Published in final edited form as:
Med Ref Serv Q. 2006 ; 25(3): 13–31. doi:10.1300/J115v25n03_02.

TOXMAP: A GIS-Based Gateway to Environmental Health Resources

Colette Hochstein, DMD, MLS and
Technical Information Specialist, Division of Specialized Information Services (SIS), National Library of Medicine (NLM), 6707 Democracy Blvd., Bethesda, MD 20892

Marti Szczur, MS
Deputy Associate Director, Division of Specialized Information Services (SIS), both at the National Library of Medicine (NLM), 6707 Democracy Blvd., Bethesda, MD 20892

Abstract

The National Library of Medicine (NLM) has an extensive collection of environmental health information, including bibliographic and technical data on hazardous chemical substances, in its TOXNET <http://toxnet.nlm.nih.gov> databases. TOXNET also provides access to the United States Environment Protection Agency (EPA)'s Toxics Release Inventory (TRI) data, which covers release of specific chemicals via air, water, and land, and by underground injection, as reported by industrial facilities around the United States. NLM has developed a Web-based geographic information system (GIS), TOXMAP <http://toxmap.nlm.nih.gov/>, which allows users to create dynamic maps that show where TRI chemicals are released and that provides direct links to information about the chemicals in TOXNET. By extracting the associated regional geographic text terms from the displayed map (e.g., rivers, towns, county, state), TOXMAP also provides customized chemical and/or region-specific searches of NLM's bibliographic biomedical resources. This paper focuses on TOXMAP's features, data accuracy issues, challenges, user feedback techniques, and future directions.

Keywords

TOXMAP; hazardous substances; health; environment; environmental health; GIS; geographic information systems; maps; public health; toxicology; Toxics Release Inventory; TRI; CERCLIS; chemical maps; chemical releases; chemicals; environmental maps; hazardous chemicals; NPL; toxic releases; toxic environmental substances; Superfund; toxins

INTRODUCTION

The National Library of Medicine (NLM) is part of the National Institutes of Health (NIH), within the Department of Health & Human Services (HHS). (For a complete list of Federal Government acronyms used in this document with their expansions, see Table 1). At the NLM, the Division of Specialized Information Services (SIS) is responsible for a collection of databases and related information on environmental health and toxicology. Some of these

FOR MORE INFORMATION
More information about TOXMAP can be found at: <http://www.nlm.nih.gov/pubs/factsheets/toxmap.html>. Questions about TOXMAP can be sent to Dr. Colette Hochstein (colette@nlm.nih.gov) and Ms. Marti Szczur (szczurm@mail.nlm.nih.gov) or to tehip@teh.nlm.nih.gov.

resources are created in SIS; others originate from a variety of national and international agencies and associations.

A federal law called the Emergency Planning and Community Right to Know Act (EPCRA) [1] requires certain U.S. facilities to report annually on their releases of specified chemicals. This rule pertains to industries with ten or more full-time employees that manufacture, process, or use more than 25,000 pounds total, or greater than 10,000 pounds of any one specified Toxics Release Inventory (TRI) chemical <http://www.epa.gov/tri/chemical/index.htm>. The reports contain information about the types and amounts of these chemicals that are released each year into the air, water, land, and by underground injection, as well as about transfers to waste sites and waste treatment methods and efficiency.

Prior to the existence of the Internet, as a part of the Toxicology and Environmental Health Information Program (TEHIP),[2] NLM collaborated with the United States Environmental Protection Agency (EPA)[3] to make TRI accessible to online subscribers. With the advent of the Internet, the EPA began publishing its own TRI data directly to the Web. The EPA now offers comprehensive information about the TRI program on its Web site[4]; a 2003 EPA report discusses the various ways in which the TRI data are being used by citizens, government, business, and academia.[5] As a service to NLM users, the TEHIP has also continued to provide the TRI data (1987 to the most current year available) to its community through a multi-database Web application, TOXNET.[6]

BACKGROUND

NLM's TOXNET contains an extensive collection of bibliographic and research information in the areas of toxicology and environmental health, as well as data excerpted from the literature on hazardous chemical substances. TRI is the only TOXNET database that contains discrete geospatial data fields (e.g., latitude/longitude, street address, city/state, ZIP code) in each record. In TRI, searches on location parameters (e.g., city, state, ZIP) return a summary list of all matching facilities, with information about, or a record of, each of the chemical substances for which the facility has submitted a report.

With a strategic goal to facilitate and encourage use of high-quality information,[7] NLM has an interest in exploring new ways to foster better understanding of its resources and databases. It also seeks to make its information more compelling and understandable to a broad audience through integration of data from reputable health data sources and via new visual data presentation techniques.

Geographic Information Systems (GIS) use visualization by electronically capturing, storing, analyzing, and displaying geographically referenced information (data identified according to location). For NLM, the discrete geospatial data fields of TRI made it a candidate for applying GIS technology and for using maps of the United States to show the amount and location of TRI chemicals released into the environment. The application, called TOXMAP <http://toxmap.nlm.nih.gov>, would provide a map-based gateway to relevant bibliographic references and to other data resources about the TRI chemicals.

TOXMAP OVERVIEW

To avoid duplicating an existing GIS application's functionality, NLM staff first reviewed the significant features and capabilities of current Web-based environmental health GIS applications. These included resources such as the EPA's TRI Explorer <http://www.epa.gov/triexplorer/>, Window to My Environment <http://www.epa.gov/enviro/wme/background.html>, and EnviroMapper <http://maps.epa.gov/enviromapper/>; the United States Geological Survey's National Atlas

<http://www.nationalatlas.gov/>; the CDC/ATSDR (Centers for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry)'s GATHER <http://gis.cdc.gov/>; the Pew Charitable Trust's Health-Track <http://healthyamericans.org/>; the NIH's National Cancer Institute (NCI)'s Atlas of Cancer Mortality <http://www.nci.nih.gov/atlasplus/>; and the Environmental Defense's Scorecard <http://www.scorecard.org/>.

NLM found that while the sites reviewed did map toxicology and environmental health data, they did not provide information about related research/studies or link to related health information about the particular chemicals. NLM determined that TOXMAP could provide unique value by showing geographic distribution of releases by chemical and by linking to chemical information in TOXNET's Hazardous Substances Databank (HSDB)[8] and other authoritative resources. This new resource would also use chemical and geographic terms from the displayed map to search bibliographic databases, integrate geographically coded data from other sources, and be easy to navigate and understand.

TOXMAP ARCHITECTURE

In implementing TOXMAP, NLM decided to maximize use of free, open-source tools. In addition to being written in Java, TOXMAP uses software from the Apache Software Foundation,[9] including Apache HTTP Server, Tomcat, Struts, JMeter, and Ant. It also uses the open-source relational database application MySQL,[10] which has provided cost savings as well as scalability and speed. A nationwide base map was developed from data available from the U.S. Geological Survey (USGS)'s National Atlas.[11]

Because NLM was unable to find an open-source GIS that met the minimum required capabilities, TOXMAP uses ESRI's ArcIMS,[12] a popular proprietary GIS software package that supports the needed functionality and also allows customization. ESRI's Place Finder Web service[13] is used to allow searching for cities, ZIP codes, counties, and other places in the United States.

CREATING MAPS

TOXMAP allows users to create nationwide or local area maps that show locations of TRI facilities and chemical releases and provides region-specific links to chemical and bibliographic information. The following scenarios illustrate some of the application's capabilities.

Scenario 1: Releases

A public health professional is interested in dioxane because of its known adverse health effects and wants to investigate where it has been released in the United States. After entering "dioxane" in TOXMAP's "Quick Search" box, a map is generated showing all the reporting facilities releasing dioxane in the United States (see Figure 1). She zooms in on an area showing a large amount of dioxane release (sites are color-coded by release amount). She selects a facility that reported releasing a large amount of dioxane to find more detailed information such as the yearly release amount to each environmental medium (e.g., air, water, land, underground injection), details about each release, and information about all chemicals reported by the facility (see Figure 2).

Scenario 2: Trends

A researcher is aware that the Houston, Texas area is known to contain high concentrations of benzene. Since benzene is a confirmed human carcinogen, he wants to learn more. He uses TOXMAP to generate a map of the area that shows the most recent data on the released amounts

of benzene, as reported in TRI. After studying the map, he chooses to see how the amount of released benzene has changed over time via a new map showing benzene release trends (see Figure 3). Finally, he investigates published research studies relating to benzene in Houston by selecting TOXMAP's "Chemical & Map Area" feature, which automatically searches the TOXNET database TOXLINE,[14] an extensive array of references to literature on biochemical, pharmacological, physiological, and toxicological effects of drugs and other chemicals (see Figure 4).

Scenario 3: Facility Location

A family is moving to Los Angeles, California, and wants to learn more about environmental health issues there. They create a map of all TRI facilities in the area by entering "Los Angeles" in TOXMAP's "Quick Search" box (see Figure 5). When they "identify" the facilities listed on this map, they are presented with information about the chemicals released by each facility (see Figure 6). For a consumer-oriented information resource, they can click to learn more about the released chemicals in the Agency for Toxic Substances and Disease Registry's (ATSDR) ToxFAQs[15] (see Figure 7); for more technical information about potential health effects of the chemicals, they can select the link to NLM's Hazardous Substances Data Bank (HSDB) (see Figure 8).

Superfund Sites

One of TOXMAP's newest features is inclusion of Superfund sites.[16] Superfund sites are those throughout the United States and its territories which contain substances that are either designated as hazardous under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA),[17] or identified as such under other laws. (CERCLA was amended by the Superfund Amendments and Reauthorization Act (SARA)[18] in 1986.) CERCLA designates more than 800 substances as hazardous,[19] and many more as potentially hazardous to human health or to the environment when improperly treated, stored, transported, disposed of, or otherwise managed. Sites where releases or potential releases have been reported are listed in a searchable EPA database called the Comprehensive Environmental Response Compensation and Liability Information System (CERCLIS).[20]

The National Priorities List (NPL)[21] contains the most serious uncontrolled or abandoned hazardous waste sites throughout the United States and its territories. The NPL primarily serves as an information and management tool to guide the federal government in the site cleanup process.

The EPA's Window to My Environment[22] and EnviroMapper[23] both display Superfund sites along with other locations that report to the EPA. The USGS National Atlas can also map Superfund sites.[24] TOXMAP provides users with links to research studies and other related health information about the Superfund contaminants.

Scenario 4: Superfund

An environmental health professional wants to learn more about TRI and Superfund sites in the state of Virginia. She selects the "Superfund" dataset in the TOXMAP "Quick Search" box, and chooses "VA" from the state menu. A map of Superfund sites is created (see Figure 9); she then "identifies" the facilities listed on the map. Each site record provides an alphabetical list of contaminants with links to health information about each from the National Library of Medicine. The site record (see Figure 10) also provides the Hazard Ranking System (HRS) score, as well as links to the associated EPA Superfund Site Progress Profile (information on EPA's cleanup progress at the site), the EPA and the CDC/ATSDR contaminants lists, and associated CDC/ATSDR informational documents.

Bar Charts

TOXMAP also includes bar charts (see Figure 11). Users selecting the "Facilities" tab can see a bar chart for each facility, showing up to five of the top reported chemical emissions. TOXMAP's "Releases" tab provides bar charts showing the distribution medium (land, air, water, underground injection) for the emissions of the selected chemical by each facility. The "Trends" tab presents bar charts of emissions estimates for the most recent 15 years for the selected chemical, as reported annually to EPA.

Customized Maps

TOXMAP can be used to generate specific custom-made maps from other Web sites via a simple Web link.[25] Linking to TOXMAP works by adding a single HTML tag that instructs a Web page to go to the TOXMAP Web site. Information about the requested custom map (for example, a map of TRI facilities in the Texas panhandle) is passed to TOXMAP through a URL that includes specific information about the type of map desired.

ISSUES AND CHALLENGES

Maps are a powerful way of visualizing data. However, a key concern when presenting data in a geospatial view is the potential for misinterpretation. For example, a casual viewer of this map (see Figure 12) might infer that an area with a high release of a chemical always indicates a heightened threat to human health or the environment. However, many other factors must be considered in risk assessment, for example, the level of a chemical's toxicity and how quickly it dissipates into the environment. In other words, a small release of one chemical may be a more serious threat than a large release of another.

This concern about interpretation is aggravated by the fact that a GIS can enable an application to integrate and overlay dissimilar data sets. For example, if cancer mortality data is overlaid with TRI site facility locations, the results might show an interesting disease/chemical correlation, which would be useful for a scientist to consider in his or her cancer research. The concern comes from the possibility that a casual user may infer from the same map that a certain cancer was being ***caused*** by a chemical released from a specific TRI facility.

In his book, *Visual Explanations*,[26] Edward Tufte discusses the importance of an information design that represents the integrity of the content displayed. Tufte suggests that system designers ask themselves these questions: Are the data revealing the truth? Is the representation accurate? Are the data carefully documented? Do the methods of display avoid spurious readings of the data? Are appropriate comparisons and context shown? As decisions are made about what data to include in TOXMAP and what display design/techniques to use, Tufte's questions will serve as useful guidelines.

TOXMAP FAQ

Because some users may not be experienced in reading maps or understanding map data, and to offset potential misinterpretation, TOXMAP provides a Frequently Asked Questions (FAQ) section.[27] The FAQ provides questions and answers to supplement the user's ability to understand the map displays and data. The FAQ includes questions from "What is GIS?" and "What is TOXMAP?" to "How accurate is TRI Data?" and "What are some tips for reading maps critically?"

USER FEEDBACK

Although geographical information systems offer many benefits, they can be a challenge to navigate. As Web designers have long known, involving users in the process of a resource's

development is crucial to maximizing its usefulness. Catherine Burroughs notes in *Measuring the Difference: Guide to Planning and Evaluating Health Information Outreach*, "Direct user feedback is preferred when trying to establish a basic understanding about problems, satisfaction, and unmet information access needs …."[28]

To enhance TOXMAP's usability and keep its presentation readable and understandable, TEHIP has performed a variety of usability studies, including conducting intermittent, informal usability tests on various versions of TOXMAP, requesting feedback from specific users (such as health professionals), and reviewing feedback from user e-mails. In addition, the National Library of Medicine conducted two professionally moderated Web-based focus groups on TOXMAP in April 2005, which provided detailed usability comments.

Focus Groups

In general, a focus group consists of specially selected individuals brought together to discuss and share opinions about a specific issue. Its primary goal is to "gather data on the opinions, knowledge, perceptions, and concerns of small groups of individuals …."[29] "The power of focus groups lies in the fact that they are nondirective. Information can surface that otherwise might not emerge in a structured interview."[30]

The two TOXMAP focus groups consisted of professionals and concerned citizens (9 to 12 individuals per group), with a balance of adult men and women. The participants were employed in the environmental, occupational, industrial, and public health and information fields, and reported being active in community or national efforts related to environmental health. Prior to the 60-minute discussions, each spent 20 to 30 minutes completing a Web-based "tour" of TOXMAP's current and potential future features, along with several simple exercises. Both the tour and the exercises were developed specifically for these sessions.

A Web-based interaction system[31] was used to conduct the discussions in an effort to maximize time efficiency and cost effectiveness for participants (no travel time/cost), to provide a comfortable approach for users familiar with the Web environment, and to build rapport and the potential for developing future working relationships. This approach also enabled the participants to observe particular parts of the Web site as a group (displayed and controlled by a moderator), and allowed for simultaneous discussion and comments. The proceedings became a written transcript from which further analysis was conducted.

Feedback on TOXMAP was generally positive across both groups. Some of the "best-liked" characteristics of TOXMAP included its "drill-down" to detailed information, quick links to relevant information, and its ease of navigation and searchability. TOXMAP's chemical search feature received the highest rating. Respondents found TOXMAP to be appropriately designed for anyone in the health profession, including researchers, academics, students, and activists.

Some of the weaknesses of the site noted by participants included the "small" maps, which were sometimes difficult to read; somewhat "cluttered" screens; lack of a glossary of acronyms and terms; and inability for the user to limit the trend data to a specific time frame.

Participants provided opinions on possible improvements to the TOXMAP interface and functionality, and regarding addition of specific types of new data to overlay with the existing TRI data, such as health statistics, additional census data, school locations, and environmental data (e.g., superfund sites, water quality, pesticide usage, and floodplains).

Future Directions

Based largely on user feedback, NLM recently added Superfund sites and contaminants to TOXMAP and is also planning other features such as more data sets (additional

epidemiological data related to cancer, heart disease, and asthma); the ability to display multiple chemicals on a single map; updated and expanded U.S. Census demographics; and the ability to select whether to display one or a combination of types of releases (air, water, land, and/or underground injection).

CONCLUSION

TOXMAP provides users with a new way to explore and understand a number of toxicology and environmental health resources. Its distinct approach has been especially useful for developing a resource that engages a technology (GIS) and a subject (hazardous chemicals) that may not be familiar to many users. Professionally moderated, Web-based focus groups have provided cost-effective, detailed feedback from a broad spectrum of NLM users. Analyzing this feedback has and will continue to directly impact the future direction of TOXMAP.

REFERENCES

1. Emergency Planning & Community Right to Know Act. [Accessed: December 13, 2005]. Available: <http://www.epa.gov/region5/defs/html/epcra.htm>
2. National Library of Medicine's Toxicology and Environmental Health Information Program/TEHIP. [Accessed: December 13, 2005]. Available: <http://sis.nlm.nih.gov/enviro.html>
3. United States Environmental Protection Agency/EPA. [Accessed: December 13, 2005]. Available: <http://www.epa.gov>
4. United States Environmental Protection Agency/EPA's Toxics Release Inventory (TRI) Program. [Accessed: December 13, 2005]. Available: <http://www.epa.gov/tri/>
5. EPA-260-R-002-004: "How are the Toxics Release Inventory Data Used?– Government, Business, Academic and Citizen Uses". 2003 May [Accessed: December 13, 2005]. Available: <http://www.epa.gov/tri/guide_docs/2003_datausepaper.pdf>
6. National Library of Medicine's TOXNET. [Accessed: December 13, 2005]. Available: <http://toxnet.nlm.nih.gov/>
7. National Library of Medicine (U.S.) Board of Regents, 2000, Long Range Plan 2000–2005, NLM 100963683. [Accessed: December 13, 2005]. Available: < http://www.nlm.nih.gov/pubs/plan/lrp00/lrp00.html>
8. National Library of Medicine's Hazardous Substances Databank (HSDB). [Accessed: December 13, 2005]. Available: <http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB>
9. Apache Software Foundation. [Accessed: December 13, 2005]. Available: <http://www.apache.org/>
10. MySQL. [Accessed: December 13, 2005]. Available: <http://www.mysql.com/>
11. United States Geological Survey's National Atlas of the United States of America®. [Accessed: December 13, 2005]. Available: <http://www.nationalatlas.gov/>
12. ESRI ArcIMS. [Accessed: December 13, 2005]. Available: <http://www.esri.com/software/arcgis/arcims/index.html>
13. ESRI Place Finder Web Service overview. [Accessed: December 13, 2005]. Available: <http://arcweb.esri.com/arcwebonline/services/pf_overview.htm>
14. National Library of Medicine's TOXLINE. [Accessed: December 13, 2005]. Available: <http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?TOXLINE>
15. Agency for Toxic Substances and Disease Registry (ATSDR)'s ToxFAQs™: Frequently Asked Questions About Contaminants Found at Hazardous Waste Sites. [Accessed: December 13, 2005]. Available: <http://www.atsdr.cdc.gov/toxfaq.html>
16. United States Environmental Protection Agency/EPA Superfund Program. [Accessed: December 13, 2005]. Available: <http://www.epa.gov/superfund/about.htm>
17. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). [Accessed: December 13, 2005]. Available: <http://www.epa.gov/superfund/action/law/cercla.htm>

18. Superfund Amendments and Reauthorization Act (SARA). [Accessed: December 13, 2005]. Available: <http://www.epa.gov/superfund/action/law/sara.htm>
19. CERCLA Hazardous Substances. [Accessed: December 13, 2005]. Available: <http://www.epa.gov/superfund/programs/er/hazsubs/cercsubs.htm>
20. Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS). [Accessed: December 13, 2005]. Available: <http://www.epa.gov/superfund/sites/cursites/index.htm>
21. United States Environmental Protection Agency/EPA's National Priorities List (NPL). [Accessed: December 13, 2005]. Available: <http://www.epa.gov/superfund/sites/npl/index.htm>
22. United States Environmental Protection Agency/EPA's Window to My Environment. [Accessed: December 13, 2005]. Available: <http://www.epa.gov/enviro/wme/>
23. United States Environmental Protection Agency/EPA's EnviroMapper. [Accessed: December 13, 2005]. Available: <http://maps.epa.gov/enviromapper/>
24. United States Geological Survey (USGS)'s National Atlas Map Layer Info/EPA Envirofacts Data/ Superfund National Priorities List Sites. [Accessed: December 13, 2005]. Available: <http://www.nationalatlas.gov/mld/efct05x.html>
25. National Library of Medicine TOXMAP FAQ. "How Can I Link My Site to TOXMAP?". [Accessed: December 13, 2005]. Available:<http://toxmap.nlm.nih.gov/toxmap/help/faq.jsp#39>
26. Tufte, Edward R. Visual Explanations: Images and Quantities, Evidence, and Narrative. Cheshire, CT: Graphics Press; 1997.
27. National Library of Medicine TOXMAP Frequently Asked Questions (FAQ). [Accessed: December 13, 2005]. Available: <http://toxmap.nlm.nih.gov/toxmap/help/faq.jsp>
28. Burroughs, C.; Wood, F. Measuring the Difference: Guide to Planning and Evaluating Health Information Outreach. Seattle, WA: Bethesda, MD: National Network of Libraries of Medicine Pacific Northwest Region; National Library of Medicine; 2000 Sep. p. 5-7.Also available in portable document format (PDF) at <http://nnlm.gov/evaluation/guide/>
29. Glitz, Beryl. Focus Groups for Libraries and Librarians. New York: Forbes Custom Publishing; 1998. p. 1
30. Biblarz, Dora; Bosch, Stephen; Sugnet, Chris, editors. Guide to Library User Needs Assessment for Integrated Information Resource: Management and Collection Development. (Series: Collection Management and Development Guide #11). Lanham, MD: Scarecrow Press. Co-published with Association for Library Collections & Technical Services (ALCTS); 2001. p. 13
31. Itracks Online Focus Groups. [Accessed: December 13, 2005]. Available: <http://www.itracks.com>

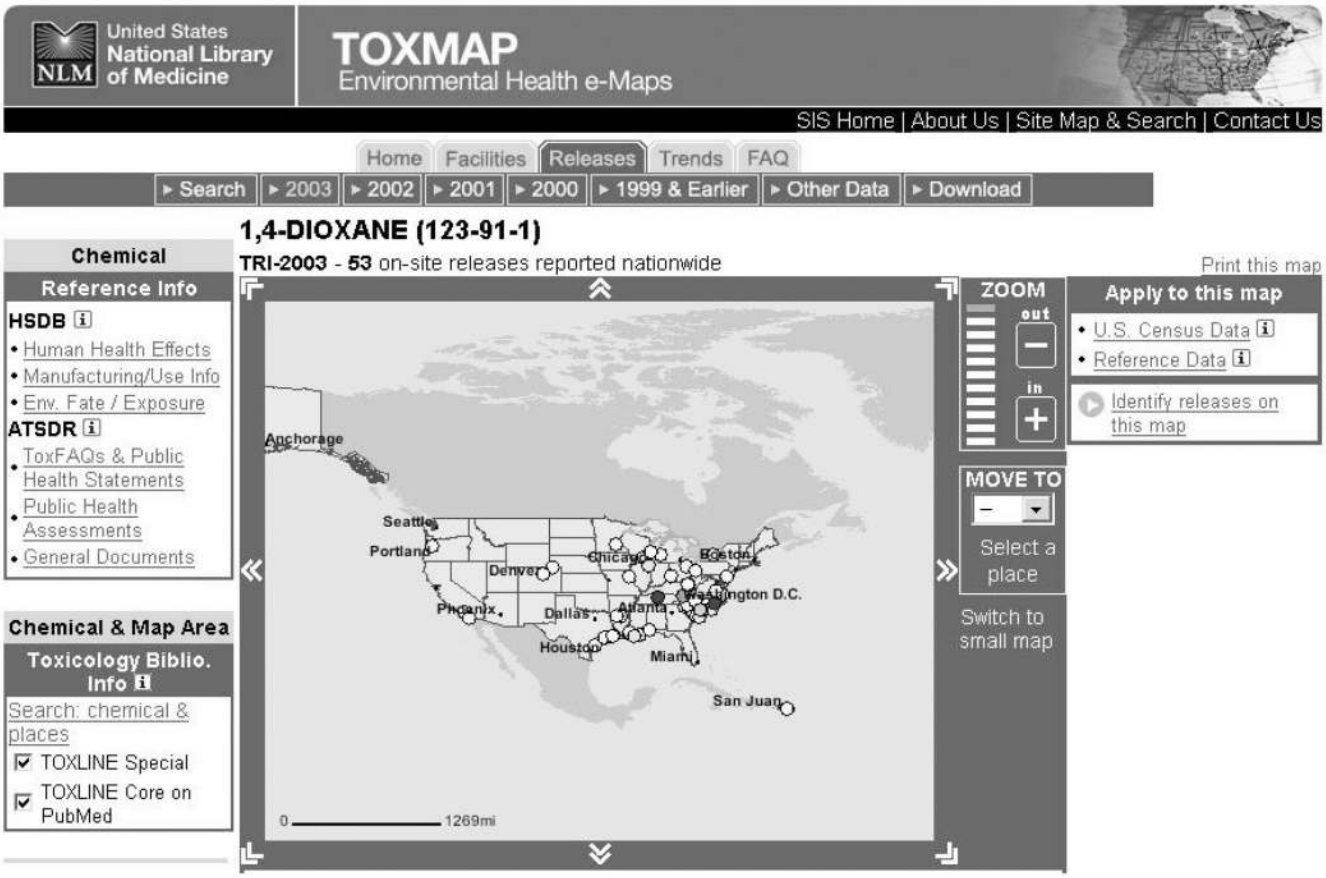


FIGURE 1.
TRI Facilities Reporting Release of Dioxane in the United States, 2003

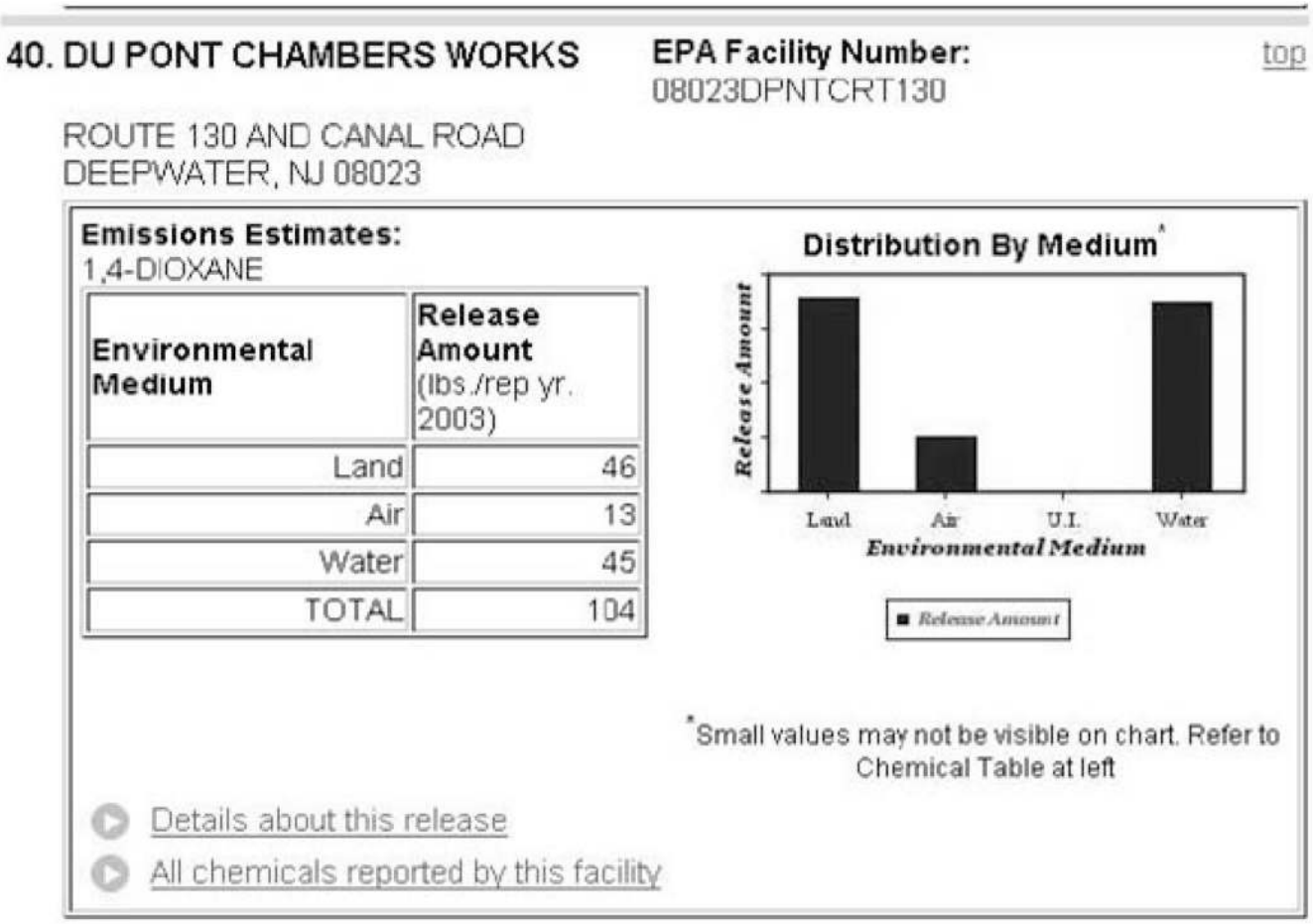


FIGURE 2.
Dioxane Release Information for TRI Facility

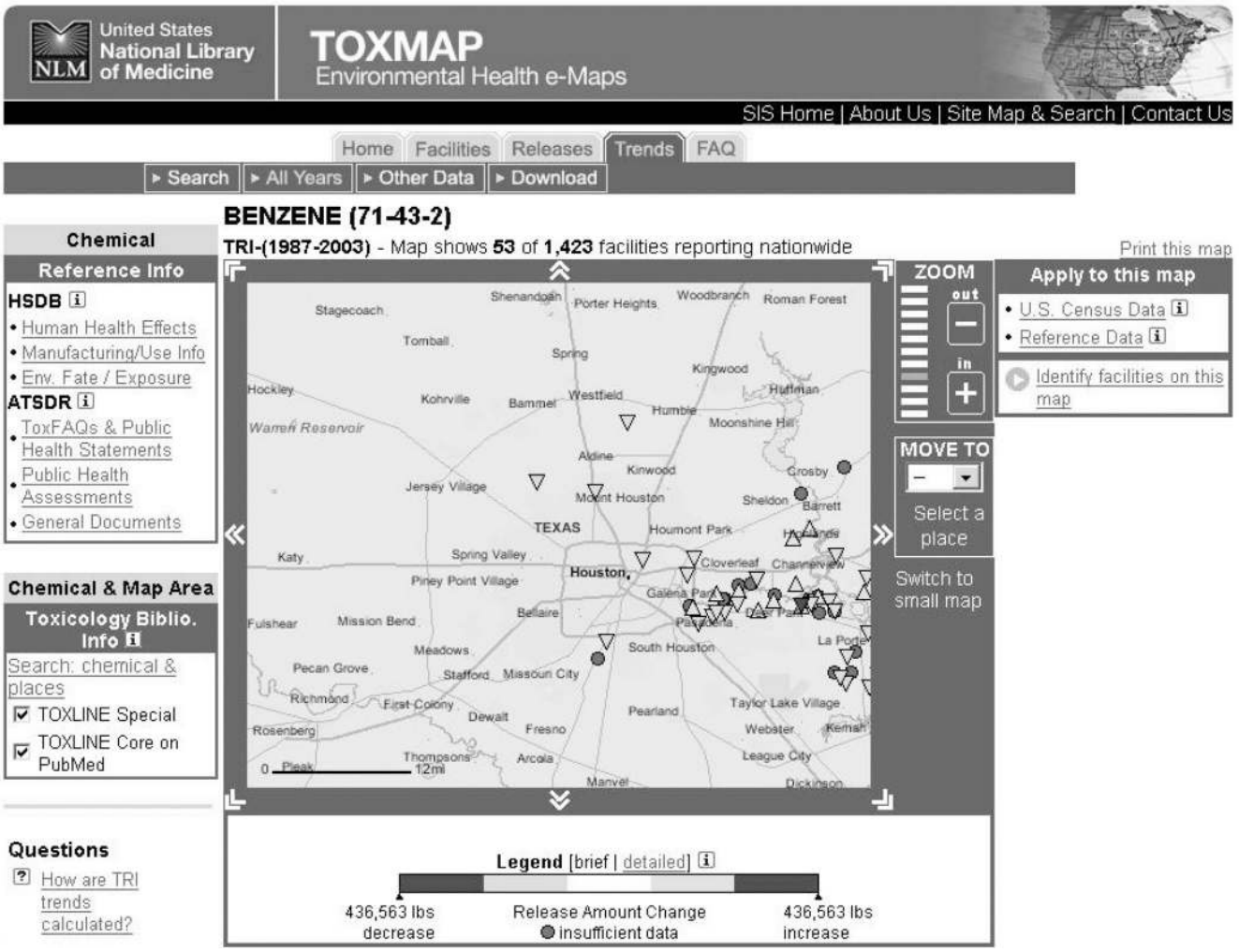


FIGURE 3.
TRI Facility Benzene Release Trends, Houston, TX Area

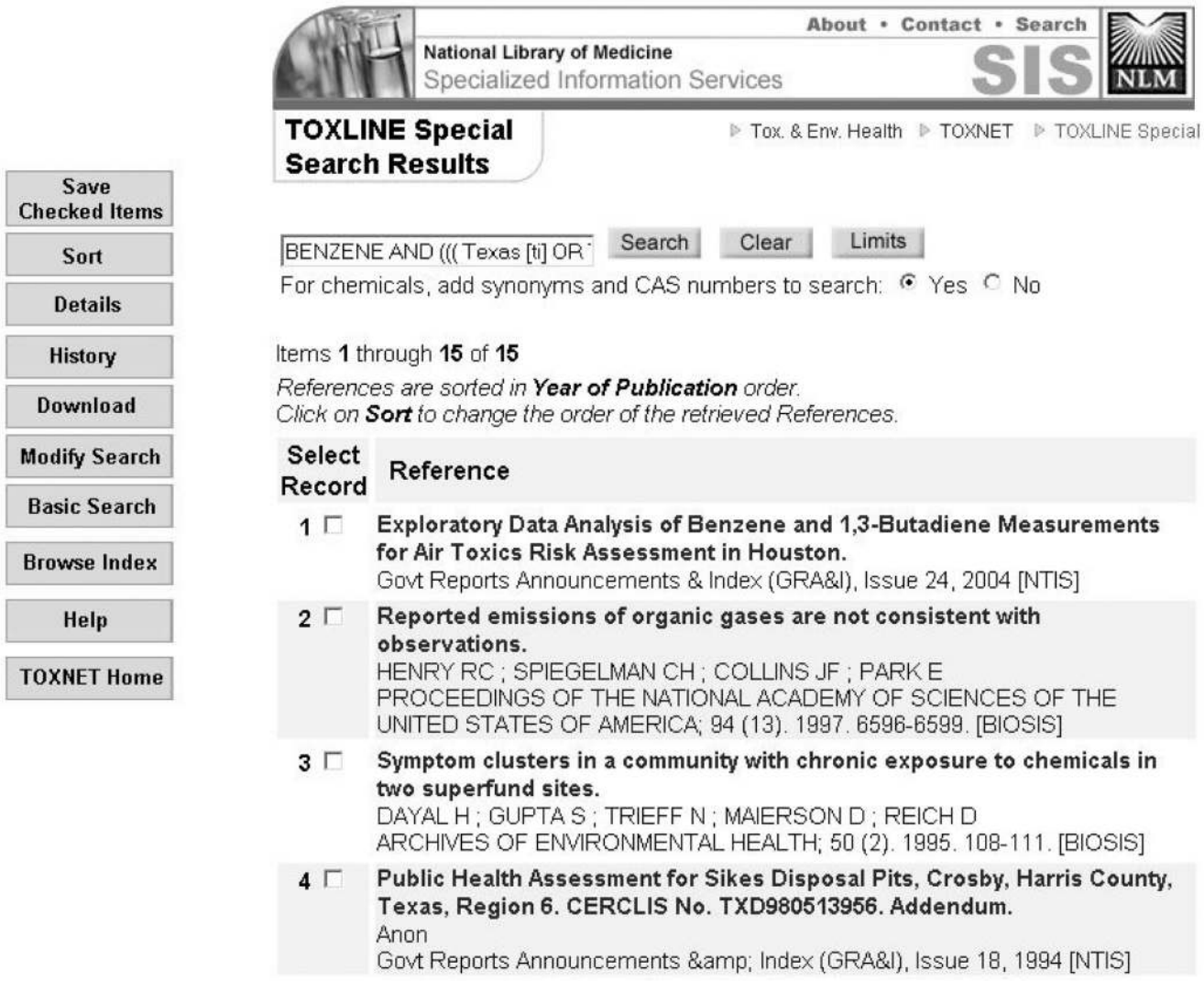


FIGURE 4.
TOXLINE Search Results, Benzene/Houston Area

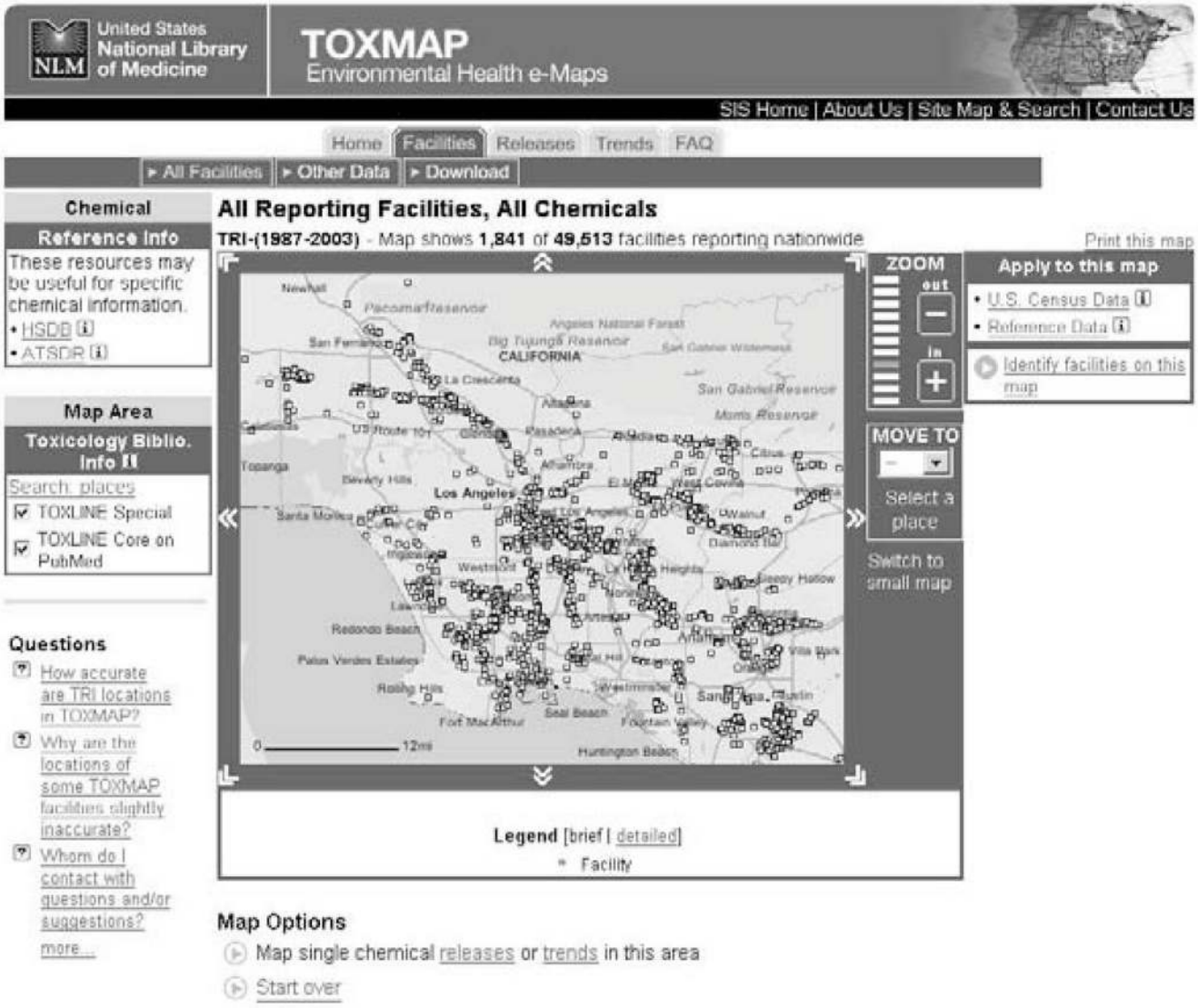
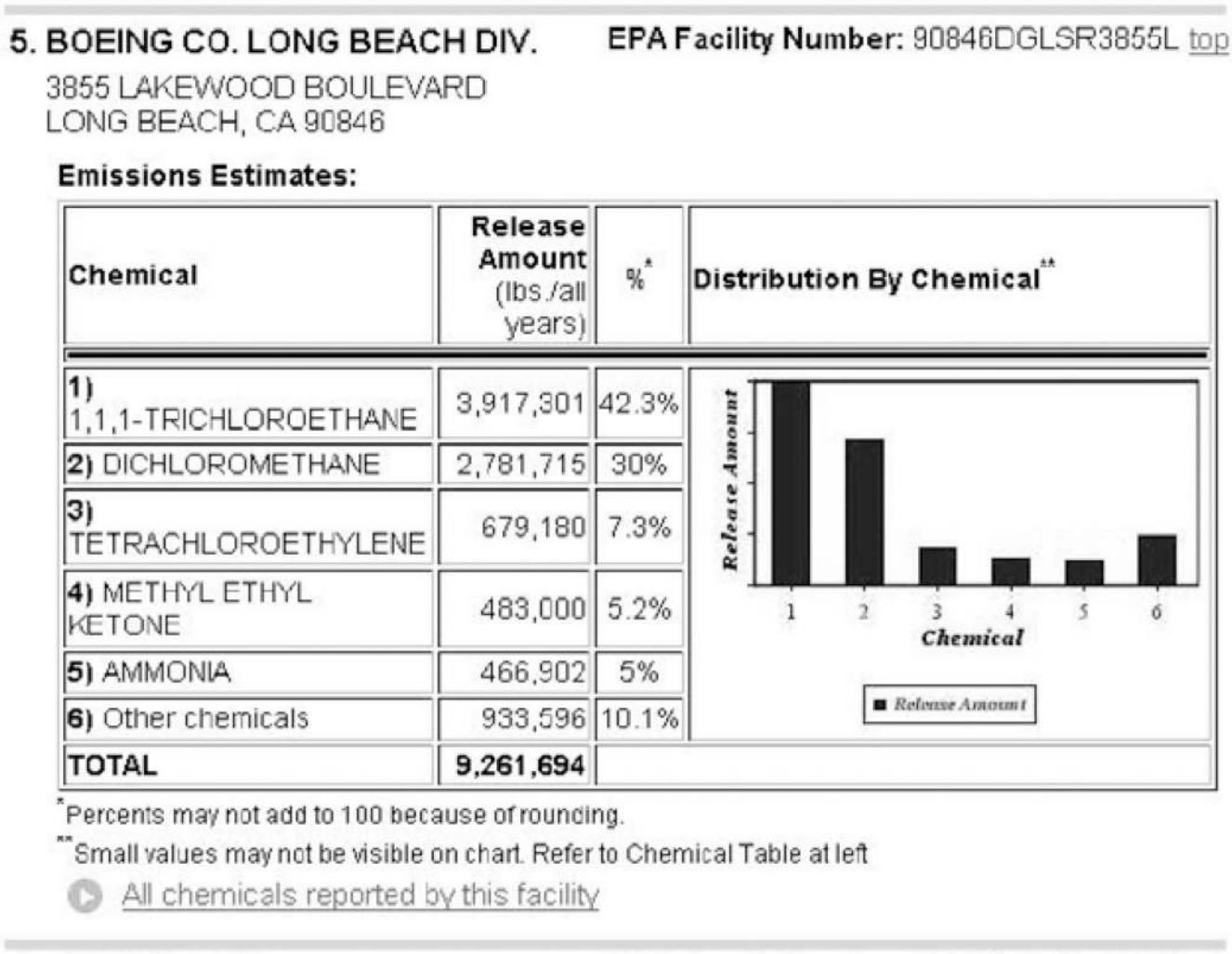


FIGURE 5.
TRI Facilities in the Los Angeles Area, 2003



5. BOEING CO. LONG BEACH DIV. **EPA Facility Number:** 90846DGLSR3855L top

3855 LAKEWOOD BOULEVARD
LONG BEACH, CA 90846

Emissions Estimates:

Chemical	Release Amount (lbs./all years)	%*	Distribution By Chemical**
1) 1,1,1-TRICHLOROETHANE	3,917,301	42.3%	
2) DICHLOROMETHANE	2,781,715	30%	
3) TETRACHLOROETHYLENE	679,180	7.3%	
4) METHYL ETHYL KETONE	483,000	5.2%	
5) AMMONIA	466,902	5%	
6) Other chemicals	933,596	10.1%	
TOTAL	**9,261,694**		

*Percents may not add to 100 because of rounding.

**Small values may not be visible on chart. Refer to Chemical Table at left

All chemicals reported by this facility

FIGURE 6.
TRI Facility Record, Los Angeles Area, 2003

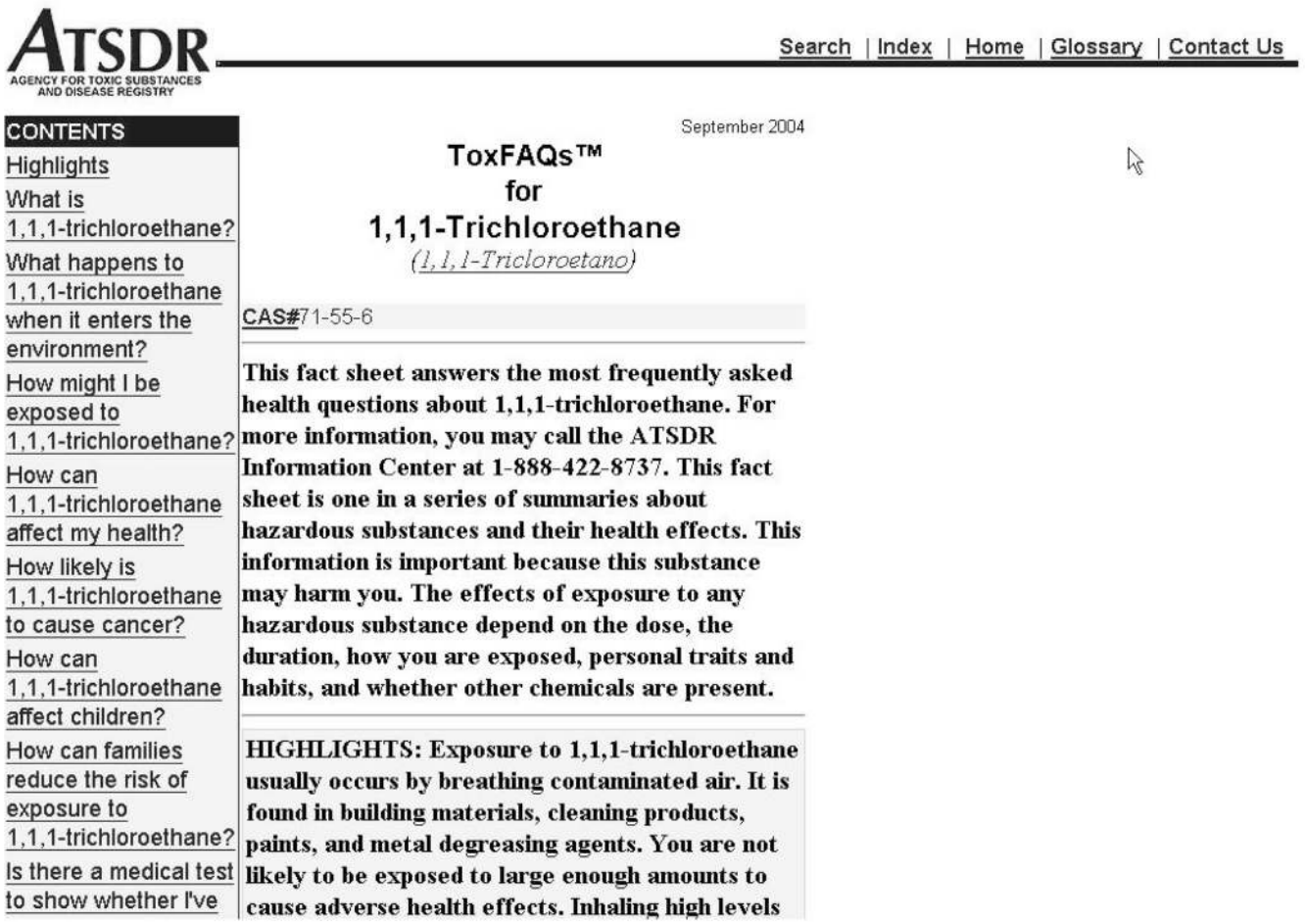


FIGURE 7.
ATSDR ToxFAQ

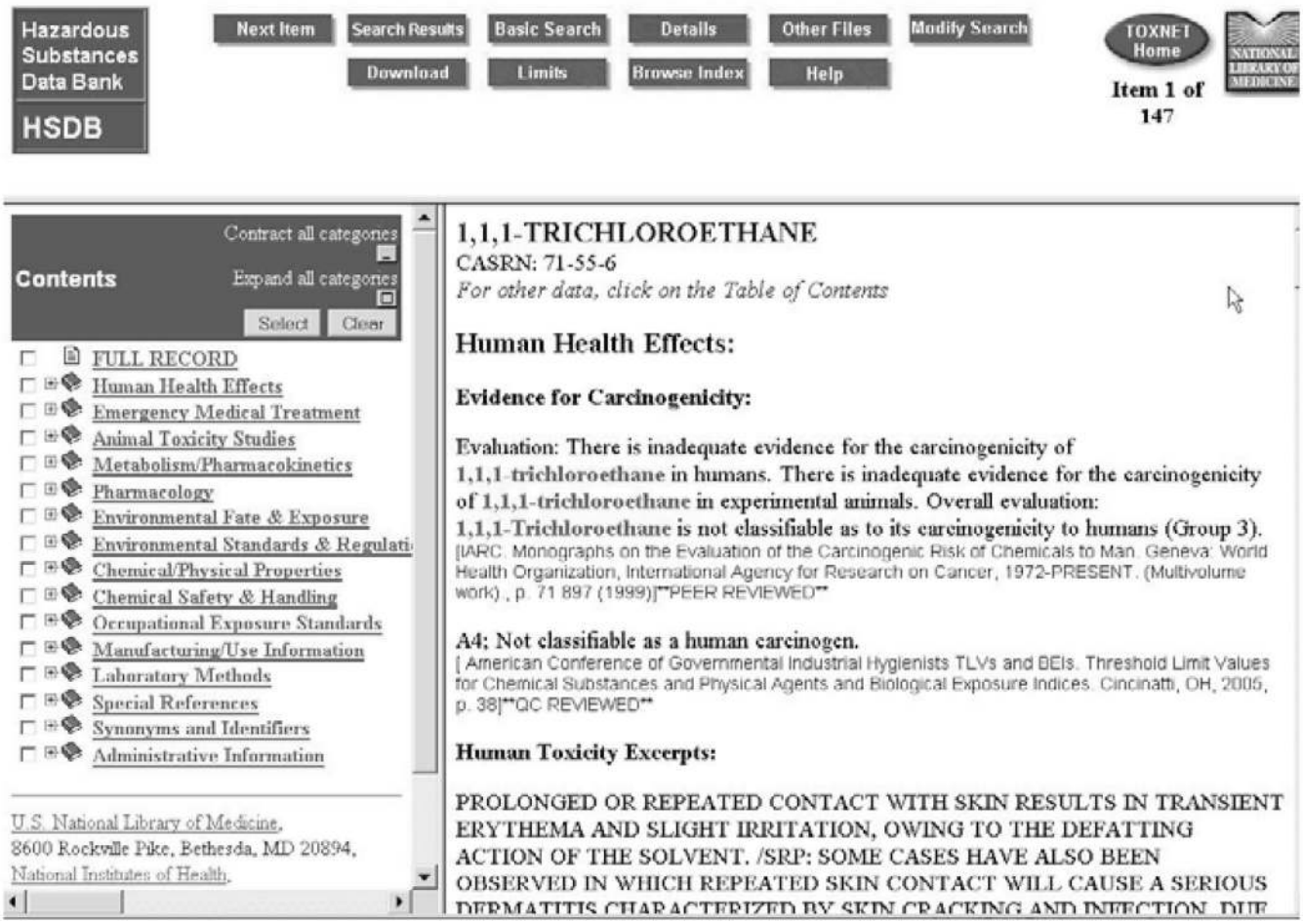


FIGURE 8.
Chemical Record, NLM's Hazardous Substances Databank (HSDB)

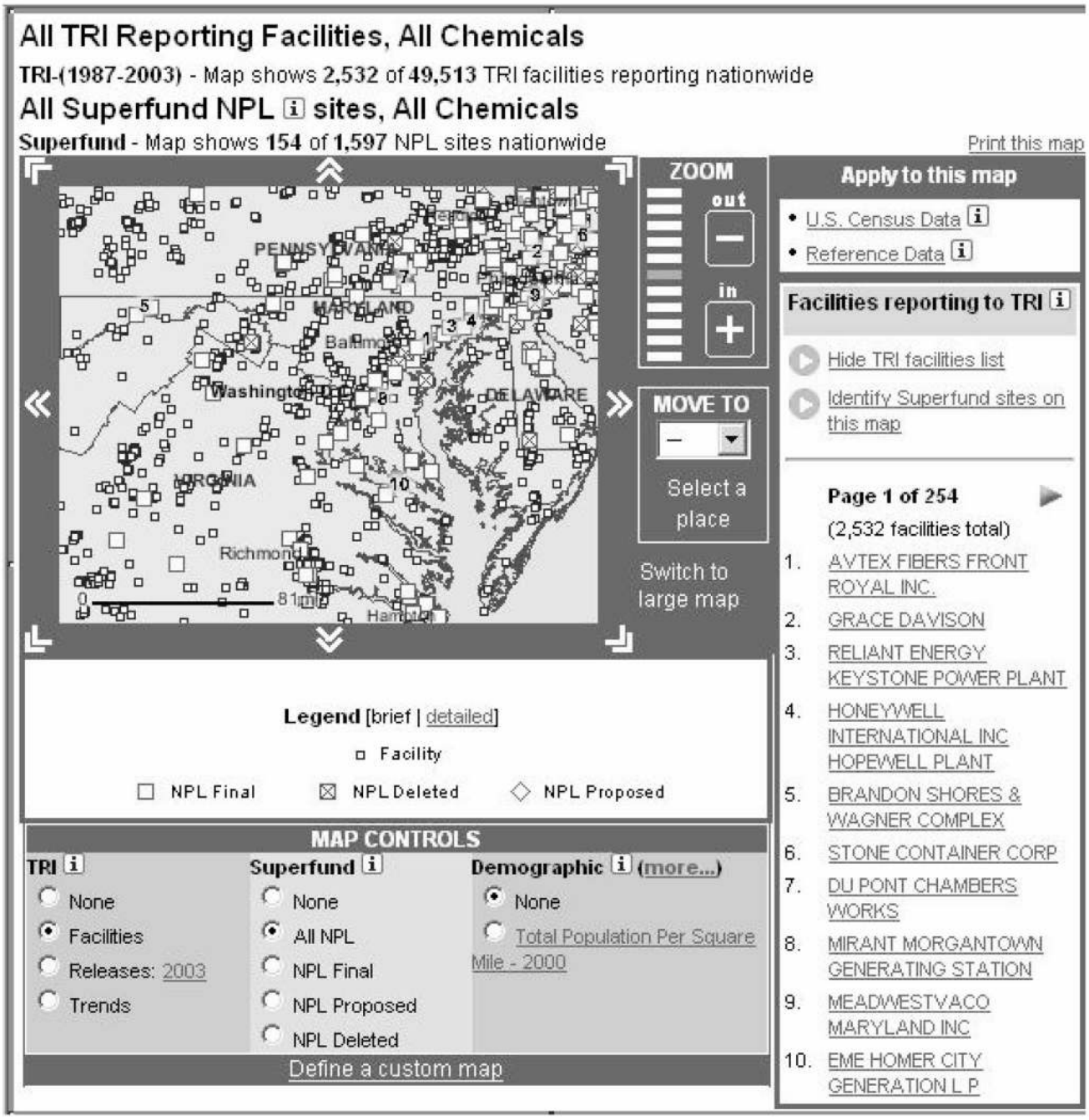


FIGURE 9.
Superfund Site Map

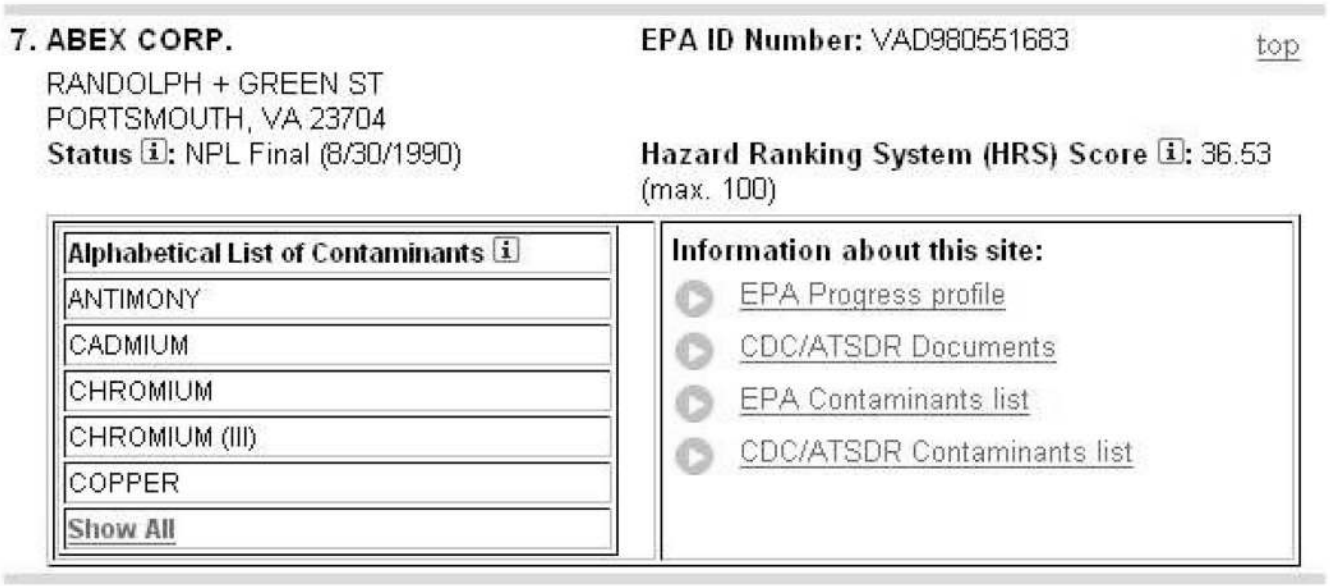


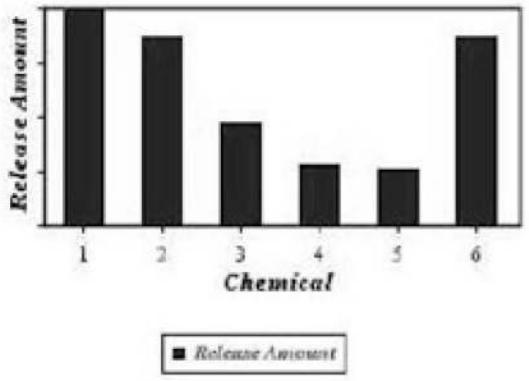
FIGURE 10.
Superfund Site Record

3. LYONDELL CHEMICAL CO EPA Facility Number: 77530RCCHM2502S top

2502 SHELDON RD.
CHANNELVIEW, TX 77530-0030

Emissions Estimates:

Chemical	Release Amount (lbs /all years)	%*	Distribution By Chemical**
1) METHANOL	22,314,983	26.8%	
2) SODIUM HYDROXIDE (SOLUTION)	19,404,240	23.3%	
3) ETHYLBENZENE	10,311,815	12.4%	
4) ACETOPHENONE	6,191,519	7.4%	
5) SODIUM SULFATE (SOLUTION)	5,800,000	7%	
6) Other chemicals	19,331,171	23.2%	
TOTAL	83,353,728		



*Percents may not add to 100 because of rounding.

**Small values may not be visible on chart. Refer to Chemical Table at left

All chemicals reported by this facility

FIGURE 11.
Release Distribution by Chemical for a Texas TRI Facility

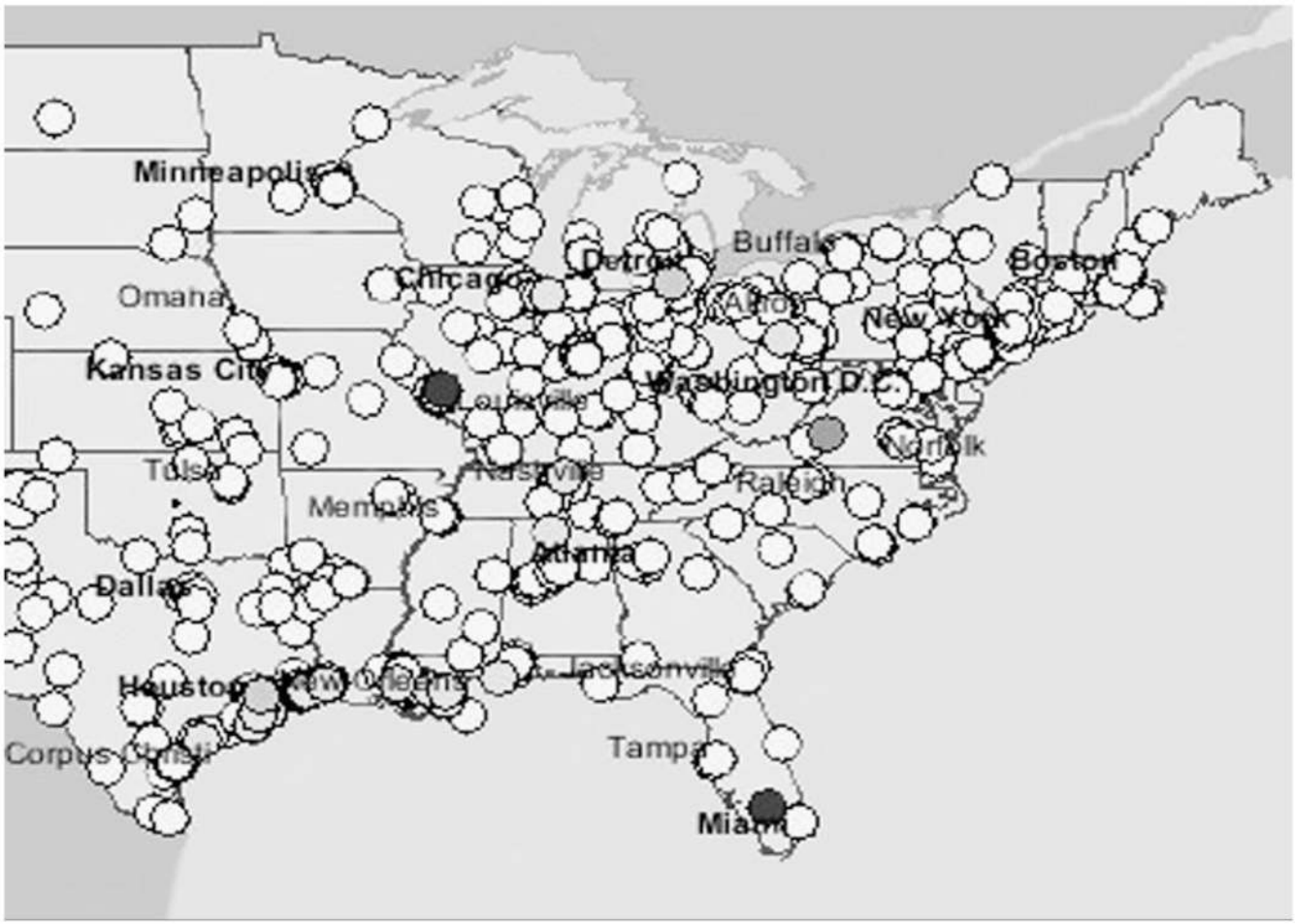


FIGURE 12.
Map Showing High Chemical Release

TABLE 1

Guide to Federal Government Acronyms

ATSDR	United States Centers for Disease Control and Prevention's Agency for Toxic Substances and Disease Registry
CDC	United States Centers for Disease Control and Prevention
EPA	United States Environmental Protection Agency
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation and Liability Information System
HHS	United States Department of Health and Human Services
HRS	Hazard Ranking System
HSDB	National Library of Medicine's Hazardous Substances Data Bank
NCI	United States National Institutes of Health's National Cancer Institute
NIH	United States National Institutes of Health
NLM	United States National Institutes of Health's National Library of Medicine
NPL	National Priorities List
SARA	Superfund Amendments and Reauthorization Act
SIS	United States National Library of Medicine's Division of Specialized Information Services
TEHIP	National Library of Medicine's Toxicology and Environmental Health Information Program
TOXNET	National Library of Medicine's Toxicology Data Network
TRI	United States Environmental Protection Agency's Toxics Release Inventory
USGS	United States Geological Survey