 reports probably represent the most refined database since the major facilities have had four years of experience with the Section 313 reporting requirements. Also, many facilities have improved their methodologies for estimating releases and transfers.

Table 17 presents the TRI releases and transfers for 1987 through 1990, ordered alphabetically by New Jersey county. While there was a reduction in total releases and transfers reported in 14 counties for 1990, there was an increase observed in six counties - Hudson, Ocean, Passaic, Salem, Somerset and Sussex. Hudson County is up is due to a large increase in discharges to POTWs in 1990. Ocean County increased due to a doubling in off-site transfers. Passaic County's quantities increased for both POTW discharges and off-site transfers. Off-site transfers increased nearly three-fold in Salem County. Somerset County is up in 1990 due to an increase of more than 70,000 pounds in POTW discharges. And Sussex County's total quantities increased relative to 1989 due to larger stack air emissions and off-site transfers.

Thirteen counties reported decreases of 1990 on-site releases (versus 1989) while seven counties reported increases, as evidenced by data in Table 17. The largest decrease for on-site releases, almost 2.2 million pounds, was noted in Gloucester County. The largest increase for on-site releases, almost 205,000 pounds, was noted in Morris County.

Figure 9 presents the total releases and transfers by county for all four years (there were no reports from Cape May County in any year). The general trend in reductions in total reported quantities is seen in this figure while the increases are graphically evident for Hudson and Passaic counties. These observations may not, however, reflect a real change in the quantities of releases as much as a clearer understanding of the reporting requirements and improvements in release-estimating techniques. A detailed review of reporting facilities and their substances would be necessary to determine whether this is an actual increase for these counties or if certain facilities' data are missing from the databases, that is, not received by the Department for previous years.

Figure 10 presents the four-year trend by reporting media. Total reported quantities of air emissions, and surface water discharges have declined in the successive years. An increase for on-site releases to land is observed from 1987 through 1989 and then followed by a significant decrease for the 1990 reporting year. Discharges to POTW*s* have fluctuated over the four years while remaining above 50 million pounds for each year. A significant drop in off-site transfers is observed from 1987 to 1989; 1990 quantities increased approximately 1.4 million pounds over the 1989 quantity.

Conclusion

Beginning in 1987, manufacturing-sector facilities covered by SARA Section 313 have been required to submit annually a report to the USEPA and their state listing their releases of more than 300 chemicals and 20 chemical categories. Environmental releases include emissions to air, discharges to surface water, on-site land disposal, and underground injection. Quantities of off-site transfers, including discharges in waste water to POTW*s* and other treatment facilities, are also reportable.

The TRI data is a tool which has quickly proven to be of value to government regulators, facility owners/operators, and the public at large. After only four years of toxic chemical release reporting, it appears that industry may have taken advantage of some opportunities to consider changes in the mix of materials and processes during manufacturing and, thereby, cut reported TRI releases and transfers sharply. An apparent trend of release reductions to most environmental media, in light of increasingly more stringent reporting criteria, is presented by these data - the one exception is transfers to public waste water treatment facilities where the annual reported quantities have fluctuated from year to year and total discharges continue to be reported above above 50 million pounds per year.

Some subtle, as well as not-so-subtle, differences in the reporting requirements combined with the application of better estimation techniques may lead to incorrect interpretations of the data and a conclusion that annual reductions may be larger than what actually occured. Also, environmental releases and transfers identified on Form R in earlier years may not have been as large as reported. As stated throughout the report, facilities have become better at estimating releases and transfers as well as understanding the reporting requirements of the program. Some facilities are substituting non-TRI substances for those on the Toxic Chemical List. Some facilities may be falling below the TRI reporting thresholds. Therefore, total reductions may be attributed to both real reductions and better release-estimating techniques.

And again it is important to remember that the TRI is not the total picture of all toxic releases and transfers. Only manufacturing sector facilities that meet the reporting criteria (see page 18 of this report) are subject to the Section 313 requirements. While the TRI facilities may be large generators and emitters of hazardous chemicals, there are other facilities in the manufacturing sector and also non-manufacturing sector businesses which release hazardous substances into the environment. Further, motor vehicles (cars, trucks, buses, etc.) have been identified as significant sources of toxic air contaminants, especially in urban areas. Non-point sources, including farm water runoff and contaminated sediments, are major sources of water pollution. Therefore, the data reported under Section 313 may represent the larger releases of these select substances but are certainly not the only sources that release them.

Table 16. TRI Releases and Transfers Reported by New Jersey Facilities for Delisted Substances through 1990 (Ordered Alphabetically by Chemical). (Environmental Releases & Transfers are reported in pounds for the calendar year.)

CAS #	Chemical Name	Fugitive Air Emissions	Stack Air Emissions	Surface Water Discharges	On-Site Releases to Land	Discharges to POTWs[2]	Other Off-Site Transfers	Total[3] Releases & Transfers	Total Tri Forms
a. 1987 Reporting Year									
1344-28-1	Aluminum oxide[1]	135,470	137,807	19,450	3,325,244	67,115	8,650,095	12,335,181	39
108-78-1	Melamine	334	250	270	0	0	946	1,800	4
1310-73-2	Sodium hydroxide (solution)	54,690	43,256	133,693	35,958	6,374,866	2,380,741	9,022,954	265
7757-82-6	Sodium sulfate (solution)	1,476	500	52,592,765	5,648	59,849,175	305,377	112,754,941	52
100-21-0	Terephthalic acid	250	284	5,625	0	0	250	6,409	2
		192,220	182,097	52,751,803	3,366,850	66,291,156	11,337,409	134,121,285	362
b. 1988 Reporting Year									
1344-28-1	Aluminum oxide[1]	26,177	174,112	11,100	3,795,095	591	6,266,598	10,273,673	39
108-78-1	Melamine	250	250	4	0	0	5,700	6,204	2
1310-73-2	Sodium hydroxide (solution)	19,827	48,101	45,251	1,250	4,989,259	1,933,004	7,036,692	279
7757-82-6	Sodium sulfate (solution)	250	250	1,788,500	0	21,415,506	1,327,807	24,532,313	28
100-21-0	Terephthalic acid	254	39	5,383	0	0	250	5,926	3
		46,758	222,752	1,850,238	3,796,345	26,405,356	9,533,359	41,854,808	351
c. 1989 Reporting Year									
1344-28-1	Aluminum oxide[1]	2,400	2,857	0	18,550	250	1,735,826	1,759,883	12
100-21-0	Terephthalic acid	752	287	5,339	0	0	865	7,243	5
		3,152	3,144	5,339	18,550	250	1,736,691	1,767,126	17
d. 1990 Reporting Year									
1344-28-1	Aluminum oxide[1]	1,000	250	0	0	0	1,169,150	1,170,400	4

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1. Non-fibrous forms of aluminum oxide were deleted from EPCRA Section 313 beginning with the 1989 reporting year. TRI data indicate that facilities continued to report both the non-fibrous and fibrous forms of aluminum oxide for the 1989 reporting year, but reported only fibrous forms of aluminum oxide in the 1990 reporting year. Thus, aluminum oxide (fibrous forms) is treated as if it were a newly added chemical reportable beginning with the 1990 reporting year.
2. "POTW" means publicly owned treatment works (municipal or public sewage system).
3. Total Releases & Transfers = fugitive air emissions + stack air emissions + water discharges + on-site land + POTW + other off-site transfers.

Table 17. TRI Releases and Transfers by New Jersey County, 1987 - 1990.

County	Year	Fugitive Air Emissions (lbs/yr)	Stack Air Emissions (lbs/yr)	Surface Water Discharges (lbs/yr)	On-site Releases to Land (lbs/yr)	Discharges to Potws (lbs/yr)	Other Off-site Transfers (lbs/yr)	Total Releases & Transfers (lbs/yr)
Atlantic	90	36,905	104,159	5	0	440	81,527	223,036
	89	34,459	87,307	5	0	540	699,394	821,705
	88	88,182	139,042	500	0	760	310,930	539,414
	87	214,895	86,010	1,000	750	410	686,300	989,365
Bergen	90	1,025,918	1,181,715	1,339	500	6,702,978	2,458,641	11,371,091
	89	708,544	1,340,580	2,815	805	8,513,679	2,237,898	12,804,321
	88	875,644	2,266,158	38,065	500	10,200,076	2,563,646	15,944,089
	87	1,269,903	2,155,168	29,158	13,302	8,892,850	1,890,570	14,250,951
Burlington	90	243,943	535,169	18,684	428,914	9,307	390,669	1,626,686
	89	336,175	436,057	17,800	483,452	1,676	425,945	1,701,105
	88	270,160	598,336	102,823	427,298	60,665	535,042	1,994,324
	87	210,529	392,863	434,001	378,212	22,500	637,561	2,075,666
Camden	90	242,319	950,890	250	1,015	129,621	1,681,168	3,005,263
	89	289,234	1,447,876	250	0	53,431	2,149,380	3,940,171
	88	243,946	1,391,937	24,081	7,013	54,884	1,988,829	3,710,690
	87	333,290	1,385,210	28,256	7,913	55,593	2,396,420	4,206,682
Cumberland	90	14,955	250	0	0	0	9,580	24,785
	89	19,913	12,250	0	0	0	4,100	36,263
	88	33,803	24,379	0	4	250	43,885	102,321
	87	33,000	750	0	0	1,750	50,140	85,640
Essex	90	737,198	2,100,451	0	1,510	16,734,535	3,638,639	23,212,328
	89	1,196,861	2,573,774	250	180,010	22,845,200	3,273,944	30,070,039
	88	1,710,485	2,514,352	1,000	175,233	18,042,397	3,285,497	25,728,964
	87	2,222,414	2,688,319	3,025	30,400	18,225,740	4,178,832	27,348,730

Table 17. TRI Releases and Transfers By New Jersey County, 1987 - 1990, Continued.

County	Year	Fugitive Air Emissions (lbs/yr)	Stack Air Emissions (lbs/yr)	Surface Water Discharges (lbs/yr)	On-site Releases to Land (lbs/yr)	Discharges to Potws (lbs/yr)	Other Off-site Transfers (lbs/yr)	Total Releases & Transfers (lbs/yr)
Gloucester	90	389,209	620,847	162,622	10,570	15,834	1,320,798	2,519,880
	89	415,415	780,010	157,947	2,011,650	23,292	1,229,949	4,618,263
	88	363,598	859,199	175,154	1,305,748	18,750	997,186	3,719,635
	87	512,038	1,040,335	307,800	1,363,450	2,650	2,294,439	5,520,712
Hudson	90	412,181	718,319	5,939	20,265	2,546,242	1,628,365	5,331,311
	89	359,015	1,083,603	1,225	650	189,427	1,243,295	2,877,215
	88	420,181	913,438	2,094	750	418,441	1,461,551	3,216,455
	87	472,671	1,438,366	4,592	68,360	4,701,160	1,047,153	7,732,302
Hunterdon	90	104,194	107,899	9	0	5	235,096	447,203
	89	91,525	222,719	750	0	500	165,723	481,217
	88	87,534	558,909	500	0	0	124,806	771,749
	87	68,800	935,199	4,800	0	0	61,497	1,070,296
Mercer	90	103,439	293,719	316	0	9,778	375,470	782,722
	89	210,528	426,075	0	0	29,131	725,102	1,390,836
	88	232,576	463,057	0	0	21,708	724,812	1,442,153
	87	247,208	599,947	0	0	19,824	1,217,293	2,084,272
Middlesex	90	2,486,672	3,902,052	3,837	5,474	12,318,016	7,281,153	25,997,204
	89	2,632,686	5,736,173	25,404	149,740	13,070,131	6,693,712	28,307,846
	88	3,024,819	6,750,272	28,781	136,220	8,242,374	16,539,158	34,721,624
	87	3,610,987	8,313,342	21,196	9,929	20,907,247	26,678,244	59,540,945
Monmouth	90	191,770	240,776	250	770	412,271	441,707	1,287,544
	89	192,789	217,484	0	0	507,036	621,716	1,539,025
	88	200,093	363,127	750	0	528,859	589,615	1,682,444
	87	161,586	327,390	250	2,350	456,105	2,506,686	3,454,367

Table 17. TRI Releases and Transfers By New Jersey County, 1987 - 1990, Continued.

County	Year	Fugitive Air Emissions (lbs/yr)	Stack Air Emissions (lbs/yr)	Surface Water Discharges (lbs/yr)	On-site Releases to Land (lbs/yr)	Discharges to Potws (lbs/yr)	Other Off-site Transfers (lbs/yr)	Total Releases & Transfers (lbs/yr)
Morris	90	1,053,952	545,772	276	0	26,534	1,088,896	2,715,430
	89	699,242	694,036	2,018	0	63,629	1,085,055	2,743,980
	88	2,775,553	1,551,129	31,890	14,440	588,655	1,810,522	6,772,189
	87	1,246,442	1,291,152	1,000	32,000	193,795	1,457,848	4,222,237
Ocean	90	25,120	118,498	7,631	99	0	326,604	477,952
	89	17,151	181,294	22,756	62	0	148,301	369,564
	88	31,952	154,701	26,188	62	0	133,618	346,521
	87	59,131	214,957	43,349	144	0	190,002	507,583
Passaic	90	552,093	671,838	3,833	0	10,674,923	2,382,951	14,285,638
	89	939,858	1,266,981	100,510	250	8,950,570	924,169	12,182,338
	88	921,361	1,855,253	129,211	501,837	6,538,799	1,390,479	11,336,940
	87	1,070,145	1,211,759	263,044	5,200	4,235,274	1,459,943	8,245,365
Salem	90	76,673	915,687	159,863	276,849	55	1,740,141	3,169,268
	89	91,823	1,123,877	352,955	255,720	750	608,065	2,433,190
	88	95,638	1,365,447	294,309	287,726	14,254	157,972	2,215,346
	87	84,454	1,475,803	723,676	17,553	1,250	498,666	2,801,402
Somerset	90	63,083	177,199	14	500	494,611	481,075	1,216,482
	89	91,108	141,459	259	0	421,246	510,793	1,164,865
	88	103,098	227,671	251	1,805	209,113	576,662	1,118,600
	87	172,591	347,268	1,500	2,250	705,664	1,164,223	2,393,496
Sussex	90	80,658	123,311	0	0	0	80,000	283,969
	89	101,231	55,691	0	0	0	3,000	159,922
	88	155,072	116,236	0	0	0	93,180	364,488
	87	137,388	44,320	0	0	0	5,499	187,207

66X

Table 17. TRI Releases and Transfers By New Jersey County, 1987 - 1990, Continued.

County	Year	Fugitive Air Emissions (lbs/yr)	Stack Air Emissions (lbs/yr)	Surface Water Discharges (lbs/yr)	On-site Releases to Land (lbs/yr)	Discharges to Potws (lbs/yr)	Other Off-site Transfers (lbs/yr)	Total Releases & Transfers (lbs/yr)
Union	90	1,150,090	2,035,582	72,892	3,160	6,494,395	4,077,252	13,833,371
	89	1,455,594	2,672,000	130,946	557	6,493,798	5,304,266	16,057,161
	88	1,873,967	2,726,004	198,375	475	8,786,422	33,264,449	46,849,692
	87	2,867,319	2,814,520	217,408	11,740	8,641,742	23,689,496	38,242,225
Warren	90	330,141	419,552	25,981	755	3,323	134,317	914,069
	89	660,492	242,452	34,116	0	20,512	413,689	1,371,261
	88	1,237,049	261,849	279,693	500	156,910	530,432	2,466,433
	87	1,955,673	289,691	295,852	2,100	181,600	906,798	3,631,714
Total	90	9,320,513	15,763,685	463,741	750,381	56,572,868	29,854,049	112,725,232
	89	10,543,643	20,741,698	850,006	3,082,896	61,384,548	28,467,496	125,070,287
	88	14,744,711	25,100,496	1,333,665	2,859,611	53,883,317	67,122,271	165,044,071
	87	16,950,464	27,052,369	2,379,907	1,945,653	67,245,154	73,017,610	188,591,157

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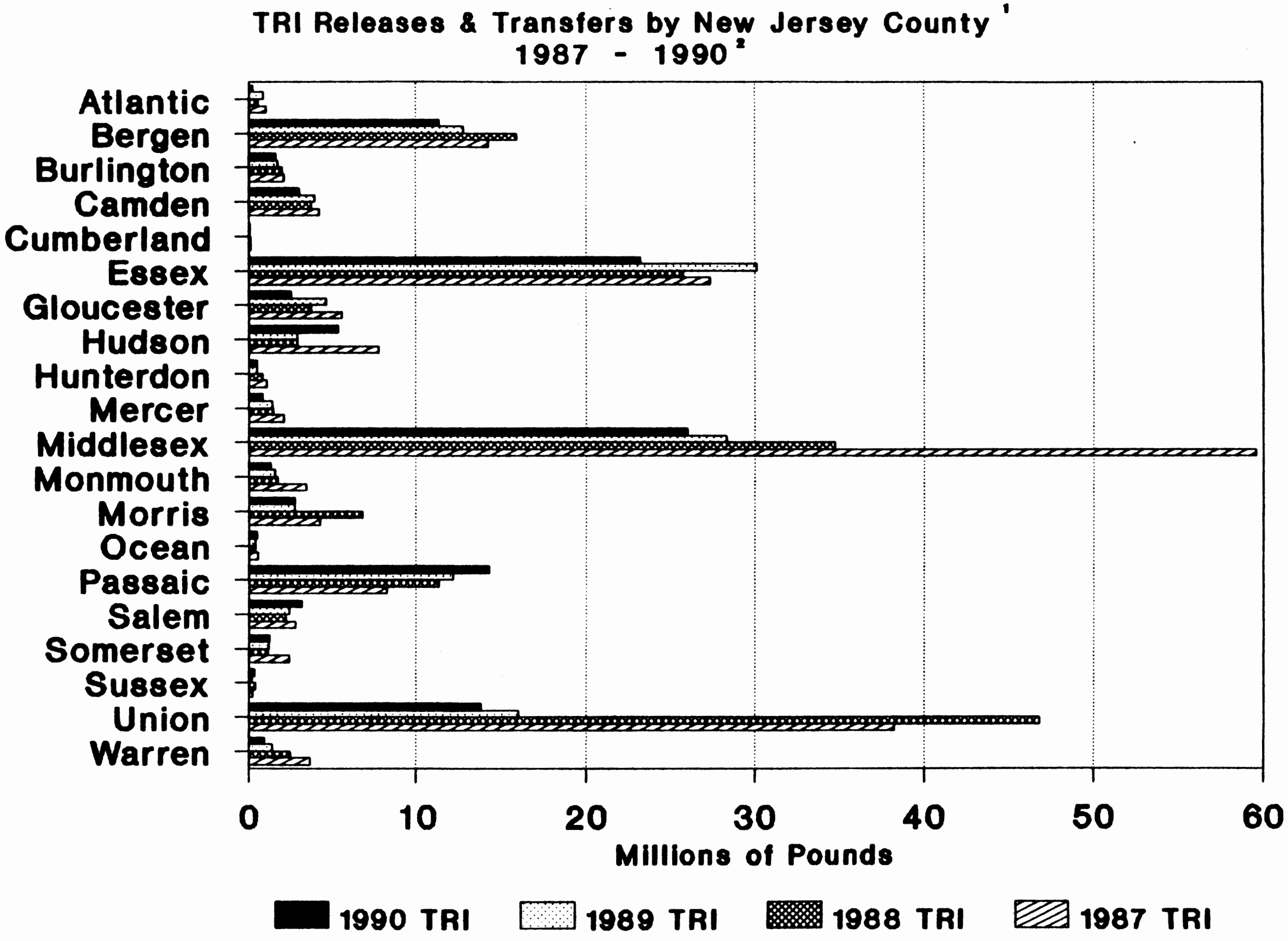


1. No reports have been received for Cape May County.
2. All data sets have been adjusted to include the same substances.

Figure 9. TRI Releases & Transfers by New Jersey County, 1987 - 1990.

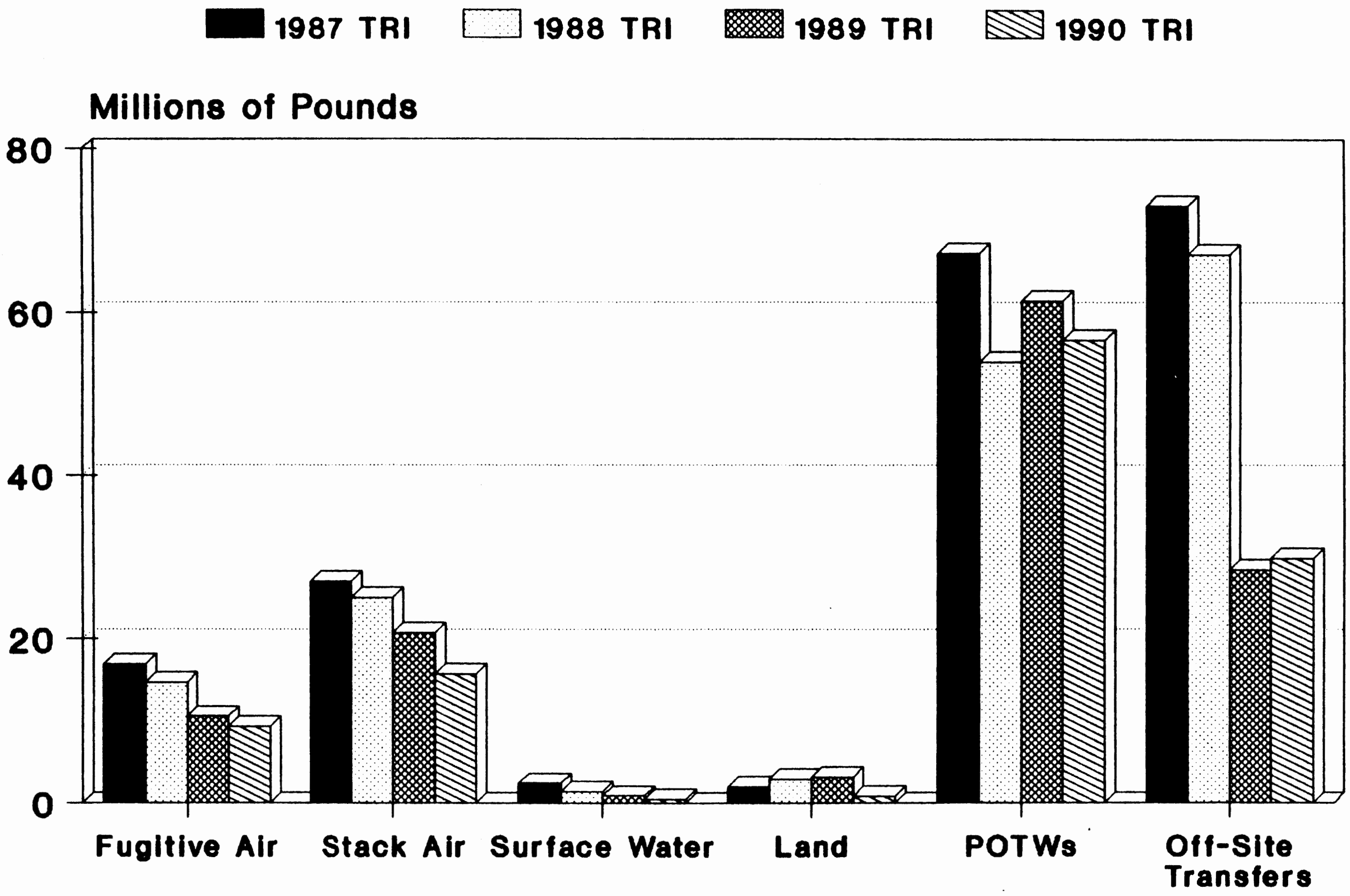
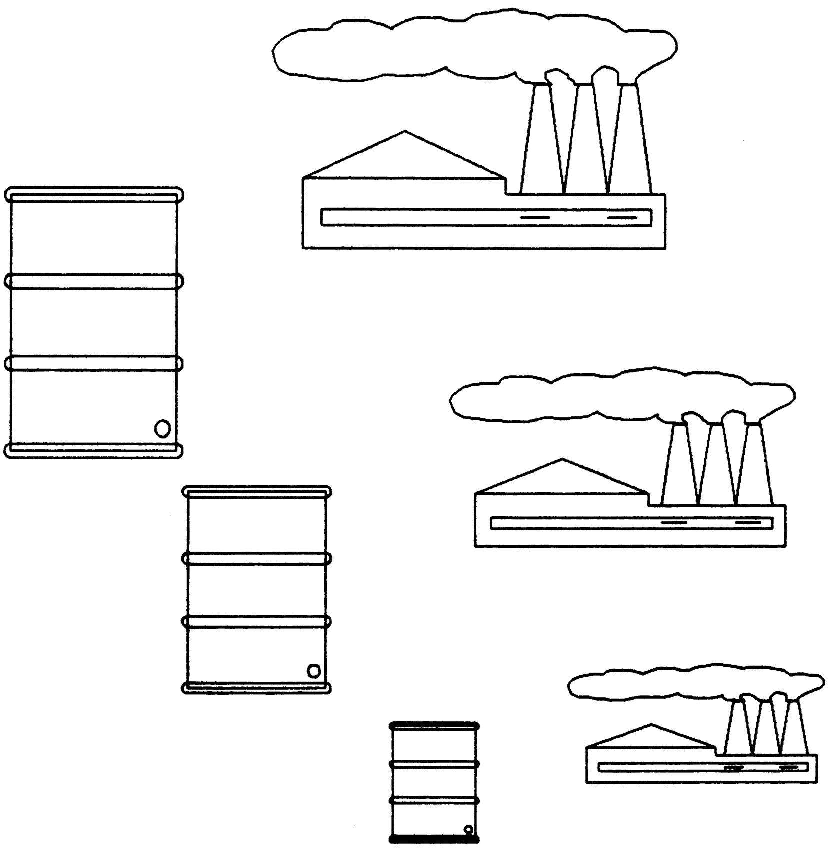


Figure 10. TRI Releases & Transfers by Media, 1987 - 1990.

USEPA's 33/50

TOXICS REDUCTION PROGRAM



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USEPA's 33/50 Toxics Reduction Program

Goals and Approach

In February 1991, USEPA Administrator, William K. Reilly, announced the establishment of the 33/50 Toxics Reduction Program. The program is a USEPA initiative designed to reduce toxic waste generation from industrial sources quickly and with an unprecedented degree of flexibility. Industry participation in the program is voluntary; the program aims to demonstrate that voluntary reduction programs can augment the traditional regulatory approach.

The 33/50 Program seeks to reduce the environmental releases and transfers of 17 high-priority toxic chemicals by 50% by 1995, with an interim goal of a 33% reduction by 1992. The 17 toxic chemicals are among the more than 320 chemicals reported annually on the Toxic Chemical Release Inventory (TRI). These chemicals are of concern to the 33/50 Program not only because of toxicity factors, but because they are all commonly used in high volumes by industry, and they all have high potential for reduction through pollution prevention. Facilities reporting under the TRI were requested to voluntarily participate and the program uses the 1988 data as a baseline by which reductions will be measured.

The 33/50 Program is part of a broad USEPA thrust to encourage pollution prevention as the best means of reducing risk to human health and the environment. Pollution prevention moves the focus on toxic chemicals upstream, away from managing wastes after they have been generated. This approach avoids the generation of wastes wherever possible through toxics use reduction (materials substitutions, product reformulation or redesign), equipment and process changes, improved operations or handling of materials, and so on. By emphasizing pollution prevention, the hope is that companies will instill a new management ethic that will achieve even greater benefits, expanding their reduction efforts beyond the chemicals, targets, and time frames established by this program.

The goal of the 33/50 Program includes the reduction of both direct releases to the environment and off-site transfers to waste water treatment plants or commercial waste management facilities. While it is important to understand the difference between direct releases to the environment and off-site transfers, both are included as measures of progress because the central theme of the 33/50 Program is to promote pollution prevention. Therefore, all waste materials are included, regardless of whether they are released on-site or transferred off-site, to encourage industry to consider all waste generation when reviewing their pollution prevention options.

Discussion

A summary of the TRI-reported data for the 17 high-priority toxic chemicals for 1988 through 1990 is presented in Table 18. Environmental releases and off-site transfers are summed for each reporting medium. Also shown is a yearly sum for total on-site releases and for total off-site transfers. While the general trend is a decrease in quantities reported relative to the preceding year, total on-site releases increased for the following chemicals (the number in parentheses is the quantity of increase):

1988 to 1989

carbon tetrachloride (+60,000)
tetrachloroethylene (+151,000)
trichloroethylene (+69,000)
chromium and compounds (+34,000)
cyanide compounds (+900)

1989 to 1990

methyl isobutyl ketone (+62,000)
1,1,1-trichloroethane (+118,000)
lead and compounds (+7,500)

Total off-site transfers increased for the following chemicals:

1988 to 1989

chloroform (+27,000)
1,1,1-trichloroethane (+18,000)

1989 to 1990

benzene (+32,000)
chloroform (+84,000)
1,1,1-trichloroethane (+226,000)
cadmium and compounds (+400)
lead and compounds (+454,000)
mercury and compounds (+15,000)
xylenes (+53,000)

Total environmental releases and off-site transfers increased for the following chemicals:

1988 to 1989

carbon tetrachloride (+59,000)
tetrachloroethylene (+154,000)
trichloroethylene (+8,000)
cyanide compounds (+500)

1989 to 1990

benzene (+32,000)
chloroform (+64,000)
1,1,1-trichloroethane (+344,000)
lead and compounds (+461,000)
mercury and compounds (+14,000)

In 1988, the baseline year for the 33/50 Program, the 17 chemicals accounted for 25% of the total quantities reported for TRI (40.7 out of 165 million pounds - see Table 17 for the 1988 total). In 1989, the 17 chemicals accounted for 23% of the total reported quantities, and in 1990, they accounted for 21% of the total. When compared to the 1988 baseline data, a 29% reduction was achieved in 1989, and a 42% reduction was achieved in 1990. The interim goal of a 33% reduction, established for 1992, has been far exceeded by the 1990 reporting year, only two years after the initiation of the program, and this reduction is only 8% away from the 1995 goal. Pollution prevention benefits resulting from the Program could potentially extend to a substantial portion of the entire TRI universe, since companies are encouraged to consider reduction commitments beyond the goals of the 33/50 Program.

Table 18. **TRI Reported** Releases and Transfers of 33/50 Toxics Reduction Program Chemicals, 1988 - 1990. (Environmental Release & Transfers are reported in pounds for the calendar year.)

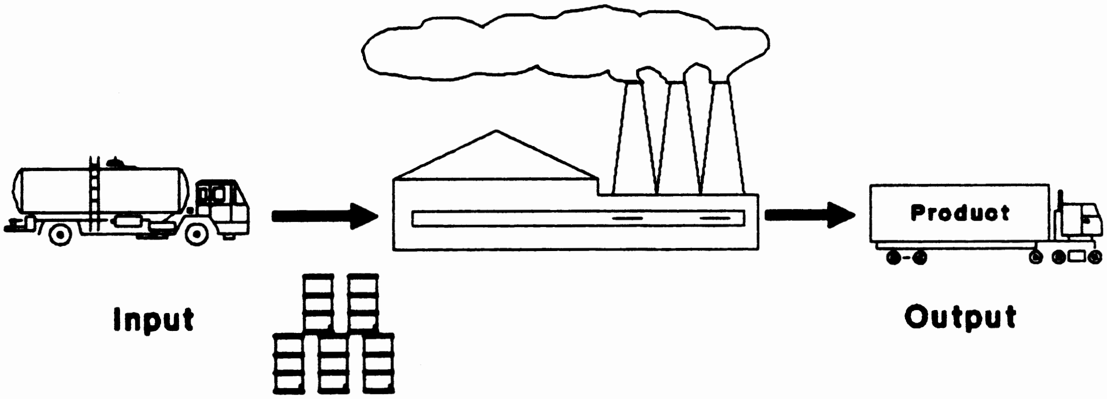
CAS #	Chemical Name	Year	Fugitive Air Emissions	Stack Air Emissions	Surface Water Discharges	On-Site Releases to Land	Total Releases
71-43-2	**Benzene**	90	82,354	45,990	804	83	129,131
		89	65,491	62,637	1,156	55	129,339
		88	76,886	89,817	1,317	188	168,208
56-23-5	**Carbon tetrachloride**	90	2,841	1,832	322	0	4,995
		89	546,278	418,326	81	224	964,909
		88	615,790	288,653	568	0	905,011
67-66-3	**Chloroform**	90	118,420	2,840	586	0	121,846
		89	139,152	2,209	72	0	141,433
		88	168,050	6,000	1,010	0	175,060
75-09-2	**Dichloromethane**	90	403,216	524,946	17,329	2,900	948,391
		89	376,815	730,739	24,940	844	1,133,338
		88	494,380	969,142	88,548	8	1,552,078
78-93-3	**Methyl ethyl ketone**	90	895,458	1,140,535	1,062	4	2,037,059
		89	610,329	2,011,640	1,054	53,931	2,676,954
		88	774,552	3,326,965	10,229	58,925	4,170,671
108-10-1	**Methyl isobutyl ketone**	90	214,583	489,806	1,165	255	705,809
		89	207,150	435,665	1,155	21	643,991
		88	325,020	550,597	932	142	876,691
127-18-4	**Tetrachloroethylene**	90	140,805	129,936	113	0	270,854
		89	108,656	169,332	258	0	278,246
		88	105,151	16,389	11	250	121,801
108-88-3	**Toluene**	90	1,354,875	2,839,454	4,145	3,973	4,202,447
		89	1,620,423	4,187,009	5,505	28,607	5,841,544
		88	1,744,229	6,202,390	8,252	21,916	7,976,787
71-55-6	**1,1,1-Trichloroethane**	90	894,929	567,368	286	2,400	1,464,983
		89	897,974	445,192	914	2,755	1,346,835
		88	2,458,712	502,932	256	0	2,961,900
79-01-6	**Trichloroethylene**	90	456,612	215,026	59	0	671,697
		89	473,140	312,085	250	0	785,475
		88	424,114	292,418	0	0	716,532
	Cadmium and cadmium compounds	90	1,507	1,306	5	0	2,818
		89	2,250	1,750	0	0	4,000
		88	2,270	1,985	0	0	4,255
	Chromium and chromium compounds	90	5,367	6,996	6,836	69,845	89,044
		89	8,960	9,507	12,492	207,386	238,345
		88	7,653	10,854	5,424	180,761	204,692
	Cyanide compounds	90	600	1,251	250	250	2,351
		89	1,290	1,770	500	250	3,810
		88	1,000	921	750	250	2,920
	Lead and lead compounds	90	7,102	60,186	19,398	159,706	246,392
		89	12,117	68,929	17,587	140,229	238,862
		88	14,173	51,069	16,626	607,056	688,924
	Mercury and mercury compounds	90	43	7	1	0	51
		89	250	250	250	0	750
		88	250	250	0	0	500
	Nickel and nickel compounds	90	2,530	6,479	1,317	5,150	15,226
		89	3,269	8,048	2,160	5,150	18,627
		88	3,755	7,362	12,292	10,415	33,824
	Xylenes	90	600,447	1,413,676	1,891	9,103	2,025,117
		89	582,059	1,843,494	81,910	36,954	2,544,417
		88	622,839	2,054,044	105,972	34,630	2,817,485

CAS #	Chemical Name	Year	Discharges to POTWs	Other Off-Site Transfers	Total Transfers	1990 Total Releases & Transfers	1989 Total Releases & Transfers	1988 Total Releases & Transfers
71-43-2	Benzene	90	120,186	22,024	142,210	271,341		
		89	91,867	18,088	109,955		239,294	
		88	228,270	122,286	350,556			518,764
56-23-5	Carbon tetrachloride	90	0	0	0	4,995		
		89	750	0	750		965,659	
		88	1,333	0	1,333			906,344
67-66-3	Chloroform	90	21,986	118,351	140,337	262,183		
		89	34,456	21,810	56,266		197,699	
		88	24,450	4,451	28,901			203,961
75-09-2	Dichloromethane	90	298,243	776,126	1,074,369	2,022,760		
		89	360,316	821,640	1,181,956		2,315,294	
		88	700,554	1,018,301	1,718,855			3,270,933
78-93-3	Methyl ethyl ketone	90	73,850	1,087,047	1,160,897	3,197,956		
		89	66,056	1,502,089	1,568,145		4,245,099	
		88	185,942	1,629,839	1,815,781			5,986,452
108-10-1	Methyl isobutyl ketone	90	248,994	196,735	445,729	1,151,538		
		89	269,409	298,203	567,612		1,211,603	
		88	222,771	928,200	1,150,971			2,027,662
127-18-4	Tetrachloroethylene	90	63	34,170	34,233	305,087		
		89	1,032	47,641	48,673		326,919	
		88	19,700	31,198	50,898			172,699
108-88-3	Toluene	90	475,043	3,104,163	3,579,206	7,781,653		
		89	643,341	4,257,540	4,900,881		10,742,425	
		88	1,027,360	5,973,137	7,000,497			14,977,534
71-55-6	1,1,1-Trichloroethane	90	17,303	696,621	713,924	2,178,907		
		89	40,467	447,357	487,824		1,834,659	
		88	11,172	458,469	469,641			3,431,541
79-01-6	Trichloroethylene	90	1,755	84,698	86,453	758,150		
		89	2,810	91,694	94,504		879,979	
		88	2,012	153,253	155,265			871,797
	Cadmium and cadmium compounds	90	605	7,947	8,552	11,370		
		89	611	7,534	8,145		12,145	
		88	270	31,167	31,437			35,692
	Chromium and chromium compounds	90	71,605	199,508	271,113	360,157		
		89	32,175	240,057	272,232		510,577	
		88	32,022	275,676	307,698			512,390
	Cyanide compounds	90	2,492	750	3,242	5,593		
		89	2,221	1,536	3,757		7,567	
		88	767	3,363	4,130			7,051
	Lead and lead compounds	90	105,221	1,005,677	1,110,898	1,357,290		
		89	371,901	285,221	657,122		895,994	
		88	62,146	1,245,751	1,307,897			1,996,821
	Mercury and mercury compounds	90	266	14,859	15,125	15,176		
		89	506	5	511		1,261	
		88	1,584	59	1,643			2,143
	Nickel and nickel compounds	90	6,574	66,910	73,484	88,960		
		89	54,014	246,994	301,008		319,635	
		88	32,694	281,219	313,913			347,737
	Xylenes	90	88,577	1,508,120	1,596,698	3,621,815		
		89	431,633	1,111,730	1,543,363		4,087,780	
		88	693,235	1,980,163	2,673,398			5,490,883
			TOTAL POUNDS FOR THE REPORTING YEAR:			23,665,327	28,793,589	40,760,404
			REDUCTION FROM 1988:			42 %	29 %	

NJ RELEASE & SOURCE REDUCTION REPORT

MATERIALS ACCOUNTING DATA SUMMARY

FOR 1990



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New Jersey Release and Source Reduction Report

Materials Accounting Data Summary for 1990

Introduction

New Jersey requires additional information from those facilities mandated to complete the federal Form R pursuant to the Toxic Release Inventory (TRI) reporting requirements. The information must be submitted on the Release and Source Reduction Report (DEQ-114). The DEQ-114 must be completed for each New Jersey Environmental Hazardous Substance (EHS) which meets the TRI reporting thresholds. For the 1990 reporting year, the EHS included 163 specific chemicals and 10 compound categories that were on the TRI list plus four (4) chemicals unique to the EHS. The four chemicals not on the TRI list were: amitrol, bromine, hydrogen sulfide and phosphorus trichloride. Facilities were requested to provide information for these four chemicals at the TRI thresholds. Additionally, facilities were requested to provide DEQ-114 data for TRI chemicals that were not on the EHS list. Providing information for the other TRI chemicals would benefit the reporting facility since the passage of New Jersey's Pollution Prevention Act was expected and, therefore, the facility would receive credit for documented pollution prevention activities as reported on the DEQ-114.

The DEQ-114 is divided into two parts: Section A provides information pertaining to the facility site and its overall operations; Section B provides information for each reportable EHS. The additional information reported includes materials throughput data (beginning and ending of year inventories), and quantities manufactured on-site, brought on-site, consumed on-site, and shipped off-site as (or in) product. Quantities of waste shipped off-site for recycling, reprocessing, etc. are required to be reported (that is, they are not exempt) under New Jersey's program. Also, source reduction/pollution prevention data reporting is required by New Jersey. And, like Form R, environmental releases and off-site transfers of waste are also reportable on the DEQ-114.

This type of data has been reportable since the 1987 reporting year. The information presented here is a summary of the 1990 data as received on the Release and Source Reduction Report (DEQ-114) by the NJDEPE through July 31, 1992. New Jersey facilities reported on 164 unique chemicals and compound categories.

Applications and Limitations of the Data

New Jersey is unique in the collection of materials throughput data and, through the 1990 reporting year, the mandatory reporting of source reduction/pollution prevention data as well as the reporting of the quantities of wastes shipped off-site for recycling purposes. However, as is true of Form R, the throughput data is part of a dynamic data set and many factors must be considered when evaluating and interpreting the reported data.

Several caveats affect the data reported by subject facilities. Materials accounting information is often an estimate of the actual value. Facilities have different methods of tracking and accounting for materials as they pass through the various processes within the plant. Reportable chemicals may be found in a variety of forms at a facility. For example, when reporting the starting inventory for the year, a chemical may be found in any, or all, of the following: raw materials, mixtures, hazardous wastes waiting to be shipped off-site, within process equipment, and in products, possibly in various concentrations. When a facility receives a shipment of a material, particularly in tanks (i.e. trucks, rail cars, etc.), the actual quantity received is often greater or less than the invoiced quantity, rarely is it perfectly accurate. It is not necessary for facilities to monitor, measure, or sample their waste streams to any extent beyond that required by existing federal of state laws, permits, etc. governing the covered chemicals and the media to which they are discharged.

Materials are accounted for on an annual basis. Quantification and estimation techniques also vary widely. Chemical inventory data may be tracked on a regular basis, e.g. the first of every month, or on an as needed basis. While some facilities may have sophisticated computer programs to account for materials, processes, environmental releases, etc., others may conduct a paper review whenever accounting becomes necessary. Then, as with Form R, when final quantities are tabulated, it is only necessary to report any quantity to two significant integers. Therefore, rounding often results in significant discrepancies when considering a chemical's annual materials balance. For this reason, the DEQ-114 instructions package includes a worksheet for verification of the materials accounting data (see Figure 11).

Comprehensive accounting of a chemical on an annual basis often provides further insight for facilities with respect to the environmental releases and transfers as reported on the Form R. In fact, many facilities have submitted voluntary revisions to previously reported Form R*s* as a result of materials balances conducted on the DEQ-114. In some cases, larger environmental releases or transfers were reported while in other cases, environmental release or transfer estimates were reduced. Many facilities have commented that they complete the DEQ-114 first, thereby having prepared most of the data for the completion of the Form R.

The materials accounting data which is reported on the DEQ-114 is playing a key role in the assessment of pollution prevention trends and opportunities. The efficiency at which chemicals are utilized in a facility's production processes can be assessed by comparing the percentage of chemical which becomes incorporated into a product or is consumed in the manufacturing process versus the amount of the chemical which is released or becomes a waste material. From this, facility operators will be able to identify areas where improvements to efficiency can be achieved in the overall process, thus creating pollution prevention opportunities. This data will also be analyzed on a year-to-year basis, which will enable the Department to determine if pollution prevention progress goals are being met.

New Jersey's Right to Know law and regulations provide the opportunity for facilities to make trade secret claims regarding information to be submitted on the DEQ-114. Confidentiality may be claimed for the inventory and throughput data that are to be provided on the DEQ-114, however, environmental release and waste transfer data may

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not be claimed as confidential. The inventory and throughput data for 1990 substances claimed as trade secret are not included in this report.

General Findings

For the 1990 reporting year, 628 facilities submitted 1,687 Release and Source Reduction Reports. Of these, 621 manufacturing-sector facilities submitted 1,647 complete DEQ-114*s*. Also, two non-manufacturing sector facilities submitted 5 complete DEQ-114*s*. Four facilities claimed confidentiality for all 21 of their reported chemicals plus one facility (included in the 621 above) claimed confidentiality for two of its four reported chemicals. In addition, one facility submitted incomplete throughput information for all 12 of its chemicals. The Department is working with this company to assemble the data using the best information available to the facility.

New Jersey's manufacturers reported on 111 chemicals and compound categories that are on both the NJ EHS List and the federal Toxic Chemical List and also reported on three of the four chemicals that are unique to the EHS List (bromine, hydrogen sulfide and phosphorus trichloride). Also, the manufacturers are to be recognized for reporting on 47 chemicals and compound categories from the Toxic Chemical List which were not regulated by New Jersey for the 1990 reporting year (see Table 19 for this list of optionally reported chemicals). These data will benefit the facilities under the New Jersey Pollution Prevention Program.

Throughput Summary - Annual chemical throughput data, reported as a variety of data fields on the DEQ-114, are evaluated as input and output. The input includes the starting inventory for the year, the quantity manufactured on-site, and the quantity brought on-site. The output includes the quantity consumed (chemically altered) on-site, the quantity shipped off-site as (or in) product, the quantity destroyed through on-site treatment, the ending inventory of the chemical, and all environmental releases and waste transfers of the chemical.

Table 20 presents a summary, ordered alphabetically, for the 161 chemicals and compounds categories. The throughput data (excluding the environmental releases and waste transfers), the total input, the total output, and the quantitative difference of the input and output are condensed in this table. For these 161 chemicals, nearly 6 billion pounds were brought on-site by the reporting facilities and more than 7.6 billion pounds were shipped off-site as (or in) product. Many chemicals are produced at one facility, shipped as a product to another facility which then uses it as a raw material. For example, benzene, toluene and xylene are refined from petroleum, and blended into gasoline as well as shipped at various purity grades for other applications.

From the data reported on the DEQ-114, the total input and total output quantities were calculated. Additionally, the quantitative difference between the two were calculated. As illustrated by Figure 11, the materials balance worksheet, the output value should approximate the input value. A positive difference means that there is more material accounted for on the input side of the equation than on the output. A negative difference accounts for more of the chemical on the output side of the equation. Also evident in Table 20 are some very large differences for many chemicals. The calculated differences for eight chemicals (dichloromethane, ethylbenzene, hydrochloric acid, lead, lead compounds, methyl methacrylate, toluene, and xylene-mixed isomers) are greater than one million pounds each. The largest difference, more than 19.3 million pounds, was observed on the output side for lead compounds. The greatest percentage difference, relative to total input, for these eight large quantitative discrepancies, was calculated as 51.2% for methyl methacrylate.

Figure 12 presents the number of individual chemical records by discrepancy range for both input and output. A materials accounting difference of zero was achieved for 619 chemical records. A difference of more than one million pounds was calculated for eight chemical records.

County Summary - Table 21 presents a detailed summary of the throughput data, input, output, and difference for each county. Middlesex County had the highest number of facilities (104), the highest number of DEQ-114 reports (299), the largest quantitative input, output, and total difference. Middlesex County also ranked #1 with 1990 TRI releases and transfers (presented in Table 4). Sussex County had the fewest facilities, the fewest DEQ-114 reports, the least total input and output quantities, and the smallest quantitative difference, with the exception of Cape May County which had no facilities reporting.

Manufacturing Industry Summary - Table 22 presents a detailed summary of the throughput data, input, output, and difference by standard industrial classification. As observed with the TRI data presented in Table 6, the Chemicals and Allied Products industry (SIC 28xx) had the most facilities (266) submitting the most DEQ-114 reports (894), and also has the largest quantitative discrepancy between input and output. The Petroleum and Coal Products industry (SIC 29xx) had the largest total input and output. The Furniture and Fixtures industry (SIC 25xx) had the fewest facilities and reports, and the lowest total input and output; however, the Leather and Leather Products industry (SIC 31xx) reported the smallest difference. Note in Table 22 the inclusion of data reported by two non-manufacturing sector facilities for five chemical records - these data are not included in the chemical summary or the county summary.

Discussion

It is important to keep in mind that much of the data were quantitative *estimates* of the actual value, summarized for the reporting year. As mentioned previously, facilities are not required to track chemicals nor to monitor, measure, or sample their waste streams to any extent beyond that required by existing federal of state laws, permits, etc. governing the covered chemicals and the media to which they are discharged. A perfect balance most likely results when facilities use the worksheet and adjust for their "softer" estimates, i.e. those values generated from other than actual data. Therefore, the reported values were, for most cases, the best estimates available. It is apparent from Figure 12 that facilities did not use the materials balance worksheet to their advantage - 60 chemical reports present data that result in accounting discrepancies of more than 100,000 pounds.

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The throughput data have been subjected to extensive quality review. It is obvious from review and discussions with facility environmental managers that there are some misunderstandings or misinterpretations of the intent of the reportable data. For example, the distinction has not been clear between *consumed on-site* and *shipped off-site as (or in) product*. Consumed on-site means that the chemical's molecular structure is altered in the process, i.e. a chemical change occurs. A chemical reaction results in a change where a rearrangement of the atoms, ions, or radicals of one or more substances results in the formation of new substances often having entirely different properties. Chemical changes need to be distinguished from physical changes, in which only the state or condition of a chemical is modified, its chemical nature remaining the same. A chemical may be shipped as (or in) product as a result of the manufacture, process, or otherwise use of the chemical, or another chemical, and remains primarily in the product or in the mixture with another chemical. Prior to quality assurance and quality review of the database, there were many records where the values for the quantity consumed and the quantity shipped were identical. Four records for which this condition is still true, and included in this summary, present a redundancy of more than 500,000 pounds. In one case the redundancy accounts for 26% of the difference between input and output; in a second case it accounts for 80% of the difference; and in the other two cases, the redundancy accounts for 100% of the difference.

Probably the most significant misreporting occurs for the metals and their compound categories. When reporting on the compound categories, only the quantity of the parent metals are to reported for the required data fields. Discussions with facility personnel indicate that in the past the total compounds have been quantified in many cases. Also, regarding throughput reporting, the metals are generally not reportable as *produced on-site* nor as *consumed on-site*. The exception would be those facilities which are engaged in the primary smelting and refining of metals, specifically SICs 3331 and 3339, and are, therefore, producing the metals. For the 1990 reporting year, the database contained one facility reporting under SIC 3331 with only one chemical record which was not a metal - 1,1,1-trichloroethane. According to Table 20, New Jersey's manufacturers reported the production of almost 104 million pounds of metals and their compounds. The Department will be taking measures to clarify this reporting for future years.

One final factor that may be responsible for large discrepancies in materials accounting is the fact that the reporting requirements allow for the rounding off of reportable quantities to two significant integers. Quantities are more likely to be rounded down than rounded up, masking a certain quantity of the "true" value (or estimate). The impact of this adjustment on reportable quantities is relative to the magnitude of the quantity itself; that is, the larger the actual value (or estimate) is, the larger the rounded off quantity will be.

Conclusion

New Jersey is unique in the nation with the collection of toxic chemical throughput data. The New Jersey Release and Source Reduction Report (DEQ-114) requires that certain manufacturing-sector facilities submit information on an annual basis regarding a select group of toxic chemicals known as Environmental Hazardous Substances (EHS). By the nature of the information submitted, facilities are essentially conducting a modified materials balance for each EHS. The materials balance tracks the quantities of the EHS entering a facility and the amount of the chemical leaving the facility as products, as environmental releases, and as waste transfers. Yet, the DEQ-114 data do not necessarily generate a true materials balance (as described above). Throughput quantities include the amounts of the chemical maintained as inventory, produced on-site, brought on-site, consumed on-site, and shipped off-site as product and as waste. Regulated facilities are required to provide actual figures on the DEQ-114 when the quantities can be determined from existing records, measurements, or monitoring data. Where actual figures are not available, facilities are permitted to estimate the reportable quantities using a variety of methodologies including engineering calculations, small scale mass balance studies, published data (whether by similar types of industries or processes, by equipment manufacturers, or by government agencies), or best engineering judgment.

The Department has conducted outreach programs on the reporting requirements of the DEQ-114 and will continue to do so in the future to ensure that regulated facilities are made aware of their reporting obligations and to provide the public with the best data available. These data are being reviewed and evaluated critically by both the Right to Know program, the Office of Pollution Prevention, and other Department programs, as well as many individuals and agencies outside of state government. The Department plans to conduct further data reviews as well as site visits at facilities that have both good and poor reporting histories.

Many corporations have made public commitments to reduce or eliminate toxic materials in the workplace and the subsequent generation of hazardous wastes and releases to the environment. At the heart of such a commitment is the tracking of chemicals through the facility, quantifying chemical uses, and evaluating product as well as non-product output. The New Jersey Release and Source Reduction Report is the heart of this tracking mechanism.

The intent of this annual report is to enable citizens of this state to be aware of the chemicals which are manufactured, used, stored, and released in the state. New Jersey was one of the first states collect this type of data and to promote this type of awareness when the Right to Know law was enacted in 1983. An increased public awareness through Right to Know generated by both the state law and the federal SARA Title III combined with positive commitments by industry to reduce releases of toxic chemicals, leads to a cautiouly optimistic determination that the data indicates a decline in the usage and environmental releases of toxic chemicals in the state, as discussed in the sections on "TRI Releases and Transfers, 1987 - 1990," and on "USEPA's 33/50 Toxics Reduction Program." Through the continued availability of this Right to Know information and the implementation of New Jersey's Pollution Prevention Program, and industries' pledge reduce the generation, release and transfer of toxic chemicals, there is every expectation that this downward trend will continue.

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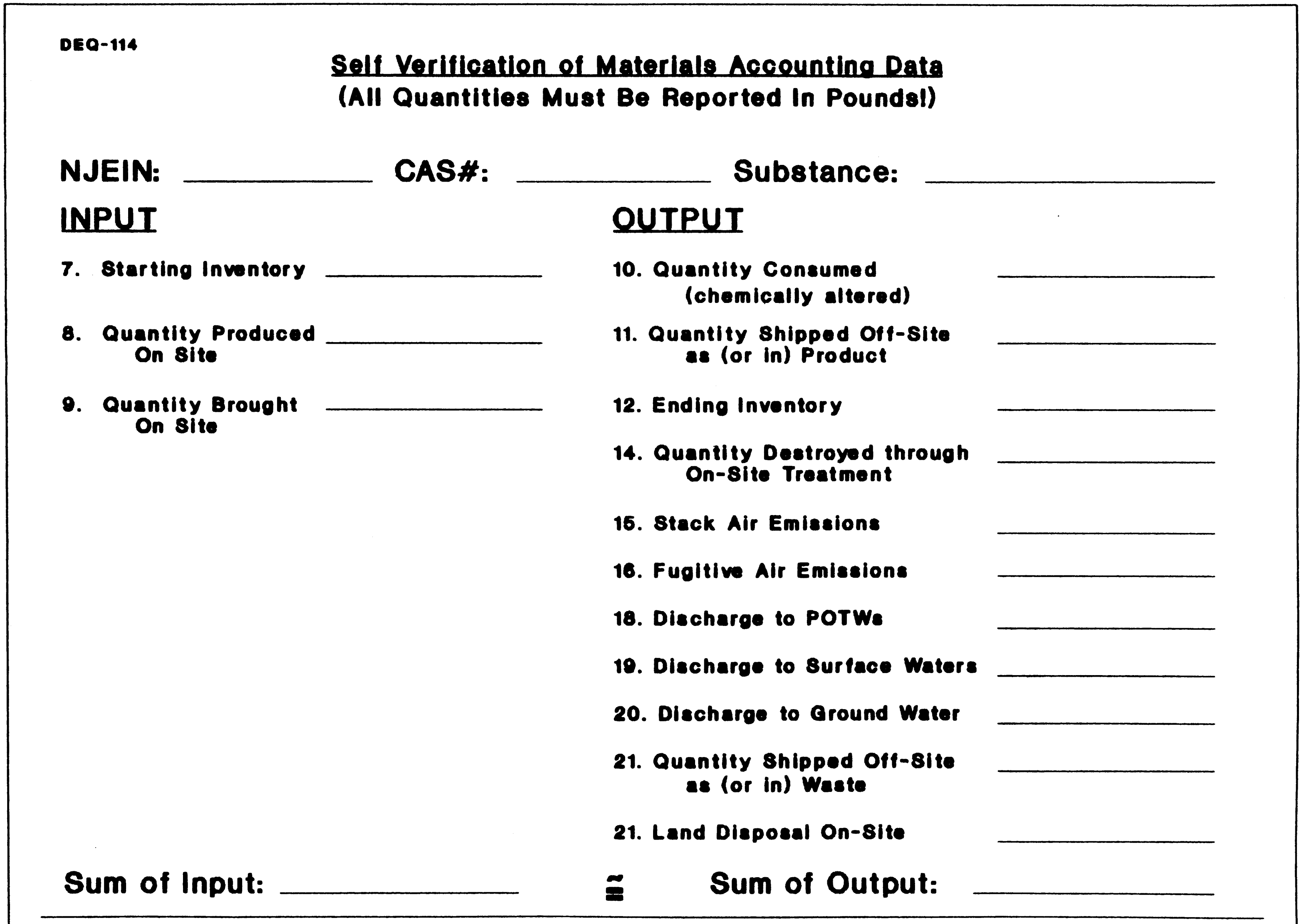

DEQ-114

Self Verification of Materials Accounting Data
(All Quantities Must Be Reported In Pounds!)

NJEIN: ____________ CAS#: ____________ Substance: ________________

INPUT		OUTPUT	
7. Starting Inventory	____________	10. Quantity Consumed (chemically altered)	____________
8. Quantity Produced On Site	____________	11. Quantity Shipped Off-Site as (or in) Product	____________
9. Quantity Brought On Site	____________	12. Ending Inventory	____________
		14. Quantity Destroyed through On-Site Treatment	____________
		15. Stack Air Emissions	____________
		16. Fugitive Air Emissions	____________
		18. Discharge to POTWs	____________
		19. Discharge to Surface Waters	____________
		20. Discharge to Ground Water	____________
		21. Quantity Shipped Off-Site as (or in) Waste	____________
		21. Land Disposal On-Site	____________

Sum of Input: ____________ ≅ Sum of Output: ____________

Figure 11. Self Verification of Materials Accounting Data Worksheet.

Table 19. Toxic Chemicals Reported Optionally[1] by New Jersey Manufacturers on the 1990 Release and Source Reduction Report.

Acetone
Aluminum
Ammonia
Barium
Barium compounds

Bis(2-chloroethyl) ether
Bromomethane
Butyl acrylate
n-Butyl alcohol
sec-Butyl alcohol

tert-Butyl alcohol
Butyl benzyl phthalate
Chloroacetic acid
Cobalt
Creosote

o-Cresol
Cyclohexane
Diethanolamine
Ethylene glycol
Freon 113

Glycol ethers
Isobutyraldehyde
Isopropyl alcohol
4,4'-Isopropylidenediphenol
Maleic anhydride

Manganese
Manganese compounds
Methanol
Methyl acrylate
Methylenebis (phenylisocyanate)

Methyl ethyl ketone
Methyl isobutyl ketone
Michler's ketone
Molybdenum trioxide
Nitric acid

Nitroglycerin
Phosphoric acid
Phthalic anhydride
Propionaldehyde
Selenium

Silver
Silver compounds
Sulfuric acid
1,2,4-Trimethylbenzene
Vinyl acetate

Zinc
Zinc compounds

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[1] These chemicals were not regulated by the New Jersey Community Right to Know Program in 1990, and therefore, were not required to be reported on the DEQ-114; they were subject to reporting requirements under the federal Toxic Release Inventory (SARA Title III, Section 313) and facilities chose to report them on the DEQ-114 as well.

to apply a one in one hundred thousand risk level to chemicals which are known human carcinogens (USEPA Group A carcinogens) and a one in ten thousand risk level to those chemicals which pose less of a carcinogenic threat (i.e., probable and possible carcinogens, or USEPA Group B and C carcinogens, respectively).

3.4 Illustrations of the Conservative Nature of USEPA's Cancer Slope Factor

The linearized multistage (LMS) model is a method by which the USEPA (and NJDEPE) generally estimates human cancer potency (i.e., cancer slope factors) from animal cancer studies (Armitage and Doll, 1961; Crump and Crockett, 1985). The model is a means of quantitatively extrapolating cancer incidence data from animals treated with high doses of chemicals to humans, who are typically exposed to far lower doses of chemicals in the environment. The model also assumes that response (tumor development) is linear for portions of the dose-response curve which cannot be experimentally evaluated (i.e., the low dose region). This section describes the conservative assumptions of the LMS model. Section 3.5 discusses the additional conservatism used by NJDEPE to estimate the cancer potency of chemicals.

3.4.1 The Maximum Tolerated Dose

The LMS model uses data from studies in animals to predict a theoretical carcinogenic response in humans. These animal studies require that certain features be included in the animal treatment regimen to assure that the carcinogenic potential of a chemical, no matter how small, is observed during the course of the study (an inherent conservative feature, since this forces acceptance of a high false positive rate to minimize a false negative rate). One such feature is the Maximum Tolerated Dose (MTD). Since it is not economically feasible to test chemicals at low doses with enormous numbers of animals to detect statistically significant increases in cancer incidence, high doses of chemicals are required to determine their carcinogenic potential. Thus, animal cancer studies use the MTD and, typically, one-half the MTD. The MTD is generally the dose (as established by test doses) which does not cause greater than a 10–15% decrease in body weight over a portion of the study period, typically, 13 weeks. In most instances, however, this 13-week period is not long enough to predict effects which may occur with lifetime (2-year) exposures in animals. Hence, in many animal cancer studies, the

$$\text{TCF} = \frac{5\ \text{days}}{7\ \text{days}} \times \frac{49\ \text{weeks}}{52\ \text{weeks}} \times \frac{25\ \text{years}}{70\ \text{years}} = 0.24$$

$$\text{Cancer risk} = \frac{4.3\ [\text{mg/kg/day}]^{-1} \times 1.0\ \text{mg/kg} \times 0.0001\ \text{kg/day} \times 0.24}{70\ \text{kg}} = 1.5 \times 10^{-6}$$

Thus, the lifetime cancer risks associated with incidental ingestion of soil containing carcinogenic metals at the State of New Jersey background concentrations are 1.5 to 6 times greater than the one in one million risk level.

3.3 Recommendations for Alternatives to the One in One Million Cancer Risk

In contrast to the one in one million cancer risk as a basis for the establishment of soil remediation standards, regulatory decisions by other agencies have been based on a cancer risk level less restrictive. For example, California has adopted a one in one hundred thousand value as the "no significant risk level" for the implementation of Proposition 65 (Kizer et al., 1988, p. 954). The one in one hundred thousand risk level is also acceptable under the Massachusetts Contingency Plan (310 CMR 40.545). Maryland (MDE, 1991, p. 15-14), Minnesota (MPCA, 1991, p. 34), Ohio (OEPA, 1991), and Oregon (ODEQ, 1991) use this one in one hundred thousand risk level for establishing ambient air quality standards, while the State of Mississippi (MOPC, 1991) has adopted a risk range of one in ten thousand to one in one million for this purpose. Louisiana uses this higher acceptable risk level (one in ten thousand) for establishing ambient air quality standards (LDEQ, 1992, p. 949).

In addition, Travis et al. (1987, p. 418) examined the basis for 132 federal regulatory decisions and reported that, while prior to 1980 it was generally agreed that the *de minimus* risk was one in one million, regardless of population, post-1980 policy has indicated that carcinogenic substances were not regulated if the risk to small populations was below one in ten thousand, or 100 times greater than the one in one million cancer risk level. Thus, given the examples of other states and the fact that such a risk would be undetectable in a small population impacted by a site that is either undergoing remediation or that has been remediated, the Commission should reconsider strict reliance on the one in one million cancer risk by following the lead of various state and federal agencies. A recommended approach would be

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Cancer risks associated with exposure to (incidental ingestion of) background soil levels of the carcinogenic metals arsenic and beryllium under nonresidential conditions exceed the one in one million risk level if one assumes the exposure and risk assumptions used by the NJDEPE to determine soil remediation standards. This is demonstrated in the following calculations:

1) Arsenic

$$\text{Cancer risk} = \frac{\text{SF x CS x IR x TCF}}{\text{BW}}$$

Where,

SF = cancer slope factor = 1.75 [mg/kg/day]$^{-1}$ (Technical Basis and Background Document for Cleanup Standards for Contaminated Sites, 1992, p. 12)

CS = background soil arsenic concentration in northern New Jersey = 10 mg/kg (Shacklette and Boerngen, 1984, pp. 18-19)

IR = soil ingestion rate = 100 mg/day = 0.0001 kg/day

$$\text{TCF} = \frac{\text{5 days}}{\text{7 days}} \text{x} \frac{\text{49 weeks}}{\text{52 weeks}} \text{x} \frac{\text{25 years}}{\text{70 years}} = 0.24$$

$$\text{Cancer risk} = \frac{1.75\ [\text{mg/kg/day}]^{-1} \text{x } 10 \text{ mg/kg x } 0.0001 \text{ kg/day x } 0.24}{70 \text{ kg}} = 6.0 \text{ x } 10^{-6}$$

2) Beryllium

$$\text{Cancer risk} = \frac{\text{SF x CS x IR x TCF}}{\text{BW}}$$

Where,

SF = cancer slope factor = 4.3 [mg/kg/day]$^{-1}$ (Technical Basis and Background Document for Cleanup Standards for Contaminated Sites, 1992, p. 12)

CS = background soil beryllium concentration in northern New Jersey = 1.0 mg/kg (Shacklette and Boerngen, 1984, pp. 22-23)

IR = soil ingestion rate = 100 mg/day = 0.0001 kg/day determined that the total background risk from the 11 chemicals was 1.4×10^{-3} (i.e., 1.4 cancers in 1,000 persons), or about 1,440 times greater than the State's proposed one in one million cancer risk level. They concluded that the total background cancer risk from all environmental chemicals is probably in the range of 2 to 5×10^{-3}, or 2,000 to 5,000 times greater than the one in one million risk level. Thus, the NJDEPE proposes to limit exposure to chemicals from its contaminated sites down to a level more than 1,000 times below that which is associated with background chemical exposure.

Archibald and Winter (1990) reported theoretical cancer risks associated with pesticide contamination of common foods. Several foods and their theoretical cancer risks are listed in Table 3-5. The lifetime cancer risks associated with eating these foods range from approximately 34 to 875 times greater than the one in one million cancer risk.

Table 3-5

Cancer Risks Associated with Ingestion of Pesticide-Contaminated Foods*

Food	Lifetime Cancer Risk† ($\times 10^{-6}$)
Apples	323
Beef	649
Lettuce	344
Oranges	376
Peaches	323
Pork	267
Potatoes	521
Tomatoes	875
Wheat	192
NJDEPE's cancer risk for establishing remediation soil levels for carcinogens	1

*Source: Archibald and Winter (1990).

†Based on average pesticide residue concentrations in these foods.

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Table 3-4

Risks Accepted by Job Category*

Job Category	Lifetime Risk of Accidental Death (x 10^{-6})
Coal mining	
Black lung disease (1969)	560,000
Accident (1970-1974 average)	91,000
Railroad worker (1974)	91,000
Fire fighters (1971-1972 average)	56,000
Agriculture	
Total	42,000
Tractor driver (one driver/tractor)	9,100
Mining and quarrying (accident only)	42,000
Trade	42,000
Transportation and utilities	23,100
Airline pilot	21,000
Steel worker (accident only; 1969-1971)	19,600
Government	7,700
Truck driver (one driver/truck)	7,000
Jet-flying consultant; professor	7,000
Service	6,300
Manufacturing	5,600
NJDEPE's cancer risk for establishing remediation soil levels for carcinogens	1

*Source: Wilson (1980) (based on fatalities in 1975 unless stated otherwise).

Travis and Hester (1990) reported the risks associated with exposure to 11 organic chemicals (benzene, trichloroethylene, tetrachloroethylene, carbon tetrachloride, formaldehyde, xylenes, chloroform, dioxins/furans, dieldrin, ethylenebisdithiocarbamates, and PCBs) at "background" levels in the environment. Both home and workplace exposures were considered in their analysis. Applying methodology consistent with a "redundant conservative" approach, the authors

Table 3-3

Cancer Risks Common to Our Daily Activities*

Activity	Lifetime Cancer Risk ($x 10^{-6}$)
Tobacco (smoker)	
all risks†	210,000
cancer only	84,000
person in room with smoker	700
Air Pollution	
sulfates†	10,050
benzo[a]pyrene	2,100
Eating and Drinking	
cirrhosis (moderate drinker)†	2,800
4 tbsp. peanut butter/day (aflatoxin)	2,800
1 light beer/day	1,400
1 diet soda (saccharin)	700
1 pint milk/day (aflatoxin)	700
1/2 lb charbroiled steak/week	28
Contraceptive pills	1,400
Radiation Risks	
natural radiation at sea level	1,050
average medical x-ray	700
living in brick house vs. living in a wood house	350
Cosmic Ray Risks	
frequent flyer	1,050
living in Denver vs. New York	700
1 transcontinental flight/year	35
Airline pilot (50 hour/month)	35
NJDEPE's cancer risk for establishing remediation soil levels for carcinogens	1

*Adapted from Wilson (1980).

†Risks other than cancer.

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Table 3-2

Risks Accepted in Sports or in Our Daily Routine*

Activity	Lifetime Risk of Accidental Death (x 10^{-6})
Sunbathing (incurable skin cancer)	350,000
Motor vehicle (1975)	
Total	154,000
Pedestrian	2,800
Motorcycle racing	126,000-1,260,000
Horse racing	91,000-910,000
Automobile racing	84,000
Rock climbing (U.S.)	70,000
Powerboating	11,900
Air pollution	
Total U.S. estimate (sulfates)	10,500
Urban U.S. (benzo(a)pyrene)–cancer risk	2,100
Snowmobile	9,310
Canoeing	7,000-28,000
Falls	5,390
Living downstream of a dam	3,500
Football	2,800
Skiing	2,100
Boxing	1,400-2,800
Drowning (U.S.)	1,330-2,730
Inhalation and ingestion of objects	980
Home accidents (1975)	840
Bicycling (assuming one person per bicycle)	700
Fishing (drowning)	700
Electrocution	350
NJDEPE's cancer risk for establishing remediation soil levels for carcinogens	1

*Source: Wilson (1980).

3.2.2 Risks Associated with Daily Activities and Workplace Exposures

To further demonstrate the conservative nature of the one in one million cancer risk, we have compared this theoretical risk level to actual risks commonly encountered in our daily life. Most risk analyses of chemical exposure lack this perspective of the relative risks posed by other commonly occurring chemicals or by physical hazards in our surrounding environment. Wilson (1980, pp. 380-382) has provided the yearly risk of death associated with participation in various sports or common daily activities (Table 3-2). Common daily activities which also carry a risk of cancer are provided in Table 3-3 and the risk of death associated with going to work each day is provided in Table 3-4. [Note: For the purpose of comparing NJDEPE's one in one million lifetime risk to the risks published by Wilson (1980), this lifetime risk has been included.]

These tables illustrate three significant points. First, the theoretical one in one million risk is far smaller than a number of risks we normally consider to be acceptably small. Second, the one in one million risk is also smaller than the risk of death associated with various occupations (Table 3-4) or the unavoidable risk of cancer represented by the ambient levels of other carcinogenic agents commonly found in foods or homes (Table 3-3). Third, it must be remembered that the theoretical cancer risk of one in one million is not a true or measured risk; rather, it is an assumed risk calculated from animal data–data of questionable human relevance. In contrast to this assumed level of risk, most of the risks associated with the activities depicted in Tables 3-2 and 3-4 are actual or measured risks.

Table 3-1

Risks Associated with NJDEPE and USEPA Drinking Water Standards

Chemical*	NJDEPE MCL (μg/L)†	USEPA MCL (μg/L)§	Unit Risk (per μg/L)£	NJDEPE Cancer Risk#	USEPA Cancer Risk#
arsenic	–	50	5.00E-05	–	2.50E-03
beryllium	–	4	1.20E-04	–	4.80E-04
dibromochloromethane	–	100	2.40E-06	–	2.40E-04
bromodichloromethane	–	100	1.80E-06	–	1.80E-04
dioxin (2,3,7,8-TCDD)	–	0.00003	4.50E+00	–	1.35E-04
dibromoethane, 1,2-	–	0.05	2.50E-03	–	1.25E-04
dichloroethene, 1,1-	2	7	1.70E-05	3.40E-05	1.19E-04
polychlorinated biphenyls (PCBs)	0.5	0.5	2.20E-04	1.10E-04	1.10E-04
vinyl chloride	5	2	5.40E-05	2.70E-04	1.08E-04
toxaphene	–	3	3.20E-05	–	9.60E-05
chlordane	0.5	2	3.70E-05	1.85E-05	7.40E-05
heptachlor	–	0.4	1.30E-04	–	5.20E-05
heptachlor epoxide	–	0.2	2.60E-04	–	5.20E-05
dichlorobenzene, 1,4-	6	75	6.80E-07	4.08E-06	5.10E-05
hexachlorobenzene	–	1	4.60E-05	–	4.60E-05
benzo(a)pyrene	–	0.2	2.10E-04	–	4.20E-05
bromoform	–	100	2.30E-07	–	2.30E-05
atrazine	–	3	6.30E-06	–	1.89E-05
carbon tetrachloride	2	5	3.70E-06	7.40E-06	1.85E-05
chloroform	–	100	1.70E-07	–	1.70E-05
di(2-ethylhexyl)adipate	–	400	3.40E-08	–	1.36E-05
simazine	–	4	3.40E-06	–	1.36E-05
dichloroethane, 1,2-	2	5	2.60E-06	5.20E-06	1.30E-05
dichloropropane, 1,2-	–	5	1.90E-06	–	9.50E-06
chloropropane, 1,2-dibromo-3-	–	0.2	4.00E-05	–	8.00E-06
ethane, 1,1,2-trichloro	–	5	1.60E-06	–	8.00E-06
tetrachloroethene	1	5	1.50E-06	1.50E-06	7.50E-06
hexachlorocyclohexane, gamma-	–	0.2	3.70E-05	–	7.40E-06
alachlor	–	2	2.30E-06	–	4.60E-06
benzene	1	5	8.30E-07	8.30E-07	4.15E-06
pentachlorophenol	–	1	3.00E-06	–	3.00E-06
epichlorohydrin	–	10	2.80E-07	–	2.80E-06
phthalate, bis(2-ethylhexyl)	–	6	4.00E-07	–	2.40E-06
methylene chloride	2	5	2.10E-07	4.20E-07	1.05E-06
			Total Risk =	**4.52E-04**	**4.59E-03**
			Ave. Risk =	**4.52E-05**	**1.35E-04**
			% > 1 x 10^{-6} =	**80**	**100**

*Chemicals in this table have both MCL and oral unit risk values.

†Source: NJDWQI (1987).

§Source: USEPA (1993a).

£Sources: USEPA (1994); USEPA (1993b). Unit risks are based on a daily consumption of 2 liters of water.

#Cancer risk is the product of the MCL (column 2 or 3) and the cancer unit risk (column 4). Risks are expressed in scientific notation, where, for example, 2.50E-03 = 2.50 x 10^{-3}, or 2.5 cancer cases in one thousand persons.

The NJDEPE developed preliminary MCLs in 1987 for a total of 34 chemicals (NJDWQI, 1987). [Note: these MCLs have since been superseded by federal MCLs; John Fields, Bureau of Safe Drinking Water, personal communication, March 16, 1994.] Table 3-1 lists both federal (USEPA) and NJDEPE MCLs as well as the cancer unit risks (cancer slope factors expressed in units of water concentration) for the chemicals which possess oral cancer slope factors and are considered by the USEPA to be carcinogenic in humans.

Of the 34 chemicals in Table 3-1, the cancer risks associated with the consumption of 2 liters of water per day containing the chemical at its federal MCL concentration (determined by multiplying the MCL by the cancer unit risk) were greater than 1 x 10^{-6} (one in one million) for all 34 chemicals. The greatest individual cancer risk, 2.5 x 10^{-3} (or 2.5 cancers in 1,000 individuals) was for the consumption of arsenic at its MCL of 50 µg per liter. This value is 2,500 times greater than the State's proposed one in one million cancer risk level. The smallest risk, 1.05 x 10^{-6}, was for the consumption of methylene chloride at its MCL of 5 µg per liter. The average risk for all 34 chemicals was 1.35 x 10^{-4}, or 135 times greater than the proposed one in one million cancer risk level. The total risk, determined by summing the cancer risks for the 34 chemicals in Table 3-1, was 4.59 x 10^{-3}, or 4,590 times greater than the one in one million risk level. Theoretically, this means that one could consume drinking water containing all 34 chemicals and experience an acceptable cancer risk of 4.59 x 10^{-3}. Thus, this analysis indicates that the USEPA considers cancer risks of greater than one in one million (sometimes values 4,590 times greater) to be acceptable.

Risks due to the consumption of drinking water containing chemicals at 1987 NJDEPE MCLs were likewise generally greater than one in one million. Of the ten chemicals for which NJDEPE MCLs and unit risks exist, the cancer risks associated with eight chemicals exceed the one in one million risk level. The greatest individual cancer risk, 2.7 x 10^{-4} (or 2.7 cancers in 10,000 individuals) was for the consumption of vinyl chloride at its MCL of 5 µg per liter. This value is 270 times greater than the State's proposed one in one million cancer risk level. The total risk, determined by summing the cancer risks for the 10 chemicals in Table 3-1, was 4.52 x 10^{-4}, or 452 times greater than the one in one million risk level.

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site rules, the NCP specifically states that 10^{-6} should not be presumed to be the final target risk for hazardous waste sites, but instead a "point of departure" for deciding an appropriate target level (Kelly and Cardon, 1991, p. 5). Levels of 10^{-4} to 10^{-6} are given as a range of "generally acceptable risk," with the option that even 10^{-4} may be exceeded in some circumstances.

Thus, the one in one million risk of developing cancer was initially established as a screening tool to determine what carcinogenic animal drug residues merited further regulatory consideration. Since then, the original premise has been expanded to almost all areas of chemical regulation. Although the FDA intended to establish a lower regulatory limit of zero risk below which no further consideration would be given, many federal and state agencies have chosen to ignore the screening level intent of the one in one million risk and have adopted this value to represent a target level of acceptable risk. The NJDEPE is no different in this regard, since it has adopted the one in one million risk as the basis for determining acceptable soil remediation standards for carcinogenic chemicals. This has occurred despite the fact that Travis et al. (1987) reported that carcinogenic substances were not regulated by federal agencies if risks were below one in ten thousand, or 100 times greater than the one in one million cancer risk level (*see* Section 3.3).

3.2 Illustrations of the Conservative Nature of a One in One Million Cancer Risk

3.2.1 Cancer Risks Associated with Drinking Water Standards

One way to demonstrate that a one in one million cancer risk is a conservative risk level upon which to base soil remediation standards is to calculate the lifetime cancer risks associated with consumption of drinking water containing chemicals at their maximum contaminant levels (MCLs). MCLs are federally enforceable drinking water standards designed to protect public water users from adverse health effects due to chemical contamination of the water supply, and, as such, the cancer risks calculated for the carcinogenic chemicals on the MCL list are considered acceptable. MCLs are defined as the "maximum permissible level of a contaminant in water which is delivered to any user of a public water system" (USEPA, 1993a) and are set "as close as feasible" to levels for which no known or anticipated adverse health effects occur and which allow an adequate margin of safety (USEPA, 1990).

3.0 THE "REDUNDANT CONSERVATIVE" NATURE OF NJDEPE'S RISK PARAMETERS WHICH DETERMINE SOIL REMEDIATION STANDARDS

3.1 The "Scientific" Basis of the One in One Million Risk Level

Kelly and Cardon (1991) researched the origin of the one in one million risk level as the basis for regulatory activities concerning carcinogenic chemicals and, interestingly, found no sound scientific, social, or economic basis for it. The proposal for a *de minimus* risk was contained in a 1973 Federal Register notice by the Food and Drug Administration (FDA) concerning acceptable levels of chemical residues (specifically, diethylstilbestrol) in the edible portions of animals. In adopting this "threshold of safety" for carcinogenic animal drugs, the FDA referred to the work of Mantel and Bryan (1961), which reported on the subject of safety testing in animals. These authors arbitrarily selected as safe a one in one hundred million risk level (p. 459). When later asked how this number was selected, Mantel simply replied, "We just pulled it out of a hat" (Kelly and Cardon, 1991, p. 3). In the final FDA notice in the Federal Register (published in 1977), this level was reduced to one in one million, and it was stated this value represents a threshold of "essentially zero" risk for the purpose of determining acceptable levels of residues in meat products.

Over the past 17 years, as risk assessment principles and practices have broadened from FDA's concern for the use of possibly carcinogenic drugs in animals to a host of other agencies and applications (including water, air, hazardous waste, and others), the one in one million risk level was carried along as well. The concept of one in one million was repeated so often that it took on the stature of firm regulatory policy, although no reference to one in one million as a criterion for acceptable risk has been published in any USEPA regulation or guideline (Kelly and Cardon, 1991, p. 5). The first use of "acceptable risk" in USEPA guidance appears to be contained in the *Superfund Public Health Evaluation Manual* (USEPA, 1986, p. 83). This document stated that "... remedies considered should reduce ambient chemical concentrations to levels associated with a carcinogenic risk range of 10^{-4} to 10^{-7}" (one in ten thousand to one in ten million).

This range was modified to 10^{-4} to 10^{-6} under the National Contingency Plan (NCP). In codifying 10^{-6} (one in one million) for the first time in hazardous waste

Section 3.0 describes the "redundant conservative" nature of the risk parameters used in NJDEPE's soil remediation standards equation, i.e., the one in one million cancer risk and the cancer slope factor. Section 4.0 lists NJDEPE's "redundant conservative" exposure factors which appear in the above equation, i.e., the soil ingestion rate and time correction factors. In both of these sections, suggestions for alternative assumptions are provided to assist the Commission in proposing methodologies for the development of soil standards based on current scientific evidence which adequately protect the citizens and environment of the State. In Section 5.0, additional issues not specifically addressed in NJDEPE's soil remediation standards equation (oral bioavailability of chemicals from soil, half-lives of chemicals in soil, and subsurface soil remediation standards) are discussed and recommendations regarding these items are provided. Finally, Section 6.0 describes a method–Monte Carlo analysis–for eliminating "redundant conservative" assumptions from NJDEPE's soil remediation standards approach.

2.0 THE BASIS FOR DETERMINING SOIL STANDARDS FOR CARCINOGENS

Cancer potency estimates (cancer slope factors) are used to determine soil remediation standards for carcinogenic chemicals. In general, risk is determined by the following expression:

$$\text{Risk} = \text{dose} \times \text{cancer slope factor (SF)}$$

According to the proposed soil remediation standards guidelines (Technical Basis and Background Document for Cleanup Standards for Contaminated Sites, 1992, p. 10), standards for carcinogens (under nonresidential conditions) are determined by a variation of the above equation, in which a "risk specific dose" based on an assumed cancer risk of one in one million is substituted for dose.

$$\text{Risk Specific Dose (RSD)} = \frac{\text{assumed cancer risk}}{\text{cancer slope factor}} = \frac{1 \times 10^{-6}}{\text{SF}}$$

The RSD is also described in terms of the following factors:

$$\text{RSD} = \frac{\text{Soil Concentration} \times \text{Soil Ingestion Rate (IR)} \times \text{Time Correction Factor (TCF)}}{\text{Body Weight (BW)}}$$

Solving the above expression for the soil concentration (soil standard) term and substituting $\frac{1 \times 10^{-6}}{\text{SF}}$ for the RSD results in the following expression:

$$\text{Soil Standard} = \frac{\text{RSD} \times \text{BW}}{\text{IR} \times \text{TCF}} = \frac{1 \times 10^{-6} \times \text{BW}}{\text{SF} \times \text{IR} \times \text{TCF}}$$

Since soil standards used for regulatory purposes predict population risks rather than individual risks, conservative assumptions are made for all of the parameters describing risk and exposure. Analysis of the scientific literature, however, indicates that the NJDEPE's risk and exposure assumptions (used in the above equation) are "redundant conservative" assumptions. The following sections of this report describe the risk and exposure assumptions used by the NJDEPE to determine remediation standards for carcinogenic chemicals in soil.

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1.0 INTRODUCTION

The purpose of this document is to assist the State of New Jersey's Environmental Risk Assessment and Risk Management Study Commission (the Commission) in the selection of appropriate methods for the development of minimum remediation standards for chemicals in soil. The 10-member Commission was created by the Industry Site Recovery Act (ISRA)/Senate Bill S1070 in June of 1993 and was tasked by the State of New Jersey legislature to comment upon certain aspects of ISRA S1070: specifically, the proposal that minimum remediation soil standards for carcinogens be based on an excess cancer risk of one in one million, and the use of "redundant conservative" assumptions which determine exposure to contaminated soil from the State's remedial sites.

To assist the Commission in its evaluation of these specific aspects of ISRA S1070, the present document lists the primary "redundant conservative" components, describes the basis for their conservative nature, and also suggests alternative approaches which will allow the Commission to make recommendations on the development of soil standards based on "generally accepted and peer-reviewed scientific evidence" which will adequately protect the citizens and environment of the State. Since S1070 requires the Commission to address methodologies for the establishment of soil standards under both residential and occupational exposure conditions, this document focuses on the assumptions of these two scenarios. In addition, it is recommended that a probabilistic (Monte Carlo) approach be used to determine exposures and consequent minimum remediation standards for chemicals in soil.

the weaknesses of current risk assessment methods and has been embraced by the USEPA for use in risk assessments submitted to the Agency (Burmaster and von Stackelberg, 1989; Burmaster and Lehr, 1991; Burmaster and von Stackelberg, 1991; Paustenbach et al., 1991; Thompson et al., 1992). A number of Monte Carlo software programs (Crystal Ball®, @Risk) are commercially available and can be used to define full distributions for any or all of the exposure equation variables. Results of a Monte Carlo analysis of the proposed soil remediation standard for benzene (under nonresidential conditions) indicates this value is unnecessarily conservative. In fact, more than 90% of the values in the Monte Carlo distribution are greater than the proposed benzene standard. This analysis demonstrates the conservative nature of the NJDEPE's point estimate soil remediation standards and suggests that Monte Carlo analysis is a powerful but easy to use tool for eliminating "redundant conservative" assumptions from NJDEPE's soil remediation standard approach.

weeks of exposure per year) to account for climatic conditions which reduce the potential for exposure to soil, e.g., the average yearly number of rainy days, or the number of days in which the ground is frozen or snow-covered.

Two important considerations ignored by the NJDEPE's proposal concern bioavailability and half-life data for chemicals in soil. NJDEPE's assumption of 100% bioavailability is unduly conservative given that the systemic uptake of environmental contaminants is often reduced due to physiological limitations to absorption and physical interactions (e.g., binding) of chemical contaminants and soil. The absorption of chemicals as diverse as dioxins and metals by the human gastrointestinal tract has been shown to be relatively low (i.e., much less than 100%) when these chemicals originate in a soil matrix. The Commission should recognize the significance of this phenomenon when recommending approaches to developing remediation soil standards based on soil ingestion.

Incorporation of soil half-life data can result in remediation standards which are considerably greater than the values proposed. This is true even for chemicals which are considered to be relatively stable in soil, i.e., have relatively long half-lives, such as benzo(a)pyrene. The NJDEPE has proposed a soil remediation standard of 0.25 mg/kg for this chemical in the absence of half-life considerations (Technical Basis and Background Document for Cleanup Standards for Contaminated Sites, 1992). In contrast, the soil standard may be increased more than 10 times, to 2.99 mg/kg, when the half-life for this chemical (529 days) is considered. The effect of soil half-life on the final soil standard would be much more dramatic for a chemical with a short soil half-life, such as benzene. Therefore, the Commission needs to consider incorporating soil half-life data into its assessment of remediation soil standards for chemicals, especially for those constituents which disappear relatively rapidly from soil. Inclusion of soil half-life data will assure that exposures and risks from short-lived soil contaminants over the exposure periods assumed by the NJDEPE will not be grossly overestimated and that the resulting soil remediation standards will not be overly conservative.

As an alternative to the proposed <u>deterministic</u> approach which derives single point estimates of acceptable levels of chemicals in soil, the Commission should recommend a <u>probabilistic</u> (i.e., Monte Carlo) technique to develop distributions of acceptable soil remediation standards. Monte Carlo simulation addresses many of

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The NJDEPE has developed cancer slope factors for a total of 43 chemicals and uses these values to determine soil remediation standards for carcinogens. Of these 43 chemicals, the NJDEPE has overestimated slope factor values for a total of 12, some by as much as 16-fold. Thus, the NJDEPE has introduced conservative bias in its development of soil remediation standards simply by incorporating slope factors which are more conservative than those developed by the United States Environmental Protection Agency (USEPA).

Recent studies of soil ingestion in young children (Calabrese et al., 1989; Barnes, 1990; Davis et al., 1990; Sedman, 1989; van Wijnen et al., 1990) indicate a soil ingestion rate range of < 9 to 104 mg/day, with a range midpoint of approximately 50 mg/day. This midpoint value is considerably less than the default USEPA soil ingestion rates proposed by NJDEPE for residential conditions (200 mg/day for children and 100 mg/day for adults). The Commission should reevaluate the soil ingestion rates for children in light of this more recent data and adopt a value no greater than 50 mg/day when determining remediation standards for chemicals in soil under residential exposure conditions. Soil ingestion studies in adults indicate that less than 50 mg/day is appropriate for residential exposure conditions. As a result, the Commission should recommend an adult soil ingestion rate of no greater than 50 mg/day under residential exposure conditions. Although the NJDEPE proposed 100 mg/day to represent the amount of soil ingested under nonresidential (i.e., occupational) conditions, recent studies suggest that soil intakes for workers are likely to be much lower, perhaps on the order of 10 to 25 mg/day. Given these data, the Commission should recommend soil ingestion values of between 10 and 25 mg/day for workers.

The time correction factors proposed by the NJDEPE are "redundant conservative" assumptions and do not account for normal patterns of human behavior, such as time spent away from home on vacation, the average length of time at a single residence, the typical number of days spent away from a job due to illness or vacation, or the average number of years at a single job. Residence times (i.e., the number of years per lifetime) for individuals living near a particular site could be determined from local demographic information, and data from employment records could provide the average length of employment at a site which will be used for occupational purposes. In addition, the NJDEPE has not adjusted the exposure duration portion of the time correction factors (i.e., the number of be undetectable in a small population impacted by a site that is either undergoing remediation or has been remediated, the Commission should reconsider strict reliance on the one in one million cancer risk. A risk level reflective of the size of the population potentially affected would be more consistent with risk management decisions that federal and state agencies have made elsewhere.

The Commission should recognize that the process of deriving cancer slope factors involves several conservative steps that are independent of each other and that each step contributes a degree of conservatism to the final value. These conservative steps involve: 1) the use of a conservative model, the linearized multistage (LMS) model, to extrapolate high dose animal cancer data to low-level chemical exposures in humans; 2) the use of the maximum tolerated dose (MTD) in animal experiments which causes overt toxicity in animals and which may produce an observable number of tumors only at the doses tested; 3) the use of animals which display a high background incidence of certain tumor types, thereby exaggerating the potency of any chemical in a positive study; 4) the use of the "no-threshold" assumption which dictates that any dose, no matter how small, is associated with a finite incidence of cancer, even though certain carcinogens display threshold behavior; and 5) the use of a conservative (and unnecessary) animal-to-human scaling factor which attempts to convert the high doses given to animals which cause tumors to the appropriate low doses that humans are most likely to experience. These conservative features produce slope factors representing the upper bound of carcinogenic potency. Therefore, using the one in one million risk level in conjunction with conservative estimates of carcinogenic potency ensures that soil remediation levels represent risks far below one in one million.

The Commission should examine how the mechanism of carcinogenesis, the mathematical model selected to extrapolate cancer risk, and chemical pharmacokinetics affect cancer potency (slope factor) estimates. Human epidemiological evidence, where available, should be used to establish soil standards for carcinogens, particularly for chemicals for which a wealth of human data exists (e.g., carbon tetrachloride, tetrachloroethylene). Also, the Commission should consider the use of threshold extrapolation techniques for carcinogens reported in the literature to act via this mechanism (e.g., arsenic, dioxin).

reduced because multiplication of each conservative value produces an end value protective of 95 percent of the population. Therefore, point estimates for each equation variable which are more in line with the most probable or average value will produce a conservative yet protective soil remediation level.

Analysis of the scientific literature indicates that many of the factors used by the NJDEPE to develop remediation standards for soil are indeed "redundant conservative" assumptions. The factors which were specifically examined included:

- level of acceptable cancer risk;
- cancer slope factor;
- soil ingestion rate;
- time correction factors;
- oral bioavailability for chemicals in soil; and
- half-lives for chemicals in soil.

The one in one million cancer risk which serves as the basis for determining remediation standards for carcinogenic (cancer-causing) chemicals in soil is a "redundant conservative" assumption for two reasons. First, the one in one million risk level is below the level for most regulatory standards that have been promulgated by the federal government (Travis et al., 1987) as well as the risk level that the federal government and the State of New Jersey have adopted for many of their drinking water standards. Yet a contaminated drinking water supply is likely to impact a human population larger than that impacted by an area of contaminated soil. Thus, the NJDEPE's level of risk for areas of contaminated soil is inconsistent with the size of the population potentially affected. Second, there are a number of precedents other than the one in one million cancer risk for safe exposures to carcinogenic chemicals. For example, California has adopted a one in one hundred thousand value as the "no significant risk level" for the implementation of Proposition 65 (Kizer et al., 1988, p. 954). The one in one hundred thousand risk level is also acceptable under the Massachusetts Contingency Plan (310 CMR 40.545). Louisiana uses an even higher acceptable risk level (one in ten thousand) for establishing ambient air quality standards (LDEQ, 1992). Thus, given the examples of other states and the fact that such a risk would

Executive Summary

The State of New Jersey legislature has tasked the Environmental Risk Assessment and Risk Management Study Commission (Commission) to evaluate certain aspects of the Industry Site Recovery Act (ISRA)/Senate Bill S1070. The Commission, a 10-member panel of academic and industry representatives appointed by the Governor and members of the legislature, will specifically comment and make recommendations on: the proposal that minimum remediation soil standards for carcinogens be based on an excess cancer risk of one in one million; and the use of "redundant conservative" assumptions which determine exposure to contaminated soil from the State's remedial sites. This document presents a two-phased approach to assist the Commission in its assessment of these issues: a description of the primary "redundant conservative" components as well as the basis for their conservative nature, and recommendations for alternative approaches that will allow the development of remediation soil standards based on current scientific evidence which will adequately protect the citizens and environment of New Jersey. This document also indicates how a probabilistic (i.e., Monte Carlo) approach can be incorporated in the process for determining remediation standards for chemicals in soil.

The fact that remediation standards for chemicals in soil developed by the New Jersey Department of Environmental Protection and Energy (NJDEPE) are based on "redundant conservative" assumptions can be demonstrated in two ways. First, the point estimates for each equation variable are conservative values that have been selected to ensure that most human receptors will be protected. However, by selecting values conservative enough to ensure that each variable is itself protective for 90–95% of the population, Burmaster and Lehr (1991) demonstrated that the product of these variables is unnecessarily conservative. If, for example, three conservative (95th percentile) values are multiplied together, the outcome actually represents the 99.99th percentile of exposure, not the 95th percentile, a condition which rarely, if ever, would occur. Second, since the difference between the "average" or "typical" value and the more conservative (95th percentile) value is between 5- and 10-fold for most variables, then the final remediation value may be 125 to 1,000 times greater than the average value if only three variables determine the remediation level. Thus, when several conservative values are multiplied together, the need to select values above the 50th percentile is

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minimum, recommend that another Commission immediately be assembled to look at the subsurface soil criteria.

A final point before closing. Although the Chamber appreciates the fact that the written comments are not due till April 11, 1994, due to the short notice for this public hearing, the Chamber requests that this date be extended for 30 additional days so as to give the Chamber's membership more time to present their positions to the Commission themselves.

In closing, New Jersey always likes to consider itself a leader. Lets use this process to do just that. Let us be a leader in developing safe yet practical remediation standards. Let us not use data and concepts that were developed many years ago. Let us not use outdated data just because it is there. Let us take a proactive approach and use the most recent scientifically justifiable data and apply it in a practical way so as to make New Jersey a safe State, but yet a State that business's can thrive in once again! Thank you.

withdrawn proposal on Cleanup Standards for Contaminated Sites. This seems to be a serious omission. Just as the surface soil criteria included conservative and redundant assumptions so do the assumptions that were used to determine, "subsurface soil cleanup criteria" as the Chamber will refer to them as. This issue is of great importance in the fact, that as previously proposed, the Cleanup Standards for Contaminated Sites required the remedial party to remediate the surface soils to the subsurface soil levels if the subsurface soil levels were more stringent than the surface criteria. Prior to this Commissions task, greater than 50% of the subsurface soil cleanup levels met this criteria of being more stringent than the surface soil cleanup criteria. If the Commission determines that the surface soil levels were developed using conservative and redundant assumptions, it is safe to assume, that the subsurface soil cleanup levels would be more stringent for an even greater percentage of the chemicals. Based on this fact, the Commissions impact on recommending revisions to the surface soil cleanup standards would be greatly minimized. It is therefore strongly recommended that either the Commission look at the subsurface soil cleanup criteria concurrently with the surface soil cleanup criteria, or at a addition, the half-life of chemicals is also not addressed. Factors which contribute to the half-life of a chemical in soil include biodegradation, photodegradation, volatilization, leaching and surface runoff. These variables amongst others, such as binding coefficients, etc. should be incorporated into the equation so as to make it not only as realistic to real life conditions as possible but it would also make the remediation standards non conservative and redundant in nature.

Furthermore, the Chamber recommends that the Commission calculate the numeric remediation standards. Although this is not currently the Commissions task, the benefits would be two fold. Since it is the Commission that is doing the in-depth scientific study for developing the risk criteria, they would be most familiar with the applicability of the data as it relates to the risk process, and second, since the Commission is an uncompensated panel that will be dissolved after this task is complete, they would not have to be concerned to the political ramifications of their actions.

One other major point the Chamber would like to address is the fact that the Commission is not addressing "impact to groundwater soil cleanup criteria", previously referred to as the "subsurface soil cleanup criteria" in the now

This information is important not only when determining non-residential remediation standards but also for determining residential remediation standards. In particular, demographic and meteorological information should be used. As an example how this can impact the TCF, recent united States housing survey data suggest that the average total residence time for all U.S. households was 4.6 years. This, in addition to meteorological information would necessitate the lowering of the 29.5 years residence time that the NJDEPE proposed on using. In light of this, the Commission should review the most recent demographic, labor and meteorological information available for New Jersey. If this is done, it would seem to the Chamber, that the TCF would be reduced to a more realistic number.

The Chamber would like to comment on the equation that will be used in calculating the remediation standards. This equation should be as complete as possible so as to reflect the most realistic type situations. As the equation now stands it does not. For one, it does not address bioavailability, the amount or percentage of a chemical that would be absorbed by the body. While the NJDEPE made the assumption that 100% of the chemical is bioavailable the opposite is more likely the case. In

Another issue the Commission should look at is the time correction factor (TCF). The TCF accounts for the number days per week, weeks per year and years per lifetime a person would be exposed at a site. In regards to non-residential, the NJDEPE assumed that a person would be exposed to chemicals in the soil on the site for 5 days per week for 49 weeks per year for 25 years. In the age of transportation, where it is easy to move from one job to another, including company downsizing along with recent demographic information, it is highly unlikely that the average worker would not only be at the same site for 25 years, but would also be exposed to a contaminated area of that site for 25 years. In addition, the Department of Labor, in all probability, would also be able to supply documentation that would depict NJDEPEs criteria that an individual stays at the same job for 25 years as overly conservative. One other aspect the Commission should look at when looking at the TCF is the climatology of New Jersey. When there is adverse weather outside, it is very likely that the ingestion pathway would not be available. Meteorological data would show how many days it rains in New Jersey thus making the ingestion pathway unavailable. Also during the winter, the ground is frozen or snow covered for many days, as evidenced by this past winter, thus again negating the ingestion exposure pathway.

our members. The NJDEPE when they proposed their cleanup standards back in 1992 used an ingestion rate of 200 mg/day for children and 100 mg/day for adults. These numbers were based on studies that were done many years ago and in most likelihood, developed by using methodologies that are not now considered state of the art and or less accurate than those used today. There are many recent studies out there that show these numbers to be conservative in nature, an aspect the legislature directed the Commission to remove. For children, these recent studies show an ingestion rate in the range of less than 9 mg/day up to a maximum of 104 mg/day. For adults, recent studies suggest that ingestion rates in residential settings range from as little as 1 mg/day to 50 mg/day. In regards to occupational setting, even the USEPA in 1991 developed a default value of 50 mg/day. All of these numbers, that were developed in recent studies, are less than the 200 and 100 mg/day numbers proposed by the NJDEPE. It is recommended that the Commission reevaluate these ingestion rates proposed by the NJDEPE in light of more recent data and studies as mentioned above and come to a number that is not only protective of human health but are also realistic and not overly conservative as the numbers proposed by the NJDEPE. The Chamber is confident that ingestion rates when looked at in a scientific manner and based on recent data would be less than those proposed by the NJDEPE.

laws and regulations has adopted a higher risk level, a one in one hundred thousand as the "no significant risk level" for the implementation of their Proposition 65.

These examples illustrate two significant points. One is that the theoretical one in one million risk that the Commission is directed to address is far more conservative than a number of risks that are normally associated within the course of our daily activities. Second, it must be remembered that unlike the examples above, the theoretical cancer risk of one in one million is not a true or measured risk, but rather, it is an assumed risk calculated from animal data; data which was developed when the animals were injected with huge doses of chemicals in concentrations that far exceed anything that we would come into contact with in our daily activities. It is recommended that a risk value be developed that would be more in line with the daily activities that we are associated with, say one in 10,000 (10^{-4}), one in 100,000 (10^{-5}) or something in between.

One in one million cancer risk is not the only component that the Chamber's membership have a concern about. Soil ingestion is also of a concern to

Since I do not have a scientific background, my comments will not be technical in nature, but they will address the concerns of the Chamber's membership concerning the one in one million cancer risk along with the methodologies that were used.

To begin with, there is no scientific basis for the one in one million cancer risk. This risk level, which is also conservative in nature, will unnecessarily put the Chambers members at a competitive disadvantage. To demonstrate the conservative nature of the one in one million cancer risk, I am going to briefly compare this theoretical risk level to actual risks that are commonly encountered in our daily activities. For example, drinking one diet soda or drinking one pint of milk a day give us a lifetime cancer risk of 70 per 100,000. Natural radiation at sea level gives us a cancer risk of 105 per 100,000. Other risks associated with our daily activities such as driving a car is 15,400 per 100,000. Even in the home, the risk of having an accident is 98 per 100,000. All of these before mentioned risks, activities that we are exposed to in our daily lives are orders of magnitude higher than the conservative one in one million risk factor. Even California, the state that New Jersey seems to be in competition with for the strictest environmental

Good Evening. I am Michael A. Egenton, Manager of Governmental Relations for the New Jersey Chamber of Commerce. On behalf of the New Jersey Chamber of Commerce, I would like to thank the Environmental Risk Assessment and Risk Management Study Commission for this opportunity to comment and share our views on issues concerning the establishment of remediation standards.

Prior to the convening of the Commission, the New Jersey Department of Environmental Protection and Energy (NJDEPE) in 1992, proposed and then based upon comments received, withdrew cleanup standards that were based upon on a one in one million cancer risk. A review of the criteria that the NJDEPE used in developing those proposed cleanup standards showed that the methods and criteria used by the NJDEPE were redundant and conservative in nature. It is on the redundancy and conservativeness of the NJDEPEs withdrawn proposal that I will base my testimony on.

Along with its 110 affiliated local and regional chambers of commerce, the New Jersey Chamber of Commerce represents more than 45,000 businesses throughout New Jersey.

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PUBLIC HEARING

SCIENTIFIC BASIS FOR THE SELECTION OF ONE IN ONE MILLION CANCER RISK, ALTERNATIVE SCIENTIFIC STANDARDS AND METHODOLOGIES

March 9, 1994

Camden County College
Lincoln Lecture Hall
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mechanism that will ensure that up-to-date information is available for use in site risk assessments. One possible suggestion would be to afford periodic reviews of any guidance documents associated with this process, so that updated information can be incorporated.

IV. SUMMARY

In directing the development of the site remediation standards, the commission has a unique opportunity to establish a system that can streamline the process of site remediation in the State of New Jersey. However, these values must be developed using the best available scientific information, including reasonable estimates of human exposure. Otherwise, application of these standards could force unnecessary expenditure of limited resources of both government and industry in direct contradiction to their originally intended use.

In many instances, site-specific risk assessment will play an integral part in the site investigation, evaluation and remediation process. However, if the results are to be meaningful, risk assessments must be conducted using the best available scientific information in a way that reflects realistic exposure conditions at a given site. Finally, no single estimate of risk can hope to portray the full breadth of information that supports a risk assessment. As such, ranges of risk and their associated uncertainties should be provided.

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agency to apply successive, conservative point estimates for exposure and toxicity inputs to the risk assessment. The flaws in this approach are several-fold, and the commission should bear these learnings in mind as it proceeds with its charge to develop risk assessment guidelines.

First, by using successive, multiple, conservative assumptions in the risk assessment, the resulting point estimate of risk can so dramatically exaggerate the actual risks posed by the site as to render the entire process suspect to criticism. At a minimum, estimates of central tendency for exposure variables, as well as reasonable maximum exposures, should be used in calculating risk.

Also, by condensing the risk information into single, point estimate descriptors, much of the underlying information that supports the risk assessment conclusions, and the associated confidence in these data are lost for the risk managers and the interested public. In order to make reasoned judgments about the need for and magnitude of remediation, ranges of risk should be provided, along with an indication of the degree of certainty associated with the various risk estimates.

One of the preferred means of describing both the range of risks presented and the degree of certainty associated with the various potential risks is a quantitative uncertainty analysis. Monte Carlo simulation (MCS) is one of the more readily available and established methods for performing a quantitative uncertainty analysis. In a MCS, probability distributions are substituted for the point estimate parameter variables in the exposure and risk equations. A computer then runs different combinations of values through the equations several thousand times calculating not a single estimate of risk, but a range of risks, along with the associated probability of occurrence for each. The benefit of a MCS is that it enables a full consideration of the complete range of parameter inputs, rather than placing undue credence on point estimates of exposure, the combination of which can result in an overestimate of risk that does not truly reflect site conditions.

The Risk Assessment Methodology Should be Kept "Evergreen":

Virtually every aspect of the field of risk assessment is evolving at a rapid rate. Scientific advances in dose-response assessment, exposure assessment, and risk characterization occur almost daily. In light of this rapid advancement, it is important that up-to-date methodologies be continuously applied in site-specific risk assessment, so that the best available approaches and information are being brought to bear on this important issue. Therefore, it is recommended that the commission develop a for residential purposes, unless there is a clear and compelling reason to do so. As acknowledged in S-1070, there are a number of administrative controls, such as deed notifications, that can be used to ensure future site land use, and hence the protectiveness of remedies based on such future uses.

Risk Assessments Should Include the Full Range of Scientifically Valid Toxicity Information:

In performing a risk assessment, it becomes necessary to evaluate the significance of the anticipated site exposures against established human health toxicity criteria. Such criteria include carcinogenic slope factors in the case of carcinogens, and verified reference doses for non-carcinogenic toxicants.

The USEPA's Integrated Risk Information System (IRIS) represents the source of constituent toxicity information that is most often used in site risk assessments. While IRIS is a valuable repository for toxicity information, it is not without its shortcomings and, in some instances, does not represent the full extent of information available on a given constituent. Although peer reviewed by a group of agency scientists, the IRIS database is not open to public peer review or comment. Moreover, frequently IRIS does not contain toxicity information on all of the constituents identified at a site. In these instances, the responsible site operator may be the only entity in possession of such information.

The various member companies of the CIC/NJ have extensive experience with managing exposures to their particular chemicals of interest, some of which are now found in waste sites. As such, the core toxicological and epidemiological information on these same chemicals of interest should be incorporated into the analysis and decision-making concerning hazardous waste sites. As noted in S-1070, a site-specific risk assessment may consider available toxicological data that are based upon generally accepted and peer reviewed scientific evidence or methodologies. Thus, the IRIS database should not be cast as the sole source of toxicity information for risk assessment; but rather, a broader range of scientifically valid data should be considered, when such data are available.

Site Risk Assessments Should Describe a Range of Risk and the Associated Uncertainty, Rather than Unrealistic "Point Estimates" of Risk:

The risk characterization stage of a risk assessment quantifies the risk associated with site contaminants and conditions. Unfortunately, historically there has been a tendency to distill the risk characterization information down into select "point estimates" of risk. This has largely arisen out of a desire on the part of the regulatory

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for human or environmental exposure. For example, even in situations where ground water is recognized as a non-potable resource, in Superfund baseline risk assessments EPA has required the assumption that ground water will serve as a source of drinking water. Further, under Superfund, engineering controls implemented to prevent human exposure often are not considered when it comes time to perform the risk assessment. This type of approach leads to the assessment of risks from a hypothetical site, rather than from the actual site under study.

While developing guidance on a risk assessment, the commission should strongly encourage the use of site-specific exposure information, to the extent such information is available, and reasonable assumptions in its absence. For example, if site-specific leaching tests are conducted to evaluate constituent migration in the subsurface environment, these data should be considered in assessing the potential for impacts to ground water. Similarly, if air monitoring data are collected, they should be used in favor of "generic" air release modeling information. Application of actual, site-specific data will reduce the uncertainty in the risk assessment, and hence will make the risk assessment a more meaningful tool in identifying actual risk to human health and the environment, and evaluating the need for site remediation.

As part of this assessment, site-specific institutional and engineering controls that limit exposure should be considered. For example, if a site's ground water is under hydraulic control such that off-site migration of contaminants in the ground water is not reasonable, such control should specifically be acknowledged when developing the site exposure scenarios.

There are numerous site-specific physiochemical attributes which also should be considered in evaluating site exposure. One such variable is contaminant bioavailability. Bioavailability (i.e., the degree of biological uptake from environmental media) of both organic and inorganic constituents is profoundly impacted by such site attributes as soil particle size, organic carbon and clay content, ion exchange capacity; and contaminant speciation. For example, the bioavailability of mercury ranges over several orders of magnitude, depending upon the particular metallic species involved. Also, lead bioavailability varies considerably from site-to-site, depending on the variables mentioned above. To the extent that such information is available on a site-specific basis, it should be included in the risk assessment. This approach is clearly consistent with the direction provided by S-1070.

Finally, a complete and accurate estimation of site risks must consider the actual present and expected future land use. Many of the sites that will be subject to restoration under S-1070 will involve land that is currently used for commercial or industrial purposes. Rather than industry locating facilities in "greenfields", former industrial sites should be recycled for industrial use. Therefore, in evaluating the risks from these sites, it would be inappropriate to assume that these sites would be used

1) the arithmetic mean of the concentrations in all soil samples shall be less than or equal to the applicable soil cleanup standard for a contaminant; 2) no single soil sample may exceed the standard by more than a specified factor, which is based on the standard concentration; and, 3) no more than ten percent of the samples may exceed the soil standard. While the first criterion is acceptable, meeting the other two criteria would implicitly require a mean much lower than the applicable cleanup standard. Thus these two latter requirements contradict the underlying methodologies employed in the developing the soil remediation standards. In fact, in order to meet the second and third criteria, the average concentration for a contaminant would have to be 25 to 100 percent less than the applicable remediation standard, regardless of the distribution of the soil sampling data. Therefore CIC/NJ believes that criteria (2) and (3) should not be employed to determine compliance with the developed standards.

III. PROPER APPLICATION OF SITE-SPECIFIC RISK ASSESSMENT

Use of generic standards will not be appropriate for many sites, due to either the complexities of these sites, or the impracticability of remediating to the generic standards. Thus, a clear reliance on risk assessment to direct resources at the aspects of a given site that contribute to the risk is necessary. Methods which overstate actual risks will result in unnecessarily excessive remedies, which will in turn drive misallocation of resources. Thus, CIC/NJ supports the use of scientifically sound, site-specific risk assessments which identify a range of risks to human health and the environment. CIC/NJ provides the following specific recommendations regarding the performance of risk assessments at hazardous waste sites for the commission's consideration.

Site Risk Assessments Should Consider Reasonable, Site-Specific Exposure Conditions:

The accurate characterization of human and environmental exposure is critical to providing a meaningful estimation of site risk, as ultimately, risk itself is a function of exposure. Because of this critical interdependence, actual site conditions should be used as the basis for estimating potential exposures. Moreover, exposure estimates should reflect both present and reasonably expected future land use.

The importance of accurate exposure assessment can best be depicted by examining the shortcomings of this aspect of the current federal Superfund risk assessment program. Under Superfund, a "baseline" risk assessment is performed which assumes virtually unlimited exposure to contaminated media, regardless of the actual potential previous directive, EPA states that: "OSWER believes that the best available approach [for setting cleanup levels] is to use the EPA Uptake/Model as a risk assessment tool to predict blood lead levels and to aid the risk management decision on soil lead cleanup levels at CERCLA/RCRA sites which are characterized as residential. The UBK model will predict blood lead levels in the most sensitive populations (i.e., children 0-6 years old)." When the model is run using the default parameters, an acceptable soil level of approximately 500 ppm is predicted for lead (USEPA, 1991b). This level is recommended for use in residential settings in New Jersey, in the absence of site-specific information to support an alternate cleanup level.

CIC/NJ also recommends that the Department consider an initial nonresidential remediation standard of 1,750 mg/kg. Two independent rationales support this goal. First, this remediation standard is supported by the Department-endorsed SEGH model, when proper input assumptions are used. Second, such a level would acknowledge the current USEPA policy for residential cleanups to 500 mg/kg, while reflecting the difference in anticipated exposure conditions between a residential and an industrial setting.

The Department's methodology for developing soil remediation standards should include a factor to account for the bioavailability of the constituents in soil. Variations in chemical speciation and adsorption onto the soil matrix can have a large impact on the degree of uptake of these constituents. Bioavailability is considered in the risk assessment process through the use of absorption adjustment factors (AAFs) (EPA, 1989b). These factors should also be included in the risk-based derivation of remediation standards, in order for these standards to be scientifically correct.

In the Department's initially-proposed cleanup standards an additional factor of ten was applied to the reference dose (RfD) for all contaminants classified as Class "C" carcinogens. CIC/NJ does not believe that it is appropriate to apply an additional "safety factor" to the RfD for "C" carcinogens. NJDEPE did not offer any rationale for this decision in the 1992 Technical Basis and Background Document. In taking this action NJDEPE has chosen to ignore the basis upon which EPA classified materials under a weight-of-evidence classification system. If the Department has particular concerns about the carcinogenic potential of a particular "C" carcinogen, then it should assess the existing carcinogenicity database for that contaminant, and make appropriate adjustments on a chemical-specific basis only.

A single, statistically valid criterion should be used to evaluate compliance with the remediation standards:

Three criteria were listed in the original cleanup level proposal by which compliance with the proposed soil cleanup standards would be evaluated. These criteria are:

distributions that describe the range of anticipated exposures conditions for a broad range of population characteristics. This approach reflects the current scientific trend in exposure assessment toward the use of the best available exposure factors coupled with information on available distributions.

In the event that the Commission elects to not embrace a Monte Carlo approach, at a minimum, an estimate of central tendency should be considered in addition to other exposure descriptors. Such an approach would be consistent with EPA's method for characterizing exposure and risk, as specified in a memo from former EPA Deputy Administrator Henry Habicht (February 26, 1992). That memo states: "It is Agency policy to present information on the range of exposures derived from exposure risk descriptors... Use of a range of descriptors, instead of a single descriptor enables Agency programs to present a picture of risk that corresponds to the range of different exposure conditions encountered for most environmental chemicals."

EPA's OSWER Directive 9285.6-03 (EPA, 1991a) provides data on time activity patterns. These data indicate that children do not spend all of their time at home outdoors. Moreover, adults are not at work the entire work week, and spend roughly two weeks of their time away from their residence. Thus, the assumptions used to calculate the standards should reflect these activity and time correction values. For example, the time correction factor (TCF) of 1.0 for residential exposure should be equal to 350/365 or 0.958, and not 1.0. CIC/NJ also suggests that exposure frequency for workers be adjusted to account for sick days, holidays, and state-specific meteorological conditions.

The soil ingestion rates of 200 mg/day for children and 100 mg/day used by NJDEPE to calculate previous cleanup standards significantly overestimate the risk and are not supported by more recent studies (Calabrese, 1989, 1990 and Van Wignen, 1990) NJDEPE should consider new evidence on soil ingestion rates for adults and children. For adults, recent studies by Calabrese (1990) suggest the best available estimated soil ingestion rates for adults and children is approximately four times less than the value proposed by NJDEPE.

Development of remediation standards should employ the best available methods for dose-response assessment, including application of pharmacokinetic models, consideration of chemical bioavailability in a soil matrix, and use of established procedures for deriving toxicity criteria:

A lead cleanup standard for soil should be based on USEPA's scientifically accepted Uptake and Biokinetic (UBK) Model. In 1989, USEPA established a policy for setting lead cleanup levels at CERCLA sites at 500-1000 mg/kg, based on a presumed residential use of the land (USEPA, 1989a). In an August 1991 clarification to the

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II. PROPER DEVELOPMENT OF SITE REMEDIATION STANDARDS

In February 1992, the NJDEPE proposed a new rule, Cleanup Standards for Contaminated Sites (N.J.A.C. 7:26D), along with the accompanying document, Technical Basis and Background for Cleanup Standards for Contaminated Sites. Due to the large volume of comments received on these proposed standards, NJDEPE did not promulgate these standards. In February 1994, members of the CIC/NJ received a document entitled Soil Cleanup Criteria (revised 2/3/94). This document stated, "This listing represents the combination of Tables 3-1 and 7-1 from the NJDEPE's February 3, 1992, proposed rule entitled, Cleanup Standards for Contaminated Sites, N.J.A.C. 7:26D, with noted corrections based upon errors identified to the Department during and subsequent to the comment period as well as new toxicological information obtained since the rule proposal." These documents have provided the CIC/NJ with an insight into the approach and methodology that NJDEPE has used in the past to develop cleanup standards. The cleanup standards, as they were calculated by NJDEPE in 1992, employed methods and assumptions that are no longer current in the field of risk assessment as practiced by USEPA and the scientific and consulting community. These inappropriate methods and assumptions compromise the resulting cleanup standards. The following comments and approaches are suggested by the CIC/NJ as improvements to this process and utilize the most up to date information available pertaining to the methodology for establishing remediation standards.

A range of reasonable exposure assumptions, including exposure duration, frequency, and time activity patterns should serve as the basis for developing remediation standards:

The use of fixed, often worst case exposure factors results in the development of standards which are unnecessarily conservative, and which do not reflect realistic exposure conditions. This overestimate of exposure results in the establishment of unnecessarily stringent remediation standards. Excessively stringent standards, in turn, will precipitate a large number of unnecessary cleanups taking place, thus diverting time and resources away from other potentially more significant sources of risk.

The standards should reflect a broad range of potential exposures, rather than point estimates of exposure. An approach that is technically superior to using point estimates is to apply a Monte Carlo simulation to develop remediation standards. In a Monte Carlo simulation, discrete point estimates of exposure are replaced with

I. INTRODUCTION

The New Jersey Chemical Industry Counsel (CIC/NJ), and its member companies have long been committed to the protection of human health and the environment. A significant aspect of that commitment involves the responsible management of hazardous wastes at active and abandoned waste sites. Consequently the CIC/NJ is supportive of legislative efforts that streamline the process of site investigation, evaluation and remediation. The Industrial Site Recovery Act (S-1070) specifically addresses this issue by establishing a commission to "...examine and assess methodologies of risk assessment and their efficacy and applicability for the purposes of establishing remediation standards." In support of the efforts of that commission, the CIC/NJ offers this document to provide input on these important topics.

The CIC/NJ applauds the efforts of both the New Jersey legislature and the New Jersey Department of Environmental Protection and Energy to establish remediation standards. Such standards could conserve the resources of both industry and the State by streamlining the site remediation process for simple, straightforward facilities. However, it is imperative that a reasonable, scientific approach be used in the development of such standards. If such an approach is not taken, the resulting standards have the potential to significantly strain the financial resources of both industry and the regulatory community, without clear environmental benefit. Section II of this document provides specific recommendations regarding the development of remediation standards, stressing the application of best available scientific information in all aspects of the standard setting process. The comments in Section II are based on the standards as proposed by New Jersey Department of the Environmental Protection and Energy in February 1992 and revised in February 1994.

Not withstanding the importance of reasonable remediation standards is the need to recognize the importance of site-specific risk assessment as a tool for site evaluation and remedy selection. CIC/NJ believes that "generic" remediation standards should only serve as a basis for remedy selection in instances where the benefits of remediating to the generic standards outweigh the possible cost of developing a site-specific remedy. Moreover, as acknowledged in S-1070, in many instances there will be a need to develop a site-specific remedy designed to reduce the risks posed by the particular site under consideration. Anticipating this need, Section III of this paper provides guidance on proper application of risk assessment technologies to characterize site risks and serve as a basis for remedy selection.

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PROPER APPLICATION OF RISK ASSESSMENT FOR CLEANUP LEVEL DEFINITION AND REMEDY SELECTION UNDER THE INDUSTRIAL SITE RECOVERY ACT (S-1070)

Prepared on Behalf of

The New Jersey Chemical Counsel

by

Kathleen Shelton, Ph.D.
Timothy Bingman, D.A.B.T.
E. I. du Pont de Nemours and Company
Wilmington, Delaware

March 1994

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COMMUNITY RIGHT TO KNOW INFORMATION REQUEST FORM

Name ____________________________
Address __________________________
____
Phone ____________________________
Date _____________________________

NJ Department of Environmental Protection and Energy
Bureau of Hazardous Substances Information
Community Right to Know Program
CN 405
Trenton, NJ 08625-0405

Attention: Bureau Chief

I am interested in obtaining the information listed below. I understand that there are photocopy or computer fees for producing certain types of reports. I further understand that I will be notified of charges exceeding $10.00 before the reports are sent.

I have checked off the types of information I am interested in.

___ 1. Facility Information

Please send me the hazardous substances inventory and TRI data for ...

FACILITY NAME: ____________________________
ADDRESS: ____________________________
CITY: ____________________ COUNTY: ____________________

___ 2. Municipality Information

Please send me a list of the names of all facilities subject to the Community Right to Know Reporting requirements and located in ...
(Municipality)____________________(County)____________________

I am interested in the above information because (check all that apply):

___ I am a local official interested in planning.
___ I am an emergency responder interested in being better prepared for hazardous materials incidents in my community.
___ I am a citizen who wishes to be more aware about hazardous substances stored and/or released in my community.
___ Other: ____________________________

Sincerely,

____

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COUNTY LEAD AGENCY ADDRESSES

Atlantic County Health Department
Community Right to Know Coordinator
201 South Shore Road
Northfield, NJ 08225
(609) 645-7700 Ext. 4378

Burlington County Health Department
Community Right to Know Coordinator
Raphael Meadow Health Center
Woodlane Road
Mount Holly, NJ 08060
(609) 265-5515 Ext. 120

Cape May County Department of Health
Community Right to Know Coordinator
Crest Haven Complex
Cape May Court House, NJ 08210
(609) 465-1208

Essex County Dept. of Health & Rehabilitation
Community Right to Know Coordinator
Environmental Health Office
125 Fairview Avenue, P.O. Box 500
Cedar Grove, NJ 07009
(201) 228-8212

Hudson Regional Health Commission
Community Right to Know Coordinator
215 Harrison Avenue
Harrison, NJ 07029
(201) 485-7001

Mercer County Clerks Office
Community Right to Know Coordinator
209 South Broad Street
Trenton, NJ 08650
(609) 989-6464

Monmouth Count Health Department
Community Right to Know Coordinator
Route 9 and Campbell Court
Freehold, NJ 07728
(908) 577-6796

Ocean County Board of Health
Community Right to Know Coordinator
175 Sunset Avenue
CN 2191
Toms River, NJ 08754
(908) 341-9700

Salem County Department of Health
Community Right to Know Coordinator
98 Market Street
Salem, NJ 08079
(609) 935-7510 Ext. 484

Sussex County Health Department
Community Right to Know Coordinator
RD 3, Box 166
Newton, NJ 07860
(201) 948-4545

Warren County Health Department
Community Right to Know Coordinator
Twin 57 Washington Office Center Complex
319 W. Washington Avenue, Suite 1
Washington, NJ 07882
(908) 689-6693

Bergen County Department of Health Services
Community Right to Know Coordinator
327 East Ridgewood Avenue
Paramus, NJ 07652
(201) 599-6150

Camden County Department of Health
Community Right to Know Coordinator
1800 Pavilion Building West
2101 Ferry Avenue
Camden, NJ 08104
(609) 756-3939

Cumberland County Health Department
Community Right to Know Coordinator
790 East Commerce Street
Bridgeton, NJ 08302
(609) 453-2158

Gloucester County Department of Health
Community Right to Know Coordinator
Carpenter Street and Allens Lane
Woodbury, NJ 08096
(609) 853-3411

Hunterdon County Health Department
Community Right to Know Coordinator
Administration Building
Flemington, NJ 08822
(908) 788-1351

Middlesex County Health Department
Community Right to Know Coordinator
417 Dennison Avenue
Highland Park, NJ 08904
(908) 828-3050

Morris County Department of Risk Management
Community Right to Know Coordinator
P.O. Box 900
Morristown, NJ 07963-0900
(201) 285-6113

Passaic County Right to Know Coordinator
Paterson Department of Health
176 Broadway
Paterson, NJ 07505
(201) 881-3926

Somerset County Solid Waste Dept.
Community Right to Know Coordinator
County Administration Building
North Bridge & High Streets
P.O. Box 3000
Somerville, NJ 08876
(908) 231-7000 Ext. 7511

Union County Dept. of Engineering & Planning
Community Right to Know Coordinator
Bureau of Environmental Affairs
County Administration Building, Elizabeth Plaza
Elizabeth, NJ 07207
(908) 527-4215

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Glossary of Acronyms Used in the Annual Report

33/50	USEPA's 33/50 Toxics Reduction Program
BHSI	Bureau of Hazardous Substances Information, NJDEPE
CAS	Chemical Abstracts Service
CRTK	Community Right to Know
DEQ-094	Community Right to Know Survey
DEQ-100	Supplemental Information Report
DEQ-114	Release and Source Reduction Report
EPCRA	Emergency Planning and Community Right to Know Act
Form R	Toxic Chemical Release Inventory Reporting Form, USEPA
GIS	Geographic Information System
NJDEPE	New Jersey Department of Environmental Protection and Energy
NJDOH	New Jersey Department of Health
NJDOL	New Jersey Department of Labor
POTW	Publicly Owned Treatment Works
SARA	Superfund Amendments and Reauthorization Act of 1986
SIC	Standard Industrial Classification
Title III	Emergency Planning and Community Right to Know Act
TRI	Toxic Chemical Release Inventory
USEPA	United States Environmental Protection Agency
W&CRTK	Worker and Community Right to Know

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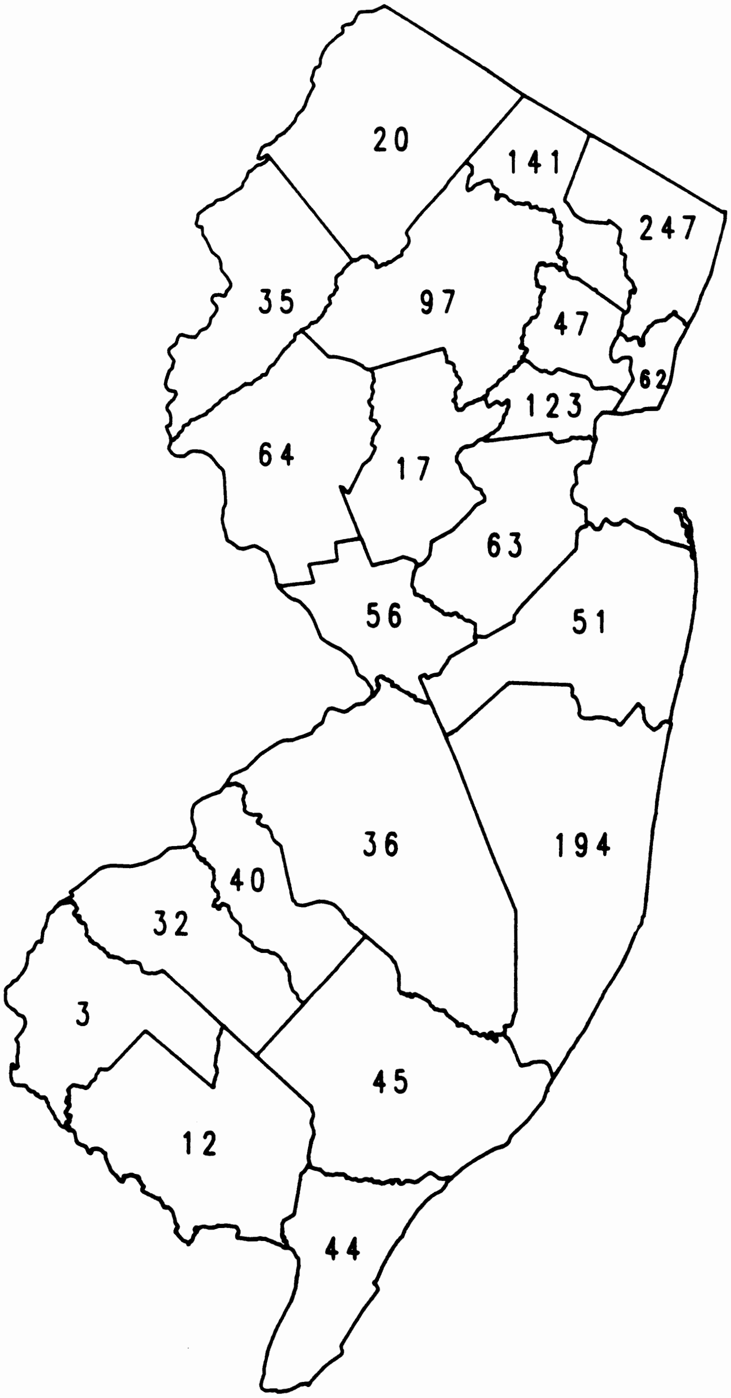

COUNTY	NO. FACILITIES
ATLANTIC	45
BERGEN	247
BURLINGTON	36
CAMDEN	40
CAPE MAY	44
CUMBERLAND	12
ESSEX	47
GLOUCESTER	32
HUDSON	62
HUNTERDON	64
MERCER	56
MIDDLESEX	63
MONMOUTH	51
MORRIS	97
OCEAN	194
PASSAIC	141
SALEM	3
SOMERSET	17
SUSSEX	20
UNION	123
WARREN	35
TOTAL =	1,429

Figure 13. Number of Community Right To Know Field Audits Conducted by the Department of Environmental Protection and Energy in 1991 by County.

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COMPLIANCE ACTIVITIES IN 1991

The Community Right to Know (CRTK) Program has been evaluating its compliance activities in order to increase compliance rates by industry groups (SICs) found to be delinquent in past reporting years. In 1991, the program continued to increase its compliance rate through aggressive efforts to identify industries that did not respond to the 1990 survey mailing. In addition, facilities in SIC groups which had less than 50% compliance as of the due date of March 1, 1991 were sent second surveys via certified mail.

A more aggressive field presence was initiated in 1990 through the use of local government agencies and local fire department referrals to the CRTK Program. In 1991, the County Lead Agencies proved extremely helpful by pursuing local businesses such as landscapers, dry cleaners, gasoline service stations, and automobile repair establishments.

Revisions to the survey booklet further clarified the requirements for compliance and included emphasis on penalties for non-compliance. Field audits were conducted to: 1) verify the accuracy of selected surveys, both with and without inventories reported, and 2) inspect non-responders. See Figure 13 for the number of field audits conducted by the Department within each county. Additionally, the Department placed emphasis on gaining compliance on regulated businesses which had not responded to the CRTK Survey for three consecutive years. These facilities were part of an intensive effort by compliance personnel to bring all regulated businesses into compliance with the law. These activities produced a significant increase in the compliance rate over reporting year 1989 (see the next section).

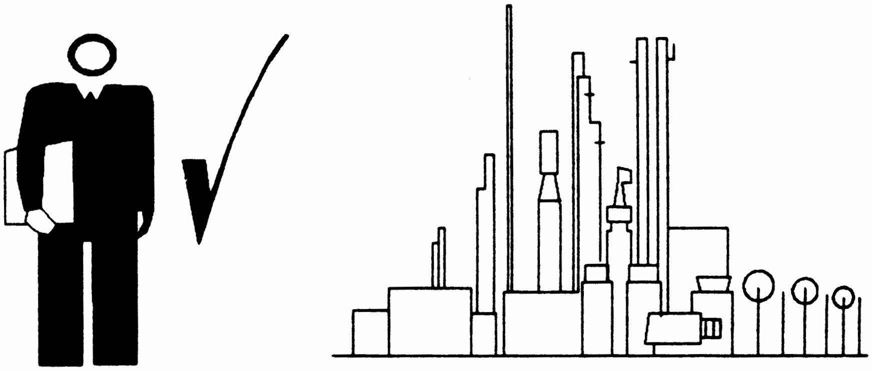
Figure 13 presents a summary of the number of field audits conducted by the Department in calendar year 1991. When compared to the number reported for 1990, a large decrease would be noted. This is not due to fewer actual field audits, but rather due to the method of tracking and accounting for this activity. In 1990 and earlier years, the number which was reported included all Department and county lead agency (CLA) Right to Know audits conducted, including many CLA audits which covered Worker Right to Know activities. In 1991, only Community Right to Know audits were accounted for.

The CRTK program also continued its quarterly database review and update with the state Department of Labor (NJDOL) to increase database reliability. This activity was found to be a critical factor in identifying the regulated community since, according to NJDOL, the state experiences a thirty percent turnover in active businesses each year.

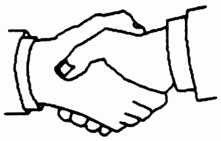
As a result of the shift in focus described above, only 337 administrative orders were sent to facilities for failure to submit their 1990 CRTK surveys, compared to 716 for the 1989 reporting year. The orders resulted in the collection of more than $40,000 in fines from businesses that had a history of noncompliance with the program.

Because of the large number of regulated companies, the Department has focused on programs that foster voluntary compliance with the Worker and Community Right to Know Act. These programs are directed at educating the regulated community to appreciate the importance of submitting their survey forms and offer guidance on how to comply. The Department will continue to work with the regulated community through outreach activities aimed at increasing Community Right to Know compliance.

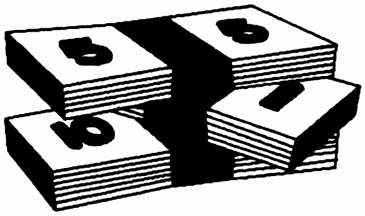
COMMUNITY RIGHT TO KNOW SURVEY
COMPLIANCE ACTIVITIES IN 1991



SITE INSPECTIONS



COOPERATION



PENALTIES

Table 22. 1990 Throughput Data Reported by New Jersey Facilities on the Release & Source Reduction Report (DEQ-114) (Ordered Numerically by Standard Industrial Classification Code).
(Summary Data Reported in Pounds.)

SIC	Category	Number of Facilities	# of Forms	Starting Inventory	Produced On-Site	Brought On-site	Consumed On-Site	Shipped Off-Site	Ending Inventory	Destroyed On-Site	Total[1] Input	Total[2] Output	Difference[3] (Input-Output)
20	Food & Kindred Products	17	40	1,045,323	51,059	6,738,719	1,077,490	4,132,488	861,518	1,671,813	7,835,101	8,161,441	-326,,340
21	Tobacco Manufacturing	0	0	0	0	0	0	0	0	0	0	0	0
22	Textile Mill Products	13	24	30,202	54,657	697,558	351,347	13,584	29,514	109,960	782,417	804,003	-21,586
23	Apparel & Other Textile Products	0	0	0	0	0	0	0	0	0	0	0	0
24	Lumber & Wood Products	4	9	535,214	0	8,270,477	193,034	7,454,184	374,842	0	8,805,691	8,051,863	753,828
25	Furniture & Fixtures	2	2	3,968	0	50,115	12,750	0	3,950	0	54,083	66,815	-12,732
26	Paper & Allied Products	16	30	936,304	82,000	14,792,583	7,181,290	757,701	661,278	4,892,621	15,810,887	16,288,558	-477,671
27	Printing & Publishing	7	12	150,530	0	773,247	244,095	73,499	107,651	262,000	923,777	1,108,602	-184,825
28	Chemicals & Allied Products	266	894	141,221,910	478,198,771	2,110,326,833	1,669,931,460	822,780,259	122,938,262	79,244,296	2,729,747,514	2,744,118,107	-14,370,593
29	Petroleum & Coal Products	15	67	294,473,522	3,627,780,817	3,128,085,758	440,878,437	6,287,139,747	329,925,550	670,482	7,050,340,097	7,063,886,623	-13,546,526
30	Rubber & Misc. Plastic Products	45	98	2,911,340	0	61,331,342	18,569,441	40,983,316	2,517,506	853,981	64,242,682	69,723,721	-5,481,039
31	Leather & Leather Products	5	9	101,697	0	1,141,073	385,469	123,768	110,208	0	1,242,770	1,255,445	-12,675
32	Stone, Clay & Glass Products	14	18	451,178	387,853	1,753,357	1,220,690	611,763	346,765	179,781	2,592,388	2,825,102	-232,714
33	Primary Metal Industries	50	114	30,287,027	633,654	354,149,501	15,225,272	337,911,742	21,545,961	1,256,445	385,070,182	392,980,560	-7,910,378
34	Fabricated Metal Products	76	161	3,798,758	260,000	23,813,610	562,995	15,306,265	2,563,453	4,704,753	27,872,368	27,724,645	147,723
35	Machinery, except Electrical	21	33	1,435,146	0	14,897,966	311,584	14,062,954	1,041,598	17,369	16,333,112	16,271,506	61,606
36	Electrical & Electronic Equipment	35	60	3,980,838	25,000,000	66,093,300	25,093,196	65,602,259	1,916,857	644,090	95,074,138	95,301,013	-226,875
37	Transportation Equipment	9	20	145,532	0	2,843,974	63,530	1,870,849	137,407	38,090	2,989,506	2,905,714	83,792
38	Instruments & Related Products	19	43	773,620	25,928	10,450,195	2,554,239	7,015,065	305,694	479,228	11,249,743	11,514,075	-264,332
39	Miscellaneous Manufacturing	7	13	2,492,806	16,215	13,030,769	712,583	12,094,619	2,349,009	111,003	15,539,790	15,319,404	220,386
	Total (Manufacturing Sector)	621	1,647	484,774,915	4,132,490,954	5,819,240,377	2,184,568,902	7,617,934,082	487,737,023	95,135,912	10,436,506,246	10,478,307,197	-41,800,951
	Non-Manufacturing	2	5	32,600	0	249,634	183,928	42,049	28,000	0	282,234	282,232	2
	1990 Total	623	1,652	484,807,515	4,132,490,954	5,819,490,011	2,184,752,830	7,617,976,131	487,765,023	95,135,912	10,436,788,480	10,478,589,429	-41,800,949

1. Total Input = starting inventory + quantity produced on-site + quantity brought on-site.
2. Total Output = quantity consumed on-site + quantity shipped off-site + ending inventory + quantity destroyed on-site + air emissions + water discharges + on-site land releases + waste transfers off-site.
3. Difference = input - output; a positive value means that a larger quantity is accounted for on the input side of the equation; a negative value means that a larger quantity is accounted for on the output side of the equation.

Table 21. 1990 Throughput Data Reported by New Jersey Facilities[1] on the Release & Source Reduction Report (DEQ-114) (Ordered Alphabetically by County[2]). (Summary Data Reported in Pounds.)

County	Number of Facilities	# of Forms	Starting Inventory	Produced On-Site	Brought On-site	Consumed On-Site	Shipped Off-Site	Ending Inventory	Destroyed On-Site	Total[3] Input	Total[4] Output	Difference[5] (Input-Output)
Atlantic	6	8	450,747	205,600	1,094,431	0	1,213,827	281,650	0	1,750,778	1,679,981	70,797
Bergen	75	214	5,101,708	170,620	103,340,939	28,086,698	67,966,365	4,147,863	4,972,412	108,613,267	109,371,474	-758,207
Burlington	26	71	5,393,081	857,371	197,227,111	176,096,793	18,698,822	4,103,492	2,213,909	203,477,563	203,393,417	84,146
Camden	31	68	648,147	454,053	7,326,443	2,789,761	3,949,730	613,611	44,580	8,428,643	9,171,520	-742,877
Cumberland	5	6	183,685	31,874	382,350	251,300	197,476	141,859	179,781	597,909	794,695	-196,786
Essex	79	205	19,029,571	66,452,435	287,628,710	67,645,049	278,493,407	14,995,813	591,231	373,110,716	373,541,541	-430,825
Gloucester	23	64	75,554,335	1,808,272,066	730,679,736	249,928,083	2,274,538,844	60,006,045	28,237,986	2,614,506,137	2,614,668,354	-162,217
Hudson	32	69	12,347,152	63,104,930	171,919,009	141,304,491	92,637,985	5,267,822	7,172,059	247,371,091	247,669,062	-297,971
Hunterdon	8	16	1,977,246	0	12,057,043	247,419	5,227,525	1,556,325	6,969,799	14,034,289	14,124,386	-90,097
Mercer	19	45	1,329,143	0	17,983,151	1,916,615	15,080,853	1,047,821	367,010	19,312,294	19,182,364	129,930
Middlesex	104	299	134,189,432	475,916,902	2,657,384,001	236,949,171	2,868,869,733	132,703,394	19,020,625	3,267,490,335	3,280,968,132	-13,477,797
Monmouth	18	44	1,036,509	3,009	12,917,812	2,462,413	6,572,270	1,188,045	727,933	13,957,330	13,678,347	278,983
Morris	38	77	2,569,862	1,178,250	21,500,594	4,213,836	15,951,360	1,980,794	240,063	25,248,706	25,915,847	-667,141
Ocean	5	24	2,586,830	0	13,570,158	10,852,523	3,085,272	457,610	1,419,538	16,156,988	16,151,197	5,791
Passaic	64	136	5,214,529	1,741,464	112,238,618	61,673,055	48,684,366	5,977,458	2,212,367	119,194,611	129,386,073	-10,191,462
Salem	6	51	60,768,915	161,619,779	720,360,174	720,330,127	153,411,374	54,524,783	18,376,660	942,748,868	953,628,720	-10,879,852
Somerset	19	48	663,738	49,950	8,174,570	1,529,175	6,372,993	624,754	106,350	8,888,258	14,821,526	-5,933,268
Sussex	4	5	32,280	0	366,277	0	0	73,277	0	398,557	397,557	1,000
Union	50	162	147,990,600	1,544,010,008	632,960,588	393,853,663	1,723,641,547	190,761,109	1,640,666	2,324,961,196	2,322,631,066	2,330,130
Warren	9	35	7,707,405	8,422,643	110,128,662	84,438,730	33,340,333	7,283,498	642,943	126,258,710	127,131,938	-873,228
Total	621	1,647	484,774,915	4,132,490,954	5,819,240,377	2,184,568,902	7,617,934,082	487,737,023	95,135,912	10,436,506,246	10,478,307,197	-41,800,951

90X

1. Manufacturing sector facilities only (SIC codes 20 through 39).
2. No facilities reported for Cape May County.
3. Total Input = starting inventory + quantity produced on-site + quantity brought on-site.
4. Total Output = quantity consumed on-site + quantity shipped off-site + ending inventory + quantity destroyed on-site + air emissions + water discharges + on-site land releases + waste transfers off-site.
5. Difference = input - output; a positive value means that a larger quantity is accounted for on the input side of the equation; a negative value means that a larger quantity is accounted for on the output side of the equation.

1. A materials accounting difference of zero was calculated for 619 chemical records.

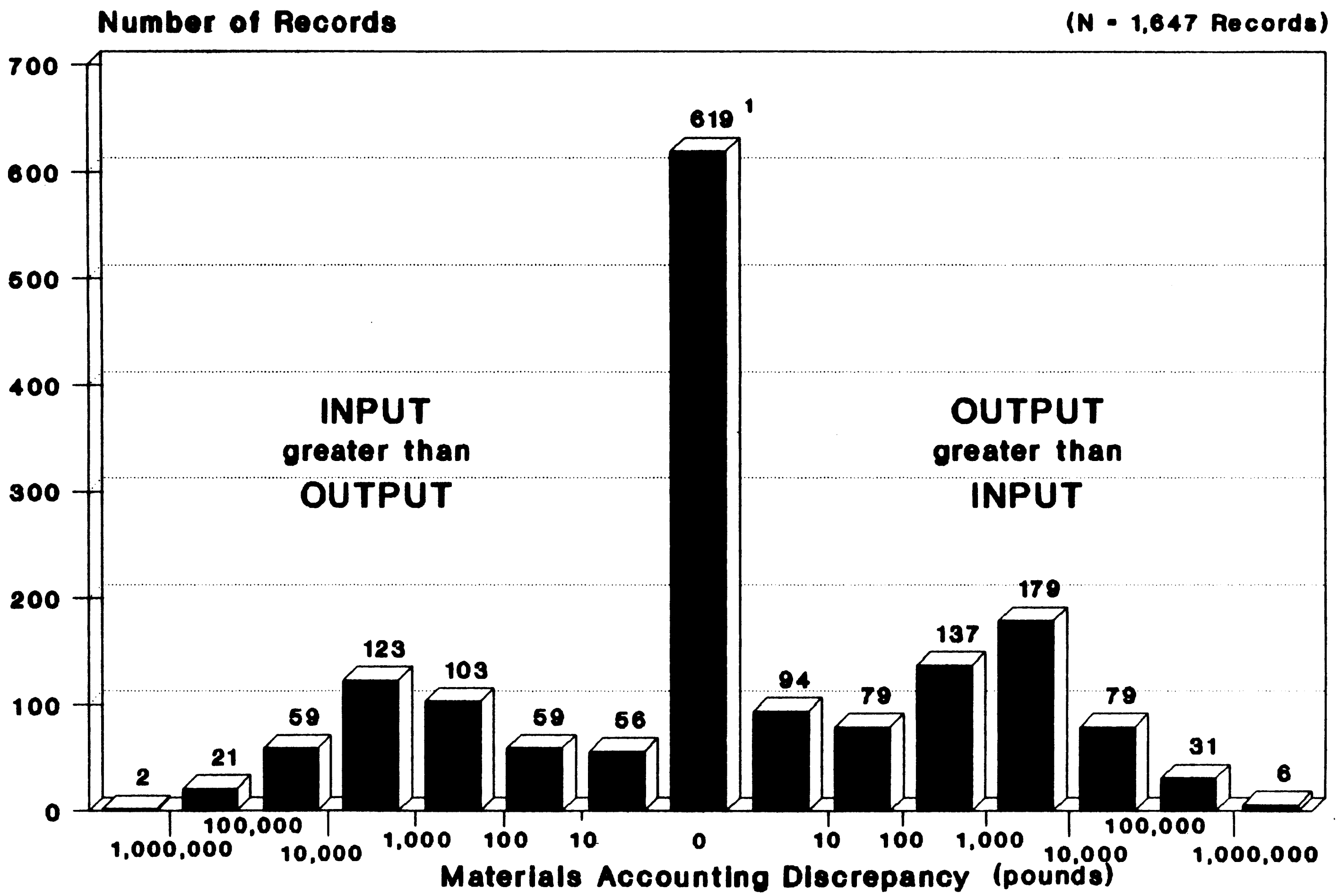


Figure 12. Number of Records by Difference in Materials Accounting, 1990 DEQ-114.

Table 20. 1990 Throughput Data Reported by New Jersey Facilities[1] on the Release & Source Reduction Report (DEQ-114) (Ordered Alphabetically by Chemical), Continued. (Summary Data Reported in Pounds.)

CAS #	Chemical Name	Starting Inventory	Produced On-Site	Brought On-site	Consumed On-Site	Shipped Off-Site	Ending Inventory	Destroyed On-Site	Total Input[2]	Total Output[3]	Difference[4] (Input-Output)	# of Forms
62-56-6	Thiourea	3,600	0	200,446	100,669	75,703	26,376	9	204,046	204,916	-870	3
108-88-3	Toluene	121,272,977	1,172,195,360	1,348,747,455	166,384,699	2,325,237,075	131,521,146	11,652,280	2,642,215,792	2,648,214,879	-5,999,087	157
26471-62-5	Toluene diisocyanate (mixed isomers)	311,485	0	10,395,971	10,391,886	9,700	292,852	24,000	10,707,456	10,718,633	-11,177	5
584-84-9	Toluene-2,4-diisocyanate	130,693	0	860,396	834,000	73,681	83,412	0	991,089	996,155	-5,066	8
91-08-7	Toluene-2,6-diisocyanate	2,669	0	77,076	76,443	420	2,859	3	79,745	79,739	6	3
95-53-4	o-Toluidine	938,138	11,760,000	766,690	799,514	12,720,000	401,003	162,000	13,464,828	14,091,363	-626,535	4
71-55-6	1,1,1-Trichloroethane	2,263,600	33,057	41,225,390	32,059,526	7,120,659	1,910,200	50,759	43,522,047	43,532,187	-10,052	94
79-01-6	Trichloroethylene	174,067	0	1,117,157	0	535,435	285,637	38,977	1,291,224	1,189,533	101,691	9
1582-09-8	Trifluralin	11,965	0	44,550	0	47,827	7,880	0	56,515	56,506	9	2
95-63-6	1,2,4-Trimethylbenzene	3,000	0	140,000	140,000	0	3,000	0	143,000	145,030	-2,030	1
51-79-6	Urethane	13,600	0	267,666	0	250,600	20,283	0	281,266	280,633	633	2
108-05-4	Vinyl acetate	168,576	0	4,526,375	4,414,343	20,000	166,302	17,500	4,694,951	4,677,375	17,576	2
75-01-4	Vinyl chloride	10,023,070	0	464,693,515	461,161,388	2,200	11,732,025	1,148,417	474,716,585	475,037,996	-321,411	4
75-35-4	Vinylidene chloride	6,666	0	82,000	79,157	0	9,480	0	88,666	90,654	-1,988	1
1330-20-7	Xylene (mixed isomers)	116,051,180	1,496,012,130	1,334,290,779	90,696,511	2,724,510,874	133,127,320	1,304,331	2,946,354,089	2,955,842,633	-9,488,544	113
108-38-3	m-Xylene	389,837	0	3,102,399	25,693	3,459,169	0	6,503	3,492,236	3,492,258	-22	2
95-47-6	o-Xylene	1,215,020	0	79,406,754	79,125,016	1,415,296	80,000	209	80,621,774	80,694,975	-73,201	3
106-42-3	p-Xylene	293,930	0	2,316,808	0	2,607,621	0	2,720	2,610,738	2,610,740	-2	1
87-62-7	2,6-Xylidene	8,000	120,000	0	0	150,000	10,000	3,200	128,000	165,123	-37,123	1
7440-66-6	Zinc	14,632	282,321	47,708	0	47,708	18,710	0	344,661	348,025	-3,364	3
	Zinc compounds	224,775	0	5,132,269	624,432	4,354,998	327,796	0	5,357,044	5,407,506	-50,462	15
	Total	484,774,915	4,132,490,954	5,819,240,377	2,184,568,802	7,617,934,082	487,737,023	95,135,912	10,436,506,246	10,478,307,197	-41,800,951	1,647

X88

There were 423 individual chemical records with an excess INPUT; the sum DIFFERENCE for those records = 13,183,463 pounds.
There were 605 individual chemical records with an excess OUTPUT; the sum DIFFERENCE for those records = 54,984,414 pounds.

1. Manufacturing sector facilities only (SIC codes 20 through 39).
2. Total Input = starting inventory + quantity produced on-site + quantity brought on-site.
3. Total Output = quantity consumed on-site + quantity shipped off-site + ending inventory + quantity destroyed on-site + air emissions + water discharges + on-site land releases + waste transfers off-site.
4. Difference = input - output; a positive value means that a larger quantity is accounted for on the input side of the equation; a negative value means that a larger quantity is accounted for on the output side of the equation.
5. One of four substances on the New Jersey Environmental Hazardous Substance List but not on the SARA Section 313 Toxic Chemical List - facilities were requested to report these substances at the Section 313 thresholds.
6. Isopropyl alcohol has a reporting qualifier of "manufacturing by the strong acid process". All records are reported here, however, several, by information included on the DEQ-114, are not manufacturing the substance at all.

Table 20. 1990 Throughput Data Reported by New Jersey Facilities[1] on the Release & Source Reduction Report (DEQ-114) (Ordered Alphabetically by Chemical), Continued. (Summary Data Reported in Pounds.)

CAS #	Chemical Name	Starting Inventory	Produced On-Site	Brought On-site	Consumed On-Site	Shipped Off-Site	Ending Inventory	Destroyed On-Site	Total Input[2]	Total Output[3]	Difference[4] (Input-Output)	# of Forms
96-33-3	Methyl acrylate	26,754	0	846,460	842,721	30,493	30,493	0	873,214	903,707	-30,493	1
101-14-4	4,4'-Methylenebis (2-chloro aniline)	28,510	0	221,420	102,990	131,740	15,200	0	249,930	249,930	0	2
101-68-8	Methylenebis (phenylisocyanate)	404,728	0	4,171,266	4,100,629	623,884	79,197	0	4,575,994	4,920,585	-344,591	8
101-77-9	4,4'-Methylenedianiline	99,590	0	1,200,965	1,188,319	63,978	1,981	28,500	1,300,555	1,289,113	11,442	2
78-93-3	Methyl ethyl ketone	511,081	0	4,801,780	639,612	2,608,061	437,042	848,501	5,312,861	5,850,991	-538,130	29
108-10-1	Methyl isobutyl ketone	174,297	0	699,570	0	222,028	136,640	104,303	873,867	877,043	-3,176	10
80-62-6	Methyl methacrylate	570,804	0	10,202,269	9,053,554	739,883	431,089	127,016	10,773,073	16,286,147	-5,513,074	14
90-94-8	Michler's ketone	0	0	1	0	0	1	0	1	1	0	1
1313-27-5	Molybdenum trioxide	32,800	0	206,732	0	206,732	32,800	0	239,532	240,440	-908	1
91-20-3	Naphthalene	12,036,237	117,000,000	91,297,032	9,028,759	198,523,656	13,411,798	1,980	220,333,269	221,051,482	-718,213	15
7440-02-0	Nickel	2,410,790	21,343	8,759,814	40,000	8,912,227	1,846,470	0	11,191,947	11,054,219	137,728	21
	Nickel compounds	167,794	30,405	1,779,750	289,998	1,212,486	160,074	19	1,977,949	1,981,597	-3,648	17
7697-37-2	Nitric acid	300,963	0	165,083,956	1,551,220	156,634,799	227,702	5,790,923	165,384,919	164,688,133	696,786	6
55-63-0	Nitroglycerin	1,507	1,132,548	0	1,048,434	1,044,434	0	1,000	1,134,055	2,119,139	-985,084	1
100-02-7	4-Nitrophenol	6,350	0	505,101	497,945	0	13,506	0	511,451	512,751	-1,300	1
79-46-9	2-Nitropropane	295	0	12,192	0	0	2,425	6,528	12,487	12,487	0	1
79-21-0	Peracetic acid	5,980	0	10,000	0	0	3,800	12,180	15,980	15,982	-2	1
108-95-2	Phenol	3,799,398	1,229,416	82,944,787	80,803,521	621,707	3,737,033	1,579,075	87,973,601	87,988,397	-14,796	20
90-43-7	2-Phenylphenol	32,624	0	236,270	41,900	186,250	35,154	0	268,894	268,047	847	2
75-44-5	Phosgene	32,680	51,258,075	4,704,000	55,048,075	0	26,680	920,000	55,994,755	55,995,457	-702	3
7664-38-2	Phosphoric acid	311,669	0	1,627,660	914,648	469,047	103,595	407,059	1,939,329	1,909,236	30,093	14
7719-12-2	Phosphorus trichloride[5]	2,850	0	97,500	94,800	0	5,550	0	100,350	100,350	0	1
85-44-9	Phthalic anhydride	436,157	0	12,504,051	12,591,481	0	331,552	81	12,940,208	12,941,261	-1,053	4
1336-36-3	Polychlorinated biphenyls (PCBs)	6,800	6,383	0	0	0	6,800	0	13,183	19,983	-6,800	1
123-38-6	Propionaldehyde	64,668	0	2,696,950	2,572,658	0	186,275	0	2,761,618	2761,618	0	1
75-56-9	Propylene oxide	984,308	0	28,583,268	28,676,363	110,894	594,770	55,670	29,567,576	29,567,382	194	8
7782-49-2	Selenium	19,331	0	55,512	0	12,641	22,065	0	74,843	74,843	0	1
7440-22-4	Silver	530	0	84,681	0	84,172	329	0	85,211	88,031	-2,820	1
	Silver compounds	19,838	0	39,155	15	51,479	7,280	0	58,993	59,008	-15	2
100-42-5	Styrene	2,678,481	0	144,560,700	143,659,045	935,834	2,588,786	7,596	147,239,181	147,259,487	-20,306	25
96-09-3	Styrene oxide	13,142	0	1,615,646	1,520,025	0	108,741	0	1,628,788	1,629,023	-235	3
7664-93-9	Sulfuric acid	8,324,007	41,824,668	105,971,076	45,523,505	90,970,857	8,228,159	6,285,343	156,119,751	156,959,170	-839,419	31
79-34-5	1,1,2,2-Tetrachloroethane	6,552	0	26,208	0	0	21,840	0	32,760	43,089	-10,329	1
127-18-4	Tetrachloroethylene	170,312	0	613,453	0	428,129	218,471	0	783,765	787,114	-3,349	10
961-11-5	Tetrachlorvinphos	39,000	0	118,500	0	132,487	21,828	0	157,500	158,635	-1,135	1

Table 20. 1990 Throughput Data Reported by New Jersey Facilities[1] on the Release & Source Reduction Report (DEQ-114) (Ordered Alphabetically by Chemical), Continued. (Summary Data Reported in Pounds.)

CAS #	Chemical Name	Starting Inventory	Produced On-Site	Brought On-site	Consumed On-Site	Shipped Off-Site	Ending Inventory	Destroyed On-Site	Total Input[2]	Total Output[3]	Difference[4] (Input-Output)	# of Forms
107-06-2	1,2-Dichloroethane	5,400,827	0	15,315,064	0	16,350,732	4,742,925	0	20,715,891	21,166,063	-450,172	3
75-09-2	Dichloromethane	1,817,858	0	9,355,029	195,968	4,750,010	1,644,404	18,627	11,172,887	9,926,019	1,246,868	43
78-87-5	1,2-Dichloropropane	191,094	0	2,106,120	1,528,686	576,568	129,300	4,410	2,297,214	2,292,714	4,500	2
111-42-2	Diethanolamine	10,585	0	67,441	40,641	23,137	13,923	0	78,026	77,971	55	3
117-81-7	Di-(2-ethylhexyl) phthalate (DEHP)	6,980,396	56,854,655	38,039,147	1,657,503	98,421,287	1,603,537	1,384	101,874,198	101,891,327	-17,129	20
84-66-2	Diethyl phthalate	488,068	0	4,275,676	0	4,228,857	448,230	0	4,763,744	4,763,079	665	17
119-93-7	3,3'-Dimethylbenzidine	1,172	0	34,477	28,874	410	6,365	0	35,649	35,659	-10	1
77-78-1	Dimethyl sulfate	702,041	0	2,460,640	1,020,249	1,736,000	414,411	0	3,162,681	3,171,254	-8,573	5
121-14-2	2,4-Dinitrotoluene	301,722	1,681,379	0	0	1,433,000	473,120	71,728	1,983,101	1,982,276	825	1
117-84-0	n-Dioctyl phthalate	66,178	702,000	1,073,266	146,200	1,047,256	14,400	900	1,841,444	1,286,407	555,037	9
123-91-1	1,4-Dioxane	1,393	0	750,327	0	728,623	22,196	0	751,720	750,836	884	2
106-89-8	Epichlorohydrin	2,476,699	0	5,704,686	6,036,740	1,595,638	175,475	410,087	8,181,385	8,284,288	-102,903	9
100-41-4	Ethylbenzene	20,260,569	257,000,000	222,651,178	19,014,000	454,103,569	24,827,149	110,382	499,911,747	498,670,474	1,241,273	26
107-21-1	Ethylene glycol	476,275	2,584,506	6,320,754	3,578,276	2,526,917	571,723	12,580	9,381,535	9,405,917	-24,382	20
75-21-8	Ethylene oxide	2,422,940	0	53,388,788	48,039,756	5,404,588	2,269,956	48,487	55,811,728	55,812,103	-375	10
96-45-7	Ethylene thiourea	0	0	110,230	0	101,995	0	0	110,230	110,230	0	1
50-00-0	Formaldehyde	2,214,027	33,771,798	14,024,681	10,888,105	36,617,784	2,091,385	41,870	50,010,506	49,987,074	23,432	31
76-13-1	Freon 113	1,613,563	2,865	20,010,204	17,451	19,667,003	1,541,256	0	21,626,632	21,612,064	14,568	15
	Glycol ethers	204,813	0	2,146,540	163,785	1,019,748	274,008	0	2,351,353	2,321,146	30,207	15
67-72-1	Hexachloroethane	10,000	0	46,300	0	45,000	11,300	0	56,300	56,320	-20	1
302-01-2	Hydrazine	43,290	0	311,800	292,754	0	11,000	57,400	355,090	362,934	-7,844	2
7647-01-0	Hydrochloric acid	6,157,164	110,241,992	65,365,708	53,177,685	67,525,070	5,138,040	56,145,291	181,764,864	182,896,417	-1,131,553	110
7664-39-3	Hydrogen fluoride	2,544,788	145,500	50,015,409	40,688,620	7,162,476	2,884,326	2,879,172	52,705,697	53,684,899	-979,202	16
7783-06-4	Hydrogen sulfide[5]	1,603,200	196,100,000	190,000	116,000,000	79,900,000	1,803,200	18,000	197,893,200	197,742,693	150,507	3
123-31-9	Hydroquinone	63,340	0	957,909	231,405	734,433	47,784	0	1,021,249	1,021,155	94	5
78-84-2	Isobutyraldehyde	11,292	0	48,280	0	0	9,853	0	59,572	59,572	0	1
67-63-0	Isopropyl alcohol[6]	13,975	16,273	70,324	21,166	57,288	4,400	0	100,572	100,573	-1	3
80-05-7	4,4'-Isopropylidenediphenol	605,581	0	3,326,359	3,759,713	57,092	4,207	0	3,931,940	3,843,336	88,604	2
7439-92-1	Lead	5,468,993	0	76,547,604	45,701,566	28,276,417	5,207,281	979	82,016,597	79,803,644	2,212,953	19
	Lead compounds	27,785,045	98,108,496	105,814,160	66,634,764	150,470,343	24,587,438	65,072	231,707,701	251,041,826	-19,334,125	40
108-31-6	Maleic anhydride	88,440	0	399,569	460,474	0	27,337	297	488,009	488,380	-371	3
7439-96-5	Manganese	16,575	0	147,880	0	147,880	18,825	0	164,455	168,032	-3,577	1
	Manganese compounds	49,660	0	4,596,574	0	132,404	149,240	0	4,646,234	4,666,234	-20,000	2
	Mercury compounds	171,175	0	274,998	0	394,598	51,575	0	446,173	446,173	0	2
67-56-1	Methanol	1,025,916	577,118	7,961,557	147,963	3,335,781	1,198,538	694,094	9,564,591	9,630,064	-65,473	24

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Table 20. 1990 Throughput Data Reported by New Jersey Facilities[1] on the Release & Source Reduction Report (DEQ-114) (Ordered Alphabetically by Chemical), Continued. (Summary Data Reported in Pounds.)

CAS #	Chemical Name	Starting Inventory	Produced On-Site	Brought On-site	Consumed On-Site	Shipped Off-Site	Ending Inventory	Destroyed On-Site	Total Input[2]	Total Output[3]	Difference[4] (Input-Output)	# of Forms
106-88-7	1,2-Butylene oxide	6	0	18	0	0	24	0	24	24	0	1
569-64-2	C.I. Basic Green 4	29,500	0	189,086	0	188,000	29,500	0	218,586	218,148	438	2
81-88-9	C.I. Food Red 15	11,195	0	131,850	67,312	55,000	20,732	0	143,045	143,044	1	2
3118-97-6	C.I. Solvent Orange 7	21,600	0	0	0	7,200	14,400	0	21,600	21,600	0	1
97-56-3	C.I. Solvent Yellow 3	21,620	84,763	0	69,091	16,692	17,600	0	106,383	103,383	3,000	1
842-07-9	C.I. Solvent Yellow 14	5,932	27,100	0	0	26,584	6,448	0	33,032	33,032	0	1
	Cadmium compounds	106,155	0	753,734	119,256	645,627	94,679	102	859,889	863,779	-3,890	13
63-25-2	Carbaryl	0	0	116,338	0	115,943	0	0	116,338	116,588	-250	1
56-23-5	Carbon tetrachloride	13,129,850	410,984	112,056,425	118,963,543	0	6,631,591	2,792	125,597,259	125,602,716	-5,457	3
120-80-9	Catechol	0	46,000	0	0	0	0	0	46,000	46,000	0	1
7782-50-5	Chlorine	4,132,876	46,000	176,955,518	143,113,115	30,554,313	4781325	2,671,365	181,134,394	181,301,115	-166,721	23
79-11-8	Chloroacetic acid	469,626	0	6,442,590	1,888,577	4,797,796	225040	0	6,912,216	6,911,413	803	2
108-90-7	Chlorobenzene	554,506	0	15,180,090	15,225,413	0	472835	9,687	15,734,596	15,751,091	-16,495	2
67-66-3	Chloroform	2,469,624	36,340	412,796	224,842	1,105,678	1353915	163	2,918,760	2,965,592	-46,832	8
126-99-8	Chloroprene	2,000	0	32,000	0	30,600	2000	0	34,000	32,600	1,400	1
7440-47-3	Chromium	1,085,427	1,000	3,843,441	156,729	3,807,547	898,545	50	4,929,868	5,052,554	-122,686	21
	Chromium compounds	1,322,053	3,352,725	7,190,557	3,880,986	6,130,074	1,329,005	7,563	11,865,335	11,956,403	-91,068	40
7440-48-4	Cobalt	44,559	0	431,314	81,547	330,835	42,170	0	475,873	478,037	-2,164	4
7440-50-8	Copper	28,165,501	0	323,098,501	1,986,220	314,284,184	19,772,160	25	351,264,002	351,481,517	-217,515	44
	Copper compounds	1,353,171	1,961,810	10,444,927	988,263	11,274,798	1,241,282	0	13,759,908	13,810,266	-50,358	44
8001-58-9	Creosote	443,130	0	6,940,013	0	6,303,792	301,609	0	7,383,143	6,629,601	753,542	2
95-48-7	o-Cresol	45,980	0	542,669	576,649	0	0	1,336	588,649	589,584	-935	1
98-82-8	Cumene	9,029,744	101,240,768	56,729,322	50,175,976	108,253,040	8,441,669	70,926	166,999,834	167,045,354	-45,520	6
80-15-9	Cumene hydroperoxide	332,902	5,059,597	0	0	4,946,115	431,268	15,116	5,392,499	5,392,520	-21	1
	Cyanide compounds	51,265	0	181,414	31,243	0	64,197	138,769	232,679	234,877	-2,198	10
110-82-7	Cyclohexane	1,788	0	32,532	28,600	0	3,218	0	34,320	32,845	1,475	1
1163-19-5	Decabromodiphenyl oxide	56,204	0	1,536,190	0	1,488,338	71,934	0	1,592,394	1,587,167	5,227	6
101-80-4	4,4'-Diaminodiphenyl ether	38,966	2,393,700	51,812	52,633	2,207,000	65,897	144,000	2,484,478	2,469,843	14,635	2
95-80-7	2,4-Diaminotoluene	68,980	0	63,944	91,459	14,000	26,851	0	132,924	132,813	111	2
106-93-4	1,2-Dibromoethane	2,171,424	0	30,663,064	0	29,631,756	3,865,904	0	32,834,488	33,517,973	-683,485	1
84-74-2	Dibutyl phthalate	955,477	3,328,527	879,619	0	4,922,544	175,613	950	5,163,623	5,175,863	-12,240	14
25321-22-6	Dichlorobenzene (mixed isomers)	212,706	0	198,928	0	50,198	179,778	0	411,636	411,176	460	2
95-50-1	1,2-Dichlorobenzene	941,029	0	25,715,850	26,222,462	20,000	353,417	36,138	26,656,879	26,695,426	-38,547	3
106-46-7	1,4-Dichlorobenzene	0	0	276,100	0	260,000	16,100	0	276,100	276,350	-250	2
91-94-1	3,3'-Dichlorobenzidine	106,950	0	1,212,880	1,259,629	0	59,600	1	1,319,830	1,319,230	600	3

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Table 20. 1990 Throughput Data Reported by New Jersey Facilities[1] on the Release & Source Reduction Report (DEQ-114) (Ordered Alphabetically by Chemical). (Summary Data Reported in Pounds.)

CAS #	Chemical Name	Starting Inventory	Produced On-Site	Brought On-site	Consumed On-Site	Shipped Off-Site	Ending Inventory	Destroyed On-Site	Total Input[2]	Total Output[3]	Difference[4] (Input-Output)	# of Forms
75-07-0	Acetaldehyde	5,573	1,600	343,532	314,670	0	34,435	745	350,705	357,335	-6,630	2
67-64-1	Acetone	3,203,267	0	7,155,918	4,011,839	987,099	2,907,620	550,343	10,359,185	11,197,778	-838,593	29
79-10-7	Acrylic acid	229,824	0	2,170,423	1,695,792	510,938	187,567	948	2,400,247	2,409,829	-9,582	14
107-13-1	Acrylonitrile	248,934	0	3,041,560	3,067,544	36,000	175,993	10,938	3,290,494	3,294,866	-4,372	6
107-05-1	Allyl chloride	291,832	0	17,153,792	17,205,921	0	198,438	0	17,445,624	17,426,005	19,619	2
7429-90-5	Aluminum	921,360	0	2,064,305	0	2,296,030	677,768	0	2,985,665	2,975,959	9,706	1
60-09-3	4-Aminoazobenzene (C.I. Solvent Yellow 1)	4,685	0	16,500	12,760	0	8,425	0	21,185	21,185	0	2
7664-41-7	Ammonia	630,695	110,742	26,449,227	2,240,730	23,432,935	965,685	86,151	27,190,664	27,610,641	-419,977	21
62-53-3	Aniline	500,225	0	3,390,606	3,102,813	51,675	733,897	1,018	3,890,831	3,912,767	-21,936	11
90-04-0	o-Anisidine	31,616	0	62,009	73,293	0	20,332	0	93,625	93,625	0	2
120-12-7	Anthracene	1,008,771	3,400,000	28,392,650	0	30,386,844	1,833,149	240	32,801,421	32,222,703	578,718	4
7440-36-0	Antimony	48,500	0	981,089	0	980,939	48,303	0	1,029,589	1,032,838	-3,249	5
	Antimony compounds	465,843	99,368	3,428,495	114,565	3,420,306	379,815	2	3,993,706	3,981,767	11,939	25
	Arsenic compounds	49,376	0	302,580	65,934	231,294	48,621	0	351,956	354,994	-3,038	8
1332-21-4	Asbestos	500,000	0	419,150	0	419,150	500,000	0	919,150	920,529	-1,379	1
7440-39-3	Barium	75	0	645	0	974	101	0	720	1,145	-425	1
	Barium compounds	238,462	0	1,134,054	178,250	890,509	194,046	0	1,372,516	1,385,880	-13,364	8
98-87-3	Benzal chloride	51,207	3,887,677	0	0	3,793,928	144,951	0	3,938,884	3,975,892	-37,008	1
71-43-2	Benzene	24,198,255	278,855,082	218,587,242	66,391,370	428,003,446	26,606,453	73,759	521,640,579	521,333,708	306,871	13
98-88-4	Benzoyl chloride	26,493	0	80,250	94,907	0	11,833	0	106,743	106,743	0	2
94-36-0	Benzoyl peroxide	8,470	0	242,771	223,315	0	27,726	0	251,241	251,300	-59	2
100-44-7	Benzyl chloride	991,398	69,326,933	10,613,505	47,985,453	30,752,273	1,308,010	18,430	80,931,836	80,542,265	389,571	9
7440-41-7	Beryllium	20,000	0	200,000	0	100,000	20,000	0	220,000	120,000	100,000	1
	Beryllium compounds	5,580	0	17,780	0	17,400	5,680	0	23,360	23,334	26	1
92-52-4	Biphenyl	28,760	6,510	212,715	68,346	125,639	19,143	0	247,985	247,927	58	4
111-44-4	Bis(2-chloroethyl) ether	12,210	0	55,000	59,510	0	7,700	0	67,210	67,210	0	1
103-23-1	Bis(2-ethylhexyl) adipate	673,152	2,591,440	1,114,911	580,000	3,609,180	224,508	0	4,379,503	4,442,051	-62,548	8
7726-95-6	Bromine[5]	495,320	0	2,970,875	3,112,597	5,755	271,558	96,244	3,466,195	3,495,096	-28,901	6
74-83-9	Bromomethane	0	0	15,500	0	0	0	0	15,500	31,000	-15,500	1
106-99-0	1,3-Butadiene	130,060	5,530,000	1,480,000	1,000	7,030,000	110,060	0	7,140,060	7,141,596	-1,536	2
141-32-2	Butyl acrylate	98,863	0	1,522,428	1,497,403	4,400	118,045	0	1,621,291	1,621,291	0	2
71-36-3	n-Butyl alcohol	681,650	0	3,165,561	158,437	1,734,810	554,478	30,669	3,847,211	3,839,722	7,489	10
78-92-2	sec-Butyl alcohol	22,488	0	895,733	0	871,432	46,334	0	918,221	918,221	0	1
75-65-0	tert-Butyl alcohol	738,882	0	176,249	125,631	34,102	655,357	0	915,131	915,131	0	3
85-68-7	Butyl benzyl phthalate	2,300,380	0	11,451,992	767,439	10,571,602	2,181,172	0	13,752,372	13,535,450	216,922	7

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MTD is actually exceeded and the dose rate may have to be adjusted during the course of the experiment. Theoretically, the MTD is the highest dose at which the normal bodily functions of the animal are not significantly interrupted; thus, the MTD is biased to the high dose side to ensure that the carcinogenic potential is not underestimated. That is, negative responses cannot be criticized as possibly being the result of testing an inadequate dose.

Because the criteria for selecting the MTD are rather crude, it may allow various forms of toxicity to exist for the duration of the study. Thus, implementation of the MTD can have serious consequences on the biological relevance of any tumor that does occur. For example, the MTD may be high enough to cause chronic hormonal changes that produce tumors secondary to alterations in cellular growth. Examples of chemicals that appear to operate in this fashion are 2,3,7,8-TCDD (dioxin) and PCBs (National Research Council (NRC), 1993, p. 45). Thus, while one regulatory goal is satisfied by incorporating the MTD into cancer bioassays (i.e., that the rate of false negatives is low), a second goal of any testing scheme (i.e., that the rate of false positives is low) has been sacrificed.

The noted toxicologist, Dr. Bruce Ames, outlined some of the problems associated with the MTD:

> *Animal cancer tests are conducted at near toxic doses (the maximum tolerated dose, MTD) of the test chemical, for long periods of time, which can cause chronic mitogenesis. Chronic dosing at the MTD can be thought of as a chronic wounding, which is known to be both a promoter of carcinogenesis in animals and a risk factor for cancer in humans. Thus, a high percentage of all chemicals might be expected to be carcinogenic at chronic, near toxic doses and this is exactly what is found. About half of all chemicals tested chronically at the MTD are carcinogens.* (Ames and Swirsky-Gold, 1990, p. 249)

and

> *Extrapolation from the results of rodent cancer tests done at high doses to effects on humans exposed to low doses is routinely attempted by regulatory agencies when formulating policies attempting to prevent future cancer. There is little sound scientific basis for this type of extrapolation, in part due to our lack of knowledge about mechanisms of cancer induction, and it is viewed with great unease by many epidemiologists and toxicologists.* (Ames et al., 1987, p. 271)

The USEPA likewise is skeptical of some of the findings generated with the MTD:

> *Positive studies at levels above the MTD should be carefully reviewed to ensure that the responses are not due to factors which do not operate at exposure levels below the MTD. Evidence indicating that high exposures alter tumor responses by indirect mechanisms that may be unrelated to effects at lower exposures should be dealt with on an individual basis. As noted by the OSTP (1985), "Normal metabolic activation of carcinogens may possibly also be altered and carcinogenic potential produced as a consequence [of high-dose testing].* (USEPA, 1987, p. 1-5)

Dr. Robert Squire, formerly of the National Cancer Institute and a scientist with considerable experience in the execution and use of chronic animal cancer bioassay testing, described his views of animal cancer studies using the MTD in the following manner:

> *There is no question that the present approach to chronic carcinogenesis testing in rodents is a costly and relatively crude and insensitive method of detecting potential carcinogens. After three years of effort and expenditures as high as one half to one million dollars, one may be presented with results which are either inconclusive or highly controversial.* (Squire, 1984)

The LMS model and, as a result, the cancer slope factor are greatly influenced by the MTD. Not only might the MTD result in significant toxicity to the treated animal, but the MTD, on a body weight basis, represents an amount of chemical which greatly exceeds that amount of a chemical which a human would most likely come in contact with. Thus, even though the MTD is usually required in order to observe in animals a carcinogenic response to most chemicals in a short period of time, it represents an unrealistic exposure condition when applied to potential carcinogenic responses in humans. As a result, the MTD is an overly conservative estimate of the dose in humans associated with potential carcinogenicity.

3.4.2 Recommendations for Alternatives to the Maximum Tolerated Dose

The NRC has recommended a number of potential improvements in the standard animal cancer bioassay which strictly relies on the MTD to assess the carcinogenic potency (i.e., slope factor) of chemicals (NRC, 1993, pp. 63-64). One recommendation is to examine studies conducted at other doses, such as one-half of the MTD or one-tenth of the MTD, and modify slope factor values according to the numbers of tumors produced at these doses. Another is to evaluate additional studies for those chemicals which test positive at the MTD to reduce uncertainties associated with predicting human responses to chemicals. These additional studies should address mechanism of action (see below), toxicokinetics, and metabolism as well as validate MTD bioassay test results with epidemiologic studies. Thus, additional data should be considered when estimating the carcinogenic potential (i.e., slope factor) of chemicals in humans and, in turn, soil remediation standards for carcinogens. This would provide more realistic estimates of the carcinogenic potency, resulting in soil standards which are not so conservatively biased, but are still sufficiently protective of human health.

The Commission should also examine the mechanism of carcinogenesis and how mechanistic considerations affect the selection of the animal-to-human extrapolation model. For example, mechanistic considerations have led other countries to develop safe levels of dioxin in the environment which are 1,000 times greater than those currently allowed in the United States (NIEHS, 1993, p. 398). This difference is caused chiefly by differences in the models used to predict the risks. Commercially-available computer software programs such as TOX_RISK and GENTOOL® are useful for incorporating mechanistic considerations (including pharmacokinetics) into carcinogenicity assessments and allow the user to select extrapolation models (e.g., the time-to-tumor model or the Weibull model) other than the LMS and data sets other than those selected by the USEPA as the basis for their cancer slope factors. The Commission should give serious consideration to the use of other models and data to develop alternative slope factors for chemicals for which available data suggest that the LMS model is inappropriate.

Consideration of cancer mechanisms in the determination of the carcinogenic potential of a chemical has gained wide support in both the scientific and regulatory communities. The International Agency for Research on Cancer (IARC) recently made the following recommendations after assembling a working group of leading cancer researchers from a variety of disciplines:

> *When the available data on mechanisms are thought to be relevant to the evaluation of the carcinogenic risk of an agent to humans, they should be used in making the overall evaluation, together with the*

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> *combined evidence for animal and/or human carcinogenicity.... [A]n overall evaluation of human cancer hazard on the basis of animal carcinogenicity data could be downgraded by strong evidence that the mechanism responsible for tumor growth in experimental animals is not relevant to humans. In keeping with the goal of public health, priority must be given to the demonstration that the mechanism is irrelevant to humans.* (NIEHS, 1993, p. 399)

Likewise, USEPA's draft guidelines on cancer risk assessment place emphasis on the use of mechanistic information in the risk assessment process (NIEHS, 1993, pp. 399-400). Under these guidelines, straight mathematical extrapolation of risk is relegated to a default position to be used in the absence of mechanistic data. Thus, given current scientific and regulatory thinking with regard to the use of mechanistic data in carcinogenic risk assessment, the Commission should include a provision in its soil standards guidance, perhaps similar to that outlined by the IARC working group, which allows for modification of carcinogenicity assessment based on mechanistic considerations.

3.4.3 High Background Incidence of Tumors in Test Animals

Cancer researchers typically use "inbred" or "pure" animal strains because they are homogeneous, relatively inexpensive, easy to obtain, and their responses to experimental manipulation and chemical treatment have been extensively studied and are thus well-known. It must be realized, though, that many of the inbred rodent species (mice and rats) used in cancer studies display a high background incidence of tumors in certain organs. In other words, many tumors in these animals are observed even in the absence of chemical treatment. An example is the $B_6C_3F_1$ mouse which has a high background incidence of hepatocellular (liver) cancer. Approximately 20 to 30% of untreated animals develop this type of cancer (Becker, 1982, p. 3920; Maronpot et al., 1987, p. 14). Hepatocellular cancer is also frequently elicited by high dose chlorinated hydrocarbon (solvent) exposure. Consequently, the liver tumors which are commonly induced in this mouse strain by chlorinated hydrocarbons are of questionable relevance to humans, especially in light of the very low incidence of hepatocellular cancer in humans in the United States (3–5 cases per 100,000) (Kew, 1986, p. 721).

Breeders of laboratory animals have exploited this characteristic of high background cancer incidence and developed other strains of animals which are particularly sensitive to cancer, such as the SENCAR (SENsitive to CAnceR) mouse. This emphasizes another inherent conservatism: researchers choose inbred strains of animals for their experiments because, like the MTD, their use increases the chance that a carcinogenic response will be observed during the course of the study. Inbred strains, however, do not reflect the heterogeneity of the human population; extrapolations from these animals to humans is highly questionable and overly conservative.

3.4.4 Recommendations for Alternatives to Using High Background Animal Cancer Studies

As an alternative to using data from animals with high background tumor incidences as a basis for estimating the carcinogenic potency of particular chemicals, the Commission should consider human epidemiological evidence, when available, to establish soil standards for carcinogens. As described above, the problem of high background tumor incidence applies especially to compounds which target the liver, such as the chlorinated hydrocarbons. For these chemicals, a wealth of human data has developed from years of human experience in, for example, industry and medicine. This information should be used preferentially over data from animals which display large numbers of spontaneous tumors. Also, the Commission should give reduced weight to tumor incidence data developed in these cancer-sensitive animal species, as suggested in draft USEPA guidance for assessing cancer risk (USEPA, 1992, p. 24).

3.4.5 The "No Threshold" Assumption

The LMS model assumes a linear relationship between the amount (dose) of a chemical administered to an animal and the carcinogenic response (the number of tumors which develop in the animal). Stated another way, the LMS model assumes that the carcinogenic response has no threshold; i.e., any dose of a chemical, no matter how small, is associated with some, finite probability of producing cancer. This is essentially a conservative default assumption, made over a decade ago, concerning the mechanism of carcinogenesis in the absence of scientific information to the contrary. Scientists are now beginning to realize that a number of different mechanisms participate in the development of a tumor and that the "no threshold" assumption is no longer appropriate for all carcinogens.

3.4.6 Recommendations for Alternatives to "No Threshold" Assumption

Marcus and Rispin of the USEPA noted that, "[a] growing body of scientific evidence demonstrates thresholds in the dose-response curve for certain chemicals for carcinogenicity" (Marcus and Rispin, 1988, p. 133). One chemical which demonstrates this threshold phenomenon is arsenic, a chemical considered by the USEPA to be a known human carcinogen. These USEPA scientists reported that the threshold (i.e., the level below which no effects occur) for chronic adverse effects (including skin cancer) of arsenic in humans is between 200 and 250 micrograms per day (µg/day) (Marcus and Rispin, 1988, p. 155). It makes sense that a threshold for the effects of arsenic in humans exists since scientists now believe that arsenic is a nutritional requirement.

For chemicals with demonstrated thresholds (e.g., arsenic), the Commission should consider remediation standards for soil based on the threshold reported in animal studies or through examination of relevant human data. For example, in the case of arsenic, soil remediation standards could be developed which would result in an arsenic intake no greater than the 200–250 µg/day threshold. Another example of the threshold approach is the establishment of a maximum allowable daily intake for 2,3,7,8-TCDD by the Ontario (Canada) Ministry of the Environment (MOE).

> *From preceding sections, it is concluded that 2,3,7,8-T_4CDD produces tumours in rodents by an indirect mechanism. As such, it is concluded that 2,3,7,8-T_4CDD possesses a threshold level of dosage below which an increased rate of tumour production due to exposure to this compound would be unlikely. The no-observed effect level (NOEL) identified in animal studies is used as an indication of where the threshold lies. A maximum allowable daily intake can be based on this level by applying a safety factor. In the case where long-term animal studies are available, it is generally agreed that a safety factor of 100 is appropriate.* (MOE, 1984, pp. 3-145–3-146)

Thus, these examples indicate that data concerning the carcinogenic threshold for chemicals, when it exists, can be used to establish minimum soil standards for the State of New Jersey.

3.4.7 Conservative Animal-to-Human Scaling Factor

In conjunction with the LMS model, animal-to-human dose extrapolation must be "scaled" to account for differences in body size, metabolic rates, etc., between animals and man. The appropriate scaling factor for animal-to-human extrapolation of carcinogen doses has been widely discussed in the scientific literature. Proposed scaling factor exponents have values of 1.0 (corresponding to extrapolation based upon body weight) and 0.67 (corresponding to extrapolation based upon body surface area).[1] The FDA has endorsed body weight extrapolation for carcinogens, while the USEPA prefers the more conservative surface area extrapolation procedure. Although the NJDEPE has proposed to adopt the surface area scaling method of the USEPA, dogmatic adherence to either scaling factor is difficult to justify scientifically. The best scaling factor for an individual carcinogen is a function of a number of variables, including mechanism of carcinogenicity.

The use of surface area as an appropriate scaling factor (i.e., the USEPA method) can be supported by studies of alkylating agents, for which carcinogenic action is thought to result from genotoxicity (i.e., direct interaction of a carcinogen with genetic material). Empirical observations with these agents support body surface area as the best means for extrapolation (Freireich et al., 1966). However, for other carcinogens, including many compounds whose cancer effects appear to arise from non-genotoxic mechanisms (e.g., PCBs, dioxin), better animal-to-human correlations are obtained when body weight is used to normalize the dose. Allen et al. (1987, p. 51) demonstrated that scaling on the basis of surface area overestimated human cancer risks by up to 12-fold, while scaling on the basis of body weight produced less than a 2-fold overestimation of risks. This indicates that the USEPA's scaling method by surface area leads to considerable overestimation of human cancer risks.

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[1] Scaling on the basis of body weight is accomplished by dividing the body weight of the animal by the body weight of the human. This is represented by the formula $\left(\frac{\text{body weight}_{\text{animal}}}{\text{body weight}_{\text{human}}}\right)^{1.0}$. Likewise, scaling on the basis of surface area is accomplished by dividing the surface area of the animal by the surface area of the human, which empirically has been determined to be represented by $\left(\frac{\text{body weight}_{\text{animal}}}{\text{body weight}_{\text{human}}}\right)^{0.67}$.

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3.4.8 Recommendations for Alternatives to the Current Animal-to-Human Scaling Factor

Of note is the fact that the USEPA is currently considering a scaling factor exponent of 0.75 (Fed. Reg., Vol. 57, June 5, 1992), a value representing a compromise between body weight and surface area scaling. Support for this position derives in part from the study of Travis and White (1988), in which the authors used regression techniques to empirically determine the optimal power of body weight to achieve the best-fitting allometric relationship of MTDs across species. The authors determined that a power of 0.72 to 0.74 led to the best cross-species predictions (p. 123). Therefore, based on the results of the Allen et al. (1987) and Travis and White (1988) analyses, the Commission should recommend that this value, at a minimum, be adopted. This would prevent the considerable overestimation of human risks which would occur with certain classes of chemicals. Alternatively, the Commission should consider assigning scaling factor exponents on a chemical-specific basis, depending on the reported carcinogenic mechanism (i.e., genotoxic vs. non-genotoxic). Although this may be a more complicated endeavor, it would assure that the appropriate scaling factor is applied in each circumstance.

3.4.9 Current Scientific Consensus on the LMS Model

The LMS model has been subjected to considerable scrutiny by the scientific community. The consensus is that this model has little basis in scientific fact. The NRC provided the following commentary on the LMS model:

> *The linearized multistage model is widely used to estimate cancer risks associated with environmental exposures and is said to provide an upper-limit estimate of low-dose response. To some degree, the model's wide use reflects its mathematical flexibility. However, biologic support for the assumption of linearity at low doses remains largely inferential and probably wrong in a high proportion of cases.* (Bailar et al., 1988, as cited in NRC, 1989, p. 163; emphasis added)

Even the USEPA has the following reservations about the LMS model:

> *It should be emphasized that the linearized multistage procedure leads to a plausible upper limit to the risk that is consistent with some proposed mechanisms of carcinogenesis. Such an estimate, however,*

> *does not necessarily give a realistic prediction of the risk. The true value of risk is unknown and may be as low as zero. The range of risks, defined by the upper limit given by the chosen model and the lower limit which may be stated as low as zero, should be explicitly stated.* (Fed. Reg., Vol. 51, September 24, 1986, pp. 33997-33998)

Given the above NRC and USEPA commentaries, it should be apparent that universal application of the LMS model adds to the already conservative nature of the approach used by the NJDEPE to determine remediation soil standards for carcinogens. This emphasizes the importance of considering other extrapolation models which may better fit the experimental data, as well as the need to carefully assess the other factors which determine remediation standards for carcinogens in soil (*see* Section 4.0).

3.5 Additional Conservatism in the NJDEPE's Cancer Slope Factors

NJDEPE has developed a number of its own cancer slope factors to determine remediation soil standards for three classes of chemicals: volatiles, semivolatiles, and pesticides/PCBs (Technical Basis and Background Document for Cleanup Standards for Contaminated Sites, 1992, pp. 21-23). Of the 43 chemicals for which it has developed slope factors, the NJDEPE acknowledges that its values differ from those developed by the USEPA for eight chemicals. Comparison of the slope factors for the 43 chemicals developed by NJDEPE with slope factors published in USEPA's IRIS database (USEPA, 1994) and Health Effects Assessment Summary Tables (USEPA, 1993b) indicates that deviation from USEPA slope factors is actually more extensive. Of the 43 NJDEPE chemicals, the NJDEPE has overestimated slope factors for a total of 12, some by as much as 16-fold (*see* Table 3-6). Thus, the NJDEPE has introduced conservative bias in its development of soil remediation standards simply by incorporating slope factors which are more conservative than those developed by the USEPA. To remedy this situation, the Commission should recommend the use of the USEPA cancer slope factors for these chemicals.

Table 3-6

Comparison of Slope Factors Used by the NJDEPE and the USEPA

Chemical	NJDEPE Slope Factor* $(mg/kg/day)^{-1}$	USEPA Slope Factor† $(mg/kg/day)^{-1}$	Ratio of NJDEPE Value to USEPA Value
Benzene	0.23	0.029	7.9
Benzo(a)anthracene	1.15	0.73	1.6
Benzo(a)pyrene	11.5	7.3	1.6
Benzo(b)fluoranthene	1.15	0.73	1.6
Benzo(k)fluoranthene	1.15	0.73	1.6
Bromodichloromethane	0.13	0.06	2.2
Chrysene	1.15	0.073	16.0
Dibenz(a,h)anthracene	11.5	7.3	1.6
1,2-Dichloroethane	0.12	0.091	1.3
Isophorone	0.0039	0.00095	4.1
Methylene chloride	0.014	0.0075	1.9
Tetrachloroethene	0.082	0.052	1.6

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*Source: Technical Basis and Background Document for Cleanup Standards for Contaminated Sites, 1992.

†Source: USEPA's IRIS database (USEPA, 1994) and Health Effects Assessment Summary Tables (USEPA, 1993b).

3.6 The Use of Epidemiology Studies as an Alternative to Animal Data to Derive Cancer Slope Factors

In a 1989 paper, Gehring reported that standard risk assessment procedures involving animal-to-human extrapolation lead to cancer risk estimates which far exceed the actual risk for certain cancers in the United States or worldwide. As an example, Gehring noted that the predicted risk from dietary exposure to aflatoxin (which causes liver cancer) using risk assessment methods is 789 per 100,000, while the lifetime probability of dying from liver cancer in the U.S. is 210 per 100,000 persons (p.54). Thus, risk assessment methods predict a cancer risk from *aflatoxin alone* which is almost four times greater than the rate for a disease which is more likely related to viruses (Hepatitis B), and genetic (hereditary) and lifestyle (e.g., alcohol consumption) factors. Also, Gehring reported that risk assessment methods predict a cancer risk of 0.16 (16,000 per 100,000) from vinyl chloride, a chemical which causes angiosarcoma of the liver. On the other hand, there were 108 cases of angiosarcoma of the liver reported worldwide between the years 1955 and 1983 (p.54). This corresponds to a lifetime cancer incidence of 0.0000965 per 100,000 (108 cases in 4,478,000,000 people). The predicted cancer risk is more than 165 million times greater than the actual worldwide incidence of angiosarcoma.

As an alternative to the use of animal data to predict the carcinogenic potency of chemicals in humans and as a means to avoid the type of gross overestimation of risk described above, the Commission should recommend the use of human epidemiological data to determine cancer slope factors for certain chemicals. Human data can be used just like animal data to place an "upper bound" on the possible risks associated with exposure to a particular chemical. This could be done for chemicals for which there is an absence of animal data, or for which there is both human and animal data and the human database is extensive. There are a number of ways to do this. One way would be to take each statistically significant association in a human epidemiology study, assume it to be a real measure of the cancer potency, and use the observed increase in cancer incidence to generate a human cancer potency factor. A second method might be to combine the standardized mortality ratios (SMRs) for the cancer type of interest and use the average SMR from all studies in a manner much like "meta analysis" to generate an "average estimate" of the human risk. Last, even if no statistical associations between chemical exposure and a particular cancer are found, one could place an upper confidence limit on the measured zero risk, and thereby place an upper bound on the risk even in studies where the risk either does not exist or is too small to measure.

Appendix A outlines a method for determining "human cancer risk" by using a single human epidemiology study and assuming that the observed increase in cancer reported in the study is a true measure of the human cancer potency (i.e., use of the first method described above). The study by Brown (1987) is used to illustrate how data from PCB-exposed workers is used to estimate cancer potency for this class of chemicals.

4.0 THE "REDUNDANT CONSERVATIVE" NATURE OF THE EXPOSURE FACTORS WHICH DETERMINE SOIL REMEDIATION STANDARDS

In addition to the one in one million cancer risk and cancer slope factors proposed by the NJDEPE as the basis for remediation soil standards for carcinogens, there are a number of other "redundant conservative" assumptions in the NJDEPE's approach to risk assessment of contaminated soil. These relate to the assumptions which determine the amount and duration of soil contact by a person under residential or nonresidential (i.e., occupational) conditions. The need to eliminate or reduce the "redundant conservative" assumptions in the soil remediation standards approach stems from the fact that, when a number of assumptions at or near their maxima (i.e., 95th percentile values) are used in an assessment of exposure and risk, the resulting exposure or risk actually represents a condition which rarely, if ever, would occur. This was illustrated in a paper by Burmaster and Lehr (1991, p. 8), in which the authors provide a simple relationship from probability theory which describes the likelihood of occurrence of an outcome based on a series of conservative assumptions. If, for example, three conservative (95th percentile) values are multiplied together, the outcome actually represents the 99.99th percentile of exposure (not the 95th percentile), based on the following equation:

$$1 - (1 - 0.95)^3 = 0.9999$$

In other words, only 0.01% of a given population (or 1 in ten thousand) would experience exposure greater than the resulting "four nines" condition.

Recall the equation which is used to calculate remediation soil standards for carcinogens under nonresidential conditions (Technical Basis and Background Document for Cleanup Standards for Contaminated Sites, 1992, p.11):

$$\text{Soil Standard} = \frac{\text{RSD} \times \text{BW}}{\text{IR} \times \text{TCF}} = \frac{1 \times 10^{-6} \times \text{BW}}{\text{SF} \times \text{IR} \times \text{TCF}}$$

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Where,

RSD = Risk Specific Dose
BW = Body Weight
IR = Soil Ingestion Rate
SF = Cancer Slope Factor
TCF = Time Correction Factor

The exposure factors proposed in the above equation represent USEPA "reasonable maximum exposure" (RME) assumptions. Although RME assumptions define the "maximum exposure that is reasonably expected to occur at a site" (USEPA, 1989a, p. 6-19), the USEPA has recently reconsidered the parameters which define exposure assessment in an attempt to replace the RME case with more realistic assessments of probable human exposures at hazardous waste and other sites. While the RME case may have been appropriate for assessing exposure at such sites in the past, it no longer represents the most recent guidelines from USEPA.

On May 29, 1992, the USEPA published final guidelines for performing exposure analyses (Fed. Reg., Vol. 57, May 29, 1992), and the use of the guidelines was mandated by a major policy document. The exposure guidelines are expected to have a profound impact on Superfund and corrective action programs. Under old guidance (*Risk Assessment Guidance for Superfund*, USEPA, 1989a, p. 6-19), findings of exposure at a site were reduced to a single estimate of the RME. Under the new guidelines, the RME has been replaced with exposure descriptors representing "typical" and "high-end" conditions. The high-end exposure estimate is intended to be the replacement for the RME.

Unlike the RME, the doses received by the high-end exposed individual cannot be based on worst-case assumptions and, in fact, must represent doses which could actually be received by current or future individuals at the site. This definition of the high-end exposure provides the risk assessor with the ability to take into consideration site-specific information on probable land use patterns (i.e., residential, nonresidential), variation in individuals' behaviors, and information on the spatial distribution of contamination in order to more reasonably characterize current and future exposures and associated risks.

The following sections focus specifically on the conservative nature of daily soil ingestion rate and time correction factor terms of the NJDEPE's remediation soil standards equation. Also discussed are additional factors (e.g., chemical bioavailability and soil half-lives) not expressed in the calculation, but which could profoundly influence the numerical value of the remediation soil standards. In addition, alternative exposure factors are proposed. These alternative factors represent generally accepted and peer-reviewed scientific evidence yet still adequately protect human health. Use of such alternative factors would give remediation soil standards a more realistic basis.

4.1 Soil Ingestion

The NJDEPE assumes that under residential and nonresidential exposure conditions, the rate of soil ingestion is 200 milligrams per day (mg/day) and 100 mg/day, respectively. However, the 200 mg/day assumption represents the USEPA RME case for soil ingestion in children up to 6 years of age, and the 100 mg/day assumption is the RME case for soil ingestion in adults (age 7 to 70 years). The NJDEPE's use of these values certainly do not reflect the legislature's attempt to avoid "redundant conservative" assumptions, nor do these values reflect the most recent scientific opinions concerning soil ingestion.

Soil ingestion has been the subject of several recent studies in young children. These studies employed mass-balance protocols in an attempt to more accurately determine the actual amount of soil ingested by children. This approach uses fecal concentrations of tracer elements ubiquitous in soil to estimate the amount of soil ingested. The ideal tracer element for determining soil ingestion is an element common in soil, of a low dietary abundance, and of little concentration variation in either medium (soil or diet). An abundant concentration in soil ensures quantification of the tracer regardless of the amount of soil eaten and increases the likelihood that the presence of the tracer in fecal material is actually indicative of soil ingestion. Low concentration in food materials allows researchers to consider dietary intake as an insignificant source of the elemental tracer. In addition, the tracer must not be readily absorbed since significant absorption of the tracer in the digestive tract will result in the reduction of tracer present in feces and lead to an underestimation of soil ingestion.

4.2 Recommendations for Alternatives to NJDEPE's Soil Ingestion Rates

Table 4-1 provides a summary of the recent studies of soil ingestion in young children (up to approximately 6 years old) which employed the mass-balance approach and which used the most appropriate tracer elements (aluminum, silicon, yttrium, and zirconium) to quantitate ingestion rates. These studies indicate an ingestion rate range of < 9 to 104 mg/day, with a range midpoint of approximately 50 mg/day. This midpoint value is considerably less than the default USEPA soil ingestion rate proposed by the NJDEPE (200 mg/day for children). In particular, Calabrese et al. (1989) reported that the median soil ingestion rate for children ranged from 0 to 20 mg/day, with a 95% confidence interval range of 8 to 24 mg/day. The Commission should reevaluate its proposed soil ingestion rates for children in light of this more recent data and adopt, at a minimum, a value not to exceed 50 mg/day when determining remediation standards for chemicals in soil under residential exposure conditions.

Table 4-1

Summary of Recent Soil Ingestion Studies in Young Children

Study	Reported Soil Ingestion Rate (mg/day)
Calabrese et al. (1989)	9-40
Barnes (1990)	< 9-96
Davis et al. (1990)	25-81
Sedman (1989)	40-70
van Wijnen et al. (1990)	22-104

With regard to soil ingestion in adults under residential exposure conditions, Calabrese et al. (1990) derived a soil ingestion rate of 50 mg/day in a study of six individuals based on examination of the fecal content of the most reliable tracer

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elements (aluminum, silicon, yttrium, and zirconium). Paustenbach (1989) estimated that adults ingest approximately 2 to 5 mg of soil/day, or approximately one-tenth the value reported by Calabrese et al. (1990). The latter estimate is supported by evidence that the daily ingestion of dirt and dust by adults is unlikely to exceed 1 to 5 mg/day, even if all of the leafy and root vegetables, sweet corn and potatoes consumed by an adult were replaced with home-grown products. Paustenbach (1989) believes this number is consistent with studies which indicate that adults should ingest about one-tenth the amount of soil ingested by children. Thus, there is sufficient evidence to indicate that the NJDEPE's soil ingestion value for residential exposure in adults is too high and should be more in line with the studies of Calabrese et al. (1990) and Paustenbach (1989). The Commission should recommend an adult ingestion rate of no greater than 50 mg/day under residential exposure conditions, even though a value half of this is certainly justified.

The default USEPA assumption for soil intake for an adult in the nonresidential, or occupational, setting is 50 mg/day (USEPA, 1991), although the NJDEPE uses 100 mg/day to represent the amount of soil ingested under occupational conditions. However, given the results of the Thompson and Burmaster (1991) reanalysis of the Binder et al. (1986) study, soil intakes for workers are likely to be lower than the USEPA and the NJDEPE default values for soil ingestion. In particular, the tendency to mouth objects largely diminishes after age 3, indicating that incidental ingestion of soil is greatly reduced in adults. LaGoy (1987) proposed using 25 mg/day as a soil ingestion rate for exposures in persons over 11 years of age. Furthermore, Paustenbach et al. (1991) employed a soil ingestion value of 10 mg/day in the assessment of health risks to workers exposed to chromium-contaminated soils in the State. Given these data, the Commission should consider soil ingestion values of between 10 and 25 mg/day for workers. These values reflect more recent data in the area of soil ingestion research and eliminate one of the "redundant conservative" assumptions in the method for determining remediation soil standards.

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4.3 Time Correction Factors

Time correction factors (TCFs) are used by the NJDEPE to estimate the frequency and duration of exposure to chemicals in soil. As such, they account for the number of days per week, weeks per year, and years per lifetime of exposure at a residential and nonresidential site. Under residential conditions, the default values used for persons exposed to chemicals in soil are 7 days per week and 52 weeks per year for 29.5 years. This results in a TCF value of 0.421 [i.e., (7 days ÷ 7 days) x (52 weeks ÷ 52 weeks) x (29.5 years ÷ 70 years)]. Under nonresidential (occupational) conditions, the TCF is based on the assumption of exposure for 5 days per week and 49 weeks per year for 25 years. This results in a TCF value of 0.240 [i.e., (5 days ÷ 7 days) x (49 weeks ÷ 52 weeks) x (25 years ÷ 70 years)]. These are "redundant conservative" values which need to be modified to accurately determine remediation standards for chemicals in soil.

4.4 Recommendations for Alternatives to NJDEPE's Time Correction Factors

The TCF for residential conditions should at least be modified to account for the fact that few individuals reside at home for all 365 days of a year. The USEPA assumes that 350 days per year is a reasonable estimate of exposure frequency, accounting for the fact that the typical family spends an average of at least two weeks away from home (e.g., on vacation) per year (USEPA, 1991). Thus, the TCF should be lowered to 0.404 [0.421 x (350 ÷ 365)]. In addition, a recent paper by Israeli and Nelson (1992, p. 70) examined 1985 and 1987 U.S. housing survey data and reported 4.6 years as the average total residence time for all U.S. households, a value which is more than 6-fold below the residence time value used by the NJDEPE (29.5 years, a value which represents the national upper-bound, 90th percentile time at one residence). These authors also reported that only 5% of all households are expected to remain in the same residence for over 23 years. This indicates that the residence time value of 29.5 years, derived from USEPA sources (USEPA, 1989a, p. 6-40 & 1989b, p. 5-34), may substantially overestimate residential exposures to soil. The Commission should recommend the more recent residence time data of Israeli and Nelson, or, at a minimum, the USEPA's national median (50th percentile) time at one residence, 9 years (USEPA, 1989b, p. 5-34), to determine exposure to carcinogens in soil. Use of the former value, 4.6 years, lowers

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the TCF to 0.063 [0.404 x (4.6 ÷ 29.5)], while the latter value, 9 years, lowers this value to 0.123 [0.404 x (9 ÷ 29.5)].

The TCF for nonresidential, or occupational, exposure conditions should be modified to reflect recent United States Department of Commerce labor statistics concerning the average length of time in a single occupational location. In 1991, continuous tenure with a current employer averaged 4.5 years for the total employed U.S. population 16 years and older (U.S. Bureau of the Census, 1993, p. 412). This value is more than 5-fold below the value used by the NJDEPE (25 years). This indicates that the NJDEPE's value may substantially overestimate nonresidential exposures to soil. The Commission should recommend use of this more recent data to determine exposure to carcinogens in soil. Doing so lowers the TCF for nonresidential exposure conditions to 0.043 (i.e., 0.240 x 4.5 years/25 years).

4.5 Additional Time Correction Factor Considerations

The exposure duration portion of the TCF (i.e., the number of weeks of exposure per year) should be modified for both residential and nonresidential situations to account for climatic conditions in New Jersey which would reduce the potential for exposure to soil, e.g., the average yearly number of rainy days, the average yearly number of days in which the ground is frozen or snow-covered, etc. This information can be obtained from local meteorological organizations or the National Climatic Data Center in Asheville, North Carolina. For example, data from this source (NOAA, 1992) indicate that, for the year 1992, soil temperatures in northern New Jersey averaged 34.6°F in January and 32.8°F in February. During this 62-day period, the potential for exposure to soil is greatly reduced; at these temperatures, surface soil would not tend to dislodge and adhere to skin. In addition, for a month on either side of this 62-day period–i.e., December and March–average air temperatures were 33.4 and 36.7°F, respectively. At these ambient temperatures, people would be reluctant to participate in outdoor activities where soil exposure may occur and the amount of exposed skin would be limited. Therefore, at a minimum, the exposure duration term of the TCF should be adjusted to account for the 60 or so winter days during which the potential for exposure to soil is reduced or eliminated due to the frozen ground and cold air.

When possible, allowances should also be made to incorporate site-specific information in place of default assumptions so as to more accurately characterize exposure and determine remediation standards for chemicals in soil. Residence times (i.e., the number of years per lifetime) for individuals living near a particular site can be determined from local demographic information, and data from local employment records can be used to determine the average length of employment at a site which will be used for occupational purposes. Hattemer-Frey et al. (1993) have used these types of approaches to develop site-specific information for individuals potentially exposed to chemical contamination at a Superfund site.

4.6 Multiplicity of Conservatism in NJDEPE's Risk and Exposure Assumptions

The "redundant conservative" nature of the assumptions used by NJDEPE to determine soil remediation standards for carcinogens can be made more apparent when their combined effect is demonstrated. Taken separately, slight differences in the risk and exposure factors used to determine soil remediation standards would not seem to greatly impact the final standard. However, the opposite is actually true since these factors are multiplied together to produce the numerical soil standard. Recall the soil remediation standard equation (Technical Basis and Background Document for Cleanup Standards for Contaminated Sites, 1992, p.11):

$$\text{Soil Standard} = \frac{1 \times 10^{-6} \times BW}{SF \times IR \times TCF}$$

Where,

BW = Body Weight
IR = Soil Ingestion Rate
SF = Cancer Slope Factor
TCF = Time Correction Factor

Using this equation, the NJDEPE has determined a remediation soil standard of 13 mg/kg for benzene under nonresidential conditions (Technical Basis and Background Document for Cleanup Standards for Contaminated Sites, 1992, p. 21):

$$\frac{1 \times 10^{-6} \times 70\text{ kg}}{0.23\ [\text{mg/kg/day}]^{-1} \times 0.0001\text{ kg/day} \times 0.24} = 13\text{ mg/kg}$$

If, however, one was to use the alternative risk and exposure values described above, a dramatic effect on the resulting remediation soil standard would be apparent. Under nonresidential exposure conditions, a cancer risk value of 1×10^{-5} instead of 1×10^{-6} is assumed, as well as a cancer slope factor of 0.029 $[\text{mg/kg/day}]^{-1}$ instead of 0.23 $[\text{mg/kg/day}]^{-1}$, a soil ingestion rate of 25 mg/day instead of 100 mg/day, and a TCF of 0.043 instead of 0.24. Use of these alternative values results in a benzene soil remediation standard of 22,454 mg/kg:

$$\frac{1 \times 10^{-5} \times 70 \text{ kg}}{0.029\ [\text{mg/kg/day}]^{-1} \times 0.000025 \text{ kg/day} \times 0.043} = 22{,}454 \text{ mg/kg}$$

This value is more than 1,700 times greater than the NJDEPE value of 13 mg/kg and illustrates that the consistent selection of "redundant conservative" assumptions distorts the perception of a "safe" soil chemical level.

5.0 OTHER POTENTIAL AMENDMENTS TO THE NJDEPE'S SOIL REMEDIATION STANDARDS

5.1 Bioavailability

In proposing remediation standards based on the incidental ingestion of chemicals from soil, the NJDEPE did not consider the fact that chemicals in the environment (e.g., in soil) are rarely completely absorbed in the human digestive tract. In other words, the NJDEPE assumes that chemicals in soil are completely absorbed, or 100% bioavailable, following incidental ingestion of soil; thus, there is no term in the soil remediation standard equation to account for less than 100% bioavailability. This assumption is unduly conservative given that the systemic uptake of environmental contaminants is often reduced by physiological limitations to absorption and physical interactions (e.g., binding) of chemical contaminants and soil. The absorption by the human gastrointestinal tract of chemicals as diverse as dioxins and metals has been shown to be relatively low (i.e., much less than 100%) when these chemicals originate in a soil matrix. For example, Copeland et al. (1993, p. 289) reported that the oral bioavailability of 2,3,7,8-TCDD (dioxin) from soil is on the order of 25 to 50%, while that of the higher (octa-) chlorinated dioxin congeners is approximately 10-fold less, i.e., 2.5 to 5%. Paustenbach et al. (1992, p. 116) confirmed the range of bioavailabilities for soil-bound TCDD, but noted that other authors have reported much lower values, such as 0.5 to 1.6% for Newark, New Jersey, soils. Chromium metal has also been shown to possess relatively low bioavailability–on the order of 1 to 10%–based on its potential to leach from soil (Paustenbach et al., 1991, p. 171).

The significance of these and other studies on the oral bioavailability of chemicals in soil should be recognized when developing remediation standards based on soil ingestion. This approach of accounting for reduced bioavailability is preferred over that in which a default assumption of 100% oral bioavailability is assumed for all chemicals.

5.2 Half-Life of Chemicals in Soil

The half-life of chemicals should be addressed since, over time, concentrations of almost all chemicals in soil decrease, provided there are no additional chemical inputs. This is an important consideration for contaminated

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sites in the State of New Jersey, for which soil remediation standards have been developed based on assumed 25- to 30-year exposures to carcinogenic chemicals. It is also an important consideration for standards based on the reduced exposure duration times suggested in Section 3.6. The assumption of a constant (non-decreasing) soil chemical concentration over these time periods is a "redundant conservative" assumption for almost all chemicals. The factors which contribute to environmental chemical loss from soil include biodegradation, photodegradation, volatilization, leaching, and surface runoff (Copeland et al., 1993, p. 290). Certain of these processes will be more important for some chemicals than for others (e.g., volatilization will occur more readily for low molecular weight chlorinated hydrocarbons).

The effect of these processes on the concentration of chemicals in soil over time is usually measured in terms of half-lives, or the time it takes for one-half the amount of a substance to degrade in soil. Table 5-1 lists the soil half-lives for a number of common environmental contaminants.

Table 5-1

Examples of Soil Half-Lives for Organic Chemicals

Chemical	Soil Half-Life* (in days)
Acetone	7
Benzene	16
Benzo(a)pyrene	529
Bis-(2-ethylhexyl) phthalate	23
Carbon tetrachloride	365
DDT	5,694
Formaldehyde	7
2,3,7,8-TCDD	591
1,1,1-Trichloroethane	273
Toluene	22

*Source: Howard et al. (1991). This source reports both low and high values; the high values are listed in this table.

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Along with a simple expression which determines the effect of soil half-lives on soil concentrations (assuming first order kinetics), the data in Table 5-1 can be used to demonstrate that NJDEPE's soil remediation standards are too conservative for chemicals which degrade over time as a result of the processes described above, especially when considering the exposure periods discussed previously. The following equation calculates the average chemical concentration in soil, C_{ave}, over the time interval T_1 to T_2 (Copeland et al., 1993, p. 290):

$$C_{ave} = -\frac{C_o}{(T_2 - T_1)k} \times (e^{-kT_2} - e^{-kT_1})$$

Where,

C_o = initial soil concentration at time T_1
T_2 = end of time interval
T_1 = beginning of time interval
k = first order decay constant = $\frac{0.693}{\text{soil half-life}}$

This equation can be mathematically rearranged and solved for C_o as follows:

$$C_o = -\frac{C_{ave}(T_2 - T_1)k}{(e^{-kT_2} - e^{-kT_1})}$$

If the soil standard for a particular chemical is substituted for C_{ave}, then C_o in the above equation would represent an initial soil concentration which would be protective of human health due to natural degradation over a 25- or 30-year exposure period. This equation and soil half-life data for benzo(a)pyrene will be used to illustrate this point.

The NJDEPE has proposed (Technical Basis and Background Document for Cleanup Standards for Contaminated Sites, 1992, p. 22) a soil level of 0.25 milligram per kilogram (mg/kg) for benzo(a)pyrene under nonresidential (25-year) exposure conditions, based on the following calculation:

$$\text{Soil Standard} = \frac{\text{RSD} \times \text{BW}}{\text{IR} \times \text{TCF}} = \frac{1 \times 10^{-6} \times \text{BW}}{\text{SF} \times \text{IR} \times \text{TCF}}$$

$$= \frac{1 \times 10^{-6} \times 70 \text{ kg}}{11.5\ [\text{mg/kg/day}]^{-1} \times 0.0001 \text{ kg/day} \times 0.24} = 0.25 \text{ mg/kg}$$

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This value and the soil half-life for benzo(a)pyrene, 529 days (Table 5-1), is used in the equation for C_0 to calculate a soil standard which is, on average, safe over a 25-year (9,125-day) exposure period:

$$C_o = -\frac{C_{ave}(T_2 - T_1)k}{(e^{-kT_2} - e^{-kT_1})}$$

$$= -0.25 \text{ mg/kg} \times (9125 \text{ d} - 0 \text{ d}) \times \frac{0.693}{529 \text{ d}} \times 1/[e^{-(0.693 \times 9125 \text{ d}/529 \text{ d})} - e^{-(0.693 \times 0 \text{ d}/529 \text{ d})}]$$

$$= 2.99 \text{ mg/kg}$$

This example demonstrates that incorporation of soil half-life data results in a soil standard for benzo(a)pyrene which is more than ten times greater than the value proposed (0.25 mg/kg). This is true for a chemical which is considered to be relatively stable in soil, i.e., has a relatively long half-life. The effect of soil half-life on the final soil standard would be much more dramatic for a chemical with a short soil half-life, such as benzene.

Consideration of future use scenarios provides additional incentive to incorporate soil half-life data into the NJDEPE's methodology for determining remediation standards for chemicals in soil. Given that the evaluation and implementation of remediation alternatives and the eventual development of a particular site may require several years to complete, substantial degradation of site chemicals might occur prior to future use activities at the site. Under such circumstances, failure to consider chemical degradation in soil may impart an excessive degree of conservatism to remediation soil concentrations based on future use scenarios.

Therefore, the Commission should recommend incorporating soil half-life data into the assessment of remediation soil standards, especially for those constituents which disappear relatively rapidly from soil. Inclusion of soil half-life data will assure that exposures and risks from short-lived soil contaminants over the assumed time periods will not be grossly overestimated.

5.3 NJDEPE's Subsurface Soil Remediation Standards

The Commission does not appear to be addressing "impact to groundwater soil cleanup criteria," previously referred to as "subsurface soil cleanup criteria" in the now withdrawn Cleanup Standards for Contaminated Sites proposal. If this is in fact the case, then the Commission is not considering the full range of objectives the legislature had envisioned for the Commission when S1070 was passed into law.

Section 47.b of S1070 requires the Commission "to examine and assess the scientific basis for selecting the risk management standard of one in one million ... and to examine and assess methodologies of risk assessment ... for the purposes of establishing remediation standards." This language implies that the Commission is mandated to address remediation criteria for all soil–surface soil and subsurface soil.

The inclusion of subsurface soil in the Commission's task is important given the fact that, as previously proposed, the Cleanup Standards for Contaminated Sites gives precedent to subsurface soil remediation standards if they are more stringent (i.e., lower) than surface soil remediation standards. Currently, more than 62% of the subsurface soil cleanup levels are more stringent than the surface soil cleanup criteria under residential conditions, while more than 67% of the subsurface soil cleanup levels are more stringent than the surface soil values under nonresidential conditions. If the Commission achieves its goal of eliminating "redundant conservative" assumptions, then these percentages will be even higher. Thus, given the potential impact that subsurface soil remediation levels will have on the remediation of surface soils, it is of prime importance that the Commission evaluate and make recommendations concerning subsurface soil remediation levels.

A review of the methodologies and assumptions used by the NJDEPE for deriving subsurface soil standards clearly indicates the use of conservative assumptions. For example, the NJDEPE assumes a depth to groundwater of only 10 feet. There are many places in New Jersey, however, where depth to groundwater is considerably greater than 10 feet. The NJDEPE also assumes a zero degradation rate for chemicals in soil, 100% rainwater infiltration, and a soil organic carbon fraction of 0.001. These assumptions ignore the fact that chemicals degrade in soil over time (*see* Section 5.2), that surface water runoff and impermeable soil caps prevent 100% infiltration, and that New Jersey soils are much more highly organic.

The Commission should recommend the use of practical assumptions to determine remediation levels for chemicals in subsurface soil. In addition, since site-specific data for many of these physical characteristics can easily be determined in the field at minimal cost, the Commission should also recommend that site-specific criteria be used if so desired by the remedial party.

6.0 MONTE CARLO ANALYSIS AS A TOOL FOR ESTABLISHING REALISTIC EXPOSURE ASSESSMENTS

As an alternative to the NJDEPE's proposed risk assessment approach which derives single point estimates of acceptable levels of chemicals in soil, the Commission should recommend the use of probabilistic (i.e., Monte Carlo) techniques to develop distributions of acceptable soil chemical levels. The proposed risk assessment procedures suffer from a number of limitations. First, since the proposed approach lacks sufficient uncertainty analysis, it is difficult for risk managers and the public to place point estimates into perspective. Second, by erring on the side of conservatism for many of the risk assessment variables, the NJDEPE is creating scenarios that will be highly unlikely to occur. Third, it is meaningless to run sensitivity analyses (i.e., to determine which of the many exposure variables "drive" the risk assessment) because many of the input variables are at or near their maxima.

The USEPA has embraced the use of Monte Carlo techniques in risk assessments submitted to the Agency. In fact, USEPA's new guidelines on exposure assessment (Fed. Reg., Vol. 57, May 29, 1992) stipulate that Monte Carlo analysis be conducted as an integral component of an exposure assessment performed under the new guidelines. The guidelines also emphasize that this approach is appropriate for establishing the estimates for the high-end exposed individual when sufficient information is presented on the underlying distributions of key exposure parameters.

Monte Carlo simulation, used by engineers for many years, addresses the weaknesses of current risk assessment methods identified above (Burmaster and von Stackelberg, 1989; Burmaster and Lehr, 1991; Burmaster and von Stackelberg, 1991; Paustenbach et al., 1991; Thompson et al., 1992). Monte Carlo techniques estimate full distributions, rather than point estimates, for exposures and risks and, in doing so, provide perspective to risk managers and the public concerning the uncertainty in point estimates of risk.

Monte Carlo analysis is generally accomplished in the following manner. First, discrete or continuous probability density functions are determined for each of the variables to be included in the exposure and risk equations. Second, computer software is used to estimate distributions of exposures and/or risk by repeatedly solving the equation. The computer selects randomly from each distribution every time the equation is solved. This process is repeated a large number of times to produce distributions of the exposure variables and risk. Finally, the distributions can be plotted and statistical summaries of the results can be produced to aid in the interpretation of the analysis.

To illustrate the use of Monte Carlo techniques in the development of remediation standards for chemicals in soil, the following example is provided. First, using the NJDEPE's proposed equation for the calculation of soil standards for carcinogens under nonresidential conditions (*see* Section 2.0) and the NJDEPE's cancer slope factor for benzene, a single point estimate soil standard is determined. Then, to compare with the point estimate, Monte Carlo techniques are used to develop a frequency distribution of the soil standard associated with benzene exposure.

Recall the NJDEPE's equation for calculating remediation standards for carcinogenic chemicals in soil under nonresidential conditions (Technical Basis and Background Document for Cleanup Standards for Contaminated Sites, 1992, p.11):

$$\text{Soil Standard} = \frac{\text{RSD} \times \text{BW}}{\text{IR} \times \text{TCF}} = \frac{1 \times 10^{-6} \times \text{BW}}{\text{SF} \times \text{IR} \times \text{TCF}}$$

Where,

RSD = Risk Specific Dose
BW = Body Weight
IR = Soil Ingestion Rate
SF = Cancer Slope Factor
TCF = Time Correction Factor

Using the NJDEPE's default assumptions, the soil standard for benzene under nonresidential conditions is:

$$\text{Soil standard} = \frac{1 \times 10^{-6} \times 70\ \text{kg}}{0.23\ [\text{mg/kg/day}]^{-1} \times 0.0001\ \text{kg/day} \times 0.24} = 13\ \text{mg/kg}$$

The soil standard for benzene, 13 mg/kg, can be compared to the range of values determined using Monte Carlo techniques and published probability density functions for three of the variables (body weight, slope factor, and soil ingestion rate) in the above soil remediation standard equation. It is assumed, for the purpose of this example, that a one in one million risk is appropriate for calculating soil levels for carcinogens; thus, this variable will not be changed. It is also assumed that the cancer slope factor for benzene (0.029 $[mg/kg/day]^{-1}$) listed by the USEPA (USEPA, 1994; *see* Table 3-6) is appropriate, even though the NJDEPE slope factor for benzene is currently 0.23 $[mg/kg/day]^{-1}$ (Technical Basis and Background Document for Cleanup Standards for Contaminated Sites, 1992, p. 21). This approach is used because there is insufficient information concerning the distribution (mean, standard deviation, and type of distribution) of the NJDEPE's cancer slope factor for benzene.

A number of Monte Carlo software programs are commercially available. One designed specifically for the Macintosh computer is Crystal Ball® (v.2.0, Decisioneering, Inc.), which runs in conjunction with the Excel spreadsheet program. This application allows the user to define distributions for any or all of the equation variables by providing a gallery of standard distributions for which the user selects the key input parameters, i.e., the mean and standard deviation of the distribution. After establishing the distributions for the variables, Crystal Ball® runs a Monte Carlo simulation on the equation output. Again, in Monte Carlo analysis, many realizations of the variables in the exposure and risk equations are made. For each realization, the computer draws one random variable from the appropriate distribution for each of the variables in the equation and computes a single result. This computation is repeated a large number of times (10,000 in the present case) to produce distributions of the variables and the output.

Table 6-1 lists the input for the Monte Carlo analysis conducted to determine a soil remediation standard range for benzene. The table lists the type of distribution (normal, lognormal, or uniform) for each of four parameters from the NJDEPE's soil standard equation–body weight (BW), slope factor (SF), soil ingestion rate (IR), and occupational duration (OD)–the point estimate value, and distribution parameters (i.e., the mean and standard deviation of the distribution or the minimum and maximum values) used in the analysis.

Prior to running the Monte Carlo simulation, a point estimate of the soil standard for benzene is first calculated using the point estimate values in Table 6-1.

$$\text{Soil standard (point estimate)} = \frac{\text{RSD x BW}}{\text{IR x TCF}} = \frac{1 \text{ x } 10^{-6} \text{ x BW}}{\text{SF x IR x TCF}}$$

$$\text{IR} = 25 \text{ mg/day x } 10^{-6} \text{ kg/mg} = 0.000025 \text{ kg/day}$$

$$\text{TCF} = \frac{5 \text{ days}}{7 \text{ days}} \text{ x } \frac{49 \text{ weeks}}{52 \text{ weeks}} \text{ x } \frac{4.5 \text{ years}}{70 \text{ years}} = 0.043$$

$$\text{Soil standard} = \frac{1 \text{ x } 10^{-6} \text{ x } 70 \text{ kg}}{0.029 \text{ [mg/kg/day]}^{-1} \text{ x } 0.000025 \text{ kg/day x } 0.043}$$

$$= 2{,}245 \text{ mg/kg}$$

This value is approximately 170-fold greater than the State's benzene soil standard of 13 mg/kg.

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Table 6-1

Variables and Input for Monte Carlo Analysis

Variable	Distribution	Point Estimate	Distribution Parameters[*]	Reference
Body weight (BW)[†]	Lognormal	70 (kg)	4.25, 0.22	Brorby and Finley (1993)
Cancer slope factor (SF)[§]	Lognormal	0.029 $(\text{mg/kg/day})^{-1}$	-4.33, 0.67	Thompson et al. (1992, p. 56)
Soil ingestion rate (IR)[£]	Uniform	0.000025 (kg/day)	0.0000001–0.000030	LaGoy (1987); Finley and Paustenbach (1994)
Occupational duration (OD)[#]	–	4.5 (years)	–	U.S. Bureau of the Census (1993)

[*] Values listed for body weight and cancer slope factor represent the arithmetic mean and standard deviation of the underlying normal distribution. For soil ingestion rate, the listed values represent the minimum and maximum of the distribution.

[†] The NJDEPE's assumption for body weight is 70 kg.

[§] The value in column 3 is the slope factor used by the USEPA. The NJDEPE's slope factor value is 0.23 $[\text{mg/kg/day}]^{-1}$. The former value was used in this analysis due to insufficient information concerning the distribution parameters for the NJDEPE's value.

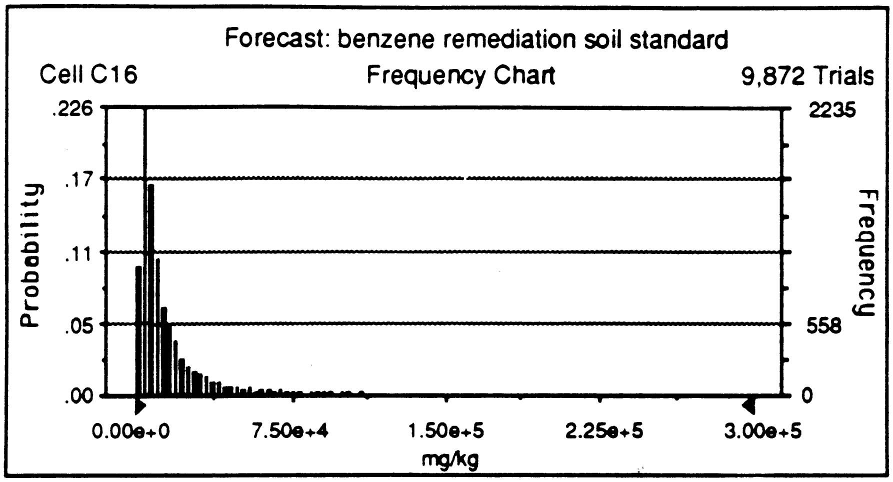
[£] The NJDEPE's assumption for soil ingestion rate is 0.0001 kg/day.

[#] Occupational duration is one component of the NJDEPE's TCF. The other components of the TCF (days per week and weeks per year) were not changed in this analysis (under nonresidential conditions, the assumptions are 5 days per week and 49 weeks per year). The NJDEPE's assumption for occupational duration is 25 years. Due to insufficient information concerning the distribution parameters for this variable, it was treated as a point estimate.

The results of the Monte Carlo analysis, using the input from Table 6-1, is graphically displayed below (Figure 6-1). This graph illustrates the frequency associated with a particular benzene soil standard, as well as the probability of a particular standard's occurrence in the distribution. Results of the analysis indicate that soil remediation values range from a minimum of approximately 470 mg/kg to a maximum of approximately 3,000,000 mg/kg. The most likely value, based on frequency of occurrence, lies between 3,000 and 6,000 mg/kg (2,235 occurrences out of 10,000 trials, for a probability of 0.224). The median value is 9,790 mg/kg, and the 10th percentile of the distribution is 2,330 mg/kg. This information is summarized in Table 6-2.

Figure 6-1

Frequency Distribution of the Benzene Soil Standard Based on Incidental Soil Ingestion Under Nonresidential Conditions



The Monte Carlo analysis indicates that both the NJDEPE soil remediation standard (13 mg/kg) and the point estimate (2,245 mg/kg) are extremely conservative values, well below the most likely value (3,000–6,000) and the median value (9,790 mg/kg) of the distribution. In addition, a full 90% of the values in the distribution are above the 10th percentile soil standard (2,330 mg/kg). Since this 10th percentile value approximates the point estimate (2,245 mg/kg), this indicates that nearly 90% of the values in the distribution are greater than the point estimate.

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Table 6-2

Results of Monte Carlo Analysis of the Benzene Remediation Soil Standard (Nonresidential Conditions)

Distribution Characteristic	Value (mg/kg)
NJDEPE soil remediation standard	13
Approximate minimum value	468
Point estimate value	2,245
10th percentile value	2,330
Most likely value	3,000–6,000
Median value	9,790
Approximate maximum value*	3,000,000

This exercise demonstrates the usefulness of Monte Carlo techniques in determining the full distribution of soil concentrations associated with a particular exposure pathway and also points out the conservative nature of the point estimate soil remediation standards proposed by the NJDEPE. By determining the full distribution of exposure and risk parameters and the most likely outcomes when these parameters are combined, Monte Carlo analysis is the most powerful tool available for eliminating "redundant conservative" assumptions from a risk assessment. As such, it is suggested that the Commission recommend Monte Carlo analysis as a decision-making tool in the development of realistic yet adequately protective soil remediation standards.

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7.0 SUMMARY

Remediation standards for chemicals in soil developed by NJDEPE under ISRA/Senate Bill S1070 are based on "redundant conservative" assumptions. In this document, we demonstrated that the generic selection of values conservative enough to ensure that each variable is itself protective for 90–95% of a given population results in a product of these variables which is unnecessarily conservative. Also, analysis of the scientific literature indicated that each of the factors used by the NJDEPE to develop remediation standards for soil were indeed "redundant conservative" assumptions. The factors demonstrated to be conservative included:

- acceptable cancer risk level;
- cancer slope factor;
- soil ingestion rate;
- time correction factors;
- oral bioavailability for chemicals in soil; and
- half-lives for chemicals in soil.

As an alternative to the NJDEPE's proposed <u>deterministic</u> approach which derives single point estimates of acceptable levels of chemicals in soil, the Commission should recommend <u>probabilistic</u> (i.e., Monte Carlo) techniques to develop distributions of acceptable soil remediation standards. Results of a Monte Carlo analysis of the proposed soil remediation standard for benzene (under nonresidential conditions) indicated that this value was unnecessarily conservative. In fact, more than 90% of the values in the Monte Carlo distribution were greater than the proposed benzene standard. This analysis underscored the conservative nature of the NJDEPE's point estimate soil remediation standards and suggests that Monte Carlo analysis is an easy to use tool for eliminating "redundant conservative" assumptions from NJDEPE's soil remediation standard approach.

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APPENDIX A

Use of Human Epidemiological Data to Estimate Human Cancer Potency (Slope Factors)

This appendix outlines a method for determining "human cancer risk" by using a single human epidemiology study and assuming that the observed increase in cancer reported in the study is a true measure of the human cancer potency. A study of PCB-exposed workers (Brown, 1987) will serve as the example.

We define certain features of a human cohort mortality study in the following manner:

SMR = Standardized mortality ratio

n_i = Worker person years in i^{th} age category as determined from the cohort

r_i = Background risk rate in i^{th} age category (determined from national cancer statistics)

EXP = Number of deaths expected for the cohort based on national background rates ($\Sigma n_i r_i$)

Δ = Incremental number of worker deaths due to exposure

OBS = Observed number of worker deaths

Σn_i = Total person years for worker cohort

r_A = Age-adjusted background risk rate ($\Sigma n_i r_i / \Sigma n_i$)

r_Δ = The incremental risk rate resulting from the chemical exposure.

The SMR is calculated as shown in Equation 1:

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(1) $$SMR = \frac{OBS}{EXP}$$

The observed number of deaths (OBS) equals the expected number of deaths (EXP) plus the incremental number of worker deaths due to exposure (Δ), i.e., OBS = EXP + Δ. Thus, Equation 1 becomes:

(1) $$SMR = \frac{OBS}{EXP} = \frac{EXP + \Delta}{EXP} = 1 + \frac{\Delta}{EXP}$$

Rearranging Equation 1 and solving for the incremental number of cancer deaths observed (Δ) produces Equation 2:

(2) $$\Delta = (SMR - 1) \times EXP$$

Then, dividing both sides of Equation 2 by the total person-years of the cohort (Σn_i) converts the total incremental number of cancer deaths observed (Δ) into the incremental risk rate (r_Δ) for the exposure and produces Equation 3:

(3) $$\frac{\Delta}{\Sigma n_i} = r_\Delta = (SMR - 1) \times \frac{EXP}{\Sigma n_i}$$

The expected number of cancer deaths (EXP) divided by the total person-years experienced by the cohort (Σn_i) yields the age-adjusted risk rate (r_A) for the cancer type of interest. Thus, Equation 3 can be rewritten to produce Equation 4:

(4) $$r_\Delta = (SMR - 1) \times r_A$$

A study by Brown (1987), which examined the mortality experience of PCB-exposed capacitor workers, will illustrate how Equation 4 can be used to derive an estimate of the cancer slope factor for PCBs. From Tables 1 and 3 of the Brown (1987) study, we find that the age-adjusted (liver cancer) risk rate for this cohort is:

$$r_A = 1.9/55{,}545 = 3.42 \times 10^{-5}$$

The SMR = 2.63 for the liver/biliary cancers observed in the study by Brown (1987). Thus, the incremental risk rate caused by exposure to PCBs is:

$$r_{\Delta} = (2.63 - 1) \times (3.42 \times 10^{-5}) = 5.58 \times 10^{-5}$$

Recall that cancer risk, as typically defined by the USEPA, is equal to the lifetime daily chemical dosage times the cancer slope factor; i.e., Risk = dosage x SF (*see* Section 2.0). We can rearrange this equation and solve for the cancer slope factor as follows:

$$SF = \frac{\text{Risk}}{\text{dosage}}$$

Thus, if we can estimate the dosage of a particular PCB-exposed cohort, we can determine the PCB slope factor by dividing the risk (5.58×10^{-5} in the present example) by the estimated dosage.

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