Findings and Recommendations for the Remediation of Historic Pesticide Contamination

Historic Pesticide Contamination Task Force

Final Report - March 1999

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Historic Pesticide Contamination Task Force Members
Stuart Cameron, New Jersey Bankers Association
Greg DeLozier, New Jersey Association of Realtors
Peter Furey, New Jersey Farm Bureau
Pat Halbe, New Jersey State League of Municipalities
Zane Helsel, Rutgers the State University of New Jersey
Gary Mount, NJ Agricultural Community
Jane Nogaki, New Jersey Environmental Federation
Dr. Daniel Wartenberg, University of Medicine & Dentistry of New Jersey
Nancy Wittenberg, New Jersey Builders Association

State of New Jersey
Christine Todd Whitman, Governor

New Jersey Department of Environmental Protection
Robert C. Shinn, Commissioner

Site Remediation Program
Richard J. Gimello, Assistant Commissioner
Tessie Fields, Principal Author

Program Support Element
Post Office Box 413
Trenton, NJ 08625-0413
(609) 984-9305
http://www.state.nj.us/dep/special/hpctf/
Copies available from the Office of Maps and Publications
March 1999

Printed on Recycled Paper

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Executive Summary

The increasing development pressures on New Jersey's remaining farmland have triggered a number of major public policy issues for the state. The Whitman administration is attempting to strike an appropriate balance between new development and the management of the State's natural resources.

Recently, one specific issue that needs to be dealt within this larger context was brought to the attention of the New Jersey Department of Environmental Protection (the Department) by the development community. The historical use of agricultural pesticides in New Jersey has resulted in pesticide residues of certain persistent pesticides in soil at concentrations that exceed the Department's residential soil cleanup criteria and may pose a human health risk. The primary concern with historical pesticide residues is human health risk from inadvertent ingestion of contaminated soil, particularly by children. The presence of moderately elevated pesticide residuals in soil present potential health and marketplace concerns. While there is currently no requirement that agricultural soil be tested prior to development, many developers and lenders are requiring that sites proposed for development undergo an evaluation of environment conditions. In fact, it was such a requirement that triggered the investigation into potential impacts of pesticide residues and soil.

The Department estimates that up to 5 percent of the state's acreage may be impacted by the historical use of arsenical pesticides alone. The presence of pesticide residues may be a concern in currently operating farms and orchards as well as properties that have already been developed. Research conducted by the Department indicates similar problems exist in other states and countries.

The challenge is how to modify the cleanup process currently used in New Jersey to remediate industrial discharges to address the risks presented by historical pesticide contamination.

Department Commissioner Robert Shinn formed the Historic Pesticide Contamination Task Force to help the Department identify technically and economically viable alternative strategies that will be protective of human health and the environment for sites with contamination due to historical use of pesticides. The Task Force met under the direction of Richard J. Gimello, Assistant Commissioner for the Department's Site Remediation Program. During their deliberations Task Force members focused on how the Department determines risk and sets cleanup criteria. This report is a product of true compromise by parties with significant interests. While supporting the overall report, the Task Force members, individually, would place different emphasis on the various conclusions, findings and recommendations. Many members continue to have questions about various elements of the report. The Task Force believes that implementation of the remedial options identified in the report are protective of human health and the environment. The Task Force agreed to offer the following recommendations while the Department continues to evaluate relevant environmental data, conduct needed research, monitor economic impacts of these policies and revisit these recommendations as needed.

The Task Force focused its efforts on several pesticides of concern based upon their extensive agricultural use over a number of years in New Jersey, their persistence in the environment after application, and their presence in sites across the state in concentrations which exceed the Department's residential soil cleanup criteria. The pesticides of concern, which have not been widely used in many years, are arsenic, lead, DDT (and its metabolites, DDE and DDD), dieldrin and aldrin.

Over the last 100 years the agricultural community has routinely and consistently applied pesticides to control pests in order to increase crop yield. Application rates, duration of use and persistence in soil are the major factors that contribute to the likelihood that residual pesticides will be present in soil at concentrations above the Department's residential soil cleanup criteria.

Once the areas of likely application are identified, it is then important to determine the behavior or fate of the pesticides in the environment to obtain a better idea of where and in what form pesticide residuals are expected to occur. Other environmental factors, which influence a pesticide's environmental fate, include its ability to become bound to the soil and its solubility. There are also human factors that influence where these residuals are likely to be found, such as site use and soil management. One of the inherent problems with the presence of arsenic and lead, in contrast to the organochlorine pesticides, is that these are two naturally occurring metals and that it is often difficult to distinguish between concentrations from the application of pesticides and those that occur naturally.

The Department has only collected limited soil sampling data concerning soil pesticide residuals at agricultural properties. While the data are included in the report, the reader is cautioned against attempting to draw conclusions and applying them to specific areas or to the entire state.

The Historic Pesticide Contamination Task Force applied the Department's paradigm for determining risk to human health from the environmental exposure to these chemicals. Primarily this includes following the Legislative guidelines in the Brownfield and Contaminated Site Remediation Act, N.J.S.A. 58:10B-1 et seq., for the acceptable risk level of one additional cancer case in one million people exposed and the application of this risk management decision through human health risk assessments following the applicable federal guidelines.

The Task Force was unable to determine the potential economic impacts which may result from the their recommendations because New Jersey is first in the nation to take actions to control exposure from historical pesticide contamination. However, both the Task Force and Department believe that it was very important to proceed with this evaluation and develop recommendations to educate the public and to make recommendations to mitigate risk from historical pesticide contamination in a timely manner.

The Historic Pesticide Contamination Task Force makes the following recommendations to assist those involved in the remediation of agricultural properties that have been developed and that will be developed in the future.

- Sampling of former agricultural areas, and any necessary remediation, should be conducted prior to site development.

- Sampling of former agricultural areas, and any necessary remediation, should be conducted for areas with exposed soil that are intensively used by children, such as schools, daycare centers and playgrounds.

- Sampling and remediation at sites that have already been developed, except as noted above, should be conducted whenever the current or potential future occupant desires. The Department should provide guidance concerning sampling methods and exposure control alternatives to any person concerned with historic pesticide contamination.

- The Department should provide an appropriate sampling methodology specifically designed for the investigation of pesticide residues in soil at agricultural properties (Addendum 5);

- The Department should authorize a remedial alternative involving soil blending for pesticide residues in soil in former agricultural areas when it is protective of human health. The Task Force recognizes that soil blending represents a substantial departure from current State policy. Therefore, the Task Force recommends that soil blending apply only to historical pesticide contamination sites.

Recommendations also include remedial options for new and existing development sites such as the consolidation and covering of contaminated soil on-site under roads and structures or capping contamination with clean soil. The Task Force recommends that the Department allow contaminated soil to be blended with clean soil from on or off-site sources to achieve concentrations at or below the Department's residential soil cleanup criteria.

I. Introduction

Farmers, orchardists, homeowners, turf growers, local governments and others have used a wide variety of pesticides over the last 100 years in an effort to control pests and increase crop yield. Many pesticides were used in limited circumstances, others became widely used, and some became the "pesticide of choice" for entire crops or industries. Some of these pesticides are persistent in the environment, and thus may be present in the soil long after they have been applied. As a result, residues of a number of pesticides (including arsenical pesticides, DDT and dieldrin) can be found in soils at levels that may pose a human health risk. The New Jersey Department of Environmental Protection ("the Department") estimates that up to 5 percent of the state's acreage may be impacted by the historical use of arsenical pesticides alone. The primary concern with historical pesticide residues is human health risk from inadvertent ingestion of contaminated soil, particularly by children.

As more and more agricultural land is developed, developers, municipal officials, homebuyers and others are becoming increasingly aware of the possible presence of pesticide residues in soils. Some municipalities now require environmental assessments of land as part of their site approval process. Banking institutions take environmental risk factors into consideration in their lending decisions. Developers and builders sample soil more frequently to determine whether or not to purchase land or how to develop land they already own. Homebuyers are also considering pesticide residues along with a myriad of other environmental factors such as indoor air radon levels, the presence of lead paint in the home, and the quality of potable water. The presence of pesticide residues is also a consideration in non-residential property uses including day care centers, schools, parks and general commercial and municipal usage.

A. Creation of the Task Force

Increased numbers of people have been requesting technical and remedial advice from the Department. Numerous questions regarding historic pesticide impacts and the appropriate course of action have been raised. At the request of Department Commissioner Robert Shinn, an informal, interagency task force started meeting in July 1996 to address these questions. It was determined that additional expertise and a more formal structure would facilitate a thorough review of these questions. Commissioner Shinn then memorialized the Historic Pesticide Contamination Task Force ("the Task Force") by Administrative Order 1997-09 (April 1997).

The mission of the Task Force was to develop strategies and recommend implementation plans that will assist the Department in establishing and achieving an environmental course of action for sites with contamination due to historical use of certain pesticides. Nine task force members were chosen with appropriate backgrounds from the stakeholder groups listed below. (See Addendum 1).

New Jersey Bankers Association
New Jersey Association of Realtors

New Jersey Farm Bureau
New Jersey Agricultural Experiment Station at Rutgers
New Jersey Agriculture Community
New Jersey Environmental Federation
University of Medicine & Dentistry of New Jersey (UMDNJ)
New Jersey Builders Association
New Jersey State League of Municipalities

The Task Force developed a number of specific goals. These included:

- Evaluation of potential adverse human health effects and environmental impacts from historic pesticide contamination.

- Identification of technically and economically viable alternatives and strategies to limit human and environmental exposure to contamination from historic pesticide use at sites that have been developed and that will be developed in the future.

- Identification of any barriers to the implementation of these options including cultural, institutional and legal barriers, and recommendations regarding removal of those barriers.

The Task Force met under the direction of Richard J. Gimello, Assistant Commissioner for the Department's Site Remediation Program. Other individuals who attended meetings and served in an advisory role were representatives from various state agencies (exofficio members) and members of the public. Representatives from the following groups served as exofficio members of the Task Force as needed:

New Jersey Department of Environmental Protection
New Jersey Division of Law
New Jersey Department of Agriculture
New Jersey Department of Health and Senior Services
United States Geological Survey
New Jersey State Soil Conservation Committee

In addition, the Department has comments made by Task Force members on file regarding historic pesticide contamination and the findings and recommendations contained in this report.

B. Selection of the Pesticides of Concern

In early 1996, a developer approached the Department with soil sampling data that showed that homes in two Burlington County developments were built on soil containing pesticide residues with concentrations of arsenic, DDT and its metabolites, and dieldrin above the Department's residential soil cleanup criteria. About the same time, the Department was conducting an investigation of a Superfund site in Monmouth County and identified several areas with similar levels of arsenic, first thought to be related to the Superfund site. Further analysis indicated a significant contribution of arsenic contamination due to pesticides used in the former apple orchards adjacent to the site (Barringer, et al. 1998). Investigations were complicated by the fact that some soils (glauconitic soils) in the region of the sites being investigated contained elevated concentrations of naturally-occurring arsenic (Barringer, et al. 1998). This information, along with additional analytical data from other sites, led the Task Force to initially focus on these pesticides as the pesticides of concern.

After additional discussion, these pesticides were kept as the pesticides of concern based on several factors including their extensive agricultural use over a number of years in New Jersey, their persistence in the environment and the fact that they have been detected at levels that exceed the Department's residential soil cleanup criteria at various sites.

The amount of analytical data upon which this report is based is very limited. The Task Force and the Department decided that it was important to proceed with this report and to develop recommendations to address the health risks associated with historic pesticide contamination to assist developers and others to make appropriate decisions concerning properties with pesticide residues. The Task Force decided it could meet its goals by focusing on select pesticides of concern.

The chemical analysis for the organochlorine pesticides of concern (DDT and its metabolites, aldrin and dieldrin) is accomplished with what is referred to as a pesticide scan. The pesticide scan (USEPA method SW 846-8081A) detects twenty-one pesticides including the pesticides noted above. A list of all of the compounds detected by this analytical method is provided in Addendum 2. It is possible that concentrations of other commonly used pesticides, such as chlordane, BHC, endrin and others will be detected in soil when additional properties are investigated. Therefore, pesticide use and human health risk information for these additional pesticides identified by the pesticide scan are provided in Addendum 3 of this report.

The guidance and recommendations contained in this report are intended to be applicable to the historical pesticide contamination resulting from routine agricultural applications. Because site conditions will vary, individual sites must be evaluated and remediated on a site specific basis.

II. Historic Pesticide Contamination in New Jersey

A. History of Pesticide Use

The agricultural community has routinely and consistently applied pesticides to control pests and increase crop yield over the past 100 years. Crop recommendations have been published by the US Department of Agriculture and the NJ Agricultural Experiment Station since the late 1800s. These crop recommendations specified the types and application rates of pesticides that could be used for specific problems with specific crops. Early in the century there were very few products available to fight crop destroying pests besides arsenical pesticides

(Hayes and Laws, 1991). As the organochlorine pesticides emerged, more products became available and the use of arsenical pesticides began to be phased out. The newer pesticides came with benefits. The organochlorine pesticides were effective at lower application rates, making them less expensive to use, and they were generally less persistent.

Application rates, duration of use and persistence of a pesticide are the major factors that contribute to the likelihood that pesticide residues will be present in a particular soil at levels above the Department's residential soil cleanup criteria. The agricultural use pattern (pesticide-crop recommendations and reported acreage of crop production) can be used to roughly estimate the potential for residual pesticide contamination in soil. While it is relatively easy to determine the use pattern for arsenical pesticides, it is more difficult to determine the use pattern of the different organochlorine pesticides because several of these different pesticides were recommended for a wide variety of crops.

The following historical review of arsenical and organochlorine pesticide use in New Jersey provides insight into the type and possible geographical extent of potential residual pesticide contamination of these pesticides of concern. While other pesticides have been used in agriculture, these groups are representative of the most widely used pesticides over the last century. Use information for additional pesticides is provided in Addendum 3.

Arsenical Pesticides

Around the turn of the 20th century, the use of arsenical pesticides became prominent in the United States, especially for insect pest control. Lead arsenate was employed extensively on apple orchards but was also used for control of agricultural pests in vegetable fields and other fruit orchards. Golf courses and turf farms also received applications of lead arsenate on a regular basis. White potato fields received applications of calcium arsenate. By 1917, the routine use of lead arsenate was initially recommended by the New Jersey Agricultural Experiment Station on apple and peach crops; use recommendations continued until 1967 when the use of synthetic organic pesticides (primarily organochlorine pesticides) became established. Lead arsenate was generally applied at a rate of several pounds per acre. (Murphy and Aucott, 1998).

Estimates have been developed for the historical use of arsenical pesticides in New Jersey (Murphy and Aucott, 1998). Based on crop recommendations, the greatest use appears to have been in fruit orchards. While pesticides may have been applied in agricultural areas in all New Jersey's counties, six counties have provided most of the fruit production (Burlington, Cumberland, Gloucester, Hunterdon, Monmouth and Salem) over the last 90 years. Prior to 1960, Burlington, Monmouth and Gloucester counties were the dominant apple and peach producing counties. Since 1960, Gloucester and Burlington have been the largest fruit-producing counties (Murphy and Aucott, 1998).

Based on agricultural production information, arsenical pesticides may have been applied to approximately 240,000 acres statewide. This acreage represents about 5 percent of New

Jersey's area, which is approximately 5 million acres. This value is based on the average acreage for each decade from 1900 through 1960. (Murphy and Aucott, 1998)

DDT (and its metabolites DDD and DDE)

DDT (dichloro diphenyl trichloroethane) was first used in World War II to control lice and was released for commercial use soon thereafter. Its use grew rapidly through the 1950s. In the 1960s, DDT use began to decline for a number of reasons including reduced effectiveness on certain insects, the detection of DDT residues in food, and concerns about the widespread occurrence of DDT in the environment and its impact on fish and birds (Hayes and Laws, 1991 and USEPA, 1990).

The breakdown products, or metabolites, of DDT are DDD (dichloro diphenyl dichloro ethane) and DDE (dichloro diphenyl dichloroethylene). DDT was broadly recommended for the control of a wide range of insect pests on vegetables and fruits and was a major pesticide used for mosquito control programs. Because of its broad application, it is very difficult to identify specific areas of the state that are more likely than others to have elevated levels of this organic pesticide or its metabolites. Unlike the arsenicals, the organochlorines had application rates that varied from a few ounces to a few pounds of active pesticide ingredient per treated acre. The US Environmental Protection Agency prohibited all uses of DDT by 1972. (Hayes and Laws, 1991 and USEPA, 1990).

Aldrin and Dieldrin

By 1949, additional organochlorine pesticides such as aldrin and dieldrin were in common usage. Aldrin is quickly metabolized to dieldrin in the environment. Both compounds were used against insects in field, forage, vegetable and fruit crops. Aldrin/Dieldrin sales peaked in 1956. The EPA prohibited its use for food commodities by 1974 and by 1987, all uses were prohibited. (Hayes and Laws, 1991 and USEPA, 1990).

B. Fate of Pesticides in the Environment

The fate of chemicals in the environment suggests where and in what form residual pesticide contamination is expected to occur. The fate of pesticides in the environment is determined by characteristics of the specific pesticide, various environmental factors, and the impacts of human activities.

An important characteristic of the pesticides discussed in this report is that they persist in the environment (e.g., they do not readily break down). Lead and arsenic are elements that do not break down and therefore will persist in the environment indefinitely. DDT and its metabolites (DDE and DDD), aldrin and its metabolite dieldrin, while persistent in the environment, will eventually break down after a number of years. Another important factor is the ability of a pesticide to become bound to soil. Pesticides tend to adhere to fine soil particles (clays) and organic matter rather than to sandy soils. Pesticides become tightly bound to soil particles so that migration of the contaminant down deeper into the soil is limited. The solubility of a pesticide indicates whether or not it will stay bound to soil particles or dissolve into water. In most cases, contaminant levels decrease substantially with depth, usually reflecting background levels at 1.5 to 2 feet below the surface (Peryea and Creaer, 1994). However, the addition of some fertilizers or lowering of soil pH and irrigation may affect the downward mobility (Peryea and Kammerck, 1997). Arsenical pesticides and the organochlorine pesticides are not particularly water soluble and therefore pose minimal threat to ground water. However, these pesticides may pose some risk to shallow aquifers in acidic, sandy soils. Pesticides bound to soil particles may impact surface waters by contaminant migration via soil erosion and runoff.

In addition to the environmental factors discussed above, there are also human factors that affect the occurrence and distribution of pesticide residues. During active farming activities certain pesticides were applied year after year based on specific crop recommendations. When land use changes, site use and soil management will affect the concentrations and distribution of residual pesticide contamination. The excavation and transportation of top soil to other sites affect the distribution of the pesticides of concern. Currently, the movement of soil from development sites is less common than in prior years for two reasons: first, many municipalities have ordinances prohibiting the movement of soil from development sites (Halbe, Personal comm. 1998; Nogaki, Personal comm. 1998) and, second, the high cost of transporting soil. Developers generally try to maintain a soil balance when developing property so that no soil will need to be purchased and no soil will need to be removed during development (Wittenberg, Personal comm. 1997).

Other soil management practices affecting the distribution of pesticides involve the mixing of clean and contaminated soils during the course of development activities. Typical site development activities, such as the excavation of basements, the installation of water and sewer lines, and streets, generally result in the mixing of contaminated soil with underlying clean soil which is likely to reduce pesticide concentration levels at the surface.

C. Sampling Results from Select New Jersey Agricultural Sites

In this section, the Department has compiled analytical soil data from current and former agricultural sites to begin to assess the nature and extent of soil contamination caused by historic pesticide use in New Jersey. The data from 18 sites were made available to the Department between 1996 and 1998, by private parties, the US Geological Survey and municipalities seeking the Department's review. These sites were specifically sampled to determine if pesticide residues were present and may not be representative of all agricultural sites. The analytical data summarized in Tables 1 through 4 were compiled from a variety of current and former agricultural sites and have been reviewed by the Department.

Table 1.
Select New Jersey Agricultural Sites
General Information

Site #	Size (acres)	Township	County	Reported Agricultural Use
1	24	Saddle River	Bergen	Apple orchard
2	30	Mount Laurel	Burlington	Field crops
3	300	Mount Laurel	Burlington	Field crops
4	33	Burlington	Burlington	Orchard and field crops
5	Unknown	Moorestown	Burlington	Field crops
6	Unknown	Colt's Neck	Monmouth	Orchard
7	84	Upper Freehold	Monmouth	Orchard and field crops
8	105	Cranbury	Middlesex	Field crops
9	10	Marlboro	Monmouth	Orchard
10	5	Marlboro	Monmouth	Orchard
11	113	Burlington	Burlington	Orchard
12	180	Upper Freehold	Monmouth	Field crops and nursery
13	105	Delanco	Burlington	Field crops
14	60	Washington	Mercer	Field crops
15	450	Hopewell	Mercer	Dairy and field crops
16	72	Florence	Burlington	Field crops
17	50	E. Greenwich	Gloucester	Field crops
18	65	Evesham	Burlington	Field crops

Table 2.
Sampling Results from Select New Jersey Agricultural Sites
Arsenic and Lead
All data provided in parts per million (PPM)

Residential Soil Cleanup Criteria		Arsenic 20 ppm		Frequency of Detection		Lead 400 ppm		Frequency of Detection	
Site	# Samples	Range	Median*	Total	>Criteria	Range	Median*	Total	> Criteria
1	11	6.6-147	29.3	11	9	69.9-517	153	11	1
2	4	6.2-22.2	14.4	4	1	ND-25.3	24.2	2	0
3	18	8.2-65.3	28.6	18	11	ND-163	79.4	16	0
4	38	4.8-310	33	38	22	66-350	300	38	0
5	16	3.89-46.5	18.7	16	6	37.1-551	77	16	1
6	2	<20	<20	NR	0	47-50	48.5	2	0
7	5	<20-55**	35.5**	5	2	<400	<400	5	0
8	92	5.8-32.7	16.1	92	21	NA	NA	NR	NR
9	15	4.2-41.5	10.9	15	4	22-204	56.8	15	0
10	18	10.4-70.5	24.7	18	14	16.9-392	117	18	0
11	111	5.5-231	27.5	111	38	8.9-924	87.9	111	3
12	69	6.38-35.2	18.6	69	32	14.9-17.7	16.9	NR	0
13	5	2.9-9	4.4	5	0	9.1-58.2	22.9	5	0
14	4	7.0-23.6	15.2	4	2	12.4-47.3	16.2	4	0
15	6	1.4-7.4	3.6	6	0	19.3-34.5	24.5	6	0
16	43	9.6-96.9	28.6	43	12	31.4-33.8	32.6	43	0
17	0	NA	NA	0	0	NA	NA	0	0
18	6	4.1-6.47	5	6	0	7.8-13.7	11.3	6	0

NR = Not Reported NA = Not Analyzed

*Median of Detected Values **Concentrations due to natural background

Table 3. Sampling Results from Select New Jersey Agricultural Sites
Organochlorine Pesticides
All data provided in parts per million (ppm)

Residential Soil Cleanup Criteria		DDT 2.0 ppm		Frequency of Detection		DDE 2.0 ppm		Frequency of Detection		DDD 3.0 ppm		Frequency of Detection	
Site	# Samples	Range**	Med*	Total	>Criteria	Range**	Med*	Total	>Criteria	Range**	Med*	Total	>Criteria
1	3	0.13-1.5	0.34	3	0	0.14-0.65	0.17	3	0	ND-0.02	na	1	0
2	24	ND-0.47	0.27	4	0	ND-0.19	0.15	4	0	ND-0.02	0.012	4	0
3	18	0.06-1.18	0.38	18	0	0.06-0.43	0.26	18	0	ND-0.43	0.02	18	0
4	3	0.06-3.0	1.3	3	1	0.1-2.6	0.33	3	1	ND	na	0	0
5	16	ND	na	0	0	ND-0.07	0.02	5	0	ND	na	0	0
6	10	0.16-0.66	0.33	10	0	0.19-0.81	0.31	10	0	ND-0.05	0.015	5	0
7	64	ND-4.0	0.44	64	2	ND-1.72	0.48	62	0	ND-0.73	0.08	13	0
8	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
9	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11	111	0.01-26	1.65	111	15	0.002-8.8	0.85	111	10	0.004-6.8	0.34	111	2
12	6	0.01-0.07	0.02	6	0	0.02-0.05	0.04	6	0	0.01-0.02	0.02	6	0
13	5	0.09-0.42	0.28	5	0	0.09-0.35	0.14	5	0	ND-0.43	0.03	4	0
14	4	ND-0.19	na	1	0	ND-0.07	0.01	3	0	ND-0.03	na	1	0
15	6	ND	na	0	0	ND	na	0	0	ND	na	0	0
16	36	ND	na	0	0	ND	na	0	0	ND	na	0	0
17	5	ND-0.03	0.02	2	0	ND-0.02	0.01	4	0	ND-0.004	na	1	0
18	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

ND = Not Detected NA = Not Analyzed na = not applicable
* Median of Detected Values ** Range is for all samples, not just detected values

Table 3. (Cont.) Sampling Results from Select New Jersey Agricultural Sites
Organochlorine Pesticides
All data provided in parts per million (ppm)

Residential Soil Cleanup Criteria		Dieldrin 0.042 ppm		Frequency of Detection		Aldrin 0.042 ppm		Frequency of Detection	
Site	No. Samples	Range**	Med*	Total	>Criteria	Range**	Med*	Total	>Criteria
1	3	ND	ND	0	0	ND	ND	0	0
2	24	0.002-0.39	0.17	11	4	ND	ND	0	0
3	18	ND-0.16	0.04	24	22	ND	ND	0	0
4	3	ND-0.37	0.33	2	2	ND	ND	0	0
5	16	ND-0.06	0.03	2	1	ND	ND	0	0
6	10	0.04-0.09	0.08	10	5	ND	ND	0	0
7	64	ND	ND	0	0	ND	ND	0	0
8	0	NA	NA	NA	NA	ND	ND	0	0
9	0	NA	NA	NA	NA	ND	ND	0	0
10	0	NA	NA	NA	NA	ND	ND	0	0
11	111	ND-0.27	0.03	71	23	ND	ND	0	0
12	6	ND	na	0	0	ND	ND	0	0
13	5	ND	na	0	0	ND	ND	0	0
14	4	ND-0.01	na	1	0	ND	ND	0	0
15	6	ND	na	0	0	ND	ND	0	0
16	36	ND-0.05	0.01	10	1	ND	ND	0	0
17	5	ND	na	0	0	ND	ND	0	0
18	0	NA	NA	NA	NA	ND	ND	0	0

ND = Not Detected NA = Not Analyzed na = not applicable
* Median of Detected Values ** Range is for all samples, not just detected values

Table 1 includes general site information and Tables 2 and 3 include the range of detected values, the median of the detected values, the frequency of detection and the frequency of detection at concentrations greater than the Department's residential soil cleanup criteria. Table 4 is a summary of the detected values for the less frequently detected organochlorine pesticides.

All samples were collected from the surface soil (0-6 inches) and were analyzed for metals and the organochlorine pesticides (Addendum 2). As indicated in the number of samples column, not all samples were analyzed for all parameters. Arsenic and lead are the only metals reported, because either the other metals reported were below the Department's residential soil cleanup criteria and thus not of concern, or because the data were not made available to the Department. Only pesticides that were detected at least once in any sample from the 18 sites are included in the Tables. The following pesticides were included in the analysis but were not detected in any sample: aldrin, delta-BHC, gamma-BHC, alpha-chlordane, gamma-chlordane, heptachlor, heptachlor epoxide, methoxychlor and toxaphene.

Arsenic was detected in all the samples (463) in the data set at concentrations ranging from 1.4 ppm to 310 ppm. Arsenic was detected above the Department's residential soil cleanup criteria more frequently than any other analyte. Arsenic was detected above the cleanup criteria in 38% of the samples. In contrast, lead concentrations, which ranged from non-detect to 924 ppm, was detected above the cleanup criteria in only 1% of the samples.

Of the organochlorine pesticides, DDT, DDE, DDD and dieldrin were detected most frequently in the samples analyzed for organochlorine pesticides. However, with the exception of dieldrin, these pesticides were rarely present at concentrations greater than the Department's residential soil cleanup criteria. DDT was detected 227 times at concentrations up to 4 ppm. However, only 6% of the samples contained concentrations of DDT greater than the cleanup criteria of 2 ppm. DDE was detected in 234 samples at concentrations up to 8.8 ppm, but only 4% of the samples contained concentrations above the Department's residential soil cleanup criteria of 2 ppm. DDD was detected in 164 of the samples ranging in concentration up to 6.8 ppm, only 2 samples contained concentrations greater than the cleanup criteria of 3 ppm. For dieldrin, even though the concentrations detected were low, ranging ND-0.39 ppm, a higher percentage of the samples contained concentrations above the cleanup criteria (18%). This is probably due to the low cleanup number for dieldrin (0.042 ppm).

Table 4 contains data for the additional pesticides that were detected at the 14 sites using the organochlorine pesticide scan. These pesticides include alpha and beta-BHC, endrin, endrin aldehyde, endrin ketone, endosulfan I and II and endosulfan sulfate. Of the 311 samples analyzed, these 8 pesticides were detected in only 20 samples at very low concentrations.

Samples from four sites (13, 15, 17 and 18) did not contain any concentrations greater then the Department's residential soil cleanup criteria; however, samples from site 17 were not analyzed for metals and samples from site 18 were not analyzed for organochlorine pesticides.

Due to the small sample size, one cannot draw any conclusions regarding the location of the sites or the type of agricultural use and the resulting analytical data.

Table 4.
Sampling Results from Select New Jersey Agricultural Sites
Organochlorine Pesticides

All data provided in parts per million (ppm)

Residential Cleanup Criteria		alpha-BH (no criteria)		beta-BHC (no criteria)		Endrin 17 ppm		Endrin aldehyde (no criteria)		Endrin ketone (no criteria)		Endosulfan I 340 ppm		Endosulfan II 340 ppm		Endosulfan sulfate (no criteria)	
Site	**No. of Sampl**	**Range**	**Freq***	**Range**	**Freq**	**Range**	**Freq**	**Range**	**Freq**	**Range**	**Freq**	**Range**	**Freq**	**Range**	**Freq**	**Range**	**Freq**
1	3	ND	0	ND-0.02	1	ND	0	ND	0	ND	0	ND	0	ND-0.45	1	ND-0.04	1
2	24	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0
3	18	ND-0.001	1	ND-0.016	2	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0
4	3	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0
5	16	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0
6	10	ND	0	ND	0	ND-0.05	5	ND-0.02	5	ND-0.02	1	ND-0.004	1	ND	0	ND	0
7	64	ND	0	ND-0.022	1	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0
8	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
9	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11	111	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0
12	6	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0
13	5	ND-0.46	1	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0
14	4	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0
15	6	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0
16	36	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0
17	5	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0
18	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

ND = Not Detected NA = Not Analyzed * Frequency compound was detected

D. Similar Issues in Other States and Countries

The Department contacted other states around the country to determine the extent of historical pesticide contamination nationally and to learn how other states were responding to the problem (Hamilton, 1998). Based on the results of the survey 14 states consider the historic use of pesticides to be problematic with respect to site regulation, development and cleanup.

For example, the state of Washington, a major producer of apples, has reported problems with pesticide contaminated soils. In situations similar to New Jersey, Washington's Department of Ecology (DEC) has reviewed site-specific data for sites slated for development. DEC reported a range of lead concentrations up to 1000 ppm and arsenic concentrations up to 800 ppm in orchard soils. Reportedly, some orchards in Washington state have experienced problems of phytotoxicity, in which the levels of arsenic in soils became toxic to fruit trees. (Roundtry, Personal comm. 1998)

Only Michigan reported that it requires sampling for pesticide residues before site development. However, fifteen states (Alaska, California, Connecticut, Delaware, Idaho, Illinois, Iowa, Michigan, Minnesota, Montana, New York, Rhode Island, South Carolina, South Dakota and Texas) reported that lenders sometimes require testing.

Based on this limited survey, nearly every state that has dealt with the problem of contamination caused by the historic legal use of pesticides and subsequent remedial action has done so using a voluntary, case-by-case approach. Depending upon the anticipated use of the land and likely routes of exposure, most states accept remedial actions such as the removal or the covering of contaminated soil. Several states allow, but do not mandate, the use of deed restrictions (Delaware, Massachusetts, Michigan, Minnesota, Missouri, New York, Rhode Island South Carolina and Texas) as part of a remediation. None of the responding states is considering regulation to address past pesticide contamination at this time.

Lead arsenate-contaminated soils have been reported in fruit growing regions of Australia, Canada and New Zealand and likely occur in many other countries (Peryea and Kammereck, 1997).

E. Natural Background Soil Concentrations of Arsenic and Lead

Arsenic and lead are naturally occurring in soil and can vary widely. All soils contain naturally-occurring arsenic and lead in some amount (Kabata-Pendias and Pendias, 1984). In general, the concentrations of arsenic in any particular soil are dependent upon the parent material and the soil forming processes. Because the soil forming processes are relatively consistent in New Jersey, differences in arsenic concentrations depend primarily on the soil parent material and past and present land use (Motto, Personal comm., 1997).

Because the underlying geologic materials vary widely throughout New Jersey, naturally-occurring concentrations of metals in New Jersey soils also vary widely. Even though soils within a specific soil series can be similar in texture and color, the mineral and organic matter composition of soil tend to be heterogeneous. As a result, concentrations of metals in adjacent soil samples can vary substantially over distances of a few feet.

Based on a Department survey of background concentrations of metals in soil in rural and suburban areas of the state, non-agricultural soils contained 0.02 – 22.7 ppm of arsenic with an average 3.25 ppm and less than 1.2- 150 ppm of lead with an average of 19.2 ppm (Fields, et al., 1993). A statistical test was conducted to determine the correlation between sand, silt and clay content of the samples and metal concentrations. Samples containing higher clay content tended to have higher concentrations of most metals, including arsenic and lead (Fields, et al., 1993).

While naturally-occurring lead concentrations have not been detected above the Department's residential soil cleanup criteria in New Jersey, elevated arsenic concentrations have been found. Higher concentrations of naturally-occurring arsenic have been specifically associated with soils containing glauconite. The US Geological Survey found arsenic concentrations generally lower than 10 ppm in sandy soils from undeveloped areas, but concentrations were as large as 40 ppm in samples containing higher clay content (Barringer, et al., 1998). Soil sampling conducted as part of site remediation activities have shown glauconite soils to commonly contain arsenic concentrations of 20-40 ppm and range as high as 260 ppm (Schick, Personal comm., 1998). The Department is currently involved in a research project with the New Jersey Geological Survey investigating metal levels in glauconite soils.

Although some metals can be expected to occur naturally at levels greater than the Department's residential soil cleanup criteria, synthetic compounds such as the organochlorine pesticides, are not naturally occurring chemicals. The natural background concentrations of such synthetic organic compounds should be zero (Fields et al., 1993). The presence of DDT and dieldrin clearly indicate human impacts to the soil. Trace levels of some pesticides have been associated with deposition of air-borne contaminants. However, concentrations of pesticides such as DDT, DDE, and dieldrin in soil (Fields et al., 1993) that exceed the Department's residential soil cleanup criteria typically result from direct application to the soil surface.

The Department is not authorized to require remediation of naturally-occurring conditions in the environment. (See N.J.S.A. 58:10B-35g(4)). However, it is important to determine during the remedial investigation and the remedial action at a site, whether elevated levels of arsenic are the result of a discharge or whether they reflect natural background conditions.

It is assumed that naturally elevated arsenic levels in soil pose similar health risks as those resulting from historical pesticide use (Florida Agricultural Information Retrieval System, 1998) . In addition, natural background conditions can also affect the selection of an appropriate remedy for a site. For example, blending would not be a viable option for a site with high background concentrations of arsenic.

III. Human Health

A. Assessment of Human Health Risk

A primary focus throughout the Task Force's discussions was on the issue of risk. Several meetings were devoted to presentations about how the Department assesses and manages risks to human health in the context of the Site Remediation Program. A detailed discussion of this issue is presented below.

In 1983, the National Research Council developed a risk assessment framework that "uses a factual base to define the health effects of exposure of individuals to hazardous materials and situations" (NRC, 1983). The Department, as do most state and federal regulatory agencies, applies risk assessment methodology to characterize health risk posed by contaminated sites throughout New Jersey. Specifically, the Department applies risk assessment methodology in accordance with N.J.S.A. 58:10B-12, which established by statute, a risk management goal of one in a million for carcinogens. This goal means that the risk presented may not result in more than one additional case of cancer in a population of one million people exposed to a certain level of a contaminant over their lifetime. In enacting this law the Legislature also created a Risk Management Commission in response to the intense technical debate over the appropriate level of risk to use as the basis for cleanup criteria. The Commission was charged with examining the scientific basis for the risk management standard of one in one million, risk assessment methodologies and evaluating their applicability for the purposes of establishing cleanup criteria. However, the Risk Commission has not completed its report. Until such time that the Risk Commission completes its recommendations and the Legislature acts to change its mandate of one in one million as New Jersey's risk management standard, the Department is required to remediate sites to that standard.

The growing reliance on risk assessment to make environmental decisions has led to increased scrutiny and criticism of this analytical tool. Certain commenters argue that some limitations of the method may cause exaggerated risk estimates resulting in unnecessary resource expenditures; others have argued that it may lead to underestimation of risk and impede remediation of hazardous situations. Nevertheless, risk assessment continues to be the cornerstone of environmental decision making with the understanding that there are limits to its accuracy imposed by scientific uncertainties and policy directives.

Task force members wanted to make sure that the risks presented by soil contaminated with pesticide residues were neither overstated or understated relative to the other health risks the citizens of New Jersey contend with in their daily lives.

Putting risk of exposure to pesticide residues in soil in context is difficult especially for the layman. Risk assessment is not an exact science. The methodologies and protocols used to evaluate risks are mathematical formulas that contain many different factors. Some factors are thought to overestimate risks and others to underestimate risk. For certain factors there is not an abundance of scientific data on which to make decisions. For example, the amount of the contaminant contained in the soil that is "available" to the human body after soil ingestion, (i.e., its bioavailability) is not well known. Bioavailability is currently a hotly debated topic (Walker and Griffin, 1998). As there is little contaminant specific bioavailability data currently available, methodologies used currently by New Jersey assume that 100 percent of the contaminant in the soil is "bioavailable."

This is unlikely to be the case for all contaminants in all the different New Jersey soil types and so the resulting soil cleanup number affected by this factor may be conservative and may overestimate the true cancer risk. However, until additional data are gathered and evaluated, the 100 percent bioavailability factor will continue to be used. In the future, if a lower percent (less than 100 percent) bioavailability were used, the resulting standard would increase.

Conversely, risk assessment methodologies currently use health impacts based on adult physiology. Studies have shown that children can be harmed by concentrations much lower than those that affect adults (NRC, 1993). The prescribed approach of using adult physiology to assess childhood risk results in less conservative soil cleanup criteria compared to cleanup numbers generated using sensitive populations or children's physiology and may underestimate cancer risk.

As the science of risk assessment improves, the public policies and technical criteria the Department uses in evaluating and mitigating risk will also improve. However, in the interim, the Department will continue to use the tools available today.

Finally, while it is true that people voluntarily accept other risks from routine activities on a daily basis which are often greater than the risk presented by environmental exposures, this fact alone should not distract us from the goal of reducing cancer risk from environmental exposures. If decisions were based only on numerical risk, none of us would drive automobiles. Risk management decision includes many other considerations which are too involved to discuss here.

B. Human Health Risk and Criteria Development

This section addresses the adverse health effects from exposure to residues of selected pesticides (arsenic, lead, DDT and dieldrin) which have historically been applied on agricultural sites. Health information for additional organochlorine pesticides is provided in Addendum 3.

Regulatory agencies examine human and animal studies to determine the health effects of a particular contaminant. Both cancer and non-cancer health effects are examined. For arsenic, DDT and dieldrin, cancer is the most sensitive human health endpoint; for lead, non-cancer endpoints are of most concern for human health. Toxicity information alone, however, does not determine whether a person will become ill. A person must be exposed to a contaminant for a health effect to occur. In estimating exposure, a variety of default assumptions are used, including specific body weights, ages and activity patterns for people. In the context of this report, it is assumed that exposure to contaminated soil would principally occur from the ingestion of soil when children play.

Using the combined toxicity and exposure data and risk management factor, regulators determine an allowable level of a contaminant in soil, the health-based cleanup criteria. For carcinogens, this number represents the level of a contaminant that is predicted to result in one additional cancer case occurring in a population of 1 million people exposed over their lifetimes. This one in a million additional cancer risk is the risk management factor and its use has been mandated by the New Jersey Legislature at N.J.S.A. 58:10B-12.

While there is little debate about the need to avoid the exposure that may result in adverse effects to human health and the environment due to soil contamination, there is considerable debate on the determination of what level of protection is appropriate. For the most part, the Department uses health-based concentrations as its cleanup criteria. It should be noted, however, that the Department's soil cleanup criteria are not adopted as regulatory standards. An effort to adopt soil cleanup criteria into regulation is currently underway.

Even though the Department primarily uses health-based concentrations for soil cleanup criteria, the cleanup criteria for arsenic is based on natural background concentrations. For example, as discussed above, arsenic is a naturally-occurring substance. Separate from the use of any pesticide, certain soils in New Jersey have substantial concentrations of arsenic. Therefore, in considering to what level to require cleanup when there have been discharges of arsenic, the Department uses natural background for arsenic because these concentrations are typically above the health-based concentrations. For compounds that are not naturally occurring, such as DDT and its metabolites and dieldrin, the Department's soil criteria are set at that concentration which poses acceptable risk (i.e., less than one in a million additional cancer cases).

It should be acknowledged that there was considerable debate among members of the Task Force regarding risk assessment methodology, assumptions and models used by the Department to define human health risk. While there are considerable uncertainties inherent in the risk assessment process, it was agreed that the Task Force's findings and recommendations would be based on the Department's current soil cleanup criteria as listed in Table 5.

Table 5.
NJDEP Residential Soil Cleanup Criteria
for the Selected Pesticides of Concern
All criteria provided in parts per million

Arsenic	20
Lead	400
DDT	2
DDE	2
DDD	3
Aldrin	0.04
Dieldrin	0.042

It was acknowledged that the base of scientific knowledge in the field of risk assessment will change over time and that it may be necessary to modify the findings and recommendations of the Task Force in the future.

C. Chemical Specific Toxicity and Soil Cleanup Criteria

1. Arsenic

Arsenic is a human carcinogen that causes lung cancer when inhaled; and liver, lung, kidney, bladder and skin cancer when ingested in drinking water (Bates, et al., 1992). Although there is ongoing debate in the technical literature about the existence of a threshold exposure below which there is no cancer risk, the available data do not provide unquestioned support for this (Beck, et al., 1995; Carlson-Lynch, et al., 1994; Smith, et al., 1995). There has also been much debate about other issues relative to assessing risk from arsenic exposure (Mushak and Crocetti, 1995; Mushak and Crocetti, 1996; Slayton, et al., 1996). For the purposes of this evaluation, the model and strength of carcinogenicity (cancer slope factor) determined by the EPA were used (Smith, et al., 1992; Smith, et al., 1995). The non-cancer health effects, such as skin disorders including keratosis, hyperpigmentation, and vascular complications, are not considered in this evaluation because the cancer endpoint occurs at considerably lower levels than non-cancer endpoints.

Using the EPA estimate of carcinogenic strength, the concentration of arsenic below which the cancer risk is less that one additional case in one million people exposed for a lifetime, corresponds to a lifetime exposure to a soil concentration of 0.4 ppm for residential exposure. The Department's soil cleanup criteria for arsenic (20 ppm) is based on naturally occurring background levels. Translated into cancer risk based on EPA assumptions and calculations, a person exposed to 20 ppm of arsenic has a 50 in one million chance of getting cancer over a lifetime due to arsenic exposure alone.

2. Lead

The major health concern for lead differs from that associated with arsenic, dieldrin, and DDT. Lead has been shown to cause behavioral changes, learning disabilities and intelligence deficits (USEPA, 1998). Excessive exposure to lead causes toxic effects to the brain, kidneys and cardiovascular system. Subtle physiologic, biochemical and neurobehavioral effects are associated with lower level exposures. There is particular concern for sensitive populations, such as children and the developing fetus. While strong efforts have been and continue to be made, current scientific research indicates that acceptable concentration of lead exposure are lower than previously thought, if they exist at all (USEPA, 1998).

The Department’s soil cleanup criteria for lead is 400 ppm for residential exposure. Unlike other criteria, this concentration is based on the results of the Integrated Exposure Uptake Biokinetic (IEUBK) model. The model is designed to assess a child’s exposure to lead in soil at concentrations that result in blood lead levels of less than 10 micrograms per deciliter of blood (ug/dL). This 10 ug/dL blood lead level is based on analyses conducted by the US Center for Disease Control that associate this and higher levels with adverse health effects in children. (USEPA, 1994)

3. DDT and Its Metabolites

DDT is suspected of causing liver and pancreatic cancer in humans (ATSDR, 1994). Using data from human studies in conjunction with data from animal studies, the USEPA has classified DDT as a probable human carcinogen. Two structurally similar breakdown products of DDT are DDE and DDD, which also are classified as probable human carcinogens.

Using the EPA's estimate of carcinogenic strength, the Department's soil cleanup criteria based on an acceptable health risk are 2 ppm for DDT, 2 ppm for DDE and 3 ppm for DDD.

4. Aldrin and Dieldrin

In the environment and in the human body, aldrin breaks down rapidly to dieldrin. Dieldrin is a probable human carcinogen that causes liver tumors in test animals. The Department's soil cleanup criteria based on an acceptable health risk are 0.042 ppm for dieldrin and 0.04 ppm for aldrin.

IV. Remediation of Soil Contaminated by Historic Pesticide Use

A. Risk Management

The management of health risks involves the reduction or elimination of human exposure to a contaminant. The remedial options described below reduce exposure to soil contamination resulting from pesticide residues in surface soil. While all the remedial options presented are protective, the remedial options that employ engineering controls have additional, long term requirements associated with them.

Remedial actions that cover or contain contaminated soil can reduce risk, provided, however, that these exposure controls are maintained. If these controls are not maintained, contaminated soil can be brought to the surface. Contaminated soil brought to the surface must be properly disposed of or covered on-site.

Current Department regulations allow for various remedies for sites with contaminated soil. The Department uses two different criteria for soil; the first are residential use remediation criteria that are appropriate for any use, without the placement of restrictions. The second soil criteria are referred to as a non-residential use remediation criteria. A deed notice is imposed at sites where non-residential criteria are applied as the remedy to ensure that the site use continues to be appropriate.

Sites contaminated by historical pesticide use, such as farmland, can be developed for any site use, including residential use, using appropriate engineering and institutional controls. For example, one foot of clean soil as a cap with a vegetative cover to stabilize the cap and a deed notice may be sufficient at many sites. Residential use remedies can be conducted at sites by excavating and disposing of contaminated soil, replacing with clean top soil or by blending contaminated soil with clean soil from on-site or from off-site sources so that the residential use remediation criteria are met throughout the soil column.

B. Existing Regulatory Framework

To put the report recommendations into context, the Department presented to the Task Force the following discussion of the Department's Site Remediation Program procedures. The Site Remediation Program is charged with the identification and remediation of discharges of hazardous substances and pollutants into the environment. With the Department's oversight, the person conducting the remediation evaluates environmental conditions at a site in relation to applicable environmental regulations.

When remedial actions have been completed at a site, the Department issues a No Further Action Letter. The Department's No Further Action Letter is based on an evaluation of the historical use of the site and other investigation deemed necessary to determine that no contaminants are present at the site above the Department's residential soil cleanup criteria or that contaminants have been remediated. The No Further Action Letter describes the location of the site and the type of remediation that has occurred at a site. It is important to understand that the issuance of a No Further Action Letter does not necessarily mean that no contamination remains at the site. A situation that can result in contamination being left at a site is when the person conducting the remediation chooses to remediate the site by leaving the contamination in place and by controlling human exposure to contaminated media. Exposure control can be a physical mechanism, such as a cap of clean soil, an asphalt parking lot, or a building. Exposure can also be controlled with the imposition of an institutional control, such as a deed notice. An institutional control is a mechanism that serves to control the type and location of activities at a site.

It should be noted that the Department does not regulate metals that are determined to be naturally occurring and therefore, it does not require their remediation. When naturally occurring metals come to the Department's attention during the remediation of a discharge, the Department will include information about the concentrations measured at the site within the No Further Action Letter for the property owner's and county health department's information.

A deed notice is required at sites where contamination remains after a remedy is implemented above the Department's residential soil cleanup criteria. This notice ensures protection of public health, disclosure of site conditions to future owners, and maintenance of required engineering controls. See the Technical Requirements for Site Remediation N.J.A.C. 7:26E for deed notice and biennial reporting requirements.

C. Remedial Strategies

The Task Force evaluated a wide range of possible remedial actions for reducing or eliminating human exposure to contaminated soil based upon land use. The selection of remedial options should include considerations such as site layout and construction plans. In addition, it may be appropriate to implement more than one remedial option at a site.

Remedial Option 1 - Contaminated soil can be consolidated and covered on-site under buildings, roads, or other areas approved by the Department. Contaminated topsoil may not have the appropriate physical properties to be used under some structures making engineering review of this option important. The use of grass and landscaping as an exposure control should only be allowed for as part of an exposure control strategy when approved by the Department. This option would require the filing of a deed notice.

Remedial Option 2 - Contaminated soil can be capped with clean topsoil (caps are typically one foot or more thick). It may be difficult and costly to find and test sufficient quantities of "clean" soil. See Addendum 4 for the Department's testing protocol for "clean" soil. The term "clean" soil means that the soil does not contain any constituent/contaminant at concentrations greater than the Department's residential soil cleanup criteria. Remedial option 2 would require the filing of a deed notice.

Remedial Option 3 - Contaminated soil can be blended with clean soil within the contaminated area (the area of concern). The area of concern is as defined in N.J.A.C. 7:26E. Blending may be done with clean soil from within or outside the area of concern to achieve concentrations at or below the Department's residential soil cleanup criteria for all contaminants. Blending involves the physical mixing of contaminated surface soil with uncontaminated soil within a given area of concern. This strategy may not be feasible in areas of the state with high background arsenic concentrations. Blending may not be a practical option if contaminant levels are very elevated because large amounts of clean soil would be needed to achieve the cleanup criteria or if there are potential ground water impacts. This option would not require the filing of a deed notice.

Remedial Option 4 – Contaminated soil may be blended with clean soil outside the area of concern, but within the site. The site is as defined the boundaries of the real property under development. Blending may be accomplished by physically mixing contaminated soil with clean soil from within or outside the site. For arsenic, the cleanup goal is to achieve concentrations that exist in the uncontaminated areas of the site within the area of concern and across the site. For the organochlorine pesticide residues, blending outside the area of concern must achieve concentrations at or below the Department's residential soil cleanup criteria. Blending outside the area of concern involves the physical mixing of contaminated surface soil with uncontaminated soil within the site. Blending may not be a practical option if contaminant levels are very elevated because large amounts of clean soil would be needed or if there are potential ground water impacts. This option would not require the filing of a deed notice.

Blending represents a significant departure from Department policy but members of the Task Force agree that it may be used to mitigate risk as a practical matter, by helping reduce the cost of remediation at some sites. Blending contaminated soils with clean soil outside the area of concern could increase the concentrations of these contaminants in previously clean areas, but the concentrations will never be increased above the Department's residential soil cleanup criteria. The Task Force accepts blending as a remedial option and acknowledges the potential for a slight increase in risk that may result from its use.

Remedial Option 5 – Contaminated soil can be removed from the site and disposed of as a waste or reused with the Department's approval and be replaced with soil that meets the Department's residential soil cleanup criteria. This option includes additional costs and problems associated with the handling and disposal of contaminated soil. This option would not require the filing of a deed notice.

Remedial Option 6 – The treatment of contaminated soil to the Department's residential soil cleanup criteria is not considered to be a practicable option for a number of reasons. Treatment technologies do exist, but would be cost prohibitive in that the cost of treatment would in most cases be greater than the value of the land. Treatment technologies would be very intrusive in residential settings and the resulting soil quality would be poor and may even be unable to support vegetation without substantial amendment. If the Department's residential soil cleanup criteria were met, this option would not require the filing of a deed notice.

V. Costs and Economic Impacts

There has been considerable apprehension regarding the costs associated with site investigation and remediation, and the potential for far reaching economic impacts associated with historic pesticide contamination. There will undoubtedly be some negative economic impacts, however, the actions recommended below are intended to minimize adverse economic impacts by providing practical solutions while minimizing health risks associated with residual pesticide contamination. This section addresses the typical costs that are associated with the investigation of sites potentially impacted by historic pesticide use and costs for the implementation of selected remedial strategies. Economic impacts on lending institutions, property owners and others that may occur as the result of this contamination problem are discussed. A discussion of potential economic impacts if the Department or the Legislature takes no actions is also included.

A. Costs Associated with Site Investigation and Remediation

Costs are associated with the environmental evaluation of a property to determine if soils are contaminated with pesticide residues. In most cases, soil sampling must be conducted to determine if a property contains pesticide residues.. The Department developed new sampling guidance (Addendum 5) to minimize costs while ensuring that properties will be consistently and adequately evaluated. It is likely that actual costs will vary among environmental consulting firms and analytical laboratories.

The Department recommends that a minimum of two samples be taken for a small property (4 acres or less); this means that the lowest cost for site investigation sampling is approximately $600-$1800. Sampling costs for a larger property, for example, a 100 acre property, would be $7,000 at a minimum.

If no pesticide residues are detected above the Department's residential soil cleanup criteria, the only additional costs would be the cost of the Department's review if a formal No Further Action determination is desired. The cost of Department oversight would range from $500 to $4,000 depending on site specifics.

If contamination were detected, additional sampling would be needed to determine the depth and areal extent of contamination to determine the appropriate remedial action for the site. The sampling and personnel costs for remedial investigations typically begin at around $10,000 and can run into six figures, depending on the site. The Department's associated oversight costs would range from $1,000 to $8,000, again depending on the site.

The costs of remediating a site will vary depending on the concentration and distribution of the contamination, the size and layout of the site, and the remedial actions implemented. Table 6 presents cost estimates associated with each remedial option presented above for 1 acre of contamination that is assumed to be 1 foot deep (1 acre foot). These costs are based on the remediation of undeveloped farmland.

Remediation costs could rise dramatically for existing development due to difficulties associated with the movement of soil around existing structures, trees, pools and decks. In addition, the remediation of properties with existing development would not have the benefits of economy of scale associated with undeveloped land.

Table 6.
Estimated Remediation Costs

Remedial Option	Cost per acre-foot
Consolidation and covering contaminated soil on-site (i.e., under roads and structures)	$1,000 - $2,000
Cap contaminated soil with clean soil	$7,000 - $12,000
Blending with clean soil from on-site	$1,000 - $2,000
Blending with clean soil from off-site	$8,000 - $15,000
Excavation and removal of contaminated soil	$32,000 -$ 80,000
Proven and innovative soil treatment technologies	$50,000- $100,000

The costs of remediation per acre would probably decrease as the size of the property being remediated increases. Also, it is important to note that the depth of contamination may be greater than 1 foot, thus increasing the cost of the selected remedial action. Elevated natural background concentrations of arsenic may impact the remedial strategy selected and may affect the costs of implementing a remediation at a site.

There are secondary costs associated with remedies that result in contaminated soil being left on-site. When contamination remains at a site (remedial options 1, 2 and possibly 6) the owner of the site must file a deed notice with the applicable county recording office that describes site conditions and any use restrictions that are placed on the property. If the property is subdivided, the applicable portions of the deed notice must be attached to the deeds of the parcels that are sold. Properties with environmental deed notices could have lower market value than those without such restrictions.

Additional costs will be associated with remedies when contamination is left at a site. The Legislature recently included a requirement that subsequent owners responsible for maintaining engineering and institutional controls (including deed notices) report the continued protectiveness of those controls to the Department every two years. See N.J.S.A. 58:10B-13. Costs associated with biennial reporting are expected to be minor (i.e., less than $500) and may simply require inspection of the property by the property owner and the submission of a certification to the Department that the implemented remedy continues to be protective of human health and the environment.

The Task Force was unable to estimate state or county-wide impacts that may be caused by sampling and remediation costs or any associated decline in market values because the exact number and location of affected properties is unknown at this time. Only those properties where contamination is documented will cost more to develop due to the addition of remediation costs. If the remediation of a site can be "worked in" to the site development plan, soil blending or consolidation could be accomplished with only minor additional costs since large quantities of soil are routinely moved during construction. However, there will be some costs associated with the tracking of contaminated soils and associated confirmatory sampling.

B. Potential Economic Impacts

The economic impacts of historic pesticide contamination will be as varied as the interests affected. Some of those affected are likely to be farmers, developers, home owners and buyers, and local governments that own or plan to purchase property for recreation, open space or other uses, and school districts. The impacts will also affect new and existing development differently.

New Development - The environmental condition of property being mortgaged is one of the important criteria that lending institutions consider when evaluating a mortgage application. When a developer seeks financing in areas of potential pesticide residue contamination, lenders can be expected to require a real estate appraisal and an environmental investigation to assess the condition of the property prior to approving the financing. If the investigation shows residual pesticide contamination, lenders can be expected to require the borrower to obtain a No Further Action Letter from the Department. Individual lenders may also require collateral protection insurance with certain environmental protection riders. For remediations involving a deed notice, the economic impacts of deed notices on property values are unknown. Recent experience suggests that as long as all parties involved act reasonably and remediation takes place, land development projects will likely receive the needed financing.

Existing Development - The potential economic impact of residual pesticide contamination may be greater for existing development than for new development. Beyond the potential impact that the contamination may have on the value of property presently used as collateral for a mortgage, it is difficult to forecast the possible extent of any other economic impacts because the number of properties that may be effected is unknown. The reaction of the Legislature and the wider marketplace may have impacts; however, they are unknown at this time.

If there is little or no reaction, then lenders and borrowers will likely continue to behave in the traditional manner when conducting real estate transactions. Lenders indicated to the Task Force that the extent of the potential impacts will become more apparent when properties are offered for resale.

Bank lending policies may also be effected by outside forces including most notably, the secondary market such as the Federal National Mortgage Association (Fannie Mae) and the Federal Home Loan Mortgage Corporation (Freddie Mac), who regularly purchase mortgage paper from banks. These institutions could choose to not buy mortgages on affected properties that would, in turn, impact where banks choose to invest. This may have the effect of reducing the amount of money available for all kinds of loans and thereby possibly increasing interest rates. In addition, federal bank regulatory agencies could require New Jersey banks to reassess the value of their loan portfolios and reappraise properties with deed notices. This property revaluation could adversely affect homeowners and other property owners.

Municipalities with a large number of affected properties may be forced to increase property tax rates to offset lower revenue streams if real property devaluation occurs. Local taxes may also be impacted in those communities whose public parks and schools are built on former farms and orchards that may require environmental investigation and remediation.

The Task Force hopes that the Department's acceptance of soil blending as a remedial alternative for residual pesticide contamination will serve to mitigate potential economic impacts. Furthermore, low interest loans should be made available from the State to assist property owners in addressing this contamination.

C. No Action Alternative

When evaluating new policies it is helpful evaluate the potential results of a "no action" response. If neither the Department nor the Legislature takes any action to address the potential risks associated with the development of former agricultural properties as reflected in this report, the Task Force believes that lenders would still require developers and home buyers to evaluate the environmental conditions prior to loan approvals. The task Force also expects that lenders would continue to require the Department's review and issuance of a No Further Action letter approving the remediation.

In addition, municipalities could choose to pass their own ordinances to address historic pesticide contamination within their jurisdiction. Separate local ordinances would most likely lead to inconsistent policies being implemented across the state. There would be a negative economic impact on developers and home buyers who would be subject to varying policies. Finally, if neither the Department nor the Legislature responds to this issue, the Department would not approve soil blending as an acceptable remedial option for historic pesticide contamination. Without soil blending as a remedial option, the cost of remediating sites with historical pesticide contamination would likely be higher.

Over time, a no action alternative could cause more people to be exposed to historical pesticide contamination resulting in increased long term health risks. At this time there is no way to estimate the costs associated with those potential increased risks.

In general, it is the Department's experience with other emerging environmental issues that, although initially controversial, once the affected parties have a greater understanding of the issue, the controversy often dies down and the new requirements are accepted as routine. New Jersey has seen economic benefits emerge from the implementation of sound environmental policy.

VI. Recommendations

A. Site Investigation and Remediation

The Historic Pesticide Contamination Task Force makes the following recommendations to assist those involved in the remediation of agricultural properties that have been developed and that will be developed in the future.

- Sampling of former agricultural areas, and any necessary remediation, should be conducted prior to site development.

- Sampling of former agricultural areas, and any necessary remediation, should be conducted for areas with exposed soil that are intensively used by children, such as schools, daycare centers and playgrounds.

- Sampling and remediation at sites that have already been developed, except as noted above, should be conducted whenever the current or potential future occupant desires. The Department should provide guidance concerning sampling methods and exposure control alternatives to any person concerned with historic pesticide contamination. Practical exposure control alternatives include maintaining grass and landscaping cover over areas with pesticide residues, washing home grown garden vegetables and washing hands after play or any lawn and gardening activity.

- The Department should provide an appropriate sampling methodology specifically designed for the investigation of pesticide residues in soil at agricultural properties (Addendum 5);

- The Department should authorize a remedial alternative involving soil blending for pesticide residues in soil in former agricultural areas when it is protective of human health. This represents a substantial departure from current State policy and the Task Force recommends blending as a remedial option only at sites with historical pesticide contamination.

B. Department Oversight

- At the request of the property owner or developer, the Department should oversee the investigation and remediation of sites with historical pesticide contamination and issue a No Further Action Letter when no contamination is present above the Department's residential soil cleanup criteria or when the site has been remediated (i.e., appropriate exposure controls are applied).

- The Department should provide local authorities (planning and zoning boards, local or county health departments) technical information and training as necessary.

- No additional action should be required at a site when information obtained by a review of the site history indicates no historic pesticide use or when sampling confirms no pesticide contamination at levels above the Department's residential soil cleanup criteria.

C. Application of Remedial Strategies

- The remedial strategies described in this report are recommended as acceptable for soils with historical pesticide contamination.

- The remedial strategies described in this report should not apply to other areas of concern on agricultural properties such as underground storage tanks or pesticide mixing and storage areas.

- One or more remedial options may be used at a site based on site conditions and development plans.

- The use of grass and landscaping as an exposure control should only be allowed as part of an exposure control strategy when approved by the Department.

D. Real Estate Disclosure

The disclosure of environmental conditions that can impact the value and/or desirability of a property have been the subject of legislative and judicial debate in recent years. The issues related to historic pesticide contamination and the frequent lack of significant site specific data create a disclosure dilemma for homebuyers, sellers, real estate professionals and others involved in the residential real estate industry.

The Task Force discussed two issues with respect to disclosing information about soil contamination resulting from the historic use of pesticides. The first issue is how and when to make buyers aware of the potential for historic pesticide contamination when purchasing property. The second is the method to convey information about completed site remediations to the prospective purchasers. The Task Force provides recommendations regarding real estate disclosure issues below.

- The Department should provide site specific data concerning historic pesticide residue contamination in soil in its geographical information system (GIS) and allow public access through each municipal clerk's office, in accordance with "The New Residential Construction Off-Site Conditions Disclosure Act" (P.L.1995 c.253).

- Real estate professionals and the Department, should develop model language in contracts informing buyers of soil contamination where appropriate, and create informational materials to explain the issue in some detail and provide buyers with contacts for more information to further educate the public.

- Sellers should provide prospective buyers with any test results that have been performed to quantify concentrations of residual pesticides that a prospective buyer requests and provide information regarding any deed notice and/or maintenance requirements applicable to the property where pesticide contamination on the property.

- Sellers should provide a written disclosure to prospective purchasers of the location and conditions of common areas where contaminated soil has been consolidated in accordance with the Department's applicable soil remediation criteria.

- The State should only require a Deed Notice on the actual property where the contaminated soil has been consolidated, such as the common areas, and not on the deed of each individual property in the development.

- Municipal clerks maintain information concerning the presence of contaminated soil in the common areas for the benefit of subsequent purchasers pursuant to the Off Site Disclosure Act.

E. Public Education and Outreach

The Department should develop a comprehensive public education program and outreach system for providing historic pesticide contamination information to the public and local authorities. Outreach should include, a Department "Hotline" phone number, brochures and information on the Department web site.

F. Research Needs

The members of the Pesticide Task Force believe that this report, while presenting a reasonable, logical approach to the problems associated with historic pesticide contamination, is based on scientific data and information that contains limitations and uncertainties. The Task Force recommends that the Department should conduct research to support the conclusions and the recommendations developed by the Historic Pesticide Contamination Task Force. Research topics should include the following:

- Research the bioavailability of arsenic and other historical pesticides from soils.
- Evaluate the effectiveness and cost of various remedial strategies for reducing concentrations of historical pesticides in soils, including treatment technologies.
- Research potential impacts on ground water quality in vulnerable soils within agricultural areas.
- Monitor the economic impacts of the policies and recommendations.
- Initiate a state-wide sampling investigation of historical pesticides in soil including sensitive use areas.

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Addendum 1

Historic Pesticide Contamination Task Force Members

Stuart Cameron
Executive Vice President and Director of Governmental Relations
New Jersey Bankers Association (NJBA)

Greg DeLozier
Director of Legislative Affairs
New Jersey Association of Realtors

Peter Furey
Executive Director
New Jersey Farm Bureau

Dr. Harry Motto
Professor Emeritus, Soil Science
Department of Environmental Science
Rutgers the State University of New Jersey
[Replaced by] Zane Helsel
Director of Rutgers Cooperative Extension
Rutgers the State University of New Jersey

Gary Mount
Representative of NJ Agricultural Community
Terhune Orchards, Princeton, NJ

Jane Nogaki
Founding Chairperson and Board Member
New Jersey Environmental Federation

Dr. Daniel Wartenberg *****
Associate Professor of Epidemiology
University of Medicine & Dentistry of New Jersey (UMDNJ)

Nancy Wittenberg
Director of Environmental Affairs
New Jersey Builders Association

Pat Halbe representing Peter McCaffrey
Mayor, Mount Laurel Township
New Jersey State League of Municipalities

*<u>Resigned November 16, 1998 prior to finalizing the report findings and recommendations</u>

Addendum 2
Organochlorine Pesticide Analyte List

Pesticide	CAS # (Chemical Abstract Number)	NJDEP Residential Soil Cleanup Criteria	NJDEP Non-Residential Soil Cleanup Criteria
Aldrin	309-00-2	0.04	0.17
alpha-BHC	319-84-6	*	*
beta-BHC	319-85-7	*	*
delta-BHC	319-86-8	*	*
gamma-BHC (Lindane)	58-89-9	0.52	2.2
alpha-Chlordane	5103-71-9	0.25	2.1
gamma-Chlordane	5103-74-2	0.25	2.1
4,4-DDD (TDE)	72-54-8	3	12
4,4-DDE	72-55-9	2	9
4,4-DDT (DDT)	50-29-3	2	9
Dieldrin	60-57-1	0.042	0.18
Endrin	72-20-8	17	310
Endrin aldehyde	7421-93-4	*	*
Endrin ketone	73494-70-5	*	*
Endosulfan I	959-98-8	340	6200
Endosulfan II	33213-65-9	340	6200
Endosulfan sulfate	1031-07-8	*	*
Heptachlor	76-44-8	0.15	0.65
Heptachlor epoxide	111024-57-3	*	*
Methoxychlor	72-43-5	280	5200
Toxaphene	8001-35-2	0.1	0.2

Notes
- All Soil Cleanup Criteria provided in units of mg/kg (ppm) on a dry weight basis.
- Table includes pesticides identified by SW-846 8081A analytical method.
- alpha and gamma chlordane isomers are summed when compared to soil criteria.

* Indicates NJDEP has not developed cleanup criteria for compound.

Addendum 3
Use and Human Health Information for Selected Organochlorine Pesticides

From the EPA Integrated Risk Information System Database and
Health Effects Summary Tables

Toxaphene
Toxaphene is an organochlorine pesticide containing over 670 individual chemicals. Toxaphene was developed in 1947 and had the greatest use of any single insecticide in agriculture. Toxaphene was used on cotton and other crops, first in combination with DDT. Then, in 1965, after several major cotton insects became resistant to DDT, toxaphene was formulated with methyl parathion, an organophosphate. It was also used to control insect pests on livestock and to kill unwanted fish in lakes. In 1982, toxaphene was canceled for most uses; and banned for all uses in 1990.

Toxaphene persists in the soil and breaks down very slowly in the environment. The residential cleanup level for toxaphene is 0.6 ppm (EPA), 0.1 ppm (DEP). It is not known whether toxaphene causes cancer in humans due to insufficient information. Breathing, eating, or drinking high levels of toxaphene can damage the lungs, nervous system, and kidneys. There is no information on how low levels affect human health.

Heptachlor/Heptachlor epoxide
Heptachlor is an organochlorine pesticide of the cyclodiene group; heptachlor epoxide is a breakdown product of heptachlor. The epoxide is more likely to be found in the environment. Heptachlor was registered as a commercial pesticide in 1952 for insects in homes, buildings and on food crops, especially corn and for malarial control programs; after 1960 it was used primarily in soil applications against agricultural pests and termites. Use slowed in the 1970s and stopped in 1988.

Heptachlor and heptachlor epoxide adhere to soil particles and can remain in soil and water for many years. Animals metabolize heptachlor to the epoxide, and plants take up heptachlor from the soils. The residential cleanup level for heptachlor is 0.1 ppm (EPA), 0.15 ppm (DEP) and for heptachlor epoxide 0.07 ppm (EPA). It is not known whether heptachlor or heptachlor epoxide causes cancer in humans due to insufficient information. Heptachlor and heptachlor epoxide mainly disrupt the function of the nervous system in humans.

Methoxychlor
Methoxychlor is a synthetic organochlorine insecticide that is structurally analogous to DDT. Methoxychlor is used on agricultural crops, livestock, animal feed, grain storage, home gardens and on pets. Methoxychlor adheres strongly to soils and breaks down slowly in air, water, and soils.

The residential cleanup level for methoxychlor is 390 ppm (EPA), 280 ppm (DEP). Human data are unavailable, and animal evidence is inconclusive with regard to cancer causing effects of this pesticide. Methoxychlor is broken down quickly in the body, and not likely to cause neurologic effects unless exposed to very high levels. Little information is available about how methoxychlor affects the health of humans.

BHC

BHC is an organochlorine insecticide that exists in eight chemical forms (isomers). Technical grade BHC is a mixture of several different forms of BHC including the five isomers; alpha, beta, gamma, delta, and epsilon. The gamma isomer (called Lindane) is reportedly the only isomer that has insecticidal properties.

The insecticidal properties of BHC were discovered in 1940 by French and British entomologists. Lindane was used as an insecticide on fruit and vegetable crops (including greenhouse vegetables and tobacco) and forest crops (including Christmas trees). Lindane is still used in ointments for the treatment of head and body lice and scabies. Lindane is also used as an insecticide based seed dressing.

Lindane has not been produced in the United States since 1977, although it is still imported to and formulated in the United States. Lindane's use is restricted by the USEPA and it is applied only by a certified applicator. Technical grade BHC was also used as an insecticide in the United States but has not been produced here since 1983. BHC was withdrawn from the US market due to concerns over its carcinogenicity and ability to cause birth and reproductive effects.

BHC is broken down by algae, fungi, and bacteria in soil, sediments and water. It is unknown how long BHC isomers can remain in the soil. As with other organochlorine pesticides, BHC can be stored in human fat for long periods of time and may be released in breast milk during lactation. Lindane has also been shown to enter the fetus through the placenta.

The residential cleanup level of BHC is:

alpha-BHC	0.1 ppm (EPA)
beta-BHC	0.4 ppm (EPA)
gamma-BHC (Lindane)	0.52 ppm (DEP/EPA)
Technical-BHC (includes delta-BHC)	0.35 ppm (EPA Region III)

Alpha-BHC is categorized as a probable human, beta-BHC is categorized as a possible human carcinogen, gamma-BHC is categorized as a probable human carcinogen, technical BHC is categorized as a probable human carcinogen, delta-BHC is not classifiable as to human carcinogenicity. Inadequate human data is available to document the carcinogenicity of BHC in humans; sufficient evidence of carcinogenicity is available in animals.

Chlordane

Technical chlordane is a mixture of at least 23 different compounds including chlordane isomers, other chlorinated hydrocarbons and by-products. Chlordane was used to control insects on a wide variety of crops from 1948 until 1988. Until 1983, chlordane was used on crops like corn and citrus and on home lawns and gardens. Between July 1983 and April 1988, the only permitted use was for the control of termites. Chlordane was canceled in April 1988 due to concerns about cancer risk, evidence of human exposure via accumulation in body fat, persistence in the environment and adverse effects on wildlife. In 1988, EPA banned all uses of the pesticide. Chlordane is persistent in soil. While sunlight may break down a small amount of chlordane, volatilization may be the only major route of removal from soils.

The residential cleanup level for chlordane is 0.5 ppm (EPA), 0.25 ppm (DEP). Chlordane is characterized as a probable human carcinogen. Inadequate human data is available to document the carcinogenicity potential of chlordane in humans. Chlordane is readily absorbed through the skin and is very irritating to the skin and the eyes. Chlordane is stored in human fatty tissue, the kidneys, muscles, liver and the brain. Chlordane has also been found in human breast milk. Excretion of chlordane is relatively slow and can take days to weeks. Chlordane may disrupt the function of the nervous system in humans. Blood disorders, liver and kidney damage may also occur. Since chlordane induces liver enzymes, interactions with medical drugs and the pesticide may occur (such as decreased effectiveness of anticoagulants, steroids and increased activity of thyroxin). Chlordane may cause an acne-like rash following skin contact with the pesticide.

Endrin/Endrin Aldehyde/Endrin Ketone

Endrin is a pesticide used to control insects, rodents and birds. The pesticide has not been produced or sold in the United States for general use since 1986. Endrin aldehyde is an impurity and breakdown product of endrin. Endrin ketone is a breakdown product of endrin when it is exposed to light. Little information is known about the properties of endrin aldehyde or endrin ketone.

While persistence of the pesticide depends on local conditions, the compound has been estimated to remain in the soil for over 10 years. The residential cleanup level for endrin is 23 ppm (EPA), 17 ppm (DEP). The basis for the cleanup level is the non cancer endpoint

Endosulfan (I & II)

Endosulfan is a mixture of two different forms of the same chemical (alpha- and beta- endosulfan). Endosulfan is an insecticide used to control insects on grains, tea, fruits, vegetables, tobacco and cotton. Endosulfan is also used as a wood preservative in the United States. The pesticide has not been produced in the United States since 1982, although it is still used in the United States to produce other chemicals. Endosulfan does not dissolve easily in water and may stay in the soil for several years before it biodegrades. The residential cleanup level for endosulfan is 470 ppm (EPA), 340 ppm (DEP). The basis for cleanup level is non cancer endpoint in animals. Hyperactivity, tremors, decreased respiration and salivation have been noted in people ingesting high concentrations of the pesticide.

Addendum 4

Testing Protocol for Soil Blending at Historic Pesticide Residue Sites

Prior to using off-site soil for blending with contaminated soil at historic pesticide residue sites the following testing should be used to verify the quality of soil before it is brought onto a site. The verification of "clean" soil does not require prior Department approval if this sampling and analytical protocol is followed. Documentation that the protocol was followed should be submitted when a No Further Action approval is requested from the Department. Soil that has been determined to be "clean" may be used for blending, to fill areas where contaminated soil was removed, or as a cap to cover existing contaminated soil. To be acceptable as "clean", soil must:

1. Be similar in physical properties to the soil in or adjacent to the area of concern. (Fill used for new building foundations or other construction in remediated areas is exempt from this requirement);

2. Be free from extraneous debris or solid waste;

3. Be of equal or less permeability than the native soil in or adjacent to the area of concern;

4. Have source documentation as required by the Technical Requirements for Site Remediation, N.J.A.C. 7:26E as follows:

> N.J.A.C. 7:26E-6.4 (b)2 iv - Documentation of the quality of the fill shall be provided by a certification stating that it is virgin material from a commercial or noncommercial source or decontaminated recycled soil.
>
> N.J.A.C. 7:26E-6.4 (b)2 vi - The bills of lading shall be provided to the Department to document the source(s) of fill. The documentation shall include:
> (1) The name of the affiant and relationship to the source of the fill;
> (2) The location where the fill was obtained, including the street, town, lot and block, county, and state, and a brief history of the site which is the source of the fill; and
>
> N.J.A.C. 7:26E-6.4 (b)3 - A statement that to the best of the affiant's knowledge and belief the fill being provided is not contaminated pursuant to any applicable remediation standards and a description of the steps taken to confirm such.

5. Be uncontaminated pursuant to a comparison of data to the Department's most recent unrestricted use Soil Cleanup Criteria. Sampling to document that soil is uncontaminated must be conducted for the analytical parameters and at the frequencies provided below, based upon the original source of the soil fill material. In all cases where analysis is required, each analytical sample must be a composite from five individual and representative samples. Analyses as prescribed in 5 a-c below must be conducted utilizing methods from the most current versions of the USEPA Contract Laboratory Program (TCL/TAL) or Test Methods for Evaluating Solid

Waste (SW-846). Where metals analysis is stipulated, the full Target Analyte List or Priority Pollutant metals suite is required. It is strongly suggested that soil to be used for “clean” fill purposes be sampled at their point of origin rather than after transport to the receiving location.

a) Where the “clean” fill can be documented to be from a pristine source, the potential for elevated naturally occurring arsenic must still be investigated. Sampling for arsenic is required at a rate of one sample per 250 yd^3. It is further suggested that sampling for base neutrals, pesticides and metals should be conducted at a rate of one sample per 1,000 yd^3.

b) Where the soil is being imported from a location currently or historically used for farming, sampling is required at the frequency indicated per volume of soil included in the table below. In all cases analysis must include pesticides, arsenic and lead.

Volume of Soil (Yd^3)	**Sampling Frequency**	**Total # of Samples**
0 – 500	1 Sample per 100 yd^3	1-5
501-5,000	1 Sample per 250 yd^3	5-23
> 5,000	1 Sample per 500 yd^3	> 23

Example – 7,000 yd^3 of clean fill is required for blending or backfill purposes. The source of the clean fill is from previously farmed land. This would require collection of 5 samples for the first 500 yd^3, 18 samples for the 500-5,000 yd^3 volume and 4 samples for the 5,000 -7,000 yd^3 volume for a total of 27 samples. Each sample must be composited from 5 locations and analysis must include pesticides, arsenic and lead.

c) Where the soil is from a source of unknown or questionable quality, sampling must be conducted at a frequency of one analytical sample per 100 cubic yards. Analysis must include volatile organics, semivolatile organics, pesticides, PCBs and metals.

The Department may reduce the sampling requirements if a detailed history of the source site is available and a proposal to reduce the number of samples or the analytical parameters is submitted for the Department’s review prior to the movement of the soil. Sampling and analysis must be conducted in accordance with the Technical Requirements for Site Remediation N.J.A.C. 7:26E and the NJDEP Field Sampling Procedures Manual (with the exception of the required compositing of samples).

Addendum 5

Site Investigation Sampling Methods

The following sampling methods were developed by the New Jersey Department of Environmental Protection and should be used state-wide so that consistent and reliable data are generated. Site investigation sampling methods are to be used to investigate current or former farm fields and orchards and should not be used to evaluate other potential areas of concern which may be present, such as chemical storage and mixing areas, underground storage tanks and waste disposal areas. The goal of site investigation sampling is to determine if contamination is present at levels exceeding the Department's soil cleanup criteria.

If contamination is detected, additional remedial investigation sampling may be necessary to determine the vertical and horizontal distribution of the contamination which is needed to develop a specific remediation plan. The Department should be contacted to oversee additional sampling and remedial action.

Sampling should be conducted pursuant to the Department's Field Sampling Procedures Manual and analysis conducted by certified laboratories pursuant to the Technical Requirements for Site Remediation, N.J.A.C. 7:26E-2.

Site Investigation Sampling

Sample location and depth:
Discrete samples should be taken at a depth of 0-6" within farm fields. If extent of former fields cannot be determined, the entire property should be sampled.

Sample frequency:
Sampling frequency is dependent on the size of the site:
Sites<1-10 acres, 1 sample for every 2 acres with a minimum of 2 samples; then sites>10 acres add 1 sample for every 5 acres. A reduced sampling frequency may be appropriate for very large sites.

Analytical Parameters
All samples should be analyzed for arsenic, lead and a pesticide scan (SW 846-8081A). The pesticide scan includes a total of 20 compounds including DDT, DDD, DDE, dieldrin and chlordane (see pesticide analyte list in Addendum 2). All analytical results obtained from the pesticide analysis should be provided to the reviewing agency.