Development and Evaluation of Environmental Exposure Metric Databases

Program 03074, Environmental and Health Effects Tracking
National Center for Environmental Health
Centers for Disease Control and Prevention

January 2007

Prepared by:
New Jersey Department of Environmental Protection

In Cooperation with the:
New Jersey Department of Health and Senior Services

Table of Contents

List of Tables and Figures

Introduction

The New Jersey Department of Environmental Protection (DEP) and the New Jersey Department of Health and Senior Services (DHSS) are working together to implement pilot projects linking data on environmental hazards/exposure to data on adverse health outcomes.   The DEP and DHSS received funding from the federal Centers for Disease Control and Prevention (CDC) under the "Environmental Public Health Tracking Program" (EPHT) to implement these pilots. A Memorandum of Agreement (MOA) between DEP and DHSS dated June 7, 2004, established financial and work plan agreements between the agencies for completing these projects.

DEP and DHSS are conducting three separate pilot projects, including linking:
- cancer incidence with air and drinking water exposure;
- childhood blood lead levels with air and drinking water; and
- birth defects with drinking water, wastewater effluents and pesticides.

The purpose of these demonstration projects is to develop and evaluate methods for linking data contained in ongoing, existing health effects and human exposure surveillance systems with existing data on environmental hazards and ambient exposures. The projects bring together the experience and expertise of the DHSS and DEP. Under the MOA, DEP is to compile and construct environmental factor databases to be used in the three linkage studies. This report summarizes how DEP constructed these databases, evaluated variation in hazards/exposure, and prepared the data so it could be linked to health outcome data maintained by DHSS.

The DEP used most of the CDC funds to upgrade and expand our enterprise data system, the New Jersey Environmental Management System.

Cancer Incidence Exposure Metrics

The first pilot project implemented under the EPHT program links data on cancer incidence to environmental hazards/exposure. DHSS and DEP first identified 17 types of cancer, based on site or histology or both, for which environmental exposures could be important risk factors. These cancers are listed in Table 1.

Table 1: Potential Cancers and Environmental Exposures for Cancer Incident Pilot

Cancer	Carcinogens or Carcinogenic Exposures for Investigation	Included in DHSS Independent SatScan Analysis	Included in Combined Linkage Demonstration Pilot
Bladder	Disinfection by products	YES	YES
Bone	Radium, mesothorium	YES	
Brain	Vinyl chloride, radiation	YES	YES
Breast	PCBs, DDT and its metabolites		
Kidney	Asbestos, coke ovens		
Larynx	Asbestos, isopropyl alcohol, mustard gas, sulfuric acid mist		
Liver	Arsenic, vinyl chloride		YES
Lymphatic and Hematopoietic System	Benzene, ethylene oxide, chlorophenols, chlorophenoxy herbicides, radiation, 1,3-butadiene, vinyl chloride	YES	YES
Nasal Cavity and Sinuses	Formaldehyde, isopropyl alcohol manufacturing, mustard gas, nickel refining, leather dust, wood dust, radium, mesothorium		
Ovary	Asbestos, talc		
Pharynx	Formaldehyde, mustard gas, dimethyl formamide		
Pleural and Peritoneal Mesothelioma	Asbestos	YES	
Prostate	Cadmium, ionizing radiation		
Skin	Arsenic, coal tars, mineral oils, ultraviolet light, radiation		
Soft-tissue Sarcoma	Chlorophenols, chlorophenoxy herbicides, dioxin		
Stomach	Ethylene oxide		
Thyroid	Radium	YES	

The DHSS conducted independent analysis of the statewide variation in six select cancers using SatScan. Results of this independent spatial analysis are discussed in a separate report.[1]

To focus work during demonstration project, DEP and DHSS identified three cancer/exposure combinations for linkage pilots. These included:

- Leukemia and benzene air exposure
- Brain and angiosarcoma cancer and vinyl chloride air exposure
- Bladder cancer and disinfection byproducts in drinking water

The DEP developed four different types of environmental exposure metrics to be used in these linkage projects.
- The first included air toxics exposures from EPA's National-scale Air Toxics Assessment (NATA).
- A second air exposure metric was developed by NJDEP using routine data tracked by regulatory programs.
- The third metric estimated impacts from mobile sources using Vehicle Miles Traveled (VMT).
- The fourth metric addresses potential drinking water exposures to trihalomethanes in community water systems.

The DEP and DHSS selected census tracts as the geographic scale for linking health data with environmental data. All metrics had to be apportioned and weighted to fit the census tract shapes used in the 2000 US Census. Methods used to develop these metrics and a brief discussion of results are presented below. Figures and Tables presenting the results are found at the end of this section.

National-scale Air Toxics Assessment for 1996

The USEPA's National-scale Air Toxics Assessment (NATA) provides estimates of potential exposure to air-borne toxic chemicals for counties and census tracts throughout the country. The assessment is a state-of-the-science national-scale screening tool to help regulatory agencies and communities as they assess their air toxic priorities. The first assessment was peer reviewed by Science Advisory Board (SAB) in 2001. The national-scale assessment is designed to help EPA, state, local and tribal governments and the public better understand the air toxics problem in the U.S. The assessment includes four steps which focus on the year 1996:

1. An inventory of air toxics emissions,

2. Estimates of annual average outdoor air toxics concentrations,

3. Estimates of exposure concentrations (what people are estimated to breathe),

---

[1] Include title and date of report.

4. A characterization of potential public health risks.

Estimates of annual average ambient air concentrations of 32 hazardous air pollutants (air toxics) and diesel particulate matter are predicted for each census tract based on the 1990 US Census shapes. NATA estimates are derived from an annual emissions inventory of major and other point sources, estimates of area and mobile source contributions, and "background" concentrations. Emissions for major and some other point sources are from known X/Y locations. Emissions for most other sources, mobile and non road mobile sources are estimated at a county level and apportioned to census tracts using different techniques. EPA used the Assessment System for Population Exposure Nationwide (ASPEN) dispersion model to estimate ambient air concentrations from these emissions. The results are best used to determine geographic patterns across broad geographic areas. The assessment is not designed as a definitive means to pinpoint specific risk values within a census tract or to characterize or compare risks at local levels such as between neighborhoods. For analysis of air toxics in these smaller areas, EPA, state, local and tribal agencies rely on other tools such as monitoring and local-scale assessments to evaluate potential hot spots using more refined and localized data.

Methods

Database Development

The DEP obtained NATA results for 1996 from EPA on a CD-ROM dated November 2001. This database includes census tract exposure estimates for all 61,642 census tracts in the country based on 1990 US Census areas. The DEP extracted data for New Jersey's 1,950 tracts.

NATA estimates had to be modified slightly to account for changes in census tract shapes occurring between 1990 and 2000. The DEP used land area data comparing the 1990 and 2000 census tract shapes to calculate weighted average concentrations for tracts that changed shapes. Land area data were obtained from Census Tract Relationship files prepared by the US Census Bureau and available on their web site[2]. See Appendix B for an example of this weighted average calculation.

Methods to Evaluate NATA Exposure Variation

The DEP examined the spatial variation in exposure through statistical analyses and mapping. First, general descriptive statistics (average, minimum, maximum, standard deviation, etc.) were summarized to characterize variability using the data analysis function in Microsoft Excel. Next, DEP used ArcGIS 9.1 to create shape files to evaluate the data spatially. Classification methods used to evaluate spatial variability included equal intervals, natural breaks and quantiles. When available, established health benchmarks were used to classify exposure.

_____

[2] Web link http://www.census.gov/geo/www/relate/rel_tract.html

<u>Results and Discussion of EPA NATA Estimates</u>

EPA NATA-Vinyl Chloride

Analysis of NATA vinyl chloride estimates (See Figure 1) show that higher concentrations are found in the southwest part of the state in Salem, Cumberland, and Gloucester Counties near a well known source of vinyl chloride air release. The maximum vinyl chloride concentration is estimated to be 0.105 ug/m3. No census tract exceeds the 10-6 excess cancer risk concentration of 0.11 ug/m3. Concentrations decrease rapidly then level off at approximately 0.011 ug/m3, a level representing a 10-7 cancer risk. This level was selected to identify census tracts in the high exposure group. There are 122 tracts in the high exposure category. Approximately 452,188 people live in these tracts.

EPA NATA-Benzene

Analysis of NATA benzene estimates (See Figure 2) show higher concentrations are found along major transportation corridors and near well known point sources of benzene, including petroleum refineries. The entire state has concentrations exceeding the 10-6 cancer risk estimate of 0.13 ug/m3. The maximum concentration is modeled to be 4.57 ug/m^3. Concentrations decrease rapidly, to a level of about 2.5 ug/m^3, after which, the change in concentration is generally more gradual. This concentration was selected to identify census tracts in the high exposure group. There are 211 census tracts in the high exposure group with approximately with 845,494 residents.

DEP Tracking Data

The DEP also developed air toxics exposure metrics for vinyl chloride and benzene using data tracked by DEPs regulatory programs from 1993 to 2004. These metrics are intended to supplement the single-year estimates provided by EPA's NATA program and to demonstrate how routine tracking data maintained by state regulatory agencies can be used for environmental health tracking purposes. These metrics also attempt to provide estimates using a finer geographic scale for known point sources.

<u>Methods</u>

Developing the tracking metric included four general steps. First, we developed an emission inventory of pollutant sources. Second, we conducted air dispersion modeling to estimate ambient concentrations for common source types. The third step was to create a database of all air dispersion results. The last step was conducting a GIS analysis to estimate cumulative concentrations and assess statewide variation. Each step is briefly discussed below.

Emission Inventory Development

DEP maintains extensive databases tracking environmental hazard data that can be used to develop an inventory of air releases. Table 2 summarizes five databases we used to develop our inventory. Much of these data are now being submitted electronically by regulated facilities and are tracked in near real time using a central computer data system—called the New Jersey Environmental Management System (NJEMS). The DEP combined these databases to develop a single inventory of air pollutant sources for vinyl chloride and benzene.

Table 2. Description of DEP Databases Used for Air Emission Inventory

Data Source	Database Contents	Geographic Coverage	Temporal Coverage
Release and Pollution Prevention Report (RPPR)	Actual emission	State-wide: ~500 facilities	Begins 1987; best from 1993 Original industrial survey 1979
Emission Statement	Actual emission	State-wide ~ 500 facilities	Begins 1991, New toxics data started in 2003
Community Right-to-Know Inventory	Storage quantity	State-wide: ~ 20,000 facilities	Begins 1984, but entered in database since 1990
Underground Storage Tank Registration	Tankssize and contents	State-wide~ 6,000	Original installation dates and closure dates
Air Permit Information	Allowable emission	State-wide ~ 3,000	Original equipment installation date as far back as 1930 and grandfathered status back to 1954

To combine data from these separate sources DEP's contractor, CGI-AMS Inc., created an integrated, comprehensive and consistent master database, referred to as the Multimedia Release Report (MMRR). The MMRR is generated by creating staging tables which are populated on command by extracting data from multiple sources using a set of Oracle stored procedures. The merging includes application of extraction rules regarding filters, algorithms to convert data into common units, calculations to estimate releases using emission factors, and a hierarchy to select the best data source when more than one valid record is available for a single site. According to that hierarchy, documented releases of contaminants in pounds per year is preferred to, and chosen instead of, releases based on emission factors or permitted to be released.

The first phase of the MMRR included data from four data sources: Air permit information, discharge monitoring reports, the Release and Pollution Prevention Report, and NJEMS/masterfile information. A second phase of the MMRR added additional air permit data, right-to-know data and data from the underground storage tank program.

The end result of this data integration is a facility-based file containing release data for each chemical and year, as well as the GIS X,Y coordinates for each facility. Table 3 below is a small portion of the final database to illustrate database structure and format.

Table 3: Portion of Multi Media Release Report

SITE_ID	X_CO ORD	Y_COO RD	MMRR_P ARAME TER_ID	YEAR	AIR_RTK _TOTAL	AIR_SO URCE_ TOTAL	AIR_SOU RCE_ALL OW	CRTK_REL EASE_EST	UST_RE LEASE_ EST	BEST_R ELEASE _VAL
15834	309060	375149	50	2003	23,591		31,052			23,591
14847	571609	638241	50	2003			23,420			23,420
14851	542056	600204	50	2003			14,666			14,666
37398	564881	646515	50	2003			11,800			11,800
14376	278061	368554	50	2003	10,657		5,600			10,657
962	570136	658222	50	2003	9,800					9,800
927	569561	647413	50	2003			8,546			8,546
177202	569902	658540	50	2003		8,433				8,433
14420	396774	456153	50	2003			5,420			5,420
5498	558214	619865	50	2003	5,065		10			5,065

Air Dispersion Modeling to Estimate Ambient Air Concentrations

All facilities in the inventory were assigned a source type based on release and stack characteristics that affect how pollutants disperse in the environment. For each source type, we ran a "base" air dispersion model using the Industrial Source Complex-Short Term model version 02035 (ISC3) to predict ambient air concentrations from a 1 gm/sec release. Each base model included X,Y receptor points placed at 100 meters out to a distance until concentrations were below a 10^{-7} cancer risk for the largest source.

Facility Database

The DEP applied these base models to all facilities with the same source type in the emission inventory. The 0,0 origin point for the base model was linked to the X/Y coordinate for each facility to place the base models into the state GIS grid for analysis. The concentration at each receptor was estimated based on releases from each facility relative to the base model. Table 4 below summarizes the statewide facility databases for vinyl chloride and benzene and the database of concentration estimates generated for each source.

Table 4. Summary of Facility Database

Vinyl Chloride				Benzene			
source type	Number of sources	X,Y receptor points in base model	total X,Y receptor points	source type	Number of sources	XY points in base model	total xy points
Industrial Large	2	425,080	850,160				
				Gas station small	10,452	448	4,682,496
Industry Small	6	45,401	272,406				
				Refineries	4	181,978	727,912
Landfill	40	6,704	268,160	Bulk terminal	34	10,201	346,834

				large			
Surface Coater	2	6,544	13,088	Gas station large	33	6,568	216,744
WWTP	3	2,297	6,891	WWTP Large	17	10,201	173,417
				Gen stack	13	10,201	132,613
				Gen area	12	10,201	122,412
				Bulk terminal small	69	1,681	115,989
				WWTP small	24	1,681	40,344
				Utilities	2	10,201	20,402
TOTALS	**53**	**486,026**	**1,410,705**	**TOTALS**	**243,361**	**10,660**	**6,579,163**

GIS Analysis to Estimate Census Tract Concentrations

The DEP used ArcGIS to estimate statewide concentrations from multiple sources. First, DEP created a GIS shape file placing all concentration estimates in the facility database into state plane coordinates. The DEP also prepared a 100 meter grid covering the entire state using the Fishnet function in Xtools Pro. It is important that this grid size match the distance between the concentration point estimates. When the distances are the same, if a grid contains more than one point, each point must be from a separate facility. Then, the points can be added to estimate cumulative concentration. To sum multiple points in each grid, a spatial join was performed summing all concentration points located in each 100 meter grid. Finally, census tract level concentrations were estimated using a weighted average calculation (zonal statistic in Spatial Analyst).

Results and Discussion of NJDEP Air Tracking Metric

NJDEP Tracking Metric-Vinyl Chloride

Analysis of NJDEP's estimate for vinyl chloride (See Figure 3) show two areas of elevated concentrations near well known point source emissions. The maximum predicted concentration is 0.404 ug/m^3. Only four census tracts have predicted concentrations exceeding the 10^{-6} cancer risk level of 0.11 ug/m^3. Concentrations decrease rapidly, leveling off at a concentration near the 10-7 cancer risk level of 0.011 ug/m^3. This level was selected to identify tracts in the high exposure category. There are 57 tracts in the high exposure group with approximately 203,585 residents.

NJDEP Tracking Metric-Benzene

Analysis of NJDEPs estimate for benzene (see Figure 4) shows the highest concentrations near the four petroleum refineries in New Jersey. Elevated concentrations are also found in areas where cumulative impacts from smaller sources combine in one tract. The maximum estimated concentration is 2.26 ug/m^3. Concentrations decrease rapidly, leveling off at a concentration near 0.13 ug/m^3, which is the 10^{-6} cancer risk level. This level was selected to identify the high exposure group. There are 20 census tracts

exceeding this concentration. Approximately 69,377 people live in these areas.

Traffic Density

The DEP and DHSS used Vehicle Miles Traveled (VMT) as a surrogate for pollutant releases from mobile sources. VMT is a standard measure of activity that is estimated from the traffic volumes recorded on sampled road segments. Public roadway mileage figures are maintained by New Jersey Department of Transportation (DOT) through road inventories. New Jersey has approximately 36,000 miles of public roadways. New Jersey's official estimate of vehicle VMT is a product of the Highway Performance Monitoring System (HPMS) Program. VMT is a measurement of the amount of traffic on a given mile of roadway. Deriving New Jersey's VMT estimate involves multiplying the traffic volume on each HPMS section, the section length and expansion factor then summing the product to yield VMT for any desired aggregation level.

Methods

The most readily available source of VMT data found during the pilot study that was spatially indexed and had generally broad statewide coverage was the Congestion Management System (CMS). The Transportation Equity Act for the 21st Century (TEA-21) requires each Transportation Management Area (TMA) to develop a CMS that is a systematic process for managing congestion. The CMS provides information on transportation system performance and finds alternative ways to alleviate congestion and enhance the mobility of people and goods to levels that meet state, regional and local needs. The CMS includes data collection, monitoring and measuring of transportation system performance and identifying alternative actions and strategies for particular locations.

The NJDEP obtained data from the CMS for 2003 from the North Jersey Transportation Planning Authority web site.[3] The CMS for New Jersey includes data for 5,253 road segments in New Jersey covering 3,478 miles of roads throughout the state. Estimates of VMT for each segment are provided. The road segments covered by the CMS include over 122 million VMT, which covers approximately 62 % of the estimated VMT miles for the entire state.

The CMS data are available in GIS shape file format. To apportion the data to census tracts, the CMS road segments were first intersected with census tract polygons. Lengths of road segments within each tract were then recalculated. New estimates of VMT were developed using the new lengths. To account for changes in the size of census tracts, VMTs estimates were weighted by acres in each tract. The final metric was the VMT per acre per census tract.

---

[3] http://njtpa.org/planning/DRD/njtpadataresources.htm

Results and Discussion

Since there are no health benchmarks or regulatory standards for VMT, the analysis used three quantile classes. Using this method the high exposure group included any tract with a VMT per acre over 30.   This included 651 tracts with approximately 2.7 million residents.

Drinking Water

The DEP and DHSS have worked together over the last several years to create databases and maps for the state's water utilities Data collected includes volatile organic contaminant and disinfection by-products (trihalomethanes or THMs), that were historically found in each drinking water system and subsystem. These data were used to develop exposure metrics for THM for the bladder cancer demonstration project.

Methods

Data on historic contaminant concentrations were collected from databases and files at the NJDEP, water utilities, and local health departments. Databases and files that were reviewed included: drinking water test results (raw, plant, and distribution samples collected under the Safe Drinking Water Act); historic samples taken before the enactment of the Safe Drinking Water Act; and files on waste sites that have impacted drinking water quality. Estimates of average concentrations of THMs, were entered into a database for each six-month period from 1978 through 1985.

System maps were based on historic paper maps in DEP files and personal communications with staff of the individual water utilities. Subsystems were created to account for expansion of the drinking water systems, areas of known contamination, and mixing zones between known contaminants and uncontaminated areas. Information on water flow (based on pumping rates of well fields, system architecture, and population mobility) were used to delineate subsystems. Approximately 500 drinking water system and subsystem areas were digitized using GIS.

Data for each water system was apportioned to census tracts.   Most census tracts were served by only one water system. For census tracts served by more than one, the Zonal Statistics function in Spatial Analyst ArcGIS 9.1 was used to estimate drinking water concentrations for the census tract. For each system a long term average using data from 1978 to 1985 was calculated.

Results and Discussion

Results of the THM analysis (see Figure 6) show only three tracts have long term

averages above the THM standard of 80 ppb.[4] Concentrations decrease rapidly, level off at both the 65 and 45 ppb level, which were used as natural cutpoints. Tracts with zero for THM were used as the reference. There are 165 tracts in the high exposure group, with approximately 824,000 residents.

---

[4] The THM standard is based on a running annual average, not the long term average developed for the linkage project. Also, the MCL for THM during the study period was 100 ug/l and was changed to 80 ug/l in 2002.

Figures 1 through 6: Exposure Metrics Used in Cancer Demonstration Project

Figure 1: Vinyl Chloride Air Concentrations NATA 1996

Descriptive Measure	VCM (ug/m3)
Mean	0.0049
Median	0.0033
Standard Error	0.0002
Standard Deviation	0.0074
Minimum	0.0001
Maximum	0.1050

Vinyl Chloride Concentration (ug/m3)
Cut Points
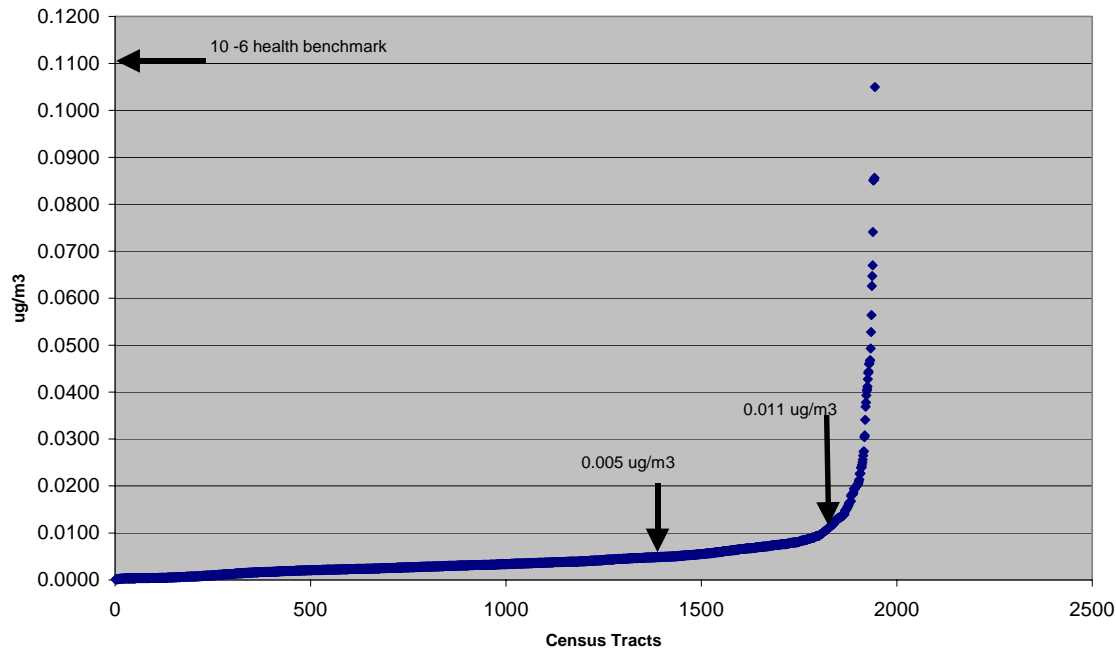
Legend

VCM ug/m3
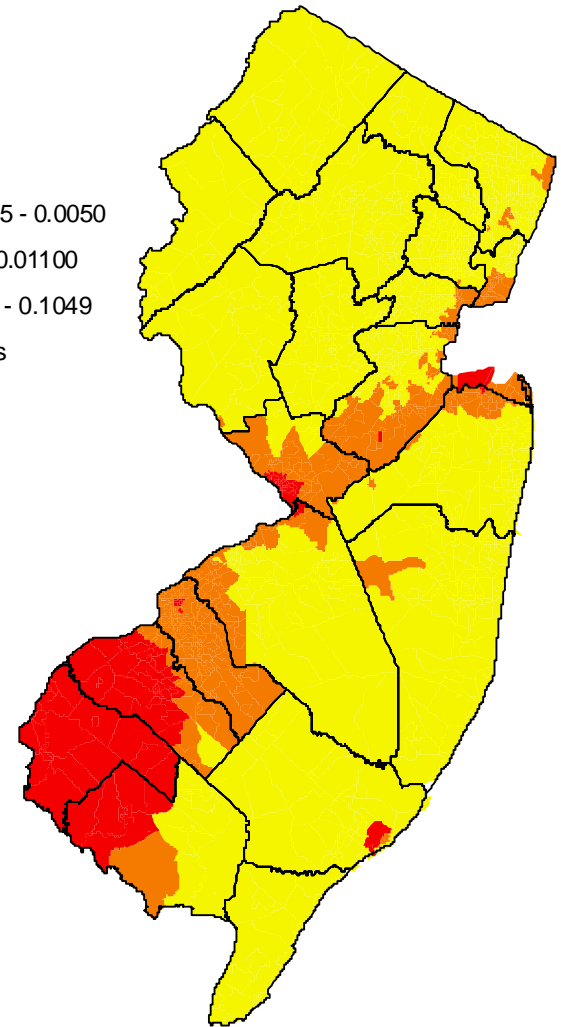
- 0.000105 - 0.0050
- 0.005 - 0.01100
- 0.01100 - 0.1049
- Counties

Figure 2: Benzene Air Concentrations NATA 1996

Descriptive Analysis of Benzene NATA Estimates

Descriptive Measure	Benzene (ug/m3)
Mean	1.6359
Median	1.5000
Standard Deviation	0.6618
Standard Error	0.0150
Minimum	0.6490
Maximum	4.5700

Benzene Concentration (ug/m3)
Cut points

Legend

Benzene ug/m3

- 0.649 - 1.400
- 1.400 - 2.500
- 2.500 - 4.570
- Counties
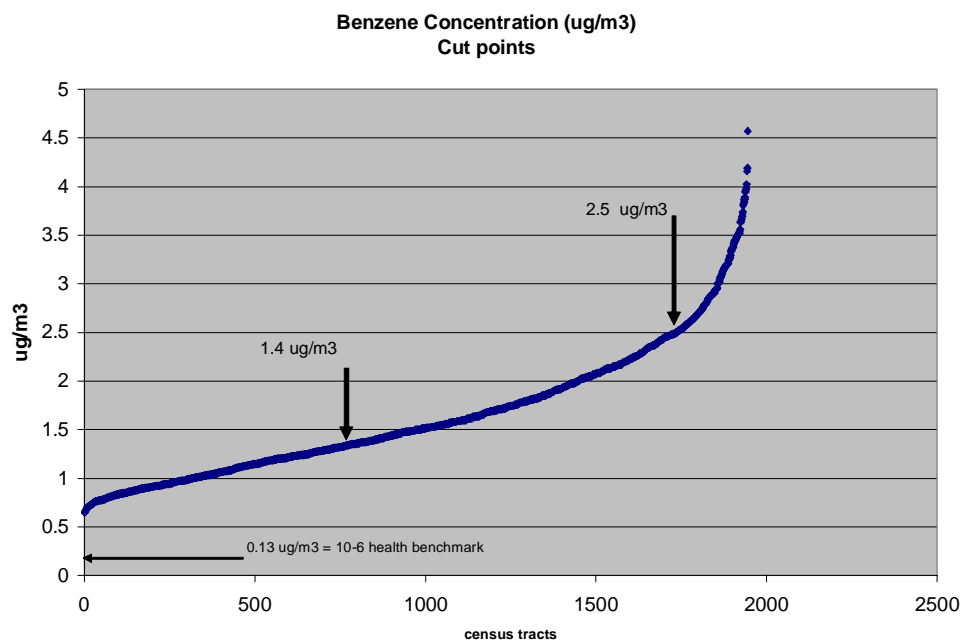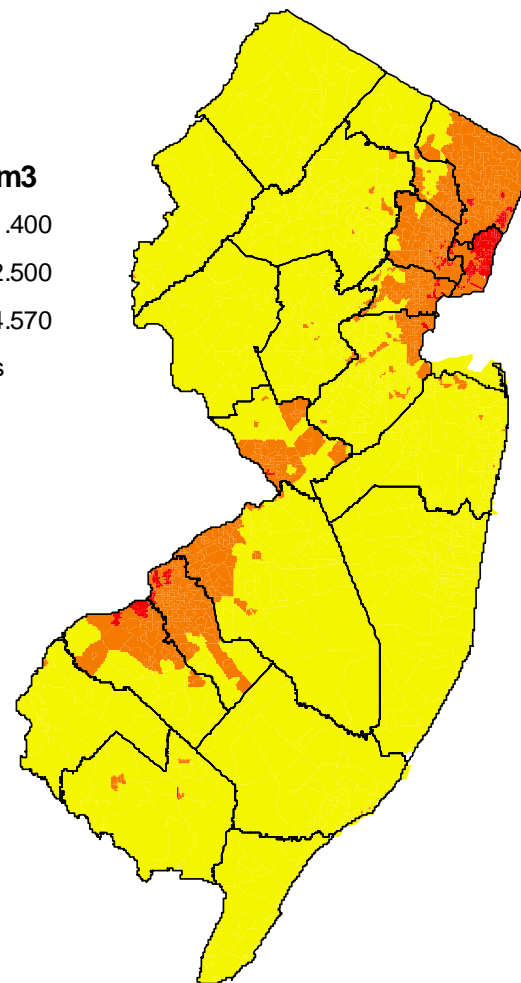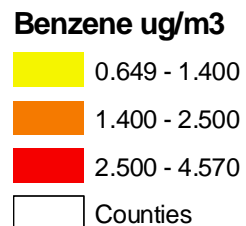
Figure 3: Vinyl Chloride Air Concentrations NJDEP 1993 – 2004 Avg Census Tract

Descriptive Measure	VCM (ug/m3)
Mean	0.00241
Median	0.00002
Standard Deviation	0.01364
Standard Error	0.00031
Minimum	0.00000
Maximum	0.40396

Distribution of VCM
NJDEP Tracking Metric

10^7 cancer risk 0.011 ug/m^3

10^8 cancer risk 0.0011 ug/m^3
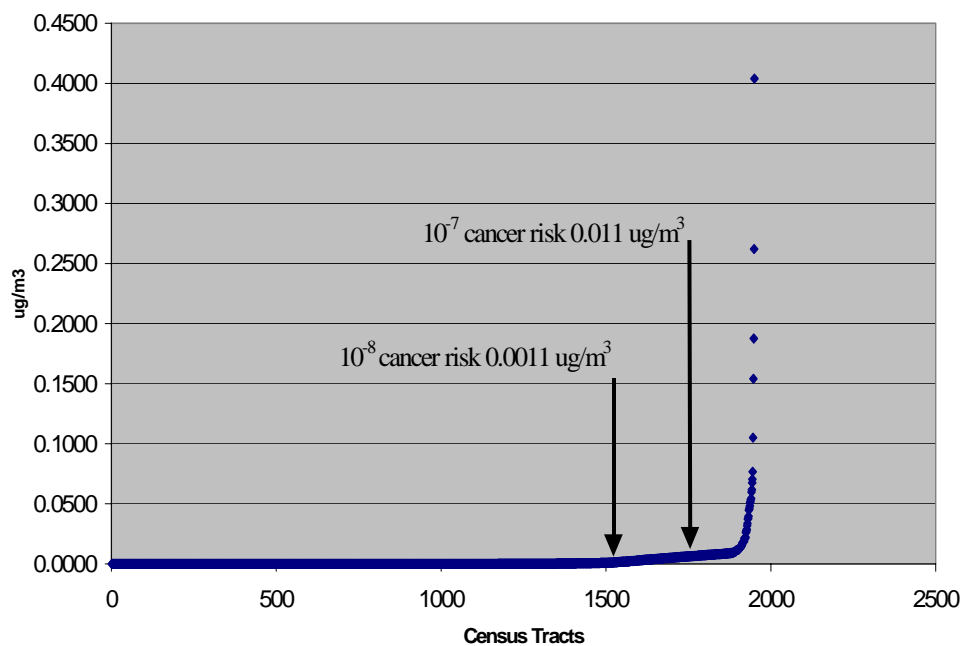
Legend

VCM ug/m3

- 0.000000 - 0.001100
- 0.001101 - 0.011000
- 0.011001 - 0.403965
- Counties

1:1,452,257
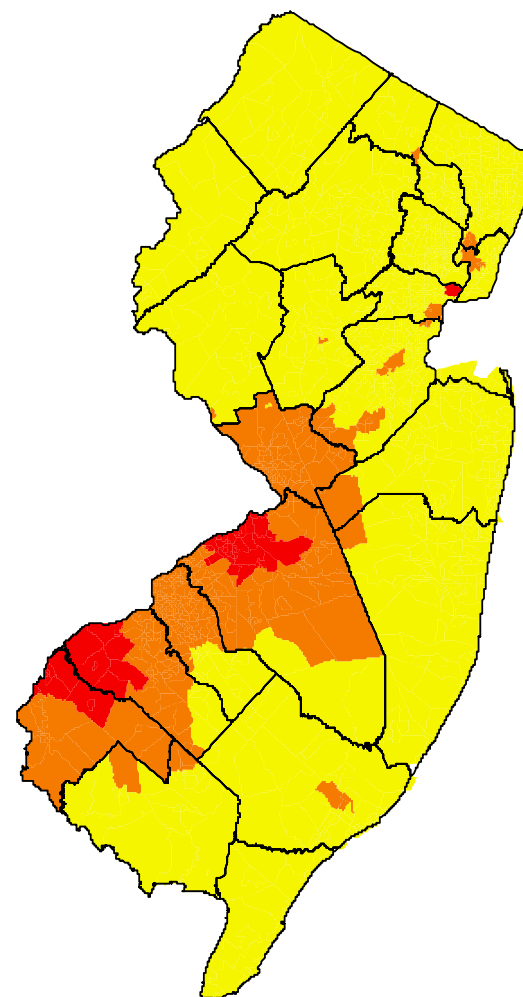
Figure 4: Benzene Air Concentrations NJDEP 1993 – 2004 Avg

Descriptive Measure	Benzene
Mean	0.01998
Median	0.01026
Standard Error	0.00131
Standard Deviation	0.05795
Sample Variance	0.00336
Minimum	0.00000
Maximum	2.26491

Legend

☐ Counties

census2000

Benzene ug/m3

🟨 0.000000 - 0.0130

🟧 0.013001 - 0.1300
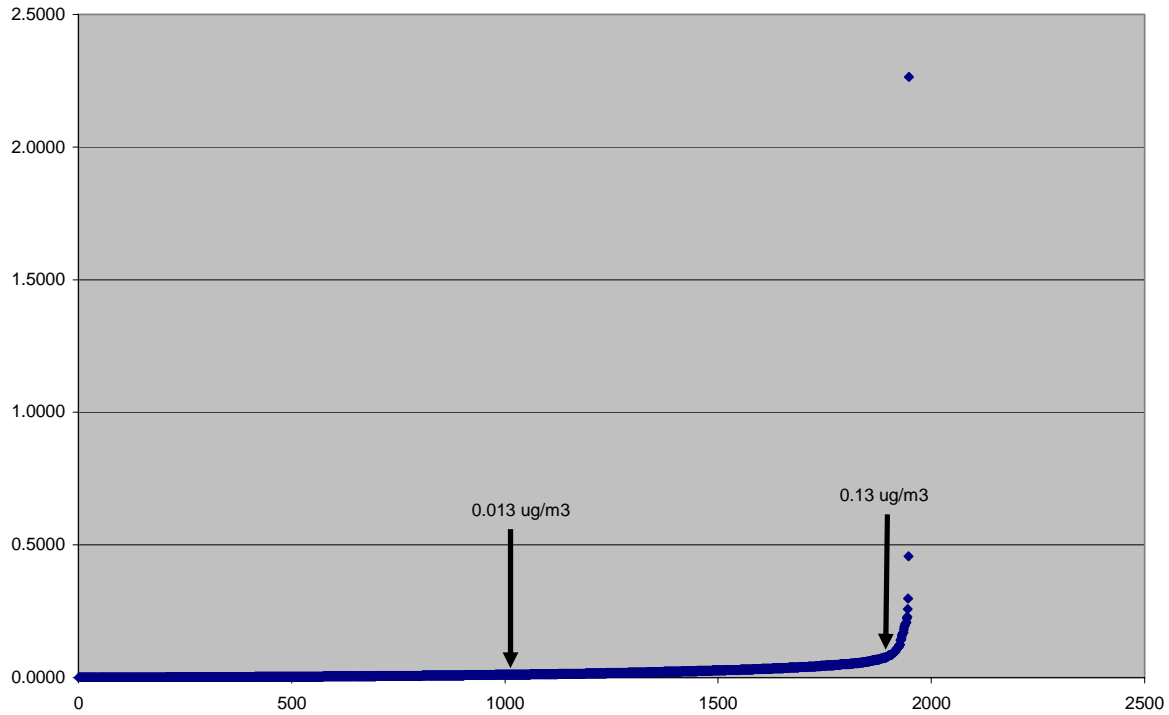
🟥 0.130001 - 2.2649
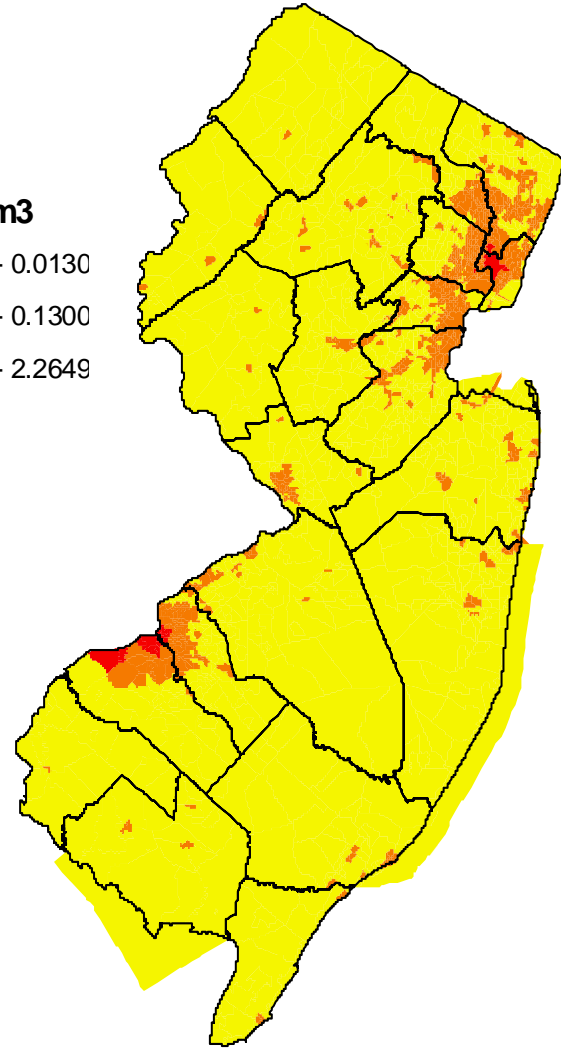
Benzene Census Tracts

0.013 ug/m3

0.13 ug/m3

Figure 5: Vehicle Miles Traveled (VMT) 2003

Descriptive Measure	VMT
Mean	30.777
Median	13.954
Standard Deviation	45.672
Sample Variance	2085.963
Minimum	0.000
Maximum	465.098

Legend

☐ Counties

Vehicle Miles Traveled

VMT/acre

▨ 0.000000 - 3.876003
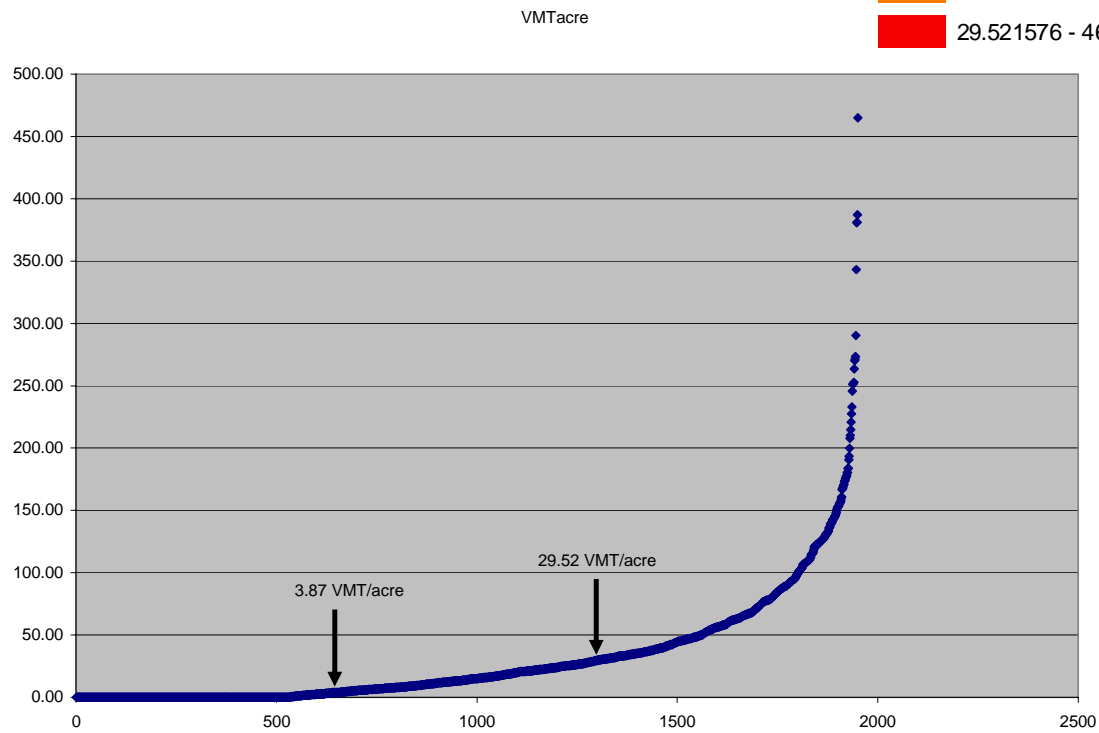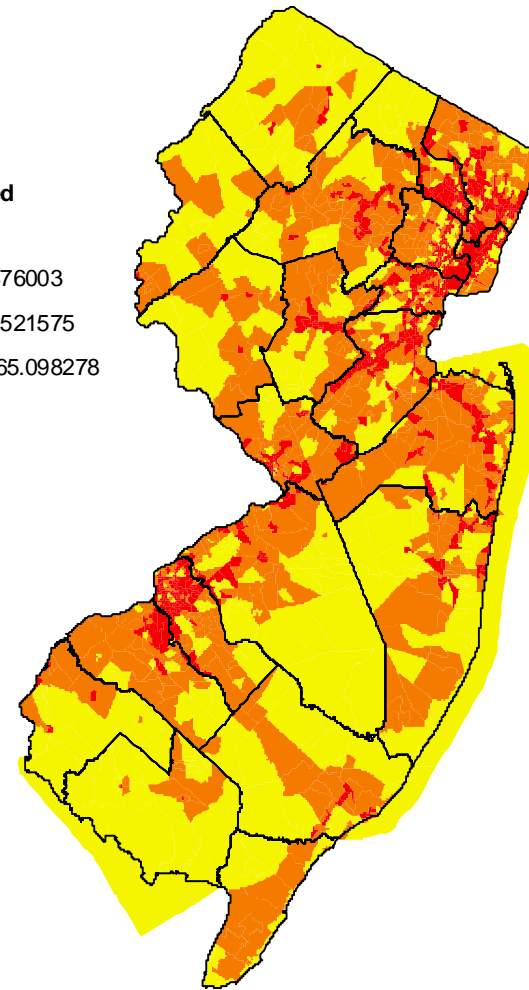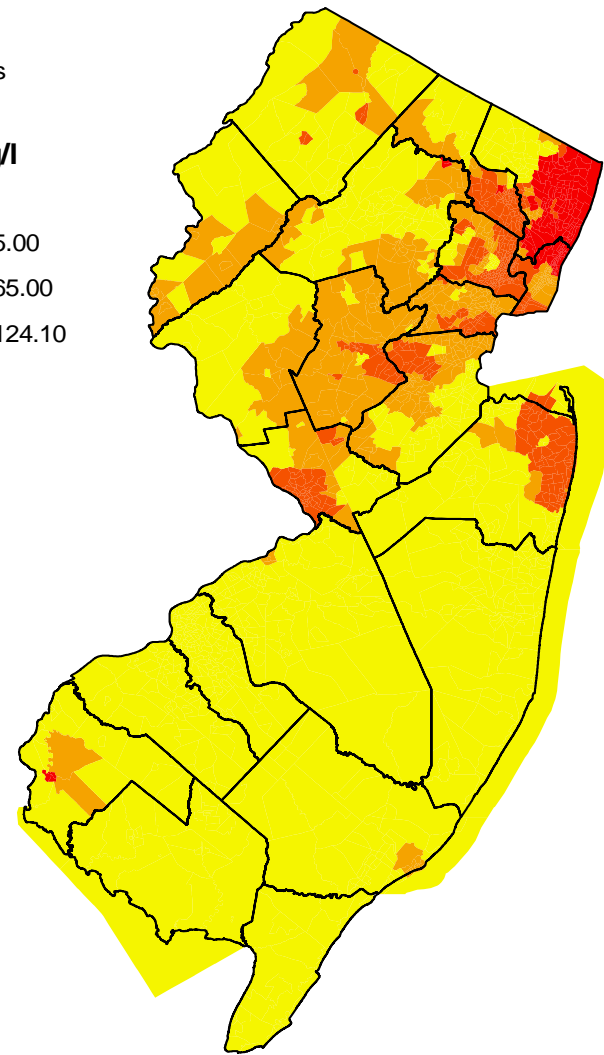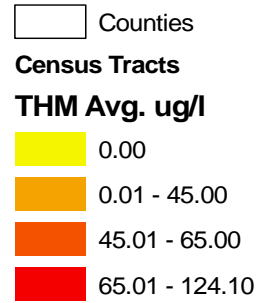
▨ 3.876004 - 29.521575

▨ 29.521576 - 465.098278

VMTacre

Figure 6: Total Trihalomethane (TTHM) Drinking Water NJDEP 1978 – 1985 Avg

Descriptive Measure	THM ug/l
Mean	25.28
Median	7.70
Standard Error	0.64
Standard Deviation	28.28
Minimum	0.00
Maximum	124.10

Legend

☐ Counties

Census Tracts

THM Avg. ug/l

- 0.00
- 0.01 - 45.00
- 45.01 - 65.00
- 65.01 - 124.10

Avg THM 1978 - 1985
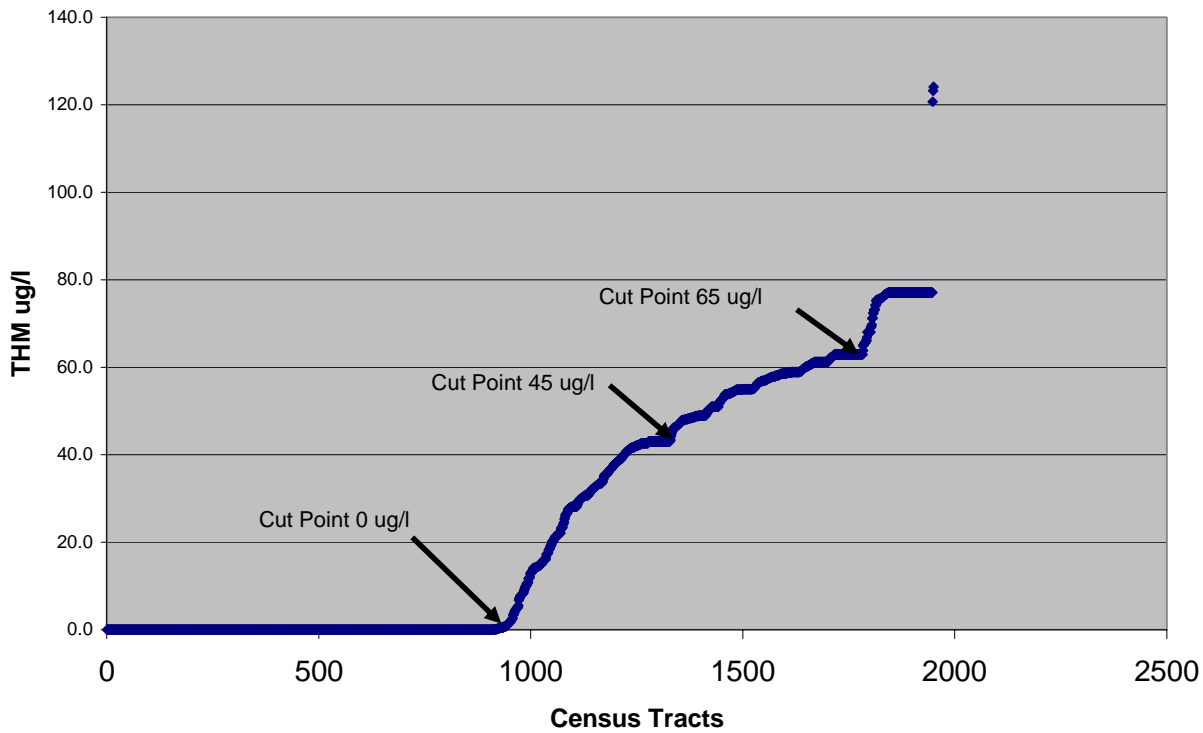
Childhood Blood Lead Exposure Metrics

The second pilot project implemented under the EPHT program links childhood blood lead measurements reported to the DHSS with environmental data from the DEP on potential lead exposure via lead in air and water. While exposure of pre-school children residing in poorly maintained older residences with peeling lead-based paint has long been established as the cause of the majority of lead poisoning in children, the role of other sources of lead – drinking water, diet, proximity to lead-emitting air pollution sources – has also been recognized (ATSDR, 1999). The relative contribution of such sources to lead body burden varies geographically depending on the mix of lead sources. This demonstration project allows DHSS and DEP to evaluate the geographic distribution of childhood blood lead in New Jersey children between 6 and 29 months; and subsequently to evaluate the relationships between childhood blood lead levels and environmental measurements of lead in air and drinking water in New Jersey.

The DEP developed two exposure metrics to be linked to childhood blood levels. The first addressed air exposure estimated by EPA's National Scale Air Toxics Assessment. The second was lead in community drinking water systems. The DHSS will be using these data to assign exposure at the individual level to conduct the linkage analysis. Methods used to develop each metric and a brief discussion of results are presented below.

National-scale Air Toxics Assessment

The USEPA's 1999 National-Scale Air Toxics Assessment (NATA) provides estimates of potential exposure to air-borne toxic chemicals for counties and census tracts throughout the country. The assessment is a state-of-the-science national-scale screening tool to help regulatory agencies and communities as they assess their air toxics priorities. The first assessment (for 1996) was peer reviewed by SAB in 2001. This assessment should not be used as the sole basis for developing risk reduction plans or regulations to control specific sources or pollutants. Additionally, this assessment should not be used for estimating risk at the local level, for quantifying benefits of reduced air toxic emissions, or for identifying localized hotspots. The national-scale assessment is designed to help USEPA, state, local and tribal governments, and the public better understand the air toxics problem in the U.S. The assessment includes four steps that focus on the year 1999:

1. Compiling a national emissions inventory of air toxics emissions from outdoor sources.

2. Estimating ambient concentrations of air toxics across the United States.

3. Estimating population exposures across the United States.

4. Characterizing potential public health risk due to inhalation of air toxics including both cancer and noncancer effects.

Estimates of annual average ambient air concentrations of about 177 of the 187 hazardous air pollutants (air toxics), plus diesel particulate matter, are predicted for each census tract based on census tract shapes used in the 2000 US Census. NATA estimates are derived from an annual emissions inventory of major and other point sources, estimates of area and mobile source contributions, and "background" concentrations. Emissions for major and some other point sources are from known X/Y locations. Emissions for most other sources, and on-road and non-road mobile sources, are estimated at a county level and apportioned to census tracts using different techniques. USEPA used the Assessment System for Population Exposure Nationwide (ASPEN) dispersion model to estimate ambient air concentrations from these emissions. The results are best used to determine geographic patterns across broad geographic areas. The assessment is not designed as a definitive means to pinpoint specific risk values within a census tract or to characterize or compare risks at local levels such as between neighborhoods. For analysis of air toxics in these smaller areas and to evaluate potential hot spots, USEPA, state, local and tribal agencies rely on other tools such as monitoring and local-scale assessments using more refined and localized data.

Methods

DEP obtained 1999 NATA data for lead from USEPA's website on March 8, 2006.[5] DEP examined the spatial variation in exposure through statistical analyses and mapping. First, general descriptive statistics (average, minimum, maximum, standard deviation, etc.) were summarized to characterize variability using the data analysis function in Microsoft Excel. Next, these data were linked to existing GIS shape files for New Jersey census tracts based on the 2000 census using the 11 digit census tract ID. DEP compared the NATA estimates to established health benchmarks and standards. Also, classification methods available in ArcGIS9.1 were used to evaluate spatial variability including equal intervals, natural breaks and quantiles.

Results and Discussion

Analysis of NATA lead estimates indicates that there are no large areas of high lead concentrations exceeding established standards or health benchmarks. No census tracts exceed the National Ambient Air Quality Standard (NAAQS) of 1.5 ug/m3 (Figure 7). Also, only one tract exceeds the reference concentration of 0.1 ug/m3 used by NJDEP. Since existing health benchmarks were not exceeded, cut points were established based on the distribution of the data.

The maximum lead concentration is estimated to be 0.135 ug/m3. Concentrations decrease rapidly before leveling off at approximately 0.015 ug/m3. This concentration

---

[5] http://www.epa.gov/ttn/atw/nata1999/tables.html for census tract level ASPEN modeled ambient air concentrations.

was selected to identify census tracts in the high exposure group. There are 99 census tracts in the high exposure group, with approximately 468,597 residents. Non-road mobile sources, which include airplanes, trains, construction vehicles and others not found on roads, are estimated to contribute the most to lead air exposure, accounting for approximately 56 % of the lead in the high exposure areas. Major stationary air sources, including chemical facilities, battery manufacturers and electric generating units are also significant sources, accounting for approximately 26 % of the lead in high exposure areas.

Drinking Water in Community Drinking Water Systems

The federal Lead and Copper Rule[6] specifies the requirements for lead in community drinking water systems, including lead levels in drinking water and monitoring requirements. The rule establishes an Action Level of 0.015 mg/l based on the 90th percentile value of all tap water samples taken. The number of samples taken is based on the size of the system and varies from 5 samples for systems serving less than 100 residents to 100 samples for large systems serving more than 100,000 residents. First draw samples must be collected at cold water taps in homes that are at highest risk of lead and copper contamination as specified in the federal Safe Drinking Water Regulations. Systems must monitor lead levels every 6 months, unless they qualify for reduced monitoring based on prior sampling results showing that concentrations are below the Action Level. Most New Jersey systems qualify for reduced monitoring.

Methods

Results of the lead monitoring are tracked in the Safe Drinking Water Information System (SDWIS). The DEP and DHSS extracted and analyzed data from SDWIS for the period 1997 to 2004 for all water systems classified as community water systems. This includes approximately 617 separate water service areas. The 90th percentile values were used to estimate potential exposure for each year during the period. For systems with more than one sampling event in a calendar year, the 90th percentile values were averaged together. If a system had no sampling data for a calendar year, data from the prior year was used to backfill the missing years. There were a total of 4,936 records (617 systems times 8 years of data) in the complete data set.

The DEP and DHSS have developed GIS shape files identifying the service areas for most, but not all, of the water purveyors in the state. We were able to link 534 purveyor areas to the lead SDWIS data. The final data set used for the linking analysis included 4,272 records (534 systems * 8 years). The Action Level of 0.015 mg/l was used to identify areas of potential high exposure.

Results and Discussion

Of the 4,272 total records, 397 met or exceeded the action level of 0.015 mg/l in 147 separate water systems. It is estimated that these systems serve approximately 1.5

---

[6] 56 FR 26460 – 26564 June 7, 1991, 40 CFR 141.80 – 141.90

million residents throughout New Jersey. The maximum concentration is 0.294 mg/l.
Concentrations decrease rapidly and level off near the action level of 0.015 mg/l.

Figures 7 and 8: Exposure Metrics Used in Childhood Lead Demonstration Project

Figure 7: Lead Air Exposure NATA 1999

Descriptive Measure	Lead (ug/m3)
Mean	0.00586
Median	0.00444
Standard Deviation	0.00641
Sample Variance	0.00004
Minimum	0.00008
Maximum	0.13511

Legend

Counties

census2000

Lead ug/m3

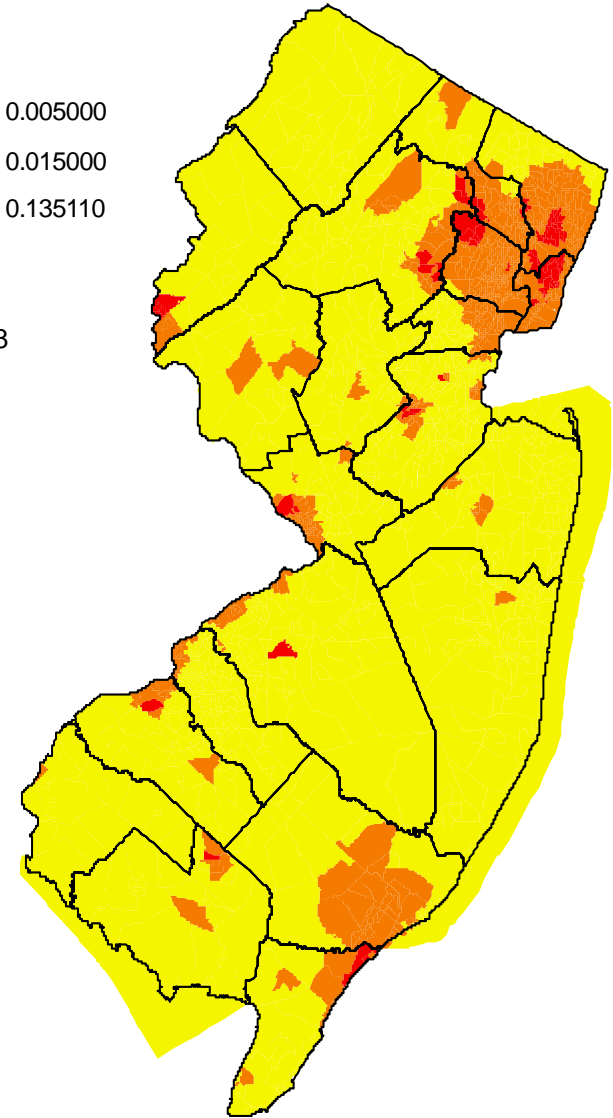0.000076 - 0.005000

0.005001 - 0.015000

0.015001 - 0.135110

1:1,460,188
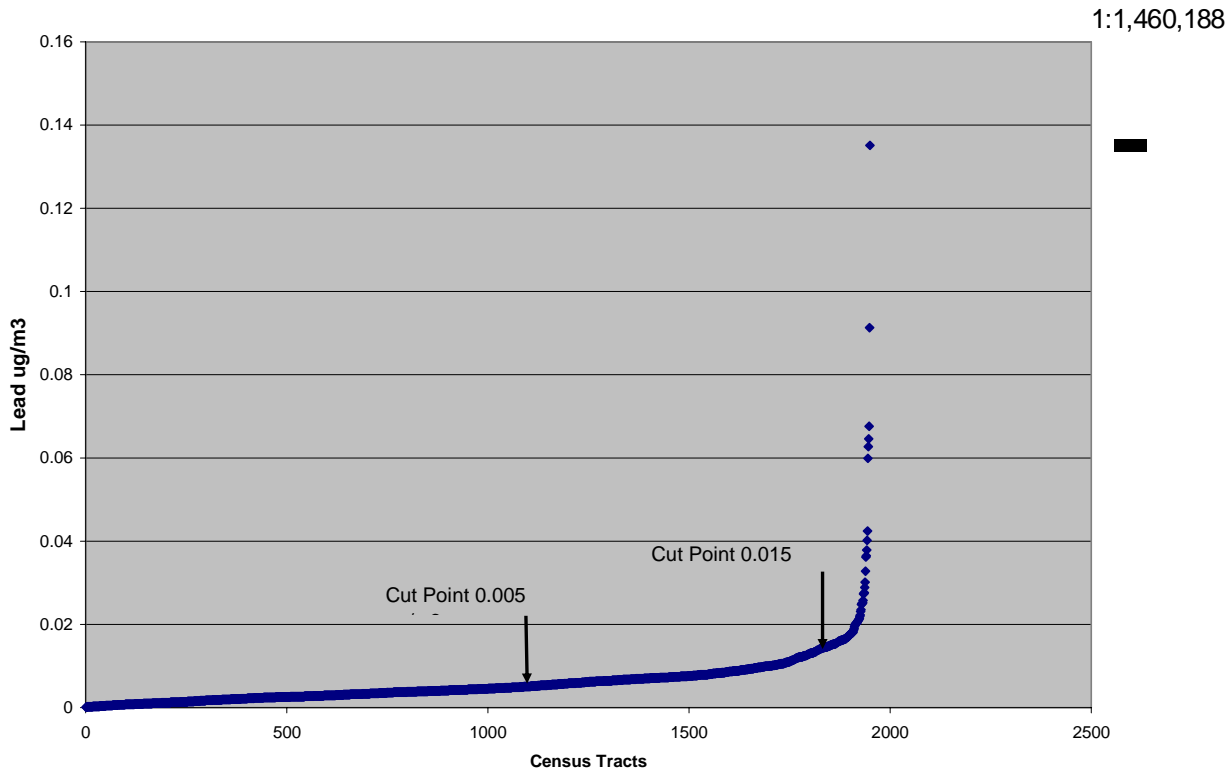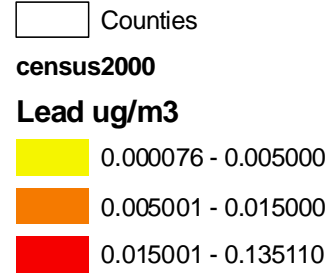
Figure 8: Lead in Community Drinking Water Systems (1997 – 2004)

Descriptive Measure	Lead 90th Percentile (ppm)
Mean	0.00769
Median	0.00400
Standard Deviation	0.01576
Sample Variance	0.00025
Minimum	0.00025
Maximum	0.29410

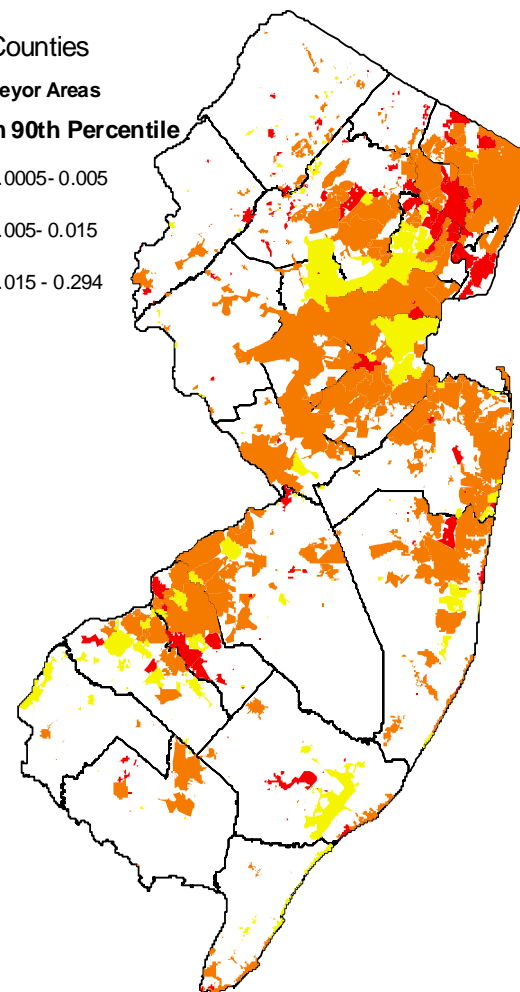**90th Percentile Lead**
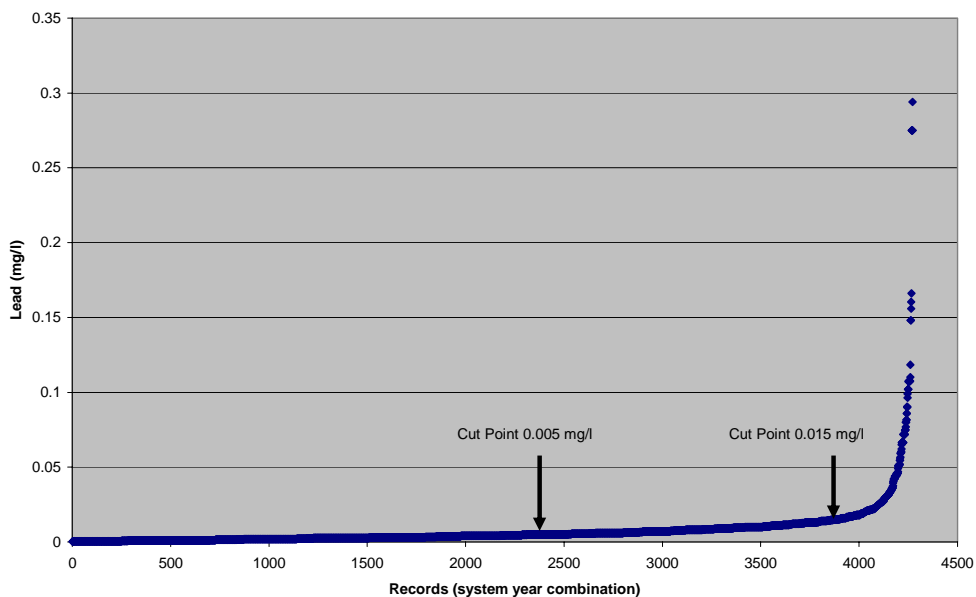
Legend

☐ Counties

Water Purveyor Areas

Maximum 90th Percentile

▨ 0.0005- 0.005

▨ 0.005- 0.015

▨ 0.015 - 0.294

Note: The DEP did not have access to the individual data to be able to display the lead drinking water results as they are used in the linkage study. Instead, the maximum annual values are presented for each water service area on the map above.

Birth Defects Exposure Metrics

The third pilot project that was to be implemented under the EPHT program links birth defects data from the NJDHSS Special Child Health (SCHS) Registry with data on environmental hazards and potential environmental exposures. However, due to time constraints, the linkage aspects of this pilot were not completed.

An interagency advisory group, the New Jersey EPHT Birth Defects Work Team, was formed to collaboratively provide scientific guidance concerning the design, implementation and analyses of the proposed demonstration project. The EPHT Birth Defects Work Team set the following criteria for selection of birth defects for epidemiologic analysis:

- Defect typically apparent at birth and diagnosis made at birth;
- Coding and diagnosis of defect well agreed upon, and not subject to differences between doctors or hospitals;
- Defect such that birth is not highly likely to occur in an out-of-state high risk hospital on the basis of prenatal diagnosis;
- Defect not likely to lead to high rates of elective termination of pregnancy.

These criteria were developed due to the potential for differential loss of cases by time and/or geography. Using these criteria, the EPHT Birth Defects Work Team selected hypospadias for case-control epidemiologic analysis and environmental linkage. Additional factors for focusing on hypospadias include: rate of this defect is believed to be higher in New Jersey than in many other states; causation is not well understood; and scientific literature has suggested that environmental factors may play a role in its etiology. Recent scientific literature has raised the issue of whether endocrine disruptors may have a causal relationship with some urogenital birth defects, such as hypospadias.

While the linkage aspects of this pilot were not completed, the DEP did develop a drinking water exposure metric that will be used in the future. This metric addresses potential drinking water exposures to trihalomethanes in community drinking water systems. In the future, the DHSS will use this metric to assign exposure at the individual level. Methods used to develop this metric and a brief discussion of results are presented below

Drinking Water

Some disinfectants and disinfection byproducts (DBPs) have been shown to cause cancer and reproductive effects in lab animals and suggested bladder cancer and reproductive effects in humans. In 1979 EPA set an interim MCL for total trihalomethanes (the sum of chloroform, bromodichloromethane, dibromochloromethane, and bromoform) of 100 ppb as an annual average. Water systems using surface water as source water in whole or in part and serving more than 10,000 residents, as well as community water systems using only ground water sources and serving a population greater than 10,000 were

required to take 4 samples per quarter per treatment plant to determine compliance with the MCL of 100 ppb. At least 25% of the samples were to be at locations within the distribution system reflecting the maximum residence time of the water in the system. The remaining 75 percent of the samples were to be taken at representative locations in the distribution system, taking into account the number of persons served, the difference sources of water and different treatment methods employed. The results of all analyses per quarter were to be arithmetically averaged and reported to the State each quarter. A community water system using only ground water sources could reduce the number of samples collected to one sample for maximum TTHM potential per year for each treatment plant. Community water systems using only ground water sources and serving a population equal to or less than 10,000 people were not required to sample during the time period of the study.

New requirements for controlling potential impacts from disinfectants and disinfectant byproducts were specified in the Stage 1 Disinfectants and Disinfection Byproducts Rule.[7] These rules establish a Maximum Contaminant Level (MCL) of 0.080 mg/l for total triholomethanes to be met by surface water systems and ground water systems under the direct influence of surface water serving greater than or equal to 10,000 people by January 2002. Surface water systems and ground water systems under the direct influence of surface water serving a population less than 10,000, and all ground water systems were required to comply with the Stage 1 Disinfectants and Disinfection Byproducts Rule by January 2004.

Methods

The THM data are tracked in the Safe Drinking Water Information System (SDWIS). NJDEP and DHSS compiled data for the period 1997 to 2002 for all water systems that use surface water as source water. This includes 201 different systems. The quarterly THM data was averaged to estimate exposure for each system. Any quarters that had no data were filled with data from the prior quarter, if available, or the next quarter if needed. The quarterly average data from SDWIS was then linked to GIS shape files estimating the extent of each water system area. We were able to match all 201 water systems. The final matched data set had a total of 4,824 records (201 systems with 24 quarters of data each).

Results and Discussion

The maximum THM concentration reported is 166 ug/l. Concentrations decrease rapidly with only 174 records out of 4,824 exceeding the MCL of 80 ug/l. This level was used to identify high exposure areas. There are 45 separate water systems in the high exposure area serving approximately 2.9 million people.

---

[7] 63 FR 69390 – 69476 December 16, 1998 Vol. 63 No. 241

Figure 9: Exposure Metric for Use in Birth Defects Demonstration Project

Figure 9: Total Trihalomethanes 1997 – 2002 Quarterly Avg, (ug/l)

Descriptive Measure	THM (ug/l)
Mean	20.169
Median	6.675
Standard Deviation	26.205
Sample Variance	686.703
Minimum	0.000
Maximum	166.715

Legend

☐ Counties

THM ug/l

MAXIMUM 1997 - 2002

🟨 0.00 - 40.00

🟧 40.01 - 80.00

🟥 80.01 - 166.72
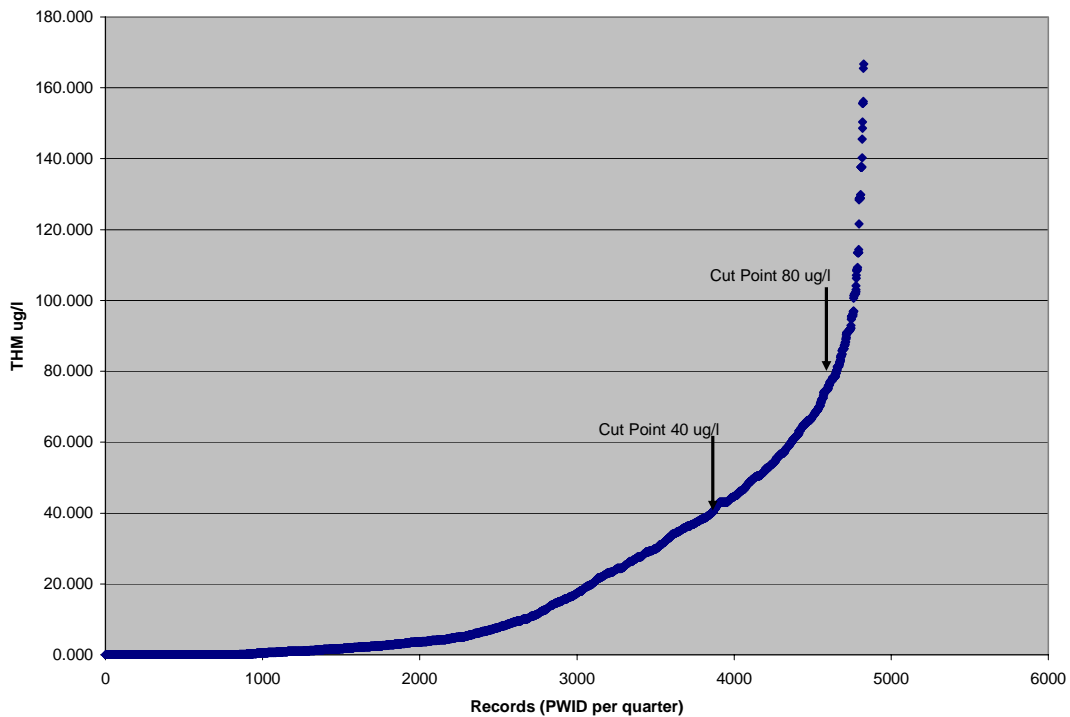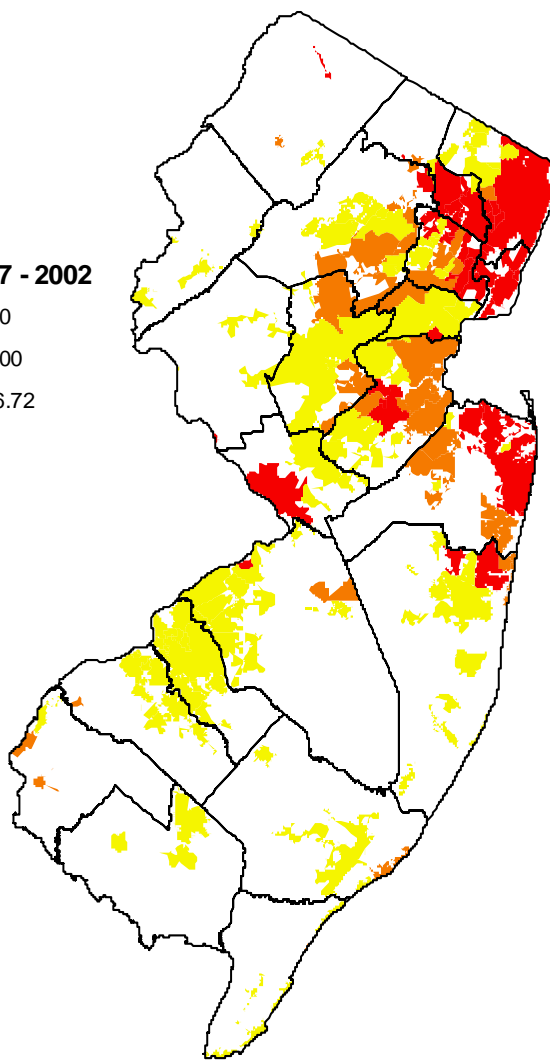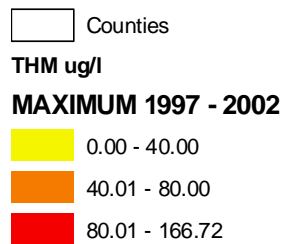
Appendix A: Description of Data Sources Used for MMRR

Master File:

The Master File is a central shared database containing DEP's master copy of descriptive data about Sites, properties and other locations of interest to one or more program areas, and the key organizations and individuals related to these sites (e.g. property owners, responsible entities, and contacts). Each Site has a unique "Site ID" with X,Y coordinates for spatial analysis. Each DEP program uses the common Site ID allowing data to be linked and shared across the entire DEP.

Air Permit Information

The DEP issues permits restricting air emissions from stationary sources of air pollution. Most of these permits are processed electronically using the Remote Air Information Management System (AIMS) Data Input User System (RADIUS). These submissions are loaded into the New Jersey Environmental Management System (NJEMS). The DEP uses NJEMS to process inputs from all stationary air-regulated industries in the state. Emissions limits for criteria air pollutants and hazardous air pollutants are specified in several different ways depending on facility operations. Limits can be specified for specific pieces of equipment, emission points, operating scenarios, emission units, and for the facility as whole. Also, limits are specified using different units including concentrations (ppm, ug/m3) and mass loading (lb/hr, Tons/yr. Air permit data specifies allowable emissions, not what is actually released into the environment. It is common for the allowable emissions to be more than double the actual emissions for specific pollutants at a facility.

Community Right-to-Know Inventory:

Businesses covered by Subchapter 3 of the Community Right-to-Know Regulations (CRTK) are required to report hazardous substance inventories by March 1 of each year. Inventory data are tracked using the Facility Inventory and Chemical Tracking System (FACITS). Daily inventories are reported in 10 different ranges. In 2003, approximately 23,000 facilities reported inventory data. This database provides the broadest coverage of hazardous substances for the state. However, data are for storage quantities only and are not a direct quantity of releases to the environment or exposure to residents.

Inventory Ranges

Range Code	Minimum Pounds	Maximum Pounds	Midpoint Pounds
20	>10,000,000		10,000,000
19	1,000,001	10,000,000	5,500,001
18	500,001	1,000,000	750,001
17	250,001	500,000	375,001
16	100,001	250,000	175,001
15	50,001	100,000	75,001
14	10,001	50,000	30,001
13	1,001	10,000	5,501
12	101	1,000	551
11	11	100	56
10	1	11	6
9	0	1	1

Release and Pollution Prevention Report:

Facilities covered under Subchapter 3 of the CRTK rules are required to report "materials accounting" for covered chemicals on a form know as the Release and Pollution Prevention Report (RPPR). Materials accounting data are also tracked using FACITS. Materials accounting is a practical application of the chemical mass balance theory providing a complete picture on the use of hazardous substances at many of New Jersey's larger manufacturing facilities. From chemicals transported through communities to an industrial facility, to the manufacture of intermediate and final products at the site, to chemicals shipped off-site as products or wastes, and chemicals released into the environment, materials accounting data identifies the quantity of toxic chemicals involved each step of the way. Figure 1 below outlines the basic structure for materials accounting data showing the flow of hazardous substances as they move through a facility. Quantities released to the environment, while not a direct measure of exposure, are the most useful for estimating exposure.

Figure 1. Overview of Materials Accounting Data
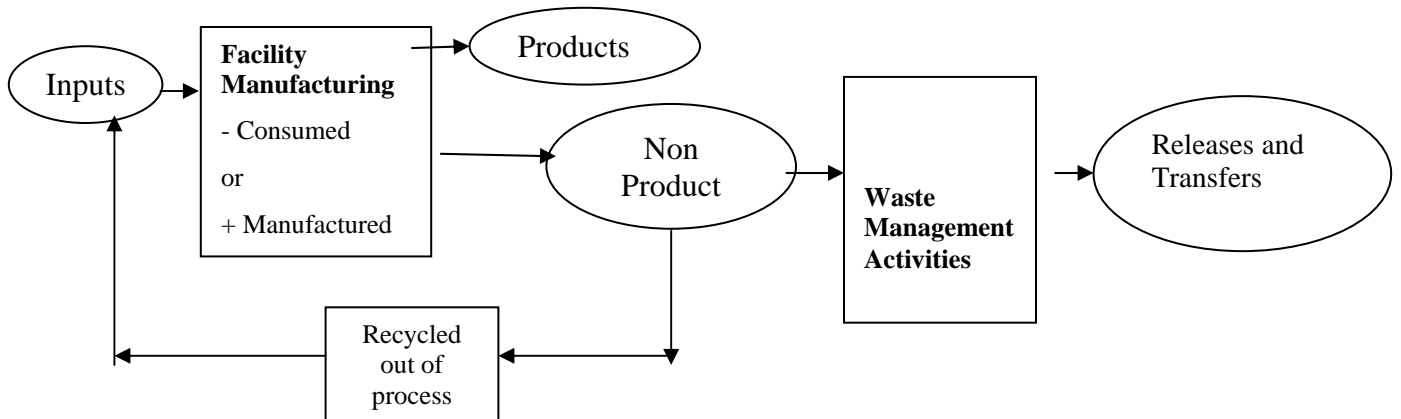
Appendix B: Example of Weighted Average NATA Conversion

2000 FIPS	1990 FIPS	Land Area	% land area	NATA ug/m3	conc* % land area
34001001200	14	42	0.03268	0.00567	0.00019
34001001200	12	1088	0.84669	0.00788	0.00667
34001001200	11	155	0.12062	0.00591	0.00071
TOTAL		1285			0.00757