Public Health Consultation

An Exposure Investigation
Conducted in Support of

Public Health Assessments for

Ciba-Geigy Corporation
Reich Farm
and
Dover Township Municipal Landfill

DOVER TOWNSHIP, OCEAN COUNTY, NEW JERSEY

May 7, 2001

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

PUBLIC HEALTH CONSULTATION

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Public Health Assessments for

Ciba-Geigy Corporation (CERCLIS No. NJD001502517)
Reich Farm (CERCLIS No. NJD980529713)
and
Dover Township Municipal Landfill (CERCLIS No. NJD980771570)

Dover Township, Ocean County, New Jersey

Prepared by:

New Jersey Department of Health and Senior Services
Hazardous Site Health Evaluation Program
Consumer and Environmental Health Services
Division of Epidemiology, Environmental and Occupational Health

Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

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Abbreviations

AL	Action Level
ATSDR	Agency for Toxic Substances and Disease Registry
CACCCC	Citizen's Action Committee on Childhood Cancer Cluster
CGC	Ciba-Geigy Corporation
CREG	Cancer Risk Evaluation Guide
CV	Comparison Value
DTML	Dover Township Municipal Landfill
EI	Exposure Investigation
EMEG	Environmental Media Evaluation Guide
MCL	Maximum Contaminant Level
MRL	Minimal Risk Level
NJDEP	New Jersey Department of Environmental Protection
NJDHSS	New Jersey Department of Health and Senior Services
NPL	National Priorities List
OMEE	Ontario Ministry of Environment and Energy
PCE	Perchloroethylene (Tetrachloroethylene)
PHAP	Public Health Action Plan
PHRP	Public Health Response Plan
ppb	parts per billion
ppm	parts per million
RF	Reich Farm
RfD	Reference Dose (EPA)
RMEG	Reference Dose Media Evaluation Guide
SAN Trimer	Styrene-Acrylonitrile Trimer
SVOC	Semi-Volatile Organic Chemical
TCE	Trichloroethylene
UCC	Union Carbide Corporation
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Chemical

Summary

The New Jersey Department of Health and Senior Services (NJDHSS) and the Agency for Toxic Substances and Disease Registry (ATSDR) have conducted an Exposure Investigation to supplement existing environmental data and to respond to community concerns in Dover Township (Ocean County), New Jersey. The Exposure Investigation is a part of an overall Public Health Response Plan, which includes Public Health Assessments on the Ciba-Geigy Corporation (CGC) and Reich Farm (RF) sites, and the Dover Township Municipal Landfill (DTML). This Public Health Consultation describes and discusses the methods and results of this Exposure Investigation.

Samples were taken of 54 private wells in Dover Township and analyzed for metals, volatile organic chemical (VOCs), semi-volatile organic chemicals (SVOCs) and radiological activity. Samples of surface soils and stream sediments were taken near the locations of breaks in the former Ciba-Geigy Corporation outfall pipeline, and of sediments of the Toms River. These samples were analyzed for metals and SVOCs. In addition, surface waters of the Holiday Lakes and the pond on the property of the Dover Township Municipal Landfill were also sampled and analyzed for metals, VOCs and SVOCs. Irrigation wells at several public schools were sampled and analyzed for radiological contaminants, VOCs, SVOCs, and metals.

Samples of soils, sediments, and surface waters did not reveal contaminants at levels of public health concern. Private wells did not contain contaminants related to the CGC, RF, or DTML sites.

However, about half of the private wells contained naturally-occurring radiological activity at levels of potential public health concern. The NJDHSS and the ATSDR recommend that owners of private wells found to contain radioactivity in excess of the maximum contaminant level should consider taking necessary measures (for example, use of a water softener) to reduce potential exposures.

Lead was also found above the action level in several private wells. Owners of private wells found to contain lead above the action level should consider measures (such as use of point-of-use filters) to reduce exposure, particularly if there are children living in the house.

Low levels of VOCs and mercury were also detected in a small number of wells, although none of these wells appeared to be affected by contaminants from the CGC, RF or DTML sites. The NJDHSS and the ATSDR recommend that owners of private wells found to contain VOCs or mercury approaching or exceeding maximum contaminant levels should regularly monitor the quality of their drinking water for these contaminants.

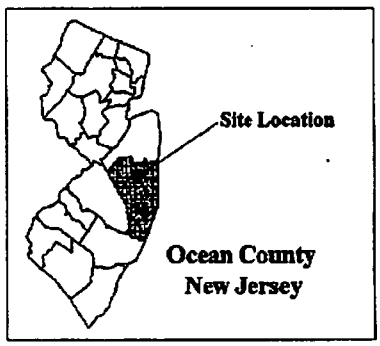
Purpose and Health Issues

The New Jersey Department of Health and Senior Services (NJDHSS) and the federal Agency for Toxic Substances and Disease Registry (ATSDR) are conducting an investigation of the incidence of childhood cancers in Dover Township (Ocean County), New Jersey. Components of this investigation were outlined in a Public Health Response Plan (NJDOH and ATSDR, 1996). Included in the plan were Public Health Assessments evaluating the nature, extent, and significance of human exposure pathways associated with two National Priorities List (NPL) sites located in Dover Township: the Ciba-Geigy Corporation (CGC) site (NJDHSS and ATSDR, 2001a) and the Reich Farm (RF) site (NJDHSS and ATSDR, 2001b). A Public Health Assessment was also developed for the Dover Township Municipal Landfill (DTML) (NJDHSS and ATSDR, 2001c). In addition, the NJDHSS, the ATSDR, and the New Jersey Department of Environmental Protection (NJDEP) conducted an extensive evaluation of the community water supply (NJDHSS, NJDEP and ATSDR, 2001).

During the health assessment process, the NJDHSS and the ATDSR conducted an Exposure Investigation (EI) to supplement existing information related to potential exposure pathways associated with the sites, and to respond to community concerns expressed about specific environmental media. An Exposure Investigation is an effort to improve understanding of potential human exposure in relation to a hazardous site. For this EI, environmental sampling was conducted at off-site locations, and focused on private wells in the township, soils near prior breaks in the Ciba-Geigy outfall pipeline, and sediments in the Toms River and the Long Swamp Creek. This Public Health Consultation summarizes and discusses the results of analyses of these samples. In addition, this document discusses samples taken of irrigation well water at Dover Township schools and surface waters near the Dover Township Municipal Landfill.

Background

Dover Township is located in Ocean County, New Jersey (see inset). As shown in Figure 1, the CGC and RF sites are located about 1.5 miles apart in Dover Township. The Dover Township Municipal Landfill (DTML) is located about 1.5 miles east of the RF site. Brief summaries of the sites are found below. The Public Health Assessments contain additional detail on the site histories, environmental contamination, and remedial activities (NJDHSS and ATDSR, 2001a, 2001b and 2001c).



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Ciba-Geigy Corporation

The CGC NPL site, located in West Dover, is surrounded by residential areas of Dover and Manchester Townships. The Toms River forms the northeastern boundary of the site. The Winding

River Park, a recreational area located within the flood plain of the Toms River, is adjacent to the site on the east.

The Ciba-Geigy Corporation (formerly Toms River Chemical Company) manufactured organic dyes and pigments at the Toms River Plant from 1952 through 1996. Epoxy resins were also manufactured at the CGC plant site from 1959 through 1991. Process wastes and waste water treatment sludge were deposited in approximately 20 areas on the CGC site. Wastewater from the manufacturing processes was directed to the Toms River until 1966; after that time, treated wastewater was discharged to the Atlantic Ocean via a 10 mile pipeline. Groundwater beneath the CGC site has been contaminated with a variety of organic chemicals and metals. Surface waters of the Toms River were contaminated during the time of direct wastewater discharge, and also from discharges from on-site waste storage lagoons. Contamination of the Holly Street well field was documented in the mid-1960s. All manufacturing, including dye standardization activities, ended at the CGC Toms River Plant in 1996.

Plans to remediate these on-site contaminated areas have been developed by the U.S. Environmental Protection Agency (USEPA). A purge-well system to capture and treat contaminated groundwater was installed in 1985. The USEPA required the installation of a larger scale groundwater extraction and treatment system, which began operating in 1996.

The Public Health Assessment identified completed human exposure pathways related to past use of the Holly Street community water supply wells and private wells (used for irrigation). Potential exposure pathways may have occurred in the past through air emissions and on-site access (NJDHSS and ATSDR, 2001a).

Reich Farm

The Reich Farm NPL site is located near the intersection of U.S. Route 9 and Church Road, in Dover Township. The site occupies an area of approximately 3 acres. The terrain is generally flat and sandy. The RF property is surrounded by small commercial facilities, residences, and wooded areas.

In 1971, the Union Carbide Corporation (UCC) contracted with an independent waste hauler to dispose of 5,000 to 6,000 drums of chemical wastes from its Bound Brook (Somerset County, New Jersey) plant. The wastes consisted of organic solvents, still bottoms, and residues from the manufacture of organic chemicals, including plastics and resins. Approximately 4,500 of these drums were found to have been illegally dumped on the RF property. Under the supervision of the NJDEP, most of the drums were removed from the RF site by UCC in 1972; the remaining drums and contaminated soils were removed in 1974. Excavation and treatment of contaminated soils on-site was completed by UCC, under the supervision of the USEPA in 1995. Groundwater beneath the site was contaminated with a variety of organic chemicals. Certain wells at the Parkway well field are currently being used to capture the contaminated groundwater plume; treated water is

pumped to waste (but may be available for use in the community water supply under high water demand conditions).

The Public Health Assessment identified completed human exposure pathways related to past use of private wells and community water supply wells contaminated by the RF groundwater plume (NJDHSS and ATSDR, 2001b).

Dover Township Municipal Landfill

The DTML is located in the Silverton section of Dover Township, approximately 1 mile east of the RF site. It is bounded by the Garden State Parkway and North Bay Avenue on the west, and by Silverton Road and Church Road on the north and south respectively. Ocean County Community College is located about 1 mile southeast of the site. The DTML site encompasses approximately 91 acres; the landfill itself is contained within an area of about 22 acres.

The DTML operated from 1956 through 1981. It was certified by NJDEP in 1970 to accept household, commercial, and industrial wastes. In 1971, an unknown number of drums from the UCC Bound Brook plant were deposited in the DTML. In 1978, permitted waste at DTML was restricted to household, commercial, institutional, and vegetative waste classes. Methane gas vents and six monitoring wells were installed on the DTML site, and the landfill was closed in 1981. In 1982, lead, arsenic, and VOCs were found in the on-site monitoring wells. In 1987, private wells on Silverton Road adjacent to the DTML site were found to have contaminants similar to those found in the on-site monitoring wells, and were subsequently sealed. Dover Township is currently conducting a Remedial Investigation of the DTML site under the supervision of the NJDEP.

The Public Health Assessment identified a completed human exposure pathway related to past use of private wells adjacent to the DTML on Silverton Road (NJDHSS and ATSDR, 2001c).

Statement of Issues

Private Wells Private wells provide potable water to approximately 10% of the citizens in Dover Township. Private wells also provide a source of irrigation water for additional segments of the population. It is likely that the majority of the private wells draw water from the shallow Cohansey aquifer. Because there is a history of contamination of private wells in several areas of the township, and because community concerns were expressed about the quality of private well water throughout the township, the NJDHSS and ATSDR decided that a representative subset of these wells should be sampled throughout the township as part of this EI.

Soils and Sediments As previously mentioned, a ten mile long underground pipeline was used to transport treated process wastewater from the Ciba-Geigy plant to the Atlantic Ocean between 1966 and 1991. The pipeline ran primarily along Mapletree and Bay Avenues. On three occasions in the 1980s, breaks and leaks in the pipeline resulted in wastewater being spilled on the

surface in residential areas along the pipeline route. At one of the spill locations (at Bay and Hooper Avenues), community concerns were expressed about the possibility of contamination of the Long Swamp Creek sediments. Because of community concerns about the possibility of residual contamination, the NJDHSS and the ATSDR decided to sample soils and sediments in the vicinity of the pipeline breaks.

Community concerns were also expressed about the possibility of contamination of the Toms River sediments from past waste and wastewater disposal practices at the CGC site. For this reason, the NJDHSS and the ATSDR collected sediment samples in the Toms River downstream from discharge areas.

During the course of the childhood cancer investigation, community concerns were also expressed about the water quality of irrigation wells at schools in Dover Township, and of surface waters near the DTML. Although not part of the original EI sampling plan, results of analyses of samples of these environmental media are also reported in this Public Health Consultation.

Methods

The methods employed in the EI are described in the Exposure Investigation Environmental Sampling Plan (NJDHSS, 1996). Sampling was conducted in accordance with standard procedures, and laboratory analysis methods incorporated appropriate quality control and quality assurance procedures (see NJDHSS, 1997 references). All analyses were conducted by the NJDHSS Public Health and Environmental Laboratory. A summary is provided below.

Sampling and Analyses

Private Potable Wells

For this EI, water samples were taken by NJDHSS at 54 private wells in February, March, and May 1997. The sampled wells were selected from among 427 residents who volunteered to have their private wells tested. (The NJDHSS solicited volunteers through announcements in local media and at community meetings.) Wells were selected in order to supplement existing groundwater data in the vicinity of the CGC, RF, and DTML sites, the CGC outfall pipeline along Bay Avenue, the Shelter Cove area of East Dover, the Pleasant Plains and Silverton areas, and in other areas unrelated to sites of concern. The depths of many of the wells are unknown, but it is likely that the wells are screened in the Cohansey aquifer.

Samples of the water from the 54 private wells were analyzed for five primary pollutant metals: arsenic, cadmium, chromium and lead, using USEPA Method 200.7 (ICP emission spectrometry), and mercury, using USEPA Method 245.1 (cold vapor atomic absorption); volatile organic chemicals (VOCs, by USEPA Method 524.2); base/neutral- and acid-extractable semi-volatile organic chemicals (SVOCs, by USEPA Methods 525.2 and 625); nitrate/nitrite, by USEPA

Method 353.1); and radioactivity (gross alpha and beta activity, and radium species). Samples were also analyzed separately for acrylonitrile by modified USEPA Method 524.2 (selective ion monitoring). At the time of these analyses, Method 525.2 had been adapted to include analysis for styrene-acrylonitrile (SAN) trimer, a contaminant associated with the RF groundwater contamination plume. (This extension of the method eliminated the need for analysis with USEPA Method 507, which had been originally included in the EI Sampling Plan.) Table 1 contains a complete list of target analytes.

Surface Soils – Sampling and Analyses

Samples of surface soils (0" to 6" depth) were taken in September 1996 at the locations of the three known spills from the Ciba-Geigy pipeline, and at fourth location along the pipeline (the eastern most) on the basis of community concerns (see Figure 2). Soil samples were analyzed for primary pollutant metals (USEPA Methods 200.7 and 245.1) and SVOCs (USEPA Method 625 for non-aqueous media).

Sediments of the Toms River and Long Swamp Creek – Sampling and Analyses

Samples of sediments (0" to 6" and 6" to 12" depths) were taken in September 1996 at five locations in Long Swamp Creek, one upstream and four downstream from the location of one of the Ciba-Geigy pipeline spills (at the intersection of Bay and Hooper Avenues in 1988). Sediment samples were also taken at four locations along the Toms River downstream from the Ciba-Geigy plant. The locations of these samples are also shown in Figure 2. Sediment samples were analyzed for primary pollutant metals (USEPA Methods 200.7 and 245.1) and SVOCs (USEPA Method 625 for non-aqueous media).

Public School Irrigation Wells – Sampling and Analyses

Samples were taken from eight irrigation wells located at five public schools in Dover Township in August and October 1996. Samples were analyzed for VOCs, SVOCs, metals, and radiological species as described above for private well sample analyses.

Surface Waters – Sampling and Analyses

Samples of the Holiday Lakes, located east of the DTML, were taken in June 1997 at three locations (Silverton Road bridge, the beach area, and the west side of the spillway) and were analyzed for metals, VOCs, and SVOCs. Surface waters were also sampled at the pond located on the DTML site behind the Public Works Garage. This pond is adjacent to an area which is used as a police firing range.

Data Interpretation

In this Public Health Consultation, results are reported for target analytes as recorded in the NJDHSS Laboratory data packages (see NJDHSS, 1997 references), except as follows. Results qualified with a "B" (denoting presence in the laboratory blank) are not reported. Results for a target analyte from a sample are reported as below the detection limit if the analyte was also reported from a trip or field blank from the same batch of samples. Results for acetone, methyl ethyl ketone and chloromethane from VOC analyses are not included because these were considered to be probable laboratory contaminants by the NJDHSS Laboratory. (Laboratory contaminants are substances detected in samples as a result of handling in the laboratory.) Phthalates from water samples are not reported if the concentration was less than 3 parts per billion (ppb), because levels below 3 ppb were considered to be possible laboratory contamination. Phthalate results from USEPA Method 625 are not reported if the substance was reported as below the detection limit from the more sensitive USEPA Method 525.2.

Results were compared to health-based Comparison Values (CVs) to determine if further public health evaluation was needed (see Appendix for definitions and uses of CVs). For drinking water samples, results were compared to Maximum Contaminant Levels (MCLs) when available. Results from samples of soil or sediment were compared to Environmental Media Evaluation Guides (EMEGs) or Reference Dose Media Evaluation Guides (RMEGs).

Communication of Results

Each participant in the private well sampling portion of the EI was sent an individual report of analytical data from his or her private well, together with general information on private well testing, specific information on contaminants found (if any), and advice on reducing exposure (as needed). The NJDHSS also provided telephone consultations to several participants with questions about the results. Laboratory data packages containing results of all analyses discussed in this Public Health Consultation have been made available in local repositories. Summary results of all tests have previously been released and discussed at meetings of the Citizens' Action Committee on Childhood Cancer Cluster (CACCCC). It should be noted that individual addresses of private wells sampled in this EI have not been released and do not appear in the data packages, summary information, or this Public Health Consultation.

Discussion

Results of Analyses

Private Potable Wells – Results

Metals The results of analyses of private potable well samples for metals are shown in Table 3 (NJDHSS, 1997b). Eleven of 54 wells showed measurable concentrations of mercury. One well

was found to have a mercury concentration above the MCL of 2 parts per billion (ppb); however, this well was retested and the mercury concentration was found to be below the MCL. Low levels of mercury may be found in groundwater naturally or from multiple environmental pollutant sources. Most wells were found to have measurable concentrations of lead, and six of the wells were above the USEPA Action Level of 15 ppb. Lead may occur in samples as a naturally occurring constituent of groundwater or from corrosion of well materials or plumbing. None of the tested wells had detectable concentrations of cadmium or chromium, while one well had a detectable level of arsenic (below the MCL of 50 ppb).

Volatile and Semi-volatile Organic Chemicals Results of VOC analyses are also shown in Table 3 (NJDHSS, 1997c). Low levels of chloroform were detected in 23 of 54 wells. In three of these wells, the chloroform level was approximately equal to the Cancer Risk Evaluation Guide of 6 ppb, but below the MCL of 100 ppb. Low levels of trichloroethylene (TCE) and/or tetrachloroethylene (perchloroethylene, or PCE) were found in two wells; in one of these wells, the PCE level (2 ppb) exceeded the drinking water MCL of 1 ppb. Five wells showed trace amounts of methyl t-butyl ether, and a small number of other wells had a detectable level of other VOCs. No acrylonitrile was detected in any of the sampled wells.

Results of SVOC analyses of private well samples are also shown in Table 3 (NJDHSS, 1997d). Two well samples showed levels of phthalates above 3 ppb. The initial findings were likely the result of contamination of the samples during sampling, handling or analysis. Three well samples initially showed the possibility of trace levels of SAN trimer, but the findings were thought to be from laboratory contamination. Two of the three wells were resampled (the owner of the third well chose not to participate), and neither showed evidence of SAN trimer.

Nitrate/Nitrite Private well analyses for nitrate and nitrite are also given in Table 3 (NJDHSS, 1997e). Nitrate and nitrite were detected in most samples, but not above the MCL of 10 parts per million (ppm).

Radioactivity The results of the ionizing radiation measurements (gross alpha, gross beta, and, in some cases, specific radium isotopes) are given and discussed in Table 2 (NJDHSS, 1997a). Approximately half (28) of the 54 sampled wells showed gross alpha concentrations which exceed the MCL for gross alpha radioactivity of 15 picoCuries per liter (pCi/l), and several also exceeded the MCL for combined radioactivity due to radium-226 and radium-228 of 5 pCi/l). No samples exceeded the MCL for gross beta radioactivity (50 pCi/l).

The radioactivity in the water samples is due primarily to isotopes of radium, which are found in the groundwater as a result of the decay of naturally-occurring uranium and thorium in the sands of the aquifer (USGS, 1998). Radium-226 occurs in the uranium decay series, and radium-228 occurs in the thorium decay series. As discussed elsewhere (NJDHSS, NJDEP and ATSDR, 2001), laboratory chemists noted that samples analyzed soon after collection had the highest gross alpha activity, and that re-analysis of samples showed lower activities. It is believed that radium-224, a

short-lived alpha particle emitter also in the thorium decay series, was contributing to the high gross alpha activities.

Due to the frequency of detection and, in some cases, relatively high radioactivity in private wells which were sampled, the NJDEP developed a guideline document for homeowners, particularly those with private wells (NJDEP, 1997), which presents possible options for reducing the radioactivity levels (due primarily to radium) in potable water.

Surface Soils – Results

The results of the analyses for metals and SVOCs in soil samples are given in Table 4 (NJDHSS, 1997f). None of the samples show concentrations of metals or SVOCs that exceed EMEGs or RMEGs.

Sediments of the Toms River and Long Swamp Creek – Results

Results of the analyses for metals and SVOCs in sediment samples are given in Table 5 (NJDHSS, 1997g). One sediment sample from the Toms River exceeded the soil CV for arsenic, and two sediment samples (one from the Toms River and the upstream sample from Long Swamp Creek) showed levels of benzo(a)pyrene above the soil CV. One sediment sample contained an elevated lead concentration of 921 ppm. Although there are no standards for human exposure to aquatic sediments, results may also be compared with sediment guidelines of the NJDEP or the Ontario Ministry of the Environment and Energy (OMEE, 1993), which are based on toxicity to benthic organisms, not humans. Several of the contaminants exceed sediment guidelines, but the levels appear to be typical of developed areas.

School Irrigation Wells – Results

Results of chemical and radiological tests of school irrigation wells are shown in Table 6. Low levels (*i.e.*, less than the MCLs) of mercury, lead, chromium, and chloroform were found in several of the wells. In addition, gross alpha radioactivity was found to exceed the MCL in four of the tested wells, and combined radium exceeded the MCL in one of the irrigation wells (NJDHSS, 1997h).

Surface Waters – Results

No metals or VOCs were detected in the June 1997 samples from the Holiday Lakes surface waters. The samples were not able to be analyzed for SVOCs due the high amounts of particulates in the samples. Resampling of the lakes in November 1997 for SVOC analysis revealed no contaminants (NJDHSS, 1998). In the sample from the surface water of the pond located on the DTML site behind the Public Works Garage, low levels of arsenic (1.5 ppb) and lead (2.3 ppb) were detected, but no VOCs or SVOCs were found.

Pathways Analysis

An exposure pathway (ATSDR, 1992) is the process by which an individual is exposed to contaminants that originate from a source of contamination. A completed exposure pathway consists of five elements: (1) a source of contamination; (2) environmental media and transport mechanisms; (3) a point of exposure; (4) a route of exposure; and (5) a receptor (exposed) population. A completed exposure pathway must include each of the elements that link a contaminant source to a receptor population.

The NJDHSS and ATSDR have identified a completed human exposure pathway to naturally-occurring radioactivity and lead through use of private wells in Dover Township. In a small number of private wells, there also exists an exposure pathway to VOCs or mercury. Since radioactive elements (uranium, thorium and radium) occur naturally in groundwater in the area, the radioactivity is not site-related. Similarly, there is no pattern that would suggest that the lead, mercury or VOCs found in some of the sampled wells are related to the CGC, RF, or DTML sites.

Based on the above definition, the NJDHSS and the ATSDR have identified no completed human exposure pathways through soils or sediments in the areas sampled. Although two sediment samples contained levels that exceeded soil CVs for arsenic and/or benzo(a)pyrene, it is unlikely that a human exposure pathway would exist because of the inaccessibility of the sampling locations. There are no exposure pathways related to surface waters in the Holiday Lakes area.

Public Health Implications

This section will briefly discuss the public health implications of exposure to gross alpha radioactivity (due to radium species) and lead in private wells. As noted, mercury and low levels of VOCs were found in several wells, but generally below MCLs. Information on public health implications of these and other contaminants was sent to owners of each affected well, as needed, and will not be discussed in this Public Health Consultation.

Radioactivity from Radium in Drinking Water

Radium exposure has been associated with increased risk of bone and paranasal sinus cancers in highly exposed workers (NRC, 1990; NRC, 1998). Few epidemiologic studies have examined the risk of cancers with respect to lower levels of exposure from radium in drinking water. Radium in drinking water has been associated with increased bone cancer incidence in adolescents (Finkelstein and Krieger, 1996) and with leukemia incidence in adults, but not in children (Lyman et al., 1985). However, the epidemiologic evidence is insufficient to draw conclusions regarding the risk from radium in drinking water.

Although the health risks may not be well understood, radium can be effectively removed from drinking water through use of a water softener treatment system.

Lead

Lead is toxic to the nervous system, particularly in the fetus and young children whose nervous systems are undergoing rapid development (ATSDR, 1997a). No MRL has been established for oral exposure to lead. However, to protect against the neurotoxic effects of lead, the USEPA has promulgated an Action Level (AL) of 15 µg per liter for lead in drinking water for community water systems.

Six of the tested wells were found to contain lead concentrations in excess of the AL. If lead levels above the AL were sustained, ingestion of this water could pose a health hazard, particularly to a developing fetus or a young child.

Effects on Children's Health

ATSDR's Child Health Initiative recognizes that the unique vulnerabilities of infants and children demand special attention, particularly in communities faced with contamination in their environment (ATSDR, 1997b). Children are at greater risk than adults from exposures to hazardous substances. They are more likely to be exposed because they play outdoors and they often bring food into contaminated areas. They are shorter than adults, which means they breathe more dust, soil, and heavy vapors closer to the ground than adults do. Children are also smaller, and therefore would receive higher doses of chemical exposure per unit body weight. The developing systems of children's bodies can sustain permanent damage if toxic exposures occur during critical growth stages. Most importantly, children depend completely upon adults for risk identification and management decisions, housing decisions, and access to medical care.

The NJDHSS and the ATSDR have evaluated the likelihood of children being exposed to the contaminants that have been identified, particularly gross alpha radioactivity and lead in the drinking water of the private wells that were sampled in this EI. As noted above, the health risks of radium exposure to children or adults are not well understood, but such exposure may present a health hazard to children. Exposure of children to lead, from drinking water and other sources, is a public health concern.

Conclusions

The following conclusions may be drawn from the results of this Exposure Investigation:

(1) In this Exposure Investigation, radiological activity and lead were found above CVs in several private potable wells tested in Dover Township. These contaminants, however, are not related to the CGC, RF, or DTML sites. There is a potential for adverse health effects from these exposures due to long-term ingestion of water from these private wells. Private well owners were informed of the potential hazard and provided with informational materials on the contaminants and methods to reduce exposure.

(2) VOCs and mercury were also found in some of the private wells, generally at low levels. Homeowners whose private wells contained these contaminants were provided appropriate information on these substances.

(3) No completed human exposure pathways were found in relation to off-site samples of surface soils, sediments, and surface waters.

Recommendations

On the basis of the conclusions presented above, the NJDHSS and the ATSDR recommend the following:

(1) Owners of private wells found to contain radioactivity in excess of the gross alpha MCL (15 pCi/l) should consider taking necessary measures (for example, use of a water softener) to reduce potential exposures (NJDEP, 1997).

(2) Owners of private wells found to contain lead above the AL (15 ppb) should consider measures (such as use of point-of-use filters) to reduce exposure, particularly if there are children living in the house.

(3) Owners of private wells found to contain VOCs or mercury approaching or exceeding MCLs or other CVs should regularly monitor the quality of their drinking water for these contaminants.

Public Health Action Plan

The Public Health Action Plans (PHAP) for the Ciba-Geigy, Reich Farm, and Dover Township Municipal Landfill Public Health Assessments contain descriptions of the actions to be taken by ATSDR and/or NJDHSS at or in the vicinity of these sites. The purpose of a PHAP is to ensure that a Public Health Assessment not only identifies public health hazards, but provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of ATSDR and NJDHSS to monitor this plan to ensure that the plan is implemented. ATSDR will provide follow-up to this PHAP, outlining the actions which have been completed, and those actions in progress, as needed. The public health actions undertaken by the ATSDR and/or the NJDHSS are as follows:

Actions Undertaken

(1) The NJDHSS and the ATSDR completed an Exposure Investigation as part of the overall Public Health Response Plan. The EI included environmental sampling of private wells, soils and

sediments, school irrigation wells, and surface waters, to supplement existing data and to respond to community concerns about particular environmental media.

(2) Participating private well owners were provided the results of all testing of their individual wells. Well owners were provided with informational materials on specific contaminants as needed (for example, lead, mercury, VOCs or radioactivity), depending on the individual testing results. These materials included the "Homeowner's Guide to Radioactivity in Drinking Water," which was developed by NJDEP to provide information on sources, testing, potential health effects, and water treatment for radiological contaminants in drinking water.

Actions Planned

No further actions are planned in relation to the activities described in this Public Health Consultation.

Certification

This Public Health Consultation reports the results of an Exposure Investigation conducted in support of Public Health Assessments on the Ciba-Geigy Corporation, Reich Farm, and Dover Township Municipal Landfill sites in Dover Township (Ocean County), New Jersey. It was prepared by the New Jersey Department of Health and Senior Services (NJDHSS) under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). This document was prepared in accordance with approved methodology and procedures existing at the time the document was initiated.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this Public Health Consultation and concurs with its findings.

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Appendix

Description of Comparison Values

ATSDR's health-based Comparison Values (CVs) are media-specific concentrations that are considered to be 'safe' under default conditions of exposure. They are used as screening values in the preliminary identification of site-specific chemical substances that the health assessor has selected for further evaluation of potential health effects.

Generally, a chemical is selected for evaluation because its maximum concentration in air, water, or soil at the site exceed one of ATSDR's CVs. However, it cannot be emphasized strongly enough that CVs are not thresholds of toxicity. While concentrations at or below the relevant CV may reasonably be considered safe, it does not automatically follow that any environmental concentration that exceeds a CV would be expected to produce adverse health effects. Indeed, the whole purpose behind conservative, health-based standards and guidelines is to enable health professionals to recognize and resolve potential public health problems before they become actual health hazards. The probability that adverse health outcomes will actually occur as a result of exposure to environmental contaminants depends on site-specific conditions and individual lifestyle and genetic factors that affect the route, magnitude, and duration of actual exposure, and not solely on environmental concentrations.

Screening values based on non-cancer effects are generally based on the level at which no health adverse health effects (or the lowest level associated with health effects) found in animal or (less often) human studies, and include a cumulative margin of safety (variously called safety factors, uncertainty factors, and modifying factors) that typically range from 10-fold to 1,000-fold or more. By contrast, cancer-based screening values are usually derived by linear extrapolation with statistical models from animal data obtained at high exposure doses, because human cancer incidence data for very low levels of exposure are rarely available. Cancer risk estimates are intended to represent the upper limit of risk, based on the available data. Listed and described below are the types of CVs that the ATSDR and the NJDHSS may have used in this Public Health Consultation:

Environmental Media Evaluation Guides (EMEGs) and Reference Dose Media Evaluation Guides (RMEGs) are estimates of chemical concentrations in an environmental medium (such as drinking water or soil) that are not likely to cause an appreciable risk of deleterious, non-cancer health effects, for fixed durations of exposure. These guides may be developed for special sub-populations such as children. EMEGs are based on ATSDR's Minimal Risk Level (MRL) while RMEGs are based on the USEPA's Reference Dose (RfD).

Cancer Risk Evaluation Guides (CREGs) are estimated concentrations of contaminants in an environmental medium (such as drinking water or soil) that are expected to cause no more than one excess cancer case for every million persons who are continuously exposed to the concentration for an entire lifetime (equaling a risk of 1×10^{-6}). These concentrations are calculated from the USEPA's cancer slope factors, which indicate the relative potency of carcinogenic chemicals. Only chemicals that are known or suspected of being carcinogenic have CREG Comparison Values.

Other health-based guides may also be used as CVs, including drinking water Maximum Contaminant Levels (MCLs) or Action Levels (ALs) established by the USEPA or the NJDEP.

Tables

Table 1. Target analytes for analyses conducted on private well samples in Dover Township.

Volatile Organic Chemicals

USEPA Method 524.2

1,1,2,2-tetrachloroethane
1,3-dichloropropane
1,2,3-trichlorobenzene
1,2-dibromoethane
1,1,2-trichloroethane
1,2,4-trichlorobenzene
1,2-dibromo-3-chloropropane
1,1-dichloroethene
1,1,1,2-tetrachloroethane
1,2-dichlorobenzene
1,1-dichloropropanone
1,2-dichloropropane
1,4-dichlorobenzene
1,3-dichlorobenzene
1,2-dichloroethane
1,2,4-trimethylbenzene
1,3,5-trimethylbenzene
1,1-dichloroethane
1,1,1-trichloroethane
1,1-dichloropropene
1,2,3-trichloropropane
1-chlorobutane
2,2-dichloropropane
2-butanone
2-chlorotoluene
2-hexanone
2-nitropropane
4-chlorotoluene
4-methyl-2-pentanone
acetone
acrylonitrile
allyl chloride
benzene
bromobenzene
bromochloromethane
bromodichloromethane
bromoform
bromomethane
carbon tetrachloride
carbon disulfide
chloroacetonitrile
chlorobenzene
chloroethane
chloroform
chloromethane
cis-1,3-dichloropropene
cis-1,2-dichloroethene
dibromochloromethane
dibromomethane
dichlorodifluoromethane
diethyl ether
ethyl methacrylate
ethylbenzene
hexachlorobutadiene
hexachloroethane
isopropylbenzene
m,p-xylenes
methacrylonitrile
methyl iodide
methyl acrylate
methyl tert-butyl ether
methylene chloride
methylmethacrylate
n-butylbenzene
n-propylbenzene
naphthalene
nitrobenzene
o-xylene
p-isopropyltoluene
pentachloroethane
propionitrile
sec-butylbenzene
styrene
tert-butyl alcohol
tert-butylbenzene
tetrachloroethene
tetrahydrofuran
toluene
trans-1,4-dichloro-2-butene
trans-1,2-dichloroethene
trans-1,3-dichloropropene
trichloroethene
trichlorofluoromethane
vinyl chloride

Semivolatile Organic Chemicals

USEPA Method 525.2

2,2',3,3',4,4',6-heptachlorobiphenyl
2,2',3,3',4,5,6,6'-octachlorobiphenyl
2,4,5-trichlorobiphenyl
2,2',4,4'-tetrachlorobiphenyl
2,2',4,4',5,6- hexachlorobiphenyl
2,2',3,4,6-pentachlorobiphenyl
2,3-dichlorobiphenyl
2-chlorobiphenyl
acenaphthylene
alachlor
aldrin
alpha-chlordane
anthracene
atrazine
benzo[a]pyrene
benzo[b]fluoranthene
benzo[g,h,i]perylene
benzo[k]fluoranthene
benz[a]anthracene
butylbenzylphthalate
chrysene
di(2-ethylhexyl)adipate
di(2-ethylhexyl)phthalate
di-n-butylphthalate
dibenz[a,h]anthracene
diethylphthalate
dimethylphthalate
endrin
fluorene
gamma-chlordane
heptachlor
heptachlor epoxide
hexachlorobenzene
hexachloropentadiene
indeno[1,2,3,c,d]pyrene
lindane
methoxychlor
pentachlorophenol
phenanthrene
pyrene
simazine
THNA trimers
trans-nonachlor

USEPA Method 625

1,3-dichlorobenzene
1,2,4-trichlorobenzene

1,2-dichlorobenzene
1,4-dichlorobenzene
2,4,6-trichlorophenol
2,4-dinitrophenol
2,4,5-trichlorophenol
2,4-dimethylphenol
2,6-dinitrotoluene
2,4-dichlorophenol
2,4-dinitrotoluene
2-chloronaphthalene
2-chlorophenol
2-nitrophenol
3,3'-dichlorobenzidene
4,6-dinitro-2-methyl phenol
4-bromophenyl phenyl ether
4-chloro-3-methylphenol
4-chlorophenyl phenyl ether
4-nitrophenol
acenaphthene
acenaphthylene
anthracene
benzo[a]anthracene
benzo[a]pyrene
benzo[b]fluoranthene
benzo[g,h,i]perylene
benzo[k]fluoranthene
bis(2-chloroethoxy) methane
bis(2-chloroethyl) ether
bis(2-chloroisopropyl) ether
bis(2-ethylhexyl) phthalate
butylbenzylphthalate
chrysene
di-n-butylphthalate
di-n-octylphthalate
dibenz[a,h]anthracene
diethylphthalate
dimethylphthalate
fluoranthene
fluorene
hexachlorobenzene
hexachlorobutadiene
hexachlorocyclopentadiene
hexachloroethane
indeno[1,2,3,c,d]pyrene
isophorone
N-nitrosodi-n-butylamine
N-nitrosodi-n-propylamine
N-nitrosodiethylamine
N-nitrosodiphenylamine
N-nitrosopyrrolidine
naphthalene
nitrobenzene
pentachlorobenzene
pentachlorophenol
phenanthrene
phenol
pyrene

Metals and Other Inorganic Chemicals

Various Methods

arsenic
cadmium
chromium
lead
mercury
nitrate/nitrite

Radiological Activity

gross alpha activity
gross beta activity
radium-226
radium-228

Table 2. Results of radiological analyses of Dover Township private wells, in picoCuries per liter (pCi/l). Samples taken February, March and May 1997. Source: NJDHSS, 1997a.

Well Number	Gross Alpha Activity	Radium-226	Radium-228	Gross Beta Activity
	MCL=15 pCi/L	MCL=5 pCi/L Combined Radium		MCL=50 pCi/L
51	**17.5±1.2**	1.2±0.2	1.2±0.4	10±1
224	**59.3±2.0**	**1.4±0.2**	**4.2±0.4**	20±1
2	**36.6±1.8**	1.2±0.2	2.7±0.6	14±1
38	**23.7±1.8**	1.0±0.2	1.8±0.5	10±1
55	12.0±0.5	1.5±0.3	<0.57	5.1±0.6
4	4.6±0.6	-	--	3.0±0.3
64	13.5±1.2	1.9±0.3	<0.61	5.6±0.4
88	12.2±1.1	1.3±0.2	1.3±0.4	4.0±0.4
24	**16.9±1.3**	2.6±0.3	1.4±0.4	7.4±0.5
186	**24.2±1.2**	1.9±0.3	1.9±0.4	10±1
73	**38.9±1.9**	**1.5±0.3**	**4.4±0.6**	16±1
72	**34.9±1.9**	1.6±0.6	2.7±0.5	16±1
71	9.2±0.9	1.0±0.2	<0.70	4.8±0.4
137	9.4±1.0	0.91±0.22	<0.66	4.7±0.4
233	**19.5±1.2**	0.93±0.25	1.4±0.4	7.0±0.4
121	**26.5±1.5**	2.0±0.3	1.9±0.4	9.1±0.5
157	**17.0±1.4**	1.1±0.2	1.5±0.4	8.1±0.5
140	0.65±0.36	-	--	0.98±0.25
235	**25.2±2.2**	2.3±0.3	1.6±0.4	9.4±0.4
86	**82.1±2.7**	**2.1±0.2**	**6.4±0.6**	30±1
244	**28.5±1.9**	2.6±0.3	1.5±0.4	12±1
274	**28.5±1.8**	2.2±0.5	2.4±0.5	11±1
41	3.4±0.4	-	--	1.9±0.3
7	7.1±0.7	0.59±0.20	0.65±0.32	4.2±0.4

Well Number	Gross Alpha Activity	Radium-226	Radium-228	Gross Beta Activity
	MCL=15 pCi/L	MCL=5 pCi/L Combined Radium		MCL=50 pCi/L
58	2.5±0.5	-	--	2.1±0.3
109	**17.4±1.1**	1.0±0.2	1.5±0.4	6.8±0.4
115	**40.8±1.8**	**1.9±0.3**	**4.9±0.7**	17±1
128	11.8±0.8	0.92±0.22	1.7±0.4	5.8±0.4
158	**39.5±1.8**	1.1±0.2	2.4±0.5	13±1
229	**17.1±1.2**	1.2±0.2	1.2±0.4	7.4±0.4
168	13.2±1.0	0.67±0.22	2.1±0.5	8.6±0.7
213	7.1±1.1	0.68±0.22	<0.73	5.1±0.6
123	**21.0±1.2**	**3.2±0.4**	**2.4±0.5**	9.5±0.5
53	**17.6±1.4**	2.4±0.3	1.7±0.4	7.4±0.5
210	10.0±0.7	1.3±0.3	1.0±0.4	9.2±0.4
275	**37.8±1.7**	**1.8±0.2**	**4.7±0.5**	18±1
160	4.8±0.5	-	--	5.1±0.4
291	0.24±0.16	-	--	0.31±0.20
194	**30.7±1.5**	1.3±0.3	3.2±0.6	16±1
16	8.9±0.7	1.8±0.3	1.2±0.4	4.9±0.4
258	**22.7±1.2**	2.3±0.3	1.3±0.4	9.4±0.5
195	**17.2±1.1**	1.3±0.3	2.0±0.4	9.2±0.5
319	12.0±0.6	1.5±0.3	1.6±0.3	5.8±0.3
91	**15.4±1.0**	1.1±0.2	1.8±0.5	7.3±0.4
97	10.9±1.1	2.3±0.3	1.6±0.4	7.2±0.6
45	**16.5±1.0**	1.1±0.2	2.6±0.5	8.0±0.5
354	1.4±0.3	-	--	1.1±0.2
99	1.5±0.2	-	--	3.0±0.2
263	6.8±0.6	0.60±0.18	1.3±0.4	3.8±0.3
273	14.8±1.0	2.2±0.3	1.8±0.5	7.7±0.4
260	7.5±0.5	0.82±0.20	<0.79	5.8±0.3

Well Number	Gross Alpha Activity	Radium-226	Radium-228	Gross Beta Activity
	MCL=15 pCi/L	MCL=5 pCi/L Combined Radium		MCL=50 pCi/L
116	**26.9±1.7**	2.3±0.3	2.0±0.5	14±1
241	10.1±0.8	1.2±0.3	<0.60	4.8±0.4
20	2.6±0.4	-	--	2.1±0.3

BOLD Exceeds MCL

MCL Maximum contaminant level

\- Not Measured

Table 3. Results of chemical analyses of Dover Township private wells, in micrograms per liter or parts per billion (ppb) unless otherwise noted. Samples taken February, March and May 1997. Sources: NJDHSS, 1997b, 1997c, 1997d and 1997e.

Well Number	Lead	Mercury	Chloroform	Other Chemicals	Nitrate + Nitrite (ppm)
	AL= 15	MCL= 2	MCL= 100 *	See Notes for MCLs	MCL= 10
51	BDL	BDL	BDL	MTBE: 2	3.7
224	14.9	BDL	0.9		2.5
2	5.6	BDL	BDL		3.6
38	9.8	BDL	0.5		5.6
55	4.4	BDL	3	MTBE: 0.5	2.6
4	6.1	BDL	0.4	Arsenic: 5.8	0.5
64	2.1	0.23	BDL		2.7
88	3.8	BDL	BDL		5.6
24	3.3	0.23	BDL		4.3
186	3.2	BDL	BDL		4.8
73	3.6	BDL	2		3.5
72	1.7	BDL	4	DBP: 8	2.4
137	4.3	BDL	0.4		1.3
71	2.8	BDL	BDL		2.8
121	3.3	BDL	9		4.2
233	1.5	BDL	BDL		3.8
157	6.3	BDL	BDL		3.0
235	11.9	0.04	1		6.0
140	1.8	BDL	BDL		BDL
86	1.9	BDL	BDL		0.2
244	27.4	0.04	BDL		3.5
274	2.0	3.3	4	PCE: 2.0 TCE: 0.7	3.6

Well Number	Lead	Mercury	Chloroform	Other Chemicals	Nitrate + Nitrite (ppm)
	AL= 15	MCL= 2	MCL= 100 *	See Notes for MCLs	MCL= 10
41	1.4	BDL	0.5		0.9
7	BDL	BDL	1		0.1
58	1.3	BDL	8	MTBE: 0.8	1.8
109	20	BDL	BDL		4.1
115	6.9	BDL	BDL		2.6
128	1.3	0.07	BDL		1.3
158	4.2	0.07	BDL		0.5
229	25	0.05	BDL		3.4
16	3.2	BDL	0.9		2.1
275	BDL	BDL	BDL		0.6
210	9.2	BDL	1		4.6
194	7.2	BDL	0.5		1.8
160	2.5	BDL	2		0.9
291	BDL	0.04	BDL	DCA: 0.5	0.1
258	3.4	BDL	6		2.3
168	1.7	BDL	BDL		4.1
195	11	BDL	BDL		1.4
213	2.8	BDL	1	MTBE: 0.5	2.9
123	4.7	0.07	BDL		3.6
53	1.6	BDL	BDL		3.4
319	11.3	BDL	BDL	TCE: 0.4 J	3.4
260	8.9	BDL	BDL		1.8
116	41.9	0.56	0.7	MTBE: 0.7	4.0
91	4.7	BDL	BDL	TCA: 0.5	1.3
97	6.7	BDL	2		3.4

Well Number	Lead	Mercury	Chloroform	Other Chemicals	Nitrate + Nitrite (ppm)
	AL= 15	MCL= 2	MCL= 100 *	See Notes for MCLs	MCL= 10
354	**33.6**	BDL	3		BDL
99	3.2	BDL	BDL		BDL
241	**22.1**	BDL	BDL		4.6
20	3.2	BDL	BDL	BEHP: 3.1	0.04
263	3.6	BDL	1		0.8
45	3.4	BDL	BDL		0.6
273	7.1	BDL	BDL		1.2

BOLD Exceeds AL or MCL

* The MCL is based on the combined concentration of chloroform and other trihalomethanes, which are common by-products of water disinfection. A CREG of 6 ppb for chloroform has been established by ATSDR.

AL Action level
MCL Maximum contaminant level
BDL Below detection limit
J Estimated concentration
TCE trichloroethylene (MCL=1 ppb)
PCE tetrachloroethylene (perchloroethylene) (MCL=1 ppb)
TCA 1,1,1-trichloroethane (MCL=30 ppb)
DCA 1,2- dichloroethane (MCL=2 ppb)
MTBE methyl-t-butyl ether (MCL=70 ppb)
BEHP bis(2-ethylhexyl) phthalate (MCL=6 ppb)
BBP benzyl butyl phthalate (No MCL available)
DBP di-n-butyl phthalate (No MCL available)

Table 4. Range of metal and organic chemical concentrations detected in surface soils along Mapletree and Bay Avenues, in milligrams per kilogram or parts per million (ppm). Samples taken September 1996. Source: NJDHSS, 1997f.

Contaminant	Old Freehold & Mapletree	Sea Court Mall (Bay and Hooper)	Bay and Vaughn	Bay and West	Comparison Value (ppm) *
Arsenic	1.1 - 4.5	BDL - 0.9	1.7 - 4.6	1.6 - 6.3	20, (0.5**)
Cadmium	BDL - 2.9	BDL - 2.7	BDL	BDL - 2.1	10
Chromium	13.9 - 19.5	3.0 - 5.9	8.2 - 15.5	7.2 - 28.5	200 (hexavalent) 80,000 (trivalent)
Lead	BDL - 63.3	BDL - 21.5	49.9 - 188	10.8 - 38.7	NA
Mercury	0.035 - 0.084	BDL - 0.12	0.037 - 0.05	0.03 - 0.10	20
Fluoranthene	0.25 J	BDL	0.52 J	0.11 J - 0.3 J	2,000
Pyrene	0.16 J - 0.19 J	BDL	0.4 J	0.15 J - 0.22 J	2,000
Diethylphthalate	0.22 J - 0.28 J	0.29 J	BDL	BDL	40,000

* Environmental Media Evaluation Guide (EMEG) or Reference Dose Evaluation Guide (RMEG)
** Cancer Risk Evaluation Guide (CREG)

BDL Not Detected
CV Comparison Value
NA Comparison Value Not Available
J Estimated

Table 5. Range of metal and organic chemical concentrations detected in sediment samples of the Toms River and Long Swamp Creek, in milligrams per kilogram or parts per million (ppm). Samples taken September 1996. Source: NJDHSS, 1997f.

Contaminant	Long Swamp Creek					Toms River				Sedi-ment CV #	Soil CV @
	Sea Court	Breezy Oaks	Raleigh	Bachelor	Bay Lea *	Lake-hurst S	Lake-hurst D	JC82S	JC82D		
Dibutylphthalate	68	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NA	NA
Fluoranthene	1.2	3.9	BDL	7.7	1.8	0.62	BDL	0.68	BDL	0.75	2,000
Pyrene	1.1	2.7	BDL	7.8	1.8	1.1	BDL	BDL	BDL	0.49	2,000
Bis(2-ethylhexyl) phthalate	1.3	1.2	0.62	17.1	0.96	1.5	BDL	0.75	BDL	NA	500 (50**)
Benzo(b)-fluoranthene	BDL	0.72	BDL	5.9	BDL	0.91	BDL	0.63	BDL	NA	NA
Benzo(k)-fluoranthene	1.4	0.26	BDL	BDL	2.3	0.55	BDL	BDL	BDL	0.24	NA
Diethylphthalate	BDL	BDL	0.29	BDL	0.32	1.7	0.82	BDL	BDL	NA	40,000
Benzo(a)Pyrene	BDL	BDL	BDL	BDL	**0.92**	**0.89**	BDL	BDL	BDL	0.37	(0.1 **)
Indeno(1,2,3-cd)pyrene	BDL	BDL	BDL	BDL	0.79	1.3	BDL	BDL	BDL	0.20	NA
Benzo(ghi)perylene	BDL	BDL	BDL	BDL	0.73	BDL	BDL	BDL	BDL	0.17	NA
Arsenic	9.8	7.8	3.5	17.9	11.5	**30.6**	2.7	7.3	6.8	6.0	20 (0.5 **)

Contaminant	Long Swamp Creek					Toms River				Sedi-ment CV #	Soil CV @
	Sea Court	Breezy Oaks	Raleigh	Bachelor	Bay Lea *	Lake-hurst S	Lake-hurst D	JC82S	JC82D		
Chromium	10.1	6.6	7.1	31.1	21.5	22.6	8.9	12.7	140	26	200 80,000 ‡
Cadmium	2.4	2.0	2.3	4.8	2.1	BDL	BDL	2.1	BDL	0.6	10
Lead	43.1	35.7	12.0	921	130	80.6	18.8	39.6	36.8	31	NA
Mercury	0.06	0.05	0.03	0.50	0.08	2.3	1.1	1.2	0.84	0.2	20

BOLD Exceeds Soil CV
CV Comparison Value
NA Comparison Value Not Available
BDL Below method detection limit (see Data Interpretation section)
JC82 Identification of utility pole at sampling location
S Shallow (0"-6")
D Deep (6"-12")

\# NJDEP - New Jersey Sediment Guidance or OMEE - Ontario Ministry of the Environment and Energy Guidelines, based on toxicity to aquatic organisms
@ Soil CVs are Environmental Media Evaluation Guide (EMEG) or Reference Dose Evaluation Guide (RMEG) unless otherwise noted
* Location upstream of pipeline spill (see text)
** Cancer Risk Evaluation Guide (CREG)
‡ CVs for chromium are 200 for hexavalent form, 80,000 for trivalent form

Table 6. Results of chemical and radiological analyses of Toms River school irrigation wells, in micrograms per liter or parts per billion (ppb) unless otherwise specified. Samples taken August and October 1996. Source: NJDHSS, 1997h.

Contaminant	High School North		Intermediate School West	East Dover Elementary	High School East			Washington St. Elementary
	Well #1	Well #2			Well #1	Well #2	Well #3	
Chloroform	BDL	BDL	BDL	3	4	2	2	BDL
Chromium	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1.2
Lead	3	3.6	3.1	4.6	3.0	2.9	5.6	9.5
Mercury	0.23	0.13	0.07	0.04	BDL	0.04	0.09	BDL
Gross alpha*	12±1	9.7±1.1	14±1	**19±1**	**31±2**	**23±2**	**15±1**	6.1±0.7
Radium-226*	0.91±0.23	1.4±0.3	2.4±0.3	2.7±0.4	**3.8±0.3**	2.5±0.4	3.0±0.4	0.86±0.26
Radium-228*	1.9±0.5	1.0±0.5	2.0±0.3	1.9±0.5	**3.6±0.6**	2.2±0.5	1.9±0.4	0.70±0.36

* Results in pCi/l

BDL Not Detected

BOLD Exceeds MCL or AL (see Tables 2 and 3 for MCLs)

Figures

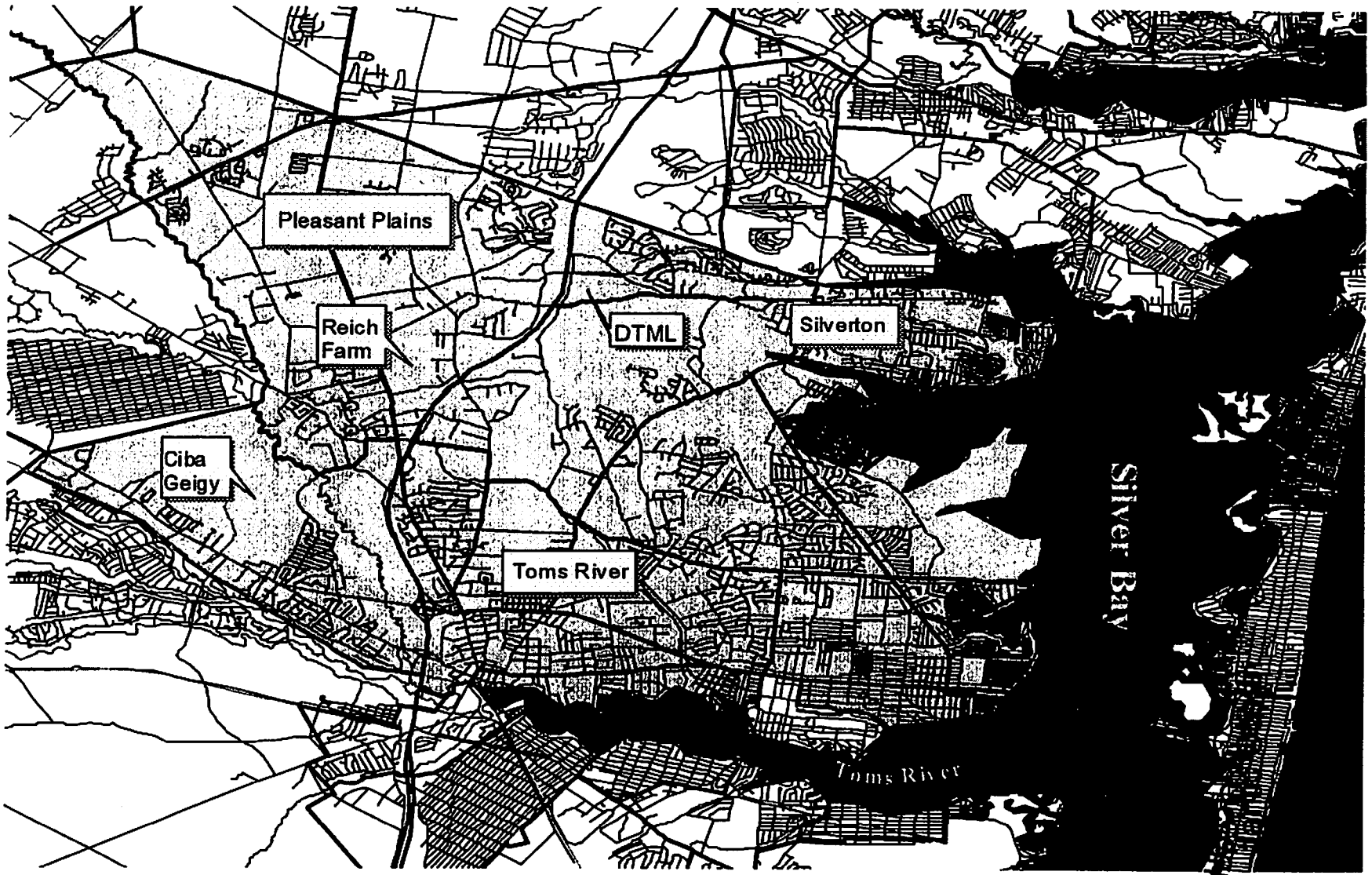

Figure 1. Dover Township and Vicinity

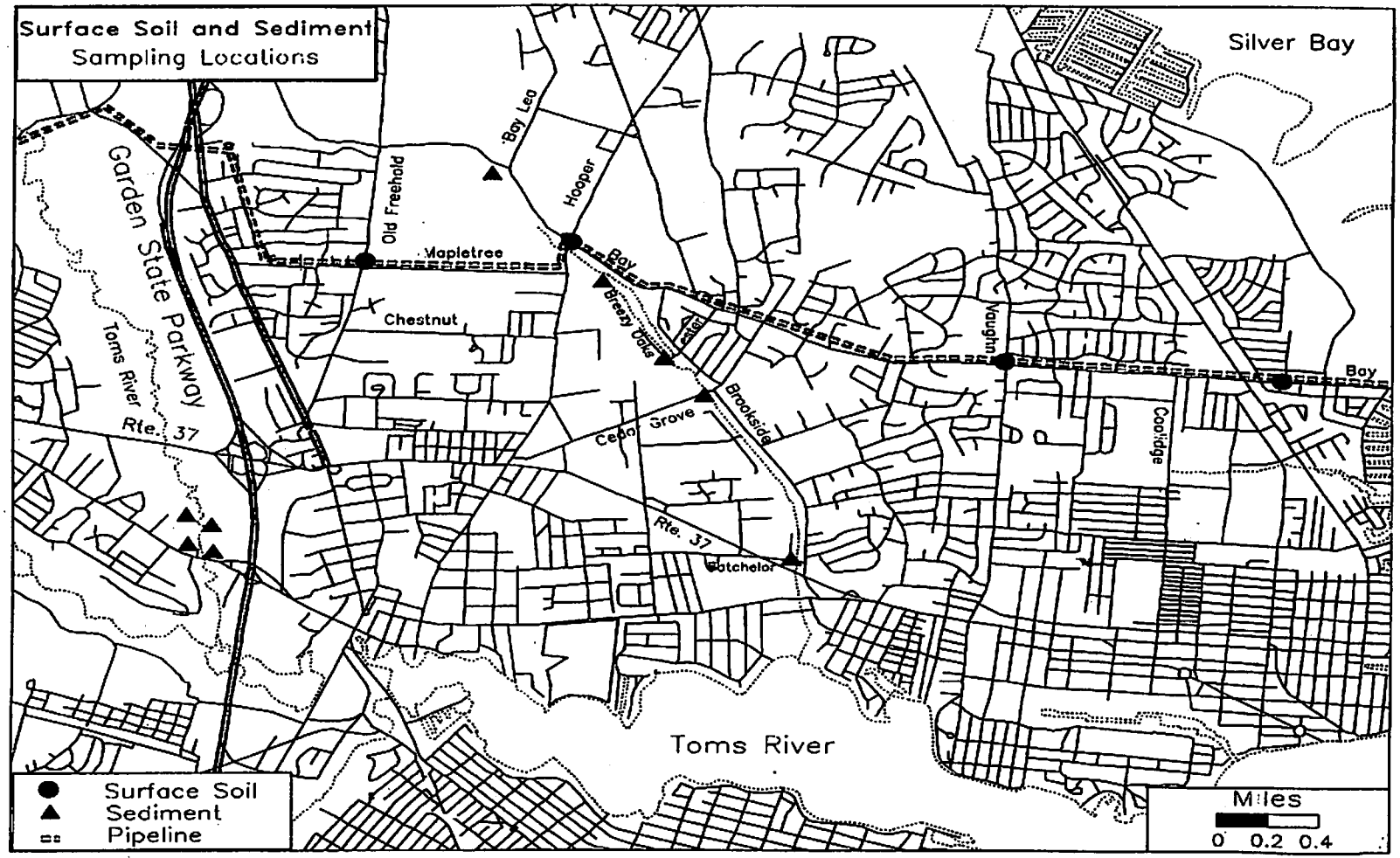

Figure 2. Surface Soil and Sediment Sampling Locations - 1996