# GIS in a County Environmental Health Agency

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**Abstract**

A geographic information system (GIS) is an effective tool that local health departments can use in their environmental health programs to perform community health and environmental assessments, improve public access to environmental health information, and increase department effectiveness and efficiency. In the daily work required to protect the public's health, environmental health programs collect large sets of useful data. Most of these datasets have a geographic component. While integral to daily environmental health tasks, these datasets can have many additional applications, particularly as the field of environmental health grows more assessment-oriented. The trend of local government agencies tracking their activities with GIS offers environmental health programs a unique opportunity to share information while serving the public's interest in health and a healthy environment. Implementation of GIS requires several components, including identification of current needs and possible future uses; cooperation with other county agencies; management commitment; budget allocations; and access to technical GIS staff. Some of these components are not readily available in an environmental health program, but can be found in other county agencies. Development of a separate GIS for environmental health purposes is an unnecessary duplication of work. Using GIS to merge data from multiple county agencies is an efficient way to deliver environmental health information. To test this, a traditional environmental health program management task was compared with the same task performed using existing county GIS resources. Use of GIS resulted in increased work efficiency, access to more complete information, and improved public notification.

Keywords: environmental health programs, county health department, hazardous waste site assessments

## Environmental Health Programs

### *Multiple Programs and Locations*

The Seattle-King County Department of Public Health (Health Department) is located in King County, Washington, the twelfth most populous county in the United States. It serves a population base of 1.6 million people. The Health Department has over 1,200 employees; its Environmental Health (EH) division has over 160 employees. EH consists of multiple programs in areas such as food protection, living environments, meat/poultry/rabbit/aquatic foods, drinking water, on-site septic, solid waste, site hazard assessment, local hazardous waste management, chemical/physical hazards, vector/nuisance control, and plumbing/gas piping inspections. Most division

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programs are administered at four regional locations and/or at a central technical support office.

### *Interactions with City, County, State, and Federal Agencies to Provide the Community with Better Access to Information*

King County includes the cities of Seattle and Bellevue, plus 36 suburban cities and the unincorporated areas of the county. EH routinely interacts with many other county agencies including local planning agencies, building departments, and the county Assessor's Office. In addition, the Health Department is connected through various grant projects and mutual environmental and health functions to the Washington State Department of Health, the Washington State Department of Ecology (Ecology), and to federal agencies such as the National Oceanographic and Atmospheric Administration (NOAA) and the US Environmental Protection Agency (EPA). Numerous opportunities exist to share information with these entities, with the Health Department involved in the health aspects.

The Health Department—like the Assessor's Office, the court system, the Records and Elections Department, and the Regional Parks and Facilities Department—is a regional department that provides services countywide in King County. Other county departments—such as the Department of Development and Environmental Services (DDES), which is the county building department—only have jurisdiction in the unincorporated areas of the county and a few contracted suburban cities. As a regional entity, the Health Department provides services throughout King County, including the cities of Seattle and Bellevue, the suburban cities, and the unincorporated parts of the county.

These interactions put EH in a unique position to function as an intermediary for sharing data between agencies. Local information is often more specific than state and federal information because it is updated more frequently and is more verifiable. The EH geographic information system (GIS) provides a logical location where various data sources can be brought together for use in evaluating health issues, benefiting the community as a whole. This role as a central data location increases the capacity of EH to interact more closely with other divisions within the Health Department and with other local, state, and federal agencies. It also enables EH to provide better assessment capabilities and risk communication to impacted communities.

## Countywide GIS Program

### *Structure*

Over the past seven years, several King County agencies have worked cooperatively toward establishing a countywide GIS. Agencies involved include Transportation, the Department of Natural Resources, the Office of Budget and Strategic Planning, the Assessor's Office, and DDES. There has been a concerted effort among these agencies to share data on a central server and to encourage other agencies to participate in the countywide GIS project. DDES uses GIS in conjunction with the computer permitting software, Sierra Permits (Sierra Computer Systems, Inc., Visalia, CA), that the Health Department currently shares with them. Both DDES and EH are in the process of

upgrading their permit systems for Year 2000 compliance and to allow an upgrade of the user interface to a Windows environment.

While EH addresses public health issues, the division's interaction with DDES centers on land development permitting issues such as plumbing, drinking water, and septic systems. Both agencies perform a good portion of work using a parcel-based system and use much of the same geographical information to make respective agency decisions. Inclusion of health data into the building permit process allows health issues to become an integral part of the decision-making process.

With one exception, all King County agencies use ESRI (Redlands, CA) software—ARC/INFO and ArcView. ARC/INFO consists of digitized information that ArcView can access (e.g., parcels, street addresses, floodplains, assessor's maps). ArcView is a user-friendly desktop interface and can be used to combine background geographical information with environmental health data (e.g., permit information, septic-system failures). Other software packages are available, although the decision to go with the county standard seemed an obvious one.

#### *Data Available on System*

A large server holds the county GIS data files in a central location. These data files are updated by various GIS programmers employed throughout the county. Some information is updated in real time as the data are entered, but most data tables must be updated manually by the respective agencies on a continuous basis.

### Benefits of Using GIS in Environmental Health

#### *GIS Program as Community Assessment Tool*

In 1993, Washington State began implementation of the Public Health Improvement Plan (1), which called upon local health agencies to collect and examine data to identify trends of disease and injury; work with communities and decision-makers to target particular issues; and assure services meet community needs. Data collection and analysis are key components of the community assessment process to be performed by local health departments. GIS is an evaluative tool that can be used to examine these datasets spatially. Looking at environmental health data on a map can allow identification of trends and patterns such as failing septic systems in a particular region, an increase or decrease in critical item restaurant violations over time, and so on. GIS can also be used to track environmental health activities in a particular region and to provide communities with site-specific information about these activities. Certain sites may in turn be targeted for specific outreach activities whose outcomes will be monitored and evaluated over time.

#### *Improved Communication*

Being a large environmental health division with multiple programs and multiple locations, it is both important and helpful to facilitate communication within the division, with other county agencies, and with the public. Environmental health specialists working in one program are only generally aware of the routine activities taking place in other programs. GIS can be used to link program information together by an address or parcel number and to make the information available to a wide audience. It can be

used as a management tool to evenly distribute inspection workloads and to evaluate the effectiveness of specific programs.

GIS also provides a way to improve public access to environmental health information. Our interaction with the public takes many forms including answering questions about a particular property, drinking-water well, or restaurant, and/or issues affecting a particular community. GIS can assist environmental health staff in answering questions regarding the status of a particular permit or can be used as a tool to evaluate trends in environmental health data.

#### *Increased Effectiveness and Efficiency*

Much of the data traditionally collected in paper form on a monthly or yearly basis are now updated automatically in the county GIS. A countywide GIS also brings together data from multiple sources and locations. Data gathering and organization become more efficient as information traditionally collected in duplicate (i.e., multiple databases containing many of the same fields) is compiled in one central location.

### Site Hazard Assessment Program

#### *Program Overview*

The Site Hazard Assessment Program (SHA) conducted by EH is grant funded by Ecology to investigate, assess, and rank potentially contaminated hazardous waste sites in King County. The Known or Suspected Hazardous Waste Sites List compiled by Ecology under the Washington State Model Toxics Control Act (MTCA), which mandates cleanup of hazardous waste sites, contains numerous sites from several sources within Ecology. Due to the large volume of potential sites on this statewide list, and to the limited staff available at Ecology to conduct site investigations and assessments, local county health departments are funded by a site hazard assessment grant from Ecology to aid in the site ranking process.

A ranking is conducted on sites found to have levels of hazardous waste above state MTCA limits, which set cleanup levels (2) for residential and industrial soils to protect the air, surface, and/or groundwaters of the state. Sites are ranked according to the *Washington Ranking Method (WARM) Scoring Manual* (3). The score estimates the relative risk to the health of people and the environment from a site relative to other ranked sites in the state. The scores range from 1 (highest relative risk) to 5 (lowest relative risk). Sites found to have levels of hazardous wastes below MTCA cleanup levels, or sites inappropriately listed, receive a designation of No Further Action (NFA), which should remove the site from the list. A site may be ranked for any and/or all of three possible exposure routes—surface water, air, and groundwater—depending on the type of hazardous waste and its relative location in the soils and/or groundwater at the site.

#### *Data Sources*

Much of the data required to rank a hazardous waste site are geographic in nature. Locations of wells, parks, fisheries resources, local populations and others in the vicinity of the contaminated site are required to assign the overall ranking factors (see Table 1 for a full list of data sources used for the ranking). Traditionally, data sources required to make these determinations were found in various computer database

**Table 1** Data Sources for Site Hazard Assessment; King County, WA

| Data Sources for Site Hazard Assessment (SHA) | Information Needed for SHA | SHA Routes |
|---|---|---|
| **Washington State** | | |
| Model Toxics Control Act (MTCA): cleanup levels, risk calculations (CLARK II) update | Levels above which SHA is required | SW, GW, A |
| *Washington Ranking Method (WARM) Scoring Manual* | Method used to assign human health and/or environmental risk | SW, GW, A |
| Toxicological database for use in WARM scoring | Values, risks assigned by compound, chemical, etc. | SW, GW, A |
| Washington State Department of Health public water supply listing (DWAIN) | Wells located by section, township, range, and # of connections by small and large drinking water systems within 2 miles of site | SW, GW |
| Washington State Department of Ecology water use data: Water Rights Information System (WRIS) | State water rights issued for surface water and wells by section, township, range for irrigation, industry, drinking water, etc. within 2 miles of site | SW, GW |
| **King County** | | |
| Sierra Permits: Health and Building Department permit system | Activities of Health and Building Departments related to permits, complaints, etc. | SW, GW, A |
| Sensitive area map folio for King County | Nearest wetland, stream, floodplain, fisheries resource | SW, GW, A |
| Situs: Assessor's Office records | Parcel-related information: address, owner's name, parcel size, etc. | SW, GW, A |
| **National** | | |
| US Department of Agriculture, Soil Conservation Service, WA Agricultural Station, King County | Surficial soil types listed for western half of county, not including city of Seattle | SW, GW, A |
| National Weather Service data, WA climate for King County (WSU, College of Agriculture, Cooperative Extension Service) | Precipitation: total annual and November through April (minus evapotranspiration) | SW, GW |
| National Oceanic and Atmospheric Administration: isopluvials of 2-yr., 24-hr. precipitation, *NOAA Atlas 2, vol. IX* | Maximum precipitation in tenths of an inch | SW |
| National census data | Population within half-mile radius | A |
| **Other** | | |
| Thomas Brothers map | Estimated distance to nearest parks, streams, etc. | SW, GW, A |
| Various sewer, water company information | Sewer and water service to site, presence of combined sewers for stormwater drainage | SW, GW, A |

SW = Surface water
GW = Groundwater
A = Air

printouts, printed lists, and paper maps (Table 2). The process of manually teasing the required elements from these sources was time-consuming, repetitious, tedious, and potentially prone to error.

**Table 2** Data Sources for Site Hazard Assessment Prior to GIS Implementation; King County, WA

| Data Sources Prior to GIS Implementation | Type of Data | Last Update | Problems Keeping Data Current |
|---|---|---|---|
| **Washington State** | | | |
| Model Toxics Control Act (MTCA): cleanup levels, risk calculations (CLARK II) update | Printed lists, regulations | 1996 | Updated by state |
| *Washington Ranking Method (WARM) Scoring Manual* | Printed document—some data sources | 1992 | Updated by state |
| Toxicological database for use in WARM scoring | Printed lists, tables | 1992 | Updated by state |
| Washington State Department of Health Public water supply listing (DWAIN) | Computer printout | 1994 | Parcel #s not included, sources are estimated on GIS; state has a new data base now |
| Washington State Department of Ecology water use data: Water Rights Information System (WRIS) | Computer printout | 1989 | Parcel #s not included, sources are estimated on GIS; state has a new data base now (WRATS) |
| **King County** | | | |
| Sierra Permits: Health and Building Department permit system | Computer permit system (tied to Situs) | Current | New permit system being installed, current one not Y2K compliant |
| Sensitive area map folio for King County | 7 types of sensitive areas—14 maps each | 1990 | Updated by county; existing maps did not include drainage basin boundaries (needed for surface water route) |
| Situs: Assessor's Office records | Computer data system (tied to Sierra permits) | Current | Updated by Assessor's office |
| **National** | | | |
| US Department of Agriculture, Soil Conservation Service, WA Agricultural Station, King County | 20 separate maps (not including City of Seattle) | 1973 | Entire county not on map |
| National Weather Service data, WA climate for King County (WSU, College of Agriculture, Cooperative Extension Service) | Map showing weather stations, associated precipitation tables | 1931–1965 data | Data not based on enough points to show differences due to slopes, valleys, or other changes in geoposition |
| National Oceanic and Atmospheric Administration: isopluvials of 2-yr., 24-hr. precipitation, *NOAA Atlas 2, vol. IX* | Map of WA state | 1970? | NOAA working on more accurate data at this time |
| National census data | From EPA internet site | 1990 | Method using 1/4 of population within a one-mile radius of site typically underestimates true population due to Puget Sound, lakes, and other non populated areas falling in sample area |
| **Other** | | | |
| Thomas Brothers map | 45 maps | 1998 | May have to work on maps from two different pages at once |
| Various sewer, water company information | Must call each purveyor | | May require all utilities to go to GIS, unknown when this will happen |

For example, state well locations were printed onto a large stack of computer paper with locations listed by section, township, and range. To locate the wells and the population served within the WARM model, surface water and groundwater routes within a two-mile radius needed to be identified. First a two-mile radius circle was drawn by hand onto a printed diagram of representative sections, townships, and ranges. Then the sections within the circle were listed on a sheet of paper. The wells were found by manually going through two separate printouts, one for the Group A wells (large water systems down to nine connections) and one for the Group B wells (smaller water systems down to two connections). The nearest well to the site would have to be located by address and its distance to the site estimated using a published street guide or similar map. Due to the rough method employed, some wells outside the two-mile radius were inadvertently included, and some wells within the two-mile radius were excluded. Another problem with the dataset used was that it was last updated in 1994. An updated report was not available with any changes or updates to the well list. In fact the computer system that produced the report was no longer available because the state had already upgraded to a new database system.

### *Data Accumulation Time*

The time required for drawing the maps, finding the wells, and writing the lists took anywhere from about 20 to 30 minutes each. That did not include the extra time spent finding a lost printout on a co-worker's desk, various other interruptions, and/or problems due to starting with the wrong information.

The time to complete all required data collection for each site ranking was about one-and-a-half to two hours (Table 3). Each site required similar repetitive tasks, although not all sites were ranked, and, if ranked, some routes were not evaluated (some sites are only ranked on the groundwater route, for example). When considering the number of sites needing evaluation by the SHA program each year (40 or more completed each year at current staffing levels, with a backlog of 275 sites), a significant time-savings could be achieved using GIS to compile, store, and view the data.

## Current GIS Program

### *GIS Simulation*

A demonstration of the current GIS shows the ease and quickness with which SHA-required data can be compiled, evaluated, and presented. Once in the system, clicking on the ArcView icon automatically opens a DDES-designed project. This project includes a parcel locator button that automatically can zoom to the site to be ranked once the parcel number, address, owner's name, or permit activity number has been entered. Once the site is chosen, parameters—such as Group B wells (systems serving 2–10 connections), drainage basin name, surface soil type, isopluvial level (a two-year, 24-hour period maximum rainfall), census blocks including population, parks, fisheries resources, floodplains, and sensitive areas themes—can be layered onto the view.

To estimate the population within a half-mile radius, for example, a Select By Theme operation can be performed. The first step is to choose the parcel to be assessed by clicking on it, or by finding it with the parcel locator button. With the Census Theme chosen as the active theme, Select By Theme can be chosen from the Theme pull-down

**Table 3** Site Hazard Assessment Data Source Time Study; King County, WA

| Data Source | Accumulation Time | Installed on GIS? |
|---|---|---|
| **Washington State** | | |
| Washington State Department of Health public water supply listing (DWAIN) | Draw map = 10 min; look through printout = 10–20 min | yes |
| Washington State Department of Ecology water use data: Water Rights Information System (WRIS) | Draw map = 10 min; look through printout = 15–25 min | no |
| **King County** | | |
| Sierra Permits: Health and Building Department permit system | Open program, get info from address = 4–5 min | yes |
| Sensitive area map folio for King County | Check all maps = 10–20 min | yes |
| Situs: Assessor's Office records | Works with Sierra (see above) | yes |
| **National** | | |
| US Department of Agriculture, Soil Conservation Service, WA Agricultural Station, King County | Find site on maps, check soil type = 10 min | yes |
| National Weather Service data, WA climate for King County | Check map, data table = 1–2 min | no |
| Isopluvials of 2-yr., 24-hr. precipitation; *NOAA Atlas 2, vol. IX* | Check map = 1–2 min | yes |
| National census data | Contact Web site, request map = 10–15 min; wait 2 hours to overnight for map completion | yes |
| **Other** | | |
| Thomas Brothers map | Hand measure for distance = 2–3 min | yes |
| Various sewer, water company information | Phone calls, may take several calls to get proper info | no |

menu. A message box opens and into the first entry box, again using the pull-down menu located there, "Are within distance of" is chosen. In the second box, Parcels is chosen and, then, in the third box the desired distance can be chosen (2,000 feet for this example). After clicking on the New Set button, ArcView sets to work. When finished, the census blocks within about a half-mile will have been highlighted. By opening the Theme Table, clicking the Promote button, clicking on the Population field heading, and then choosing Statistics from the Field pull-down menu, the sum of the population in the chosen census block set can be produced.

*Note: We are using census blocks for this calculation.*

### *Time Comparison*

Through the use of ARC/INFO and ArcView, multiple databases can be accessed instantaneously by controlling the parameters needed. The actual time required to rank the example site using GIS was clocked at about 20 minutes. In comparison, the time required to rank the example site using traditional methods was between one to two hours. The time saved is in accumulating the required data to perform an SHA ranking, not to mention the fact that the GIS uses the most current data available. Using GIS also saves time previously spent looking for missing printouts, waiting for census maps to

be drawn by the EPA Web site, and other miscellaneous time spent searching the office for the various forms, paper maps, datasets, and so on. However, all of the required data needed for a full SHA had not been added to the GIS at the time this paper was written. Parameters for water rights used to determine nearest surface water uses (for drinking and irrigation uses), Group A wells (wells serving populations of 10 or more connections), private wells, total precipitation, and evapotranspiration totals still need to be entered onto the GIS to be of use for ranking purposes.

## Conclusions

### *Establish Data Linkages*

Use of GIS within EH provides an opportunity to establish linkages with GIS programs already in existence. Much of the initial legwork associated with starting a GIS can be avoided by working cooperatively with other established agency GIS. Development of linkages is a wise use of resources wherein each agency develops databases specific to their needs and shares these data to eliminate duplication of effort. All agencies can make their respective decisions based on the best, updated, and most comprehensive information available.

The ongoing tasks of updating and installing new data sources must be recognized as a priority in the move to a fully integrated GIS. This is a necessary commitment of each program and agency, as poor data give inaccurate results and good data accurate results. All users of the GIS must work to integrate and upgrade their own data. Along with enjoying the availability of all of the county's data comes the responsibility to share Health Department data with others in the county, as well as passing along any changes and/or upgrades as required.

### *Health-Based Decision Making*

Inclusion of health data in a countywide GIS provides an opportunity for health information to be considered as a factor in broader decisions made within the county. Due to the very nature of environmental health programs, a wide variety of data is routinely collected. Use of these data in a GIS may facilitate agency and community access to health information.

### *Community Assessment*

GIS is an important tool to help in the community assessment process. It may be used to collect, store, analyze, and communicate public health and other information to the public. As the environmental health field becomes more community assessment oriented, local agencies are exploring new ways to use their data to identify areas of need and improve public access to information. GIS provides a way to accomplish these needs by capitalizing on spatial elements inherent in data routinely collected. Application of GIS within an environmental health agency can be a huge undertaking and seem unrealistic for many local governments. The benefits, however, of using GIS to administer routine environmental health functions can include overall department effectiveness and efficiency.

Implementation of GIS requires an identification of needs and future uses, commitment from management, and room in the budget to cover hardware, software,

training, data input, data updating, and GIS-dedicated technical staff. There is a need for at least one staff member to concentrate only on GIS data management. Trying to keep the GIS progressing is nearly impossible while trying to keep a full-time position workload going. Although this initial investment may seem overwhelming, the benefits to the community as a whole, with the ability to map data geographically, will reward the department on an ongoing basis. The key is sharing data with and between other city, county, state, and federal agencies. By exchanging data with other agencies and using the extensive GIS capabilities already developed by the county GIS through DDES, the community served has gained a valuable assessment tool. The implementation of GIS has added effectiveness, efficiency, and accuracy in an affordable and sustainable way.

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