# INTERNET-ENABLED INTEGRATED PRESENTATION SYSTEM FOR SITE REMEDIATION PRELIMINARY ASSESSMENT

by

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## Abstract

This thesis summarizes the development of an Internet-enabled integrated presentation system for a decision support system, called the Electronic Preliminary Assessment (PA) Scoresheet. The Electronic PA Scoresheet is designed to assist environmental engineers in a time consuming process of gathering background information about particular site during remedial investigation. It addresses specifically the Preliminary Assessment phase of the Superfund program, which was created as a result of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) passed by Congress in 1980. This phase includes filling out Preliminary Assessment (PA) Scoresheet, used in determination of the next step in the Superfund process.

The Electronic PA Scoresheet is a Web based interactive application. It has been designed to replace the traditional paper PA Scoresheet document, and to provide new tools to improve the productivity of environmental engineers. In addition to the build-in functions that calculate intermediate and final scores, it also provides a base for the implementation of more sophisticated knowledge-based information systems.

The Electronic PA Scoresheet is a part of a larger Executive Information and Decision Support System (EIDSS), designed by the 1997 Master of Engineering Information Technology Group at MIT. When fully integrated, the EIDSS system will greatly improve the entire Superfund process of remedial investigation, as the components will share information that was previously not available.

Thesis Supervisors: Feniosky Peña-Mora, Assistant Professor
Patricia J. Culligan-Hensley, Assistant Professor

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# 1. Introduction

## *1.1. Problem Statement*

This thesis concentrates on the design of the presentation layer, Electronic PA Scoresheet, for an Executive Information and Decision Support System (EIDSS) for Preliminary Assessment Process. Preliminary Assessment (PA) is the first stage of Superfund remediation process, created as a result of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) passes by Congress in 1980. Based on results of the PA , next steps of the Superfund process are determined. The PA phase is very time consuming and requires gathering large amounts of information which is all compiled in the PA Scoresheet. To aid environmental engineers, the Electronic PA Scoresheet was created as a part of a larger distributed system that encompasses the entire Superfund process.

## *1.2. Overview of the Remediation Process*

### 1.2.1. Overview of Superfund (CERCLA) Process

#### *1.2.1.1. History*

In the past, there was little understanding of what effect certain wastes have on human health and the environment. Consequently, numerous abandoned hazardous waste sites contributed to the pollution of the earth's soil, water and air. Some common hazardous waste sites include abandoned warehouses, manufacturing facilities, processing plants and landfills. In 1980 Congress established the Superfund Program to clean up these sites in response to a growing concern over the health and environmental risks posed by hazardous wastes. The Superfund program was created as part of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) which established broad authority for the government to respond to problems posed by the release, or threat of release, of hazardous substances, pollutants, or contaminants. In 1986, CERCLA was amended by the Superfund Amendments and Reauthorization Act and by the National Contingency Plan (NCP). At present the U.S. Environmental Protection Agency (EPA), in cooperation with individual states and tribal governments, administers the Superfund Program.

The Superfund Trust Fund was established to support the cost of cleanup of hazardous waste sites under the Superfund program. The Trust Fund is supported from taxes on the chemical and petroleum industries, and is used primarily when those companies or people responsible for contamination at Superfund sites cannot be found, or cannot perform or pay for the cleanup work.

#### *1.2.1.2. Current Superfund Process*

The Superfund process consists of two main phases: site assessment and remedial response action (see Figure 1). Site assessment consists of evaluation of all potential waste sites to identify those for which response action may be required. If appropriate, the result of the site assessment process is the listing of a hazardous waste site on the National Priorities List (NPL). For sites that are placed on the NPL, the second phase of the Superfund process, the remedial response action, is performed. During this phase, the nature and extent of contamination is determined, followed by the selection and implementation of any necessary cleanups at the site. If threats to human health are imminent, immediate or short-term responses may be performed during either of these two main phases.

The site assessment phase begins with notification to the EPA of possible releases of hazardous substances. Sites are then entered into the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS), which is the EPA's computerized inventory of potential hazardous substance release sites. The site assessment phase continues with Preliminary Assessment and Site Inspection stages. The Preliminary Assessment uses relatively limited data that is readily available to identify sites that may pose a threat to human health and the environment, and therefore require further investigation. If the Preliminary Assessment phase recommends further investigation, only then is the Site Inspection performed. The purpose of the Site Inspection is to determine which sites have a high probability of qualifying for the NPL. Once a site has been placed on the NPL, the site will undergo the remedial response action, as explained previously.

Recently, the EPA developed the Superfund Accelerated Cleanup Model (SACM) to allow for immediate action combined with continuing study as necessary. The SACM improves upon the traditional Superfund process, which requires a prolonged initial phase of study and assessment. Under SACM, EPA can institute actions to address threats to the health and safety of the surrounding population and environment as soon as those threats are identified. Listing sites on the NPL continues to be a prerequisite to using certain remedial action authorities to clean up sites.

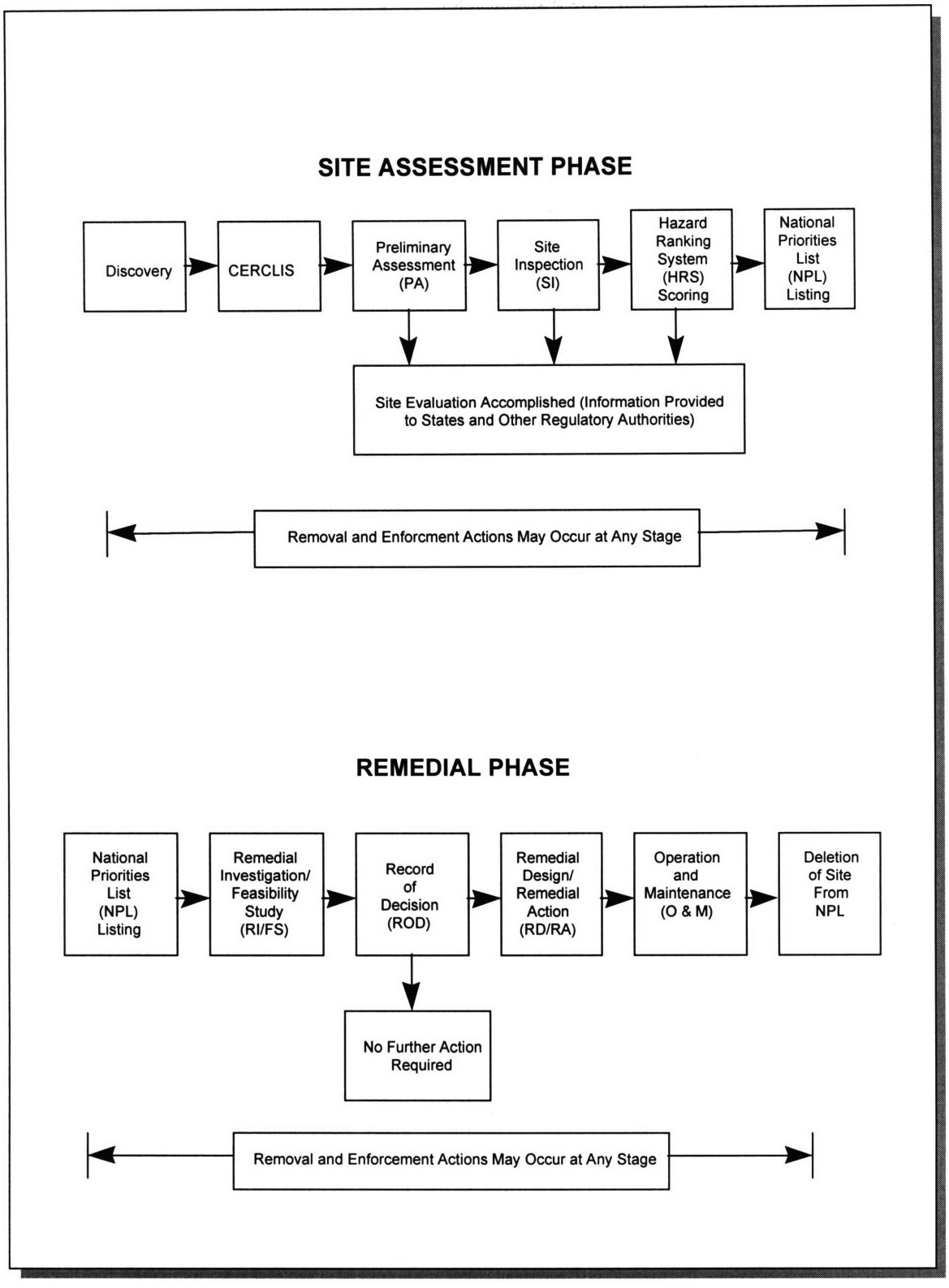


*Figure 1. Superfund Process*

## 1.2.2. Preliminary Assessment under CERCLA

### *1.2.2.1. Objective*

Based on limited data, the Preliminary Assessment (PA) phase is designed to recommend whether or not a site should undergo further investigation.

### *1.2.2.2. Scope*

The Environmental Protection Agency (EPA) maintains a computerized inventory (CERCLIS) of potentially hazardous sites that have been "discovered" by the EPA regional offices, state agencies or private citizens. Every site in CERCLIS must undergo the PA. The PA is performed using readily available information about a site and its surrounding area. The report generated from the PA summarizes the information gathered, and based on this, suggests that either (1) the site poses no threat to human health or the environment, (2) there is a potential threat and the site needs further investigation, or (3) emergency actions are necessary. If the site is determined to be potentially hazardous, the PA report will often be referred to throughout successive stages of the Superfund process.

The PA report consists of three parts: the data and site characteristic form, the narrative report and the PA Scoresheets. The data and site characteristics form, entitled the "Potential Hazardous Waste Site Preliminary Assessment Form," is a four page summary of the PA scoresheets and the narrative report. The narrative report summarizes all the information researched and presents it in a predetermined structure. The last section of the narrative report should summarize the most important characteristics of the site and explain the major points of concern. The final section, the PA scoresheet, is described in the next section.

The Guidance for Performing Preliminary Assessments under CERCLA (U.S. EPA 540/G-91/013, Sept. 1991) defines the scope of the Preliminary Assessment as sufficient to complete the following tasks:

- Review existing information about the site.
- Conduct a site and environs reconnaissance.
- Collect additional information about the site with an emphasis on target information.
- Evaluate all information and develop a site score.
- Prepare a brief site summary report and site characteristics form.

Filling out the three sections takes an average of 120 hours for each site, and the information can be presented informally (i.e. legible handwriting as opposed to type written).

### *1.2.2.3. The Preliminary Assessment (PA) Scoresheets*

The PA scoresheets are distributed as a workbook made up of checklists, worksheets, factor value tables, and scoring forms, each with brief instructions and guidelines for scoring. Some regions may require additional scoresheets, but there is a set of standard scoresheets that must be filled out for all regions.

The scoresheets are divided into the seven sections. The first two sections are: General Site Information, and Source and Waste Evaluation. The next four sections correspond to the four hazardous substance exposure routes, called pathways: Ground Water Pathway, Surface Water Pathway, Soil Exposure Pathway, and Air Pathway. Each pathway section is loosely divided into three sections based on factor categories: likelihood of release (relative likelihood of a hazardous substance migrating from the site through the specific pathway), target (presence of people, physical resources or environmental resources that may be threatened by release of a hazardous material from the site), and Waste Characteristics (an

estimation of the type and quantity of the wastes at the site). The particular importance of each factor can vary with the pathway, but, for example, primary targets are weighed heavily in the score regardless of pathway. The final section is a summary to the PA Scoresheet.

The scoresheets are set up so that the left hand pages of the workbook are instructions for filling out the right hand pages, and often explain the questions asked in greater detail, or help the environmental engineer transfer quantitative data that have been obtained into a numerical score for a particular section by providing tables and formulas. There is also a review for internal consistency included in the workbook, which is designed to eliminate inconsistencies in the report, that may undermine its overall validity. The EPA stresses, however, that the reviews and guidelines are merely to assist the environmental engineers in the scoring process, and for much of the time the engineer will be expected to use his/her professional judgment in the actual scoring.

In this manner, many sections or pages are assigned a total score, which is combined at the end to determine the overall score of the site. Many of the pages, however, simply ask for an explanation of certain aspects of the site in paragraph form, rather than as a numerical score. The total time to research the information and score a site averages about 100 hours, and writing the reports averages about 20 hours. Sites determined to be ineligible for CERCLA response (i.e. sites where there is no danger of hazardous waste leakage, not simply a lack of targets) may submit abbreviated PA reports. The scoresheets need not be submitted for CERCLIS analysis. However, the first two pages of the Potential Hazardous Waste Site Preliminary Assessment Form and the narrative report remain a requirement.

Finally, the decision (i.e. further action or no action) made concerning the PA is usually based on the overall site score. In general, a score of 28.50 or higher receives a recommendation for further investigation, while a score of less than 28.50 receives a "No Further Remedial Action Planned" (NFRAP) recommendation.

## *1.3. Overview of the EIDSS*

The Executive Information and Decision Support System (EIDSS) is an information system developed by the Class of 1997 Master of Engineering in Information Technology track, at the Massachusetts Institute of Technology, Cambridge, MA. The system provides computer tools to environmental engineers for Preliminary Site Assessment under CERCLA. The role of the information system is to retrieve relevant data from a source and to transfer it to a designated target with a different format. More advanced information systems consist of a unit for processing the data and adding meaning to it. The EIDSS in its current form consists of two modules: (1) Decision Support System and (2) Executive Information System. Figure 2 describes the architecture of the EIDSS.

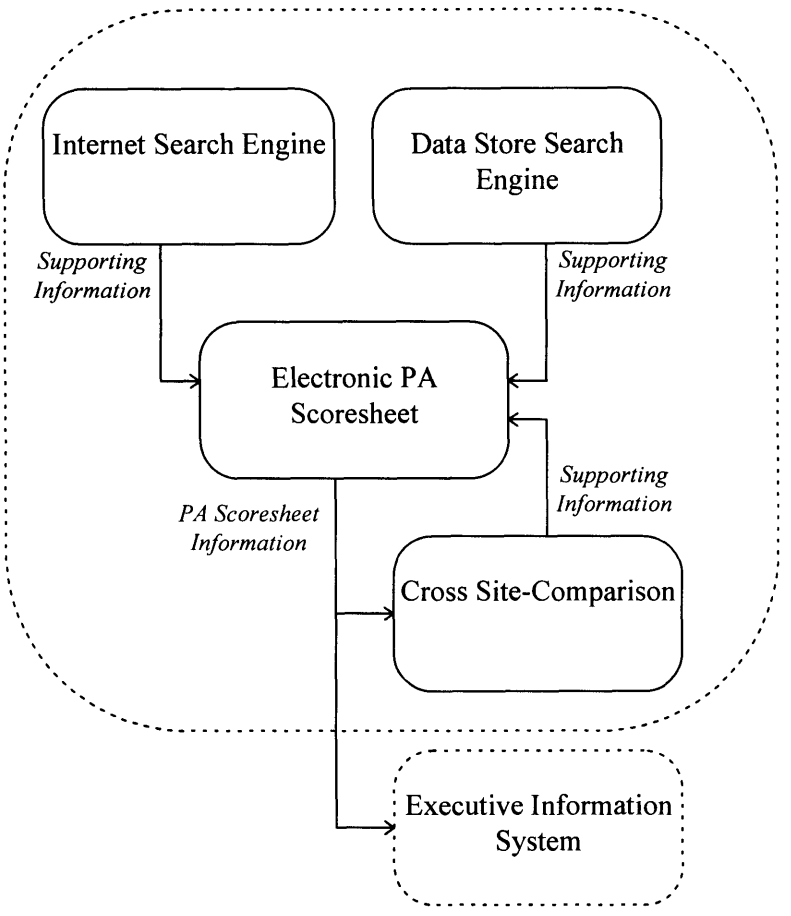


*Figure 2. Architecture of EIDSS*

### 1.3.1. Decision Support System

The Decision Support System consists of (1) Electronic PA Scoresheet and (2) Cross-Site Comparison. The Electronic PA Scoresheet is a computerized version of the current paper PA Scoresheet document. It is the focus of the remaining sections of this thesis. The Cross-Site Comparison plays a dual role for the scoresheet, namely as a storage and a source. It reuses information from already existing PA Scoresheets to serve as an information source for future investigations.

The currently existing prototype does not connect the two modules yet. Thus, the Electronic PA Scoresheet and Cross-Site Comparison are stand alone applications.

### 1.3.2. Executive Information System

The scope of Executive Information System extends beyond Preliminary Site Assessment. It provides a systematic approach to store documents from the different phases of the process and also provides retrieval tools. This part of the system takes information from various documents, including the Electronic PA Scoresheet, and stores them in a systematic way in a database. Information from the data base can be used to generate 'executive information' and assist in decision making at the waste site under consideration.

# 2. Overview and Definition of Presentation System

## 2.1. Definition of Presentation System

The main role of a presentation system is to provide the user with relevant and already filtered information from one or more sources in a visual format that will ease the decision making process. The presentation of documents depends on the strengths and limitations of the medium used to communicate the information as well as the workflow of the process. A paper medium is limited to text and diagrams, where documents presented usually follow a linear structure that depends on a sequence or a specific order of procedures. A computerized graphical system introduces new tools to present information and a set of defining concepts, like sophisticated visual presentation, pick-and-click interaction and hypertext links that provide communication between the document and the user. This new concept of interaction and better utilization of graphical presentation are driving the rapid transfer from paper media to electronic media in many applications.

## 2.2. Structure of information systems

Information structures are classified into four basic development structures: (1) linear, (2) web (or network), (3) hierarchical, and (4) grid (database like). The choice of structure of presentation system greatly depends on the nature of the content and workflow of the process.

Linear structure is used for the conversion of legacy linear documents. Linear documents are used for all items that depend on a sequence or a specific order. This includes step-by-step procedures. Linear documents imply that the user will start from the beginning and proceed until the end. It is important to provide both a (1) navigational document to enable users to go directly to the point at which they want to start and (2) navigational items on the control panel to jump from one section to the next or back to the previous section. In a Web or network structure the user is allowed to interrupt one section and go off to some other part of the document, then come back and finish. The Web document is broken into independent sections that have little dependency on each other. Hierarchies are a good way to break down a large set of ideas into related categories. By nature, the upper levels of a hierarchical structure are associated with general items, and the lower level items with a depth of specialization. For example, detailed forms can be a part of a more general documents that provide highlights of the detailed forms. Finally, the grid structure resembles a database. It incorporates concepts of the hierarchical structure. Sometimes people refer to grid structures as multi-parent hierarchical models (Morris, 1996, page 136-139).

## 2.3. Forms

Form design has been an evolving science for many years. Historically, form followed the linear structure characteristic of paper media. Currently, the new interactive capabilities of computer presentation systems are driving transfer of the forms from paper to electronic media that allows incorporating all four structures mentioned in Section 2.2. Many organizations, including corporations, government, and military, are currently redesigning their structure and workflow to move to the electronic medium from paper regime. At the same time, developers are creating new tools that allow transfer from paper documents to electronic format. Some guidelines for presentation system development have already been established for electronic forms, among the more obvious ones are: placing a submit button at the end of the document, defining and grouping fields, and limiting user choices to those that are critical (Morris, 1996, page 221).

Moving forms from one communication medium to another requires redesign of process flow and contents of the document. Content is knowledge, or relationships and associations between pieces of information. Although it is impossible to anticipate all of them, some relationships and associations can be provided through interactive links and link explanations. The main challenge in the design of interactive systems is the determination of relationships between pieces of information.

In addition, moving from paper to electronic document environment will require more than just using new enhancement offered by computers, it will require change of culture within the organization. Paper documents are an integral part of traditional cultures. Filing documents was a responsibility for which people developed sophisticated filing systems. Convincing this traditional culture to use electronic documents effectively is time and effort consuming. It can't be expected that the users will embrace this new idea with enthusiasm, especially if it will require change of their habits and learn new skills.

## 2.4. Conclusion

Interactive and graphical presentation of information has the capability to utilize person's information processing capabilities much more effectively than other presentation methods. If properly used, it can minimize the requirement for perceptual and mental information recording and reorganization, and also reduce memory overloads. Thus, it permits faster processing of information and more compact representation of information.

# 3. Design Process for Presentation System

## 3.1. Overview of the Design Process

The design process adopted for the development of a presentation system for the Electronic PA Scoresheet consisted of the following stages: (1) analysis and design, (2) development, (3) implementation, and (4) testing. The Analysis and Design stage included understanding of the scope and domain of the project, as well as designing the layout of the interface. The Development stage consisted of the selection of technologies and prototyping. The next sage consists of incremental implementation of features. Finally, the system was tested for robustness of the application, including platform compatibility, and depending on the outcome of the test, system is either redesigned or only small units of it are changed. The design process for the presentation system is shown in Figure 3.

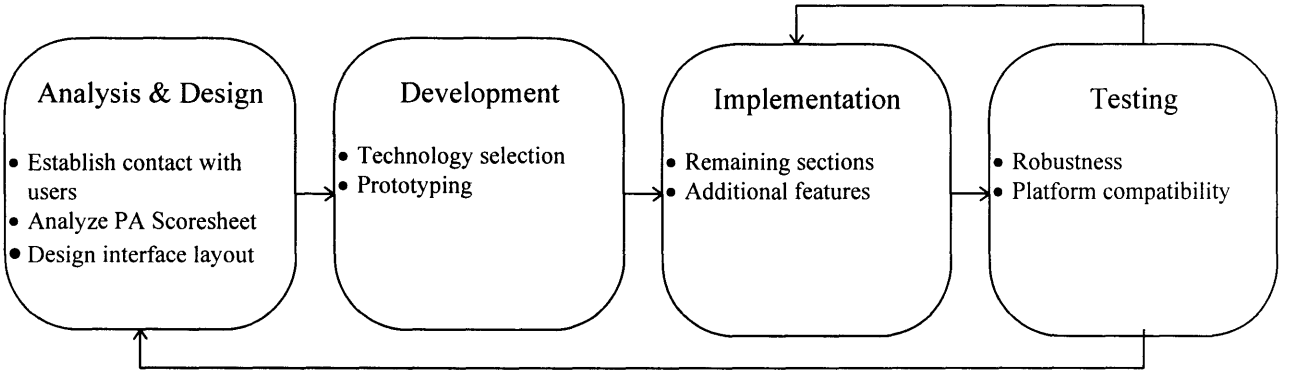


*Figure 3. Design Process for Presentation System*

## 3.2. Analysis and Design

### 3.2.1. User Input

The analysis and design stage in the development of a presentation system typically involves talking to the end users to gain understanding of their needs. This step can enrich yet at the same time limit the capabilities of the application. Allowing end users to design the main features of the presentation system will ensure their acceptance of the system. At the same time, users have a tendency to describe their needs in terms of what they already know, which usually excludes the newest technologies. In the case of the PA Scoresheet, the user may describe the new presentation system for computer application as if it was a paper medium. The existing PA Scoresheet was developed using the paper medium of communication. To decrease the user's lack of knowledge of the capabilities that a new medium of communication can offer, it is useful to ask them to describe the "perfect world." This approach was proposed by Ed Heresniak, Senior Lecturer at MIT, who had many years in industry, working for companies like IBM and Standard & Poor. According to this approach, users should not think of today's limitations of technology but describe would they would like their application to do in a"perfect world" where everything is possible (Heresniak, 1994). Therefore, it is crucial that the users do not think in terms of technology constraints.

A second alternative with respect to the user input is to provide consulting to the user in the form of suggestions. The user, who understands a particular part of the process that he/she is directly involved in,

the best, can be made aware of the capabilities of the newest technologies. It is also advisable that the consultant understands the business process in addition to current trends in technologies. Allowing the user decide on what the interface should look like with suggestions for possible solutions from the technical staff takes better advantage of new technologies and results in a more creative solutions.

### 3.2.2. Documents in Electronic Form

Historically, paper documents have been present at the core of the remediation process. Moving from a text based medium of paper documents to interactive electronic form documents provides many challenges. The new computer environment offers new interactive tools that were not previously available. In order to be able to take full advantage of the electronic application capabilities, the documents need to be redesigned to incorporate the new interactive medium. However, transferring paper documents into electronic format and making them the industry standards requires official approval. Due to lack of interaction with the end users and the regulators, the implementation of this project was based on the existing process and documents.

There are many advantages of converting traditional paper documents into electronic form on networked computers. Multiple engineers can work on the same worksheet without the delay of paperwork transfer from one office to another. When the document form needs to be changed due to changes in regulations and process, the new format can be distributed instantaneously. In the paper copy regime, it took some time for old forms to be discarded and new forms to be distributed. Completed and partially completed scoresheets may be stored for the use of updating information or retrieving records of past decisions at any point in the future. Another advantage of placing the PA scoresheets on networked computers is that they can easily be linked to the Internet or databases, where large amounts of relevant information that can assist in their completion may be found. Other features can enhance the electronic based documents, like built in calculators, tables and other lists containing default options. Lastly, once the scoresheet is completed and stored in a database, an executive summary report may easily be generated.

Setting an electronic document to be the industry standard that replaces paper forms requires careful consideration of liability and the availability of computer resources. If a bug in a system becomes a cause of a bad decision, who should be responsible: the environmental engineer or the system developer? There are no current laws that address those issues. Although the availability of computer resources was an issue few years ago, nowadays, it is almost assumed that every environmental engineer either owns or has access to a computer.

In implementing the PA Scoresheets, based on the existing preliminary assessment process and documents, many changes of the paper format document were made to aid the user. Questions were restated and new fields were created to reduce complexity. The electronic document presents all the information that the paper document does, but also makes use of some of the capabilities of the new electronic medium.

### 3.2.3. Structure

#### *3.2.3.1. Content*

The Electronic PA Scoresheet was based on the layout of the paper PA Scoresheet, which exhibits qualities of both linear and hierarchical structures described in Section 2.2. The original document, as described in Section 1.2, consists of the following sections: title page, General Information, Source Evaluation, Ground Water Pathway, Surface Water Pathway, Soil Exposure Pathway, Air Pathway, and Site Score Calculation, which need to be filled out sequentially. Each of those sections is broken down further into smaller subsections that contain similar information. The first three sections contain

background information, the next four contain supporting information and individual scoresheets, and finally the last section integrates information from the previous parts.

The first section is the Title Page: it is here where the user enters information about the site and the investigator. Currently, the format of the paper document was preserved, but in the future is can be replaced by a logging in session. The engineer (after registration with the administrator of the system) will be able to log into the Electronic PA Scoresheet, and the system will already have all the information about the investigator.

The second section stores general information about the site. This assumes that no database is available with the site information, which therefore must be gathered by the user for the purpose of answering the information that will provide the sore for the site. In the future this section can be replaced by an information search application that is independent of the scoresheet. In the "perfect world," all the general information about the site would be stored in a database prior to the site scoring stage of the remediation process. In the current application described here, many of the complex questions were reinstated in the form of fields.

The third section stores information about source of the contamination. Similarly to the previous section, it can be separated from the PA Scoresheet and stored in a separate database. This information can then be retrieved from the database when needed.

The next four sections contain information that lead to four scores for Ground Water Pathway, Surface Water Pathway, Soil Exposure Pathway, and Air Pathway. Each of the four sections follows a similar format. Sections contain the following features: a list of questions that are to support engineer's decisions as to the level of contamination at the site, called the criteria list, a scoresheet, and supporting tables.

The final section provides the final score for the entire site and summary of the PA Scoresheet.

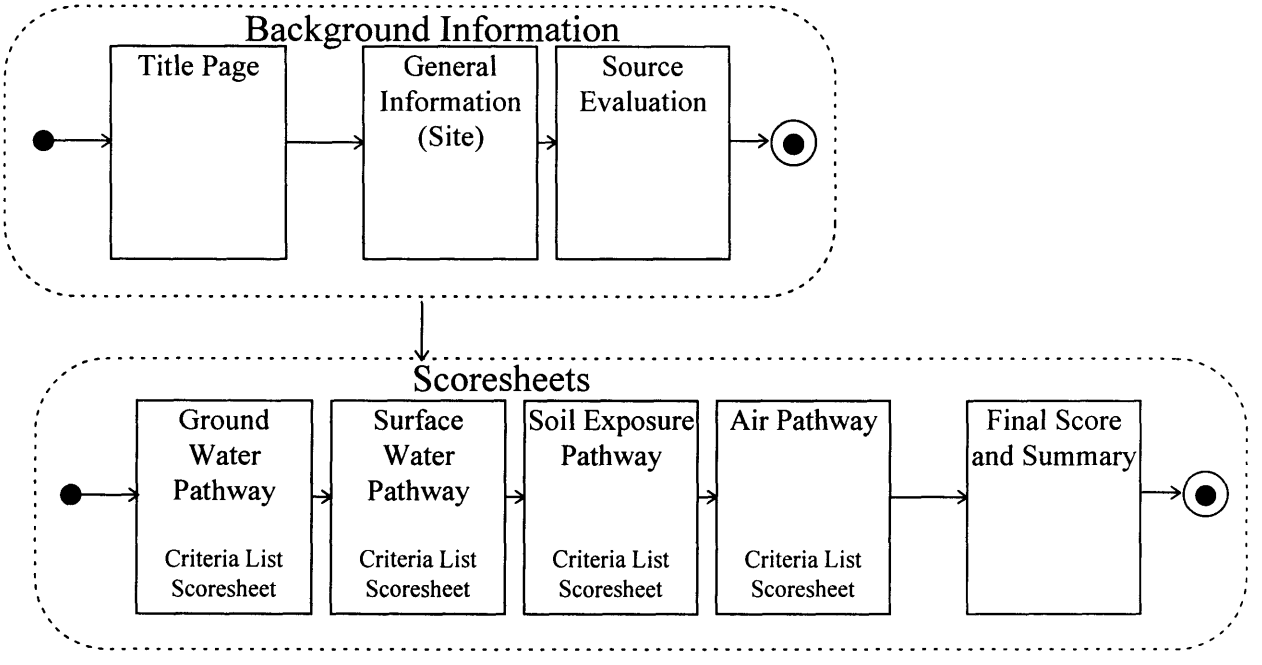


*Figure 4. Structure of Electronic PA Scoresheet*

### 3.2.4. Navigation

The navigation through the entire document currently follows linear structure. The user is not allowed to go back and forth between the pages, as each page depends on the information filled out in the previous page. Each page, has, however, links to previous sections that influence the answer to that particular section. In the future, if the process of filling out the PA Scoresheet is reengineered, navigation can be updated to allow user to freely browse through sections in any order.

## *3.3. Development*

The development stage consisted of two sub-stages: technology selection and prototyping. Below are described the technologies selected for the project and the prototyping phase.

### 3.3.1. Technology Selection

When selecting technologies to implement the PA Scoresheet, the following requirements were considered: flexibility, adaptability, and maintenance - as the process of transition from paper to electronic medium requires many iterations. For the Electronic PA Scoresheet, a Web based presentation system was chosen because of its capabilities to work in distributed environment.

#### *3.3.1.1. World Wide Web*

The roots of World Wide Web (WWW) reach back 25 years. However, most of its growth took place during the last 5 years. In 1982, with the near-universal changeover to TCP/IP protocols, the word Internet became the common term for referring to the worldwide network of research, military, and university computers. In 1993, InterNIC (the Internet Network Information Center) was created by the National Science Foundation to provide information, a directory and database, and registration services to the Internet community. In 1992, to help promote and facilitate the concept of distributed computing via the Internet, Tim Berness-Lee created the World Wide Web. Today, the Internet has become an integral part of our business, academic, and social environments. People are on the Web to conduct business, exchange information, express their creativity, and collaborate (Brown, 1996, page 9-36).

Browsers are programs that allow users to view information on their screen. Most of the browsers available today include the capability to access other Internet technologies, such as Gopher, e-mail, and the Usenet news, as well as the World Wide Web.

The Internet can be a powerful tool in gathering, sorting, and retrieving data, areas important in the development of decision support systems. However, presentation of information is probably the main draw to the Web. Web sites have the ability to integrate graphics, hypertext, links, and even video and audio files.

#### *3.3.1.2. HyperText Markup Language (HTML)*

The Electronic PA Scoresheet is implemented in HTML 3.0, an Internet standard since 1996. HTML, evolving into a complex hypermedia markup language, allows the construction of visually interesting web pages that organize and present information in a way seldom seen in other online venues. Web sites

are said to be composed of pages because the information they present looks like magazine pages. Using HTML ensures platform independence.

#### *3.3.1.3. The Common Gateway Interface (CGI)*

To support dynamic interaction on the Web, the Common Gateway Interface (CGI) was used. CGI is an interface that runs external programs under the direction of an HTTP server. It allows dynamic creation of HTML pages and acts as a middleware among WWW servers, external databases, and information sources. It handles information requests on a server's behalf(Tittel, 1995, page 9-10).

Perl, Practical Extraction and Report Language was chosen as a CGI programming language. Created in early 1980's by Larry Wall, it is an interpreted language optimized for easy manipulation of files, text, and procedures. Since reading and writing information to and from temporary files and creating HTML pages is very important, Perl was the optimal choice.

#### *3.3.1.4. Java*

For development of special features, like automatic tables and calculations, Java Applets and JavaScript were created. The Waste Characteristics Scores Table on page 5 of the PA Scoresheet (see Appendix D), was automated using first JavaScript and then Java Applet. Java Applets are more cumbersome to implement as it is more difficult to pass results calculated in the Applet back to HTML fields, unless the fields are defined as a part of Java Applet. For that reason, Java Script is a easier tool in creating interaction and automation between the fields on the HTML page.

Both Java Applets and JavaScript are both products of Sun Microsoft. Java Applets runs within a Web page via a Java-enabled browser. As opposed to the independent applications files used to deliver Java Applets to Web browsers, the actual source code for JavaScript scripts are included directly in the Web pages. It adds interactivity to Web pages with little effort. JavaScript started as Netscape's own scripting language until, in 1995, Sun embraced it as a programming language (Danesh, 1996, page 13).

### 3.3.2. Prototyping

The early prototype included only the first three sections of the scoresheet: General Information, Source Evaluation, and Ground Water Pathway. These sections were implemented as static HTML created Web pages. The fields in each form are a part of the HTML <FORM>. Text fields, check boxes, radio buttons, text areas, and lists were used to present information. Most of the formatting of the pages was done through usage of tags <TABLE> and <LIST>. For navigation, <FRAME> tag was used.

Each section was independent and no information was passed from one section to another. Also, no default values were assigned as the application lacked the capability to store information. The Waste Characteristics Scores Tables (page 5 of the PA Scoresheet or Source Evaluation page of the Electronic PA Scoresheet) was automated via JavaScript language. The prototype was limited to providing results solely based on parameters entered by the user as the application was not connected to external data sources.

## *3.4. Implementation*

After testing the prototype, the remaining sections were implemented as static HTML pages. Then, GCI Perl script was written to create HTML pages dynamically, and temporary files were created to store the input from each page and to assign default values. Finally, additional JavaScript functions were added to increase the level of interaction between the HTML fields.

The remaining sections were implemented as static HTML pages, following a similar format to the first three prototype sections in order to provide consistency and predictability to the application. All the sections use similar components, like the select list options, and operate similarly.

The implementation of the dynamic creation of HTML pages via CGI consisted of four stages. First, a submit button was added to each HTML page that connects the page with a corresponding Perl script file. Then, a function was added that reads all the values passed from the HTML page and writes them to a temporary file. Writing information into a temporary file is necessary because the HTML page itself has no capability to store any information. Upon exiting a page, all the information is lost and can not be recovered. Second, a subroutine was created that reads and processes the next HTML file. A third step is to build logic into the script that would assign default values from the temporary files to the HTML fields and display them in the browser. Finally, in the future, default values could be determined by the decision support system based on the user input about the site. Currently, the temporary files hold data only from sections in the Electronic PA Scoresheet completed by the user.

Next, several JavaScript functions were written in the Ground Water Pathway section to increase interaction of the Electronic PA Scoresheet with the user. The enhancements include Calculate buttons, that take values from appropriate fields, process them and display the results in the proper output field. Also, some of the questions that appear multiple times in the same section are automatically assigned values when an answer is provided in any other place. Each function has the same build in logic as the traditional PA Scoresheet.

In addition, the Internet Search Engine and Data Store Search Engine were implemented for some of the questions of the criteria lists in the Ground Water Pathway and Surface Water Pathway sections. The connection was established through hypertext links linked to CGI functions.

## *3.5. Testing*

Finally, testing was focused only on system robustness. It included testing the application by people who are not necessarily from the environmental field. Testing was performed on the following platforms: Windows NT, Windows 95, Suns and SGI UNIX environments to ensure platform independence. Only Netscape browsers were used as Explorer does not support JavaScript as if May, 1997.

# 4. Electronic PA Scoresheet

As mentioned in Section 3, the structure of Electronic PA Scoresheet resembles the structure of the paper document. It is composed of eight HTML pages. The first page corresponds to the title page. The next two pages are used to gather information about the site and the source of hazardous substances. The following four, correspond to four hazardous substance exposure routes: ground water, surface water, soil, and air. The final page is a summary of the findings. See Figure 4 for illustration of the information structure of the Electronic PA Scoresheet.

## *4.1. Title Page*

The title page of the PA Scoresheet very closely resembles the paper document. No new fields were defined. The site and investigator information are filled out manually by the engineer, except the date that is filled out by JavaScript *new Date()* function. In the future, however, this information could be read from a database.

On the bottom of the title page, an Open Scoresheet button is created that invokes Perl script. All the information from the HTML fields that are filled out by the engineer is stored in a temporary file. Currently, no default supporting information is being passed to the next section, General Information. In the future, however, a search can be performed based on site name to determine any supporting information that can be used to fill out the remaining sections of the scoresheet. This feature, the Cross Site Comparison, is currently under design by Joel D. Guzman (Guzman, 1997).

## *4.2. General Information*

The General Information page takes great advantage of predefined fields in the HTML form. Information that was traditionally presented as a text report in the paper PA Scoresheet, is redefined as fields. The user is also provides with default options for some of the answers.

The General Information section consists of four parts: (1) Site Description and Operational History, (2) Probable Substances of Concern, (3) Site Sketch, and (4) Map of the Site. In the paper regime, information contained in the first two sections of the General Information are presented as plain unstructured text. The first part, Site Description and Operational History requires the user to provide the following information: site name, owner/operator, type of facility and operations, size of property, status (active or inactive), and years of waste generation. It also asks for information about waste materials: waste treatment, storage, disposal activities that may have occurred on the site (indicating source of information), probable source types and prior spills. All this information lacks structure and standard format. The Electronic PA Scoresheet organizes all this information into three categories: (1) Site Description and Operational History, (2) Activities at the Site, and (3) Probable Substances of Concern.

The Site Description and the Operational History contain the following information in the form of fields: Site Name, Owner/Operator, Type of Facility, Type of Operations, Size of Property, Status of Facility (active/inactive), and Years of Waste Generation. Type of Facility and Type of Operations both have a list of choices that provide default answers.

The Activities at the Site section contains three text fields, to be filled out by the user, summarizing waste treatment activities, storage activities, and disposal activities. Each of the three text fields can be assigned a confidence level (0-5, 5 being very confident), and type of source of the information (documented/alleged). In the future, a link to previous investigations performed in the area can be added. Also, with help from an environmental engineer, more of the currently vague questions can be restated and replaced by new fields to further define structure of the information.

The third section, Probable Substances of Concern, provides space for listing and short description of three hazardous substances. Each substance is assigned one of the three activities associated with it: stored, handled, or disposed, along with a confidence level (from 0 to 5). The confidence level is used to determine reliance of data and its source. For example, information from EPA databases is very reliant and can be assigned a confidence level of 5. In the future, the list of hazardous substances can be extended from three hazardous substances to the number of items requested by the user.

The last part of the original paper document, site sketch, requires freehand sketch of the site. Currently, this subsection is omitted, but in the future, as it is expected that maps of all sites will be available in electronic standard form, it can be accessed by the Electronic PA Scoresheet site. A link to an appropriate map eliminates the need of free hand drawing.

On the bottom of the page, a *Next Page* button is created. It invokes Perl script that stores the data form the General Information page and creates the Source Evaluation page.

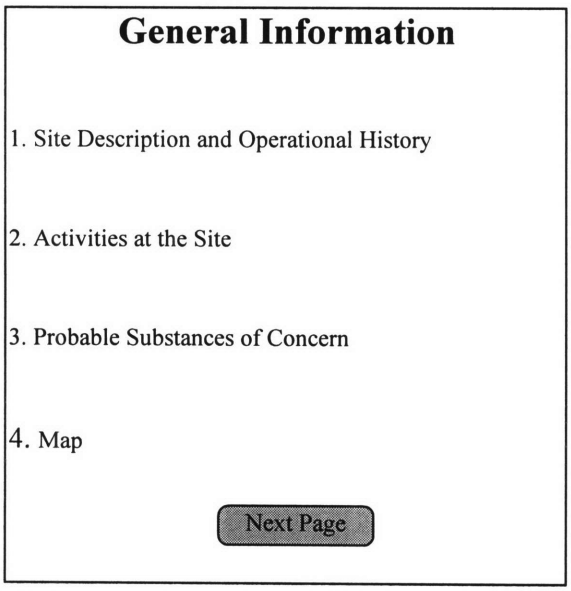


*Figure 5. General Information Page*

## 4.3. Source Evaluation

The Source Evaluation section of the paper PA Scoresheet is used to gather information and to calculate the Waste Characteristics (WC) Factor. The WC Factor is used in determining score in subsequent sections. The user needs to identify the type of hazardous substance source from a description and look up a score for each source from the WC Scores Table. The calculations differ whether they are for a single or multiple source site. Currently, the Electronic PA Scoresheet allows calculation of only one source, as only one table is implemented. Extending it to handle multiple sources requires writing relatively simple CGI script that would create multiple copies of the table for each site.

To calculate a score for a source using the table, the user needs to identify a waste quantity for each of the following: constituent, wastestream, volume, and area. Only when the waste quantity is known, is the user required to check the checkbox and fill out the corresponding field. If no information is available, the *No Information about the source is available* choice should be checked. Finally, if a primary target can be identified as either ground water, surface water, or air migration, the appropriate choice should be checked. Also, a list of source types provided by volume and area for the convenience of the user. When

all the fields are completed, the *Calculate* button will call a JavaScript routine that calculates the WC score and displays the result.

Similarly as described in the previous section, the *Next Page* button, stores the information about the source and creates the next page, the Ground Water Pathway.

This section takes great advantage of available technology capabilities. The user no longer has to go through a process of learning how to use the table, nor does he/she have to make any calculations. The table has build in logic of the traditional table and it performs all the necessary calculations.

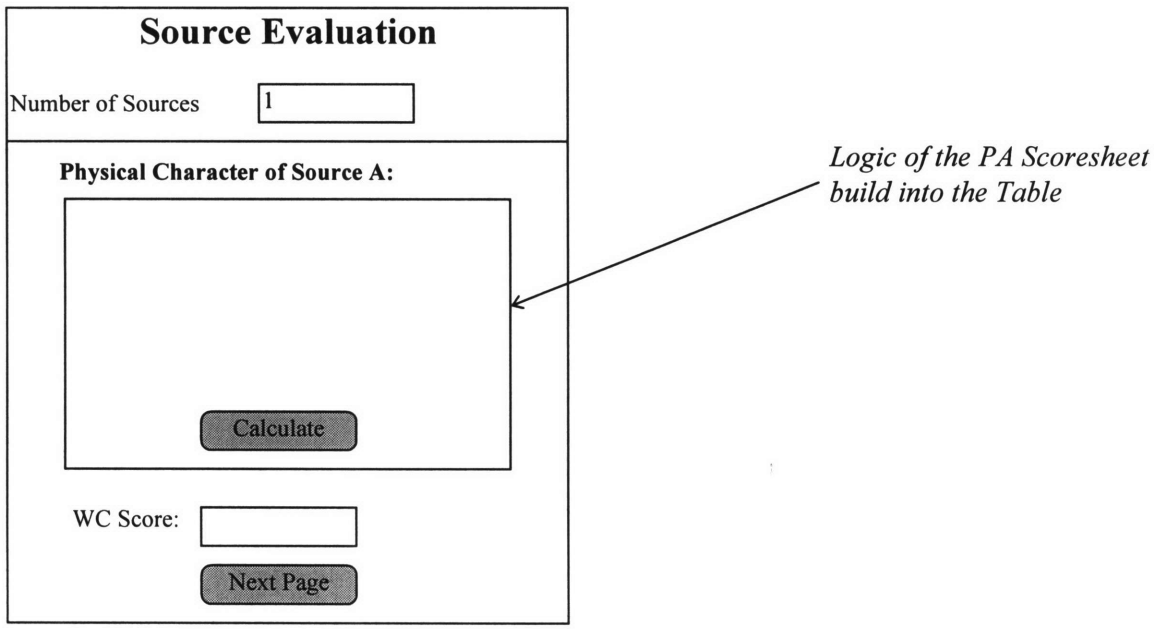


*Figure 6. Source Evaluation*

## 4.4. Ground Water Pathway

The Ground Water Pathway section is divided into four parts: (1) Ground Water Use Description, (2) Calculations for Drinking Water Populations, (3) Criteria List, and (4) Ground Water Pathway Scoresheet. The first three sections, are used to gather background information used in the fourth part that is used to determine the Ground Water Pathway score. Figure 7 describes the structure of the Ground Water Pathway Section.

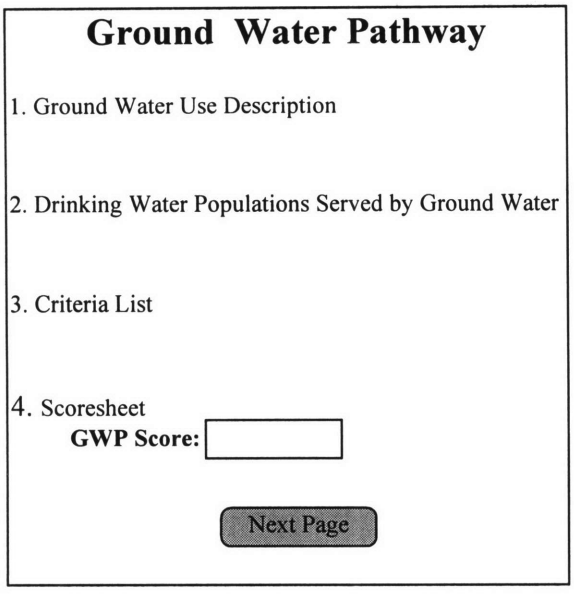


*Figure 7. Ground Water Pathway*

The first part, Ground Water Use Description, is to provide information on ground water use in the vicinity, including general stratigraphy, aquifers used, and distribution of private and municipal wells within 4-miles of the site. All this information is used to support calculations in the following parts of the Ground Water Pathway section. In the paper PA Scoresheet regime, this information was gathered from non-electronic sources. Currently, there is a hypertext link that sends the user to general Web search engine sites, that returns all information that contains key world entered by the user. An experienced person can find all kinds of information on the Web in few minutes, but it could be very time consuming and frustrating for someone who does not have any experience. In the future, an intelligent search engine could be created that provides the user with only relevant information.

The second part, Calculations for Drinking Water Populations, is also used to gather information necessary to fill out further sections of the scoresheet. The original paper document required a written report that would provide information for subsequent parts of the Ground Water Pathway section. The Electronic PA Scoresheet has a build in table that provides information to functions that calculate the scores in the scoresheet part of the Ground Water Pathway section.

The next two parts, Criteria List and individual scoresheets, are similar across the four sections of hazardous substance exposure routes.

### 4.4.1. The Criteria List

The Criteria List consists of two parts: (1) Suspected Release, and (2) Primary Targets. Figure 7 describes the layout of the Criteria List part of the Ground Water Pathway Section.

An Internet search engine was created to aid answering questions for this sections. It passes predefined key words to one of the general Web search engines. Currently, the Internet Search Engine can provide supporting information for only a few questions, but in the future this application can be extended to provide supporting information for the entire application. For more details about the Internet Search Engine, refer to Appendix A.

The paper PA Scoresheet indicates that the Criteria List can be used for more than one source and more than one primary target (provided there is a source). The Electronic PA Scoresheet currently supports only a single source and one target, but it can be expanded to multiple forms using CGI script.

The answers to the questions are in the radio check form, where user has three options, *yes*, *no*, and *unknown*. When the user answers one of the critical questions, *Suspected Release?* or *Primary Target(s) Identified?*, a function is invoked that assigns NA (Not Apply) value to fields that don't need to be filled out. Alternatively, those fields can be disabled.

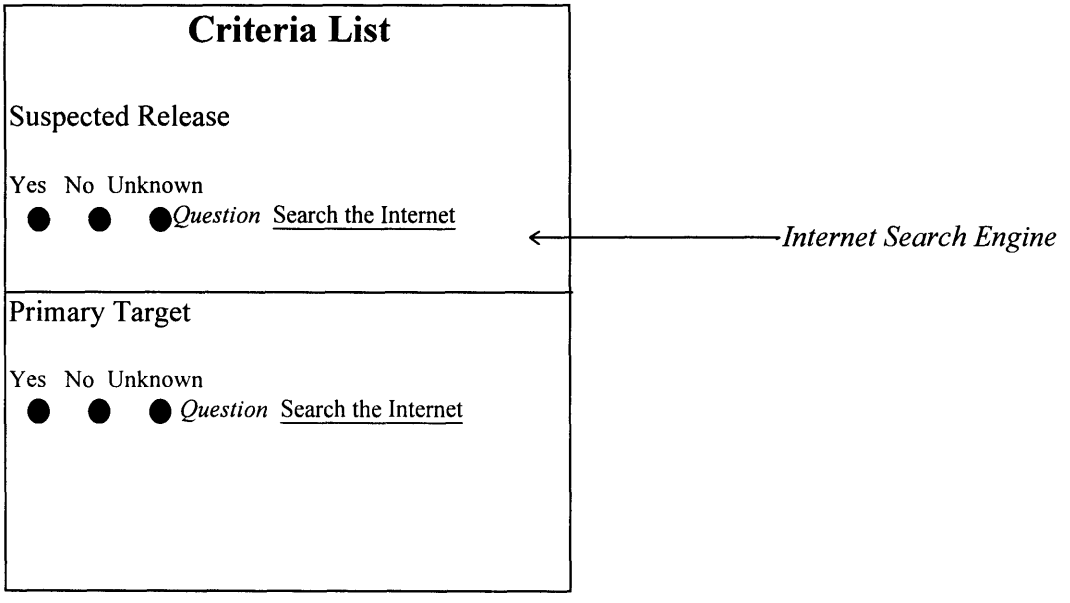


*Figure 8. Ground Water Pathway Criteria List*

### 4.4.2. Ground Water Pathway Scoresheet

The Ground Water Pathway Scoresheet consists of four parts: (1) Pathway Characteristics, (2) Likelihood of Release, (3) Targets, and (4) Waste Characteristics. The scoresheet consists of two columns, one corresponding to a score when there is a suspected release (right column) and the other when there is no suspected release (left column). All answers are entered in one column, depending on an answer from the Suspected Release section of the Criteria List. Figure 9 shows the structure of the Ground Water Pathway Scoresheet.

In the Pathway Characteristics part, all the questions must be answered in order to be able to use the build-in functions. Some of the questions may appear more than once. If the user has provided an answer to a question in one section, this question will automatically be filled out in the remaining sections. For example, if the user has already provided *Yes* answer to *Suspected Release?*, the question *Do you suspect a release?* in Pathway Characteristics will be automatically checked *Yes*.

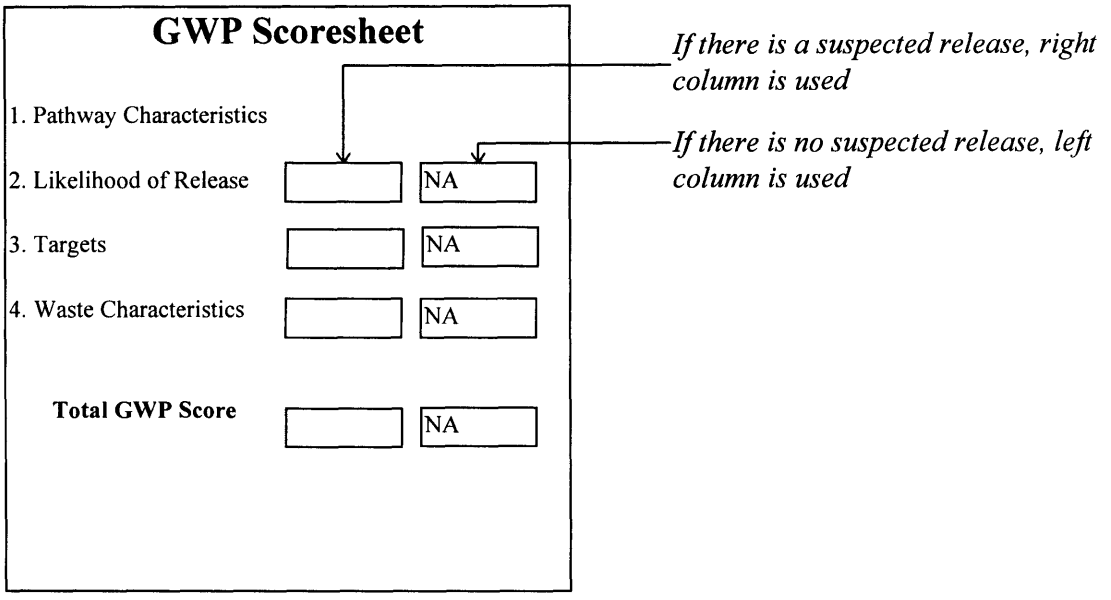


*Figure 9. Structure of GWP Scoresheet*

Each of the next three sections, Likelihood of Release, Targets, and Waste Characteristics, begins with an explanation on how to calculate the score followed with a table of actual fields to be filled out. The user has an option of either reading the information first, or to skip the instructions and go directly to calculate the score. By each field, there is a hypertext link, labeled Explanation, which brings the user back to the instruction section at any time. Some of the explanations contain additional fields to be filled out and questions to be answered, that need to be answered in order to be able to take advantage of the built-in functions to calculate the score. Figure 10 illustrates the general structure of each section.

The score corresponding to the Likelihood of Release is totally based on the three questions answered in the Pathway Characteristics upon pressing the *Calculate* button. There is a JavaScript function associated with the ONCLICK action that reads the values of fields necessary to make the calculations. The Targets part is probably the most complicated and hardest to follow on the Ground Water Pathway Section. It requires information that is not provided anywhere on the Scoresheet, like the Wellhead Protection Area information and list of resources. Waste Characteristics part takes results of the Source Evaluation Section (See Section 4.3).

The Ground Water Pathway Section is the only automated section (besides the table in the Source Evaluation Section). All the interaction between fields is done via JavaScript functions that are called upon event in the HTML pages.

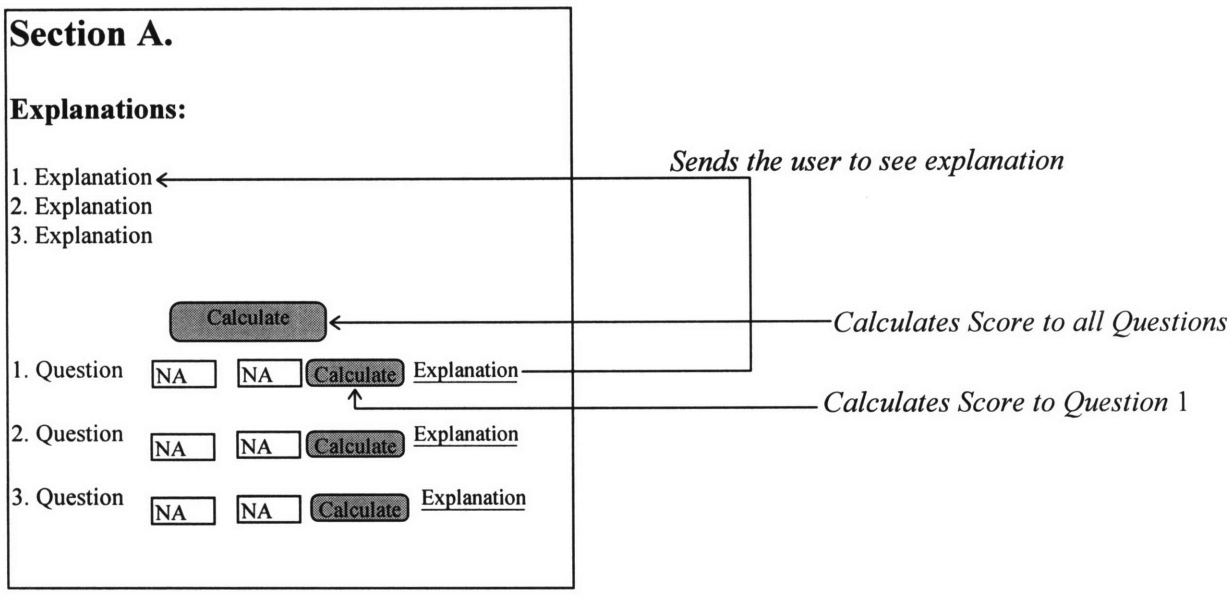


*Figure 10. General Structure of Each Section of the Scoresheet*

## 4.5. Surface Water Pathway

The Surface Water Pathway was directly translated from the paper document into HTML page without improvement of the structure of information. Its two main sections: Criteria List and Scoresheet, can be redesigned to follow the basic structures developed for Ground Water Pathway section (see Sections 4.4.1 and 4.4.2).

This page takes advantage of a build-in Data Store Search Engine in the Criteria List, which was developed by S. Rony Mukhopadhyay (Mukhopadhyay, 1997). Similarly to the Internet Search Engine, the user can search for information related to each particular question by double clicking on a hypertext link labeled Search the Database. Rather than receiving a list of potential sources, however, the he/she gets an actual answer from an existing standardized database, unless the database has no information. Appendix B describes the Data Store Search Engine in more detail.

# 5. Alternative Technology Solutions

An alternative Web based solution to the creation of HTML pages via CGI Perl script, is implementing the presentation system as a single Java Applet embedded in a single Web page. This approach has many advantages over the dynamic creation of an HTML page, but it is much more complicated to implement and not as flexible as the HTML approach. Both the advantages and drawbacks are discussed below.

The main advantage of a single Java Applet is storage of all variables in one place, which eliminates the need for temporary files. The problem of cleanup of those files upon unexpected exit is eliminated, as all traces of Java Applet are destroyed from the users machine upon exit of the site. Passing variables between the pages of the scoresheet therefore becomes very easy.

A serious drawback of using a single Java Applet for the entire scoresheet is its lack of flexibility. Changing parts of the application is complicated, involving adding functions to handle events, and recompiling the source code (although Microsoft Explorer provides just-in-time-compiling for developers of Java Applets). Such large Java Applets are hard to debug. Also, creating the user interface is complicated, as the layout of the web page is harder than in HTML. Linking Java Applets with new external databases is complex.

Finally, loading large Java Applet onto the user's machine could potentially be much slower than processing one page at a time, depending on the configuration of the user's computer.

Yet another solution would be embedding many Java Applets in HTML pages that have the capability to communicate with each other. This solution breaks the single Java Applet into smaller segments which eliminates many of the problems associated with development of large Java Applets that are listed above. This solution has similar results to JavaScript implementation. Due to time constraint that the project was under, JavaScript proved to be an easier development tool comparing to Java Applets. Java Applets need to be recompiled every time a change is made, while JavaScript functions reside in the HTML file, which needs to be only reloaded. Also, a situation when a result field embedded in one Java Applet (result fields must be part of an applet) is used as an input by another Java Applet, is not easily solved by this approach. It would require creation of additional fields.

# 6. Conclusions

This thesis presented the development of a presentation system for EIDSS to support decision-making process during the Preliminary Assessment (PA) phase of the Superfund process. There are five aspects of the system that require further resolution: (1) user input in the design of presentation system, (2) the technology used, (3) availability of electronic information relevant to the PA Scoresheets, (4) the system's integration and expandability, and (5) the potential impacts of this system on the Preliminary Assessment phase of the Superfund process. Each of these aspects is discussed under separate headings below.

## *6.1. User Input in the Design of Presentation System*

Designing a user interface that integrates the different components of the system requires cooperation of the developer and the end user. If a group of representatives the of end users is not directly involved in the design of the presentation system, the application, although presenting interesting solutions, may not meet their specific needs. The user input ensures that the presentation layer is customized to the particular group performing a particular task. Due to lack of contact with environmental engineers, the presentation layer was build based solely on the traditional paper PA Scoresheet. This shifted the focus of the project from building a totally new information system to simply transferring documents from old, paper medium of communication, to new, electronic medium. Thus, the Electronic PA Scoresheet is an application that aids the environmental engineers in the traditional process of remedial investigation. The full potential of the now available technology and information tools are not fully utilized.

## *6.2. Technology*

A number of technology-related issues arose during the system's development. There are many alternative technology solutions to choose from that potentially can be used to implement the system. Also, many restrictions on the part of technology were encountered, but advancements in the tools used are anticipated, so future, upgraded versions of the systems should not face such restrictions.

### 6.2.1. Choosing Technologies

There is an abundance of technologies that can be used in the development of an interactive Web based presentation system, including Java, Java Applets, JavaScript, and CGI scripts. Most of those technologies have overlapping functions, thus potentially anyone of them can be used. When choosing a technology, all requirements and limitations of the system must be carefully considered. For the development of the Electronic PA Scoresheet, CGI scripts and JavaScript scripts were both used to add interactivity to the HTML pages, as they offered most flexibility and were easiest to implement in the very short time available for completion of the project. Currently, JavaScript is supported by only limited number of Web browsers, not including Microsoft Explorer, which constrains the user. It is anticipated that in the future JavaScript may become a part of HTML specification, meaning that all browsers will be supporting it.

### 6.2.2. Data source connection

There were many obstacles encountered in trying to connect the scoresheet pages on the web to the data sources. A large part of this was because the development of the Data Store Search Engine was first attempted using Java Database Connectivity (JDBC), a very new tool that is not yet reliable. The system currently requires that the program executing the query on the data source and the data source itself be on

the same server. So, when more sources are gathered, either a program must be installed at the location of each data source, or all of the data sources must be brought on to a single server. Using JDBC for the entire Search Engine, however, would eliminate this requirement. JDBC will almost definitely be more reliable within a year, so the possibility of using a more robust system is conceivable in the future.

### 6.2.3. Integration of components

Currently, the two components of the decision support system, Cross-Site Comparison and the Electronic PA Scoresheet, are not integrated. The integration of these two parts was also greatly restricted by available technology, although these restrictions are expected to diminish in the near future, as the technology matures. The Electronic PA Scoresheet uses data from distributed sources from three different modules: (1) an Internet Search Engine locating possible relevant data locations in non-standard form, (2) an Data Store Search Engine retrieving data that is known to exist from standardized data sources, and (3) a Database for Cross-Site Comparison, which allows retrieval of data from previously filled out PA Scoresheets. More database types are becoming easier to connect to the Internet through the use of tools that easily display query results or table values on a web page. The versatility and reliability of these web connections, however, is not yet sound, though they are expected to be so in the near future.

## *6.3. Electronic Information*

### 6.3.1. Availability

The decision support system was severely limited by the lack of suitably stored information. There is currently very little information relevant to the PA Scoresheets in an electronic format, and even less in a standard format. Thus, the scope of both the Internet Search Engine (see Appendix A) and the Data Store Search Engine (see Appendix B), used to assist in filing out the PA Scoresheet, is currently limited. Many of the questions on the scoresheets are conducive to being answered with the assistance of electronic media, but the questions of when the information will be standardized, and who will actually set the standards, remain unanswered. It is likely that compiling such data into an electronic form will only be done by a non-profit organization, as there appears to be little commercial profitability linked with such a task.

### 6.3.2. Standardization

The information required to complete the PA Scoresheets must originate from sources reliable enough so that the potential user of the system will be comfortable with the data. If the system is to eventually be set up so users pay for accounts to use the system, the sources must conform to industry and countrywide reliability standards. This problem is best illustrated by considering the case where information is duplicated in two or more data sources. Under such circumstances, there must be a method to determine which source will be used. Possible determination methods include surveying the current clients to find their preference, and doing a thorough investigation on the origins of the data sources to determine which is more reliable.

## *6.4. Expandability*

### 6.4.1. New functions

In its final form, provided the information in electronic form is publicly or privately available, the entire scoresheet can be filled out automatically and then verified by the investigator. Upon submission of the

first page, a search for data will return necessary information that would assist with filling out the entire scoresheet. The user will have a chance to request additional information and check the confidence level of the source. This last function is already partially implemented in the current version of the application for a limited number of questions.

Also, more enhancements will be made to improve navigation of the system. In the current version, the user is allowed to fill out the scoresheet only sequentially page-by-page, question-by-question. The system can be updated to allow the user to browse back and forth between the pages in any order. HTML frames can be used to implement this feature: one frame that contains an index of all the pages can allow the user to select any page at any instance, while the other frame displays the actual page. This feature was present in the static HTML pages, but it requires more complicated changes when created via CGI scripts.

The Electronic PA Scoresheet is a part of decision support system, and it needs to be integrated with the Cross-Site Comparison application.

In the future, if the Electronic PA Scoresheet is to be used as a commercial site, each user needs to be registered by the system administrator and the information from each page needs to be stored in a database so that the users would be allowed to come back and review the document whenever necessary.

### 6.4.2. Beyond the Preliminary Assessment Phase

Due to the scope of the project, the information system is currently limited to the Preliminary Assessment phase of the Superfund process. Using the decision support system principle of combining a document-like user-interface, a search engine and a database management system, a similar information system could be designed and used in other steps of the Superfund process. This expanded system would then allow users to easily refer to, and use, information from various Superfund process steps throughout their work on a particular site.

## *6.5. Impact of the System on the Preliminary Assessment Process*

This system provides numerous advantages to its users at all levels. First of all, the documentation needed to keep track of the PA process will be greatly reduced. The questions that were filled out electronically will be stored electronically, along with the bibliographical information. In addition, if there is more than one person scoring a certain site, much of the confusion accompanying trading the papers and other documentation will be eliminated by the accessibility of the forms over the Internet. Anyone with permission who needs to access the forms can do so from any office using a desktop computer, or from the field using a laptop. Furthermore, the electronic format of the forms eliminates the need to remember to bring the proper forms to a site or to give them to the proper person before they leave for the site. It is also much faster to answer questions using the decision support system, than to manually search out, and go through, data sources stored in many different locations.

Though this system is currently limited by certain constraints, overall it has great potential to assist in the Preliminary Assessment process. Perhaps with backing from a few Environmental Engineering firms, data standards can be set and reliable data sources compiled so that future preliminary assessments will be far less error-prone, time-consuming and costly than at present.

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# Appendix A: Internet Search Engine

Through the use of modern Internet search engine utilities, we can now sort through millions of documents in an incredible number of locations around the globe in one single mouse click. There is an increasing number of commercial web sites now available to the public, free of charge, for the purpose of finding documents on the Internet that contain key words or phrases that qualify the information the user desires. Using these search engines in a decision support system gives the user the opportunity to view documentation relating to the current decision at hand, which they may possibly not have had access to in the past.

## A.1 Availability of Information on the Internet for Decision Support of PA Scoresheets

For the purpose of completing a PA Scoresheet for an environmental clean up, there are many Internet web sites available to aid in the decision making process. There can be found at both general websites[1], containing information which can be applied to virtually any clean-up site, and in some cases specific websites, where information pertaining to only one particular clean-up location can be found. It is important to note that in both cases, documents contained in the website are maintained by the party owning that particular domain, and thus the reliability of information found is often indeterminate.

One example of a general website were non-site-specific information pertaining to environment clean up can be found is Web-site, "http://www.epa.gov/", of the US Environmental Protection Agency (EPA). Here, one can find information varying from state and local environmental protection laws, to educational resources, to links to specific clean-up sites. Because the EPA maintains this website (a well credited source), the information found here could be assumed to be accurate and reliable. However, the final decision of reliability is up to the engineer completing the PA Scoresheet. It may be useful to contact the webserver administrator to verify the status of the information found.

In the case of environmental clean up at the Massachusetts Military Reservation (MMR), there is a website at "http://www.mmr.org" devoted to maintaining up-to-date information about the clean-up process at this site. Here, a wide variety of information can be found to aid in the decision process of evaluating any of the many sites at the MMR. In addition, an engineer in the process of evaluating a site *not* located at the MMR may find information here useful in comparing what was determined at the MMR, with what might be determined at their particular site. Again, it should be noted that it is up to the individual engineer to determine the reliability and confidence level of information found on this Web-site.

## A.2 Accessing Internet Search Tools Through the Use of Common Gateway Interface

As mentioned earlier, there are many Internet search utilities available free to the public. Some examples of these include Excite (http://www.excite.com), Yahoo! (http://www.yahoo.com), and Alta Vista (http://www.altavista.com). Each of these companies have developed programs that search their extensive databases of URL's (Universal Resource Locators) to return a series of web pages that contain the search string queries entered by users. In each case, the pages returned may vary due to differences in the databases maintained and the search programs created by the different companies. For this reason, it may be desirable to use multiple search engines in order to increase your chances of finding exactly the

[1] A "website" is generally considered a domain location (i.e. www.epa.gov, www.mmr.org, etc...) where any series of "web pages" (actual documents such as index.html, etc...) are located.

information you require. This is known as "metasearching". (An example of this can be found at "http://metasearch.com/".)

The Common Gateway Interface (CGI) is a method for dynamically retrieving information on the Internet.[2] Search engines, such as those listed above, use CGI protocol to allow anonymous users to access and run programs located on their web server and send the information back to the user's web browser. Furthermore, the use of CGI allows variables to be passed to these programs, as in the case of search strings or user names, etc. The usual method for accessing these search programs is through HTML forms where values for each of the variables may be entered and the program may be run with a mouse or key click. Alternatively, one may run the program *directly* by entering the variable name with their values following the URL of the CGI program at the "Go to:" line of your web browser, or through the Open URL dialog box. An example of this is:
"http://search.yahoo.com/bin/search?p=common+gateway+interface".

Knowing how to access these search engines directly, we have been able to develop a CGI script which can dynamically generate an HTML document which contains links to specific search results pages, not just search engine home pages. Using this one CGI program, the user can pass just one search string and have direct access to results from a variety of commercial search engines. This puts a wide variety of Internet documentation relating to their search in one convenient location.

## A.3 Parametric Searching

As anyone who has used an Internet search engine most likely knows, the search results returned are sometimes not exactly the results you were looking for. Often, the user will have to wade through a variety of unrelated web pages to find exactly what it is they were interested in locating. This usually happens because one (or all) of the search words used may also be found in documents pertaining to a completely different subject matter (an example of this is the word "environment", which could pertain to a wide variety of topics). In order to limit the pages returned to only those pertaining to the exact topic you are looking for; it is useful to "parameterize" the search.

Parametric searching involves adding a series of search words to your search string variable that will help to better describe the information that you are looking for. It is helpful if the words used are likely not to be found on any site pertaining to a different subject matter. An example of this would be to add the word "groundwater" to a search for the word "environment". Sites pertaining to topics such as "political environment" or "social environment" will most likely not contain the word "groundwater". Therefore, these unrelated sites will not appear at the top of your search results window, and the user need not bother wading through countless sites about President Clinton or the newest craze.

Following are two examples from the Ground Water Pathway sheet of the PA Scoresheet showing the questions asked, the call made to run the search program, and the list of keywords used.
***Question:*** Are sources poorly contained?
***HTML call:*** href="../../../scripts/gwp_test.pl?searchstring=MMR%2bgroundwater%2bGround%2bWater%2b Groundwater%2bPlume%2bplume%2bcontamination%2bsource%2bcontained%2bMassachusetts%2bMilitary%2bReservation %2bwww.mmr.org" target=search
***Keywords***: MMR groundwater Ground Water Groundwater Plume plume contamination source contained Massachusetts Military Reservation www.mmr.org
***Question***: Is waste quantity particularly large?
***HTML call***: href="../../../scripts/gwp_test.pl?searchstring=MMR%2bgroundwater%2bGround%2bWater%2b

[2] For more information on Common Gateway Interface, see "http://hoohoo.ncsa.uiuc.edu/cgi/".

Groundwater%2bPlume%2bplume%2bwaste%2bquantity%2bMassachusetts%2bMilitary%2bReservation%2bwww.mmr.org" target=search
***Keywords***: MMR groundwater Ground Water Groundwater Plume plume waste quantity Massachusetts Military Reservation www.mmr.org

## A.4 Displaying Results

As mentioned above, links to search results will be displayed in a web browser window in HTML format. Due to the fact that users will need to run the program many times (perhaps for each question answered), and then will need to return to the PA Scoresheet document window to record their decisions, it is inconvenient to use the same browser window for both scoresheet and search results. For this reason, when the search program is run, a new browser window is opened. This allows the engineer to follow long search paths without the trouble of having to return to the original PA Scoresheet document. Show below are screen captures of a theoretical user session, with just the scoresheet browser window open, or with both scoresheet and search windows open.

# Appendix B: Data Store Search Engine

## B.1 The Data Store Search Engine's Role in the System

The data store search engine contains static links to data sources that are in a known, standard format. Currently, PA Scoresheet questions that can be answered by known data sources are marked with a "Query" button placed next to them on the electronic scoresheets. This button initiates the search of the appropriate data sources. These include data sources that are in a parable standard format on the World Wide Web, on a connectable CD-ROM, or any other source where the information is in a format that allows the computer to extract specific information from the database without the user's help. Generally, data is held in a spreadsheet or database format, as opposed to a written document, or a less formatted information list.

The extent of the implementation of the data store search engine described in this Appendix was limited by the current availability of documents containing PA Scoresheet information in a standard format. The environmental consultant on this project, Kenneth Till, was able to locate one such data source; a United States Geological Survey (USGS) web site that provides water-use information for fifty states in the US. Thus, for the purpose of this project, the USGS data source file for the state of Massachusetts was connected to the PA Scoresheets for the MMR.

## B.2 Description of USGS Data Source

Each of the available USGS data source files contains information for a particular state in the United States. The data was gathered in 1990 and placed in standard text files written in spreadsheet format, with each row corresponding to a county in that state. The current file, connected to the PA Scoresheet is only valid for the state of Massachusetts. Combining the different state files into one countrywide file for conducting more generic queries, however, would be an easy task, and this system could be easily adopted for different Superfund sites in the future.

The column headings of the data file are codes for the water-use data elements present. The elements used in the current system, together with the PA Scoresheet questions that they have been used to answer are as follows:

- ps-popgw (total population served by the ground water in the area), used to answer questions 3 and 4 on page 8 of the PA scoresheet
- to-totsw (total surface water used in millions of gallons per day), used to answer the first question in the "Suspected Release" column of page 11 of the scoresheets
- do-sstot (total domestic water withdrawals), used to answer the first question in the "Primary Targets" column of page 11 of the scoresheets
- ps-popsw (total population served by the surface water in the area), used to answer questions 4 and 5 on page 12 of the scoresheets

## B.3 Matching Existing Data Source Information with Scoresheet Questions

Presently, there is lack of information in a standard form to answer all the questions on the scoresheet. However, much of the information required could be compiled into spreadsheet or database format in a relatively short period of time.

The scoresheet questions that have been linked to the existing data stores will be distinguishable by a "Query" hyperlink placed next to them. Double clicking on the hyperlink will open a new browser window that will display the results of the query. The results of any queries run from that point forwards will also appear in the same browser window.

When the answer is received from the data source, some of the PA Scoresheet questions require interpolation on the part of the user in order to translate the answer into relevant scoresheet information. For example, with the question "Is surface water nearby," (question 1, column 1, page 11), the system currently returns the amount of surface water used in the area. If this number is greater than zero, than the user will answer, "Yes," and if not, "No." Obvious answers such as this are not automatically filled in by the system, to ensure that the user takes an active role in answering any question or making any recorded decision.

Double clicking on the hyperlink executes a program that is on the same server as the web page the hyperlink resides. As mentioned in Section B.2, the system currently accesses a USGS file containing the state of Massachusetts's water-use information. It is envisioned that when the system is complete, the user will log on to a particular account and select the Superfund site that they wish to assess. This selection will automatically tell the system which data files to access. The particular hyperlink that is selected will then pass question number, and the program will determine how to run the query for that particular piece of information. The query will be run on the data source (also located at the site). The information will be parsed into HTML and posted on web browser to be read by the user.

It is important to note that for a particular scoresheet question, the program to execute the query and the data source components of the system must be on the same server. However, this server does not need to be the same server used for the main system user interface. This means that if there is an organization that maintains a standard format data source, the program to access their data will need to be on their server, otherwise their data files will need to be downloaded to another server. If the source is public, there should not be a problem bringing data into a server controlled by EIDSS administrators. If it is a private data source, permission must be obtained to access it. Once the permission is obtained, the relative locations of the data source and the program can be easily placed as required.

## B.4 Conclusions

In general, the nature of the information requested on the scoresheets is not conducive to being placed in a database. It is far more likely that if data sources are created in the future, whether they are text files on the web, or CD-ROMs, they will be in spreadsheet format, as the one currently used to demonstrate the development of a data source search engine here. The demonstration system that has been implemented in this project could be expanded to access other text data sources very easily, with the addition of approximately ten lines of code. This expansion will be simple, because the entire framework required to make this type of connection has been completed. If data sources of other types are found, it is estimated that the amount of code required to incorporate them will be similar. However, there will be some additional configuring that the system administrator would need to perform. The difficulty of implementing this process will vary with the type of data source to be included in the search engine.

# Appendix C: Information Systems in the Environmental Field

Environmental project management can be a very difficult task because it involves understanding not only the immediate impact of human activity on the environment, but also issues like human health, economic costs, current and pending regulation and fairness. In principle, all of these interrelated factors have a bearing on any decision made relating to the environment.

To deal with these complex problems, the environmental engineering industry could greatly benefit by utilizing information technology. In general, there are three domains in which information technology can make a real difference. The first domain is in the modeling of complex environmental processes. Air and water quality modeling are good examples. The second domain is in information management. Integrating information from diverse sources is necessary in order to make sound decisions. Important sources of information range from field-monitored data, to simulation results, to documents on regulatory policy. Finally, the last domain involves modeling the decision process itself and providing the structure and support to enable policy makers to make timely, balanced decisions that are consistent with what we know about the environment.

Satisfying the first criterion of environmental project management, analysis programs available in the market range from air quality modeling tools to groundwater migration modeling tools. In terms of information management, many United States government agencies are actively developing standardized information systems for storing geographic data, so called Geographic Information Systems (GIS). Using Global Positioning Systems (GPS), GIS databases store information about specific locations using their northings, eastings and elevations.

At present, most environmental engineering Decision Support Systems, which tend to be hybrid systems of modeling and information management, are in the development stage. For example, the International Institute for Applied Systems Analysis has developed a working beta of a DSS named the Decision Support System for Evaluation of River Basin Strategies (DESERT). In a user-friendly environment based upon Microsoft Windows interface, DESERT provides integration of important stages of decision support including data management, model calibration, simulation and optimization, and presentation of results (Somlyódy, 1996).

The Colorado River Decision Support System is another DSS under development. The principal goal of the CRDSS is to provide the capability to develop credible information on which to base informed decisions concerning the management of Colorado River water resources. It has the same functionality as DESERT (Johnson, 1996).

A simpler form of a DSS is an environmental engineering specific web search engine. The Amazing Environmental Organization Web Directory lists commercial companies and academic institutes ranging from Animal Interest Groups to organization concerned with Sustainable Development (Dickson, 1997). Other search engines include EnviroPhantom (Garvey, 1997), ECOLINKING (Rittner, 1997) and YAHOO (Filo, 1997).

Although many DSSs are under development and are therefore not commercially available, most of the Executive Information Systems, which combine all three functions of environmental project management, are only in the conceptual design phase. The Environmental Programs Group at MCNC's North Carolina Supercomputing Center is developing the Environmental Decision Support System (EDSS) that includes

all three aspects of environmental project management, making it more like an executive information system. Working closely with Environmental Protection Agency (EPA), EDSS focuses on a "next-generation" air quality modeling system (Bilicki, 1996).

## Appendix D: PA Scoresheet

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# *PA Scoresheets*

Site Name:_____ Investigator:_____
CERCLIS ID No.:_____ Agency/Organization:_____
Street Address:_____ Street Address:_____
City/State/Zip:_____ Date:_____

## INSTRUCTIONS FOR SCORESHEETS

### Introduction

This scoresheets package functions as a self-contained workbook providing all of the basic tools to apply collected data and calculate a PA score. Note that a computerized scoring tool, "PA-Score," is also available from EPA (Office of Solid Waste and Emergency Response, Directive 9345.1-11). The scoresheets provide space to:

- Record information collected during the PA
- Indicate references to support information
- Select and assign values ("scores") for factors
- Calculate pathway scores
- Calculate the site score

Do not enter values or scores in shaded areas of the scoresheets. You are encouraged to write notes on the scoresheets and especially on the Criteria Lists. On scoresheets with a reference column, indicate a number corresponding to attached sources of information or pages containing rationale for hypotheses; attach to the scoresheets a numbered list of these references. Evaluate all four pathways. Complete all Criteria Lists, scoresheets, and tables. Show calculations, as appropriate. If scoresheets are photocopy reproduced, copy and submit the numbered pages (right-side pages) only.

## GENERAL INFORMATION

**Site Description and Operational History:** Briefly describe the site and its operating history. Provide the site name, owner/operator, type of facility and operations, size of property, active or inactive status, and years of waste generation. Summarize waste treatment, storage, or disposal activities that have or may have occurred at the site; note also if these activities are documented or alleged. Identify probable source types and prior spills. Summarize highlights of previous investigations.

**Probable Substances of Concern:** List hazardous substances that have or may have been stored, handled, or disposed at the site, based on your knowledge of site operations. Identify the sources to which the substances may be related. Summarize any existing analytical data concerning hazardous substances detected onsite, in releases from the site, or at targets.

## GENERAL INFORMATION

**Site Description and Operational History:**

**Probable Substances of Concern:**
**(Previous investigations, analytical data)**

## GENERAL INFORMATION (continued)

**Site Sketch:** Prepare a sketch of the site (freehand is acceptable). Indicate all pertinent features of the site and nearby environs, including: waste sources, buildings, residences, access roads, parking areas, drainage patterns, water bodies, vegetation, wells, sensitive environments, etc.

## GENERAL INFORMATION (continued)

**Site Sketch:**
(Show all pertinent features, indicate sources and closest targets, indicate north)

## SOURCE EVALUATION

- Number and name each source (e.g., 1. East Drum Storage Area, 2. Sludge Lagoon, 3. Battery Pile).
- Identify source type according to the list below.
- Describe the physical character of each source (e.g., dimensions, contents, waste types, containment, operating history).
- Show waste quantity (WQ) calculations for each source for appropriate tiers. Refer to instructions opposite page 5 and PA Tables 1a and 1b. Identify waste quantity tier and waste characteristics (WC) factor category score (for a site with a single source, according to PA Table 1a). Determine WC from PA Table 1b for the sum of source WQs for a multiple-source site.
- Attach additional sheets if necessary.
- Determine the site WC factor category score and record at the bottom of the page.

**Source Type Descriptions**

Landfill: an engineered (by excavation or construction) or natural hole in the ground into which wastes have been disposed by backfilling, or by contemporaneous soil deposition with waste disposal, covering wastes from view.

Surface Impoundment: a topographic depression, excavation, or diked area, primarily formed from earthen materials (lined or unlined) and designed to hold accumulated liquid wastes, wastes containing free liquids, or sludges that were not backfilled or otherwise covered during periods of deposition; depression may be dry if deposited liquid has evaporated, volatilized or leached, or wet with exposed liquid; structures that may be more specifically described as lagoon pond, aeration pit, settling pond, tailings pond, sludge pit, etc.; also a surface impoundment that has been covered with soil after the final deposition of waste materials (i.e., buried or backfilled).

Drums: portable containers designed to hold a standard 55-gallon volume of wastes.

Tanks and Non-Drum Containers: any stationary device, designed to contain accumulated wastes, constructed primarily of fabricated materials (such as wood, concrete, steel, or plastic) that provide structural support; any portable or mobile device in which waste is stored or otherwise handled.

Contaminated Soil: soil onto which available evidence indicates that a hazardous substance was spilled, spread, disposed, or deposited.

Pile: any non-containerized accumulation above the ground surface of solid, non-flowing wastes; includes open dumps. Some types of piles are: Chemical Waste Pile -- consists primarily of discarded chemical products, by-products, radioactive wastes, or used or unused feedstocks; Scrap Metal or Junk Pile -- consists primarily of scrap metal or discarded durable goods such as appliances, automobiles, auto parts, or batteries, composed of materials suspected to contain or have contained a hazardous substance; Tailings Pile -- consists primarily of any combination of overburden from a mining operation and tailings from a mineral mining, beneficiation, or processing operation; Trash Pile -- consists primarily of paper, garbage, or discarded non-durable goods which are suspected to contain or have contained a hazardous substance.

Land Treatment: landfarming or other land treatment method of waste management in which liquid wastes or sludges are spread over land and tilled, or liquids are injected at shallow depths into soils.

Other: a source that does not fit any of the descriptions above; examples include contaminated building, ground water plume with no identifiable source, storm drain, dry well, and injection well.

## SOURCE EVALUATION

| Source No.: | Source Name: | Source Waste Quantity (WQ) Calculations: |
|---|---|---|
| Source Description: | | |

| Source No.: | Source Name: | Source Waste Quantity (WQ) Calculations: |
|---|---|---|
| Source Description: | | |

| Source No.: | Source Name: | Source Waste Quantity (WQ) Calculations: |
|---|---|---|
| Source Description: | | |

| Site WC: |
|---|

## WASTE CHARACTERISTICS (WC) SCORES

WC, based on waste quantity, may be determined by one or all of four measures called "tiers": constituent quantity, wastestream quantity, source volume, and source area. PA Table 1a (page 5) is divided into these four tiers. The amount and detail of information available determine which tier(s) to use for each source. For each source, evaluate waste quantity by as many of the tiers as you have information to support, and select the result that gives you the highest WC score. If minimal, incomplete, or no information is available regarding waste quantity, assign a WC score of 18 (minimum).

PA Table 1a has 6 columns: column 1 indicates the quantity tier; column 2 lists source types for the four tiers; columns 3, 4, and 5 provide ranges of waste amount for sites with only one source, which correspond to WC scores at the top of the columns (18, 32, or 100); column 6 provides formulas to obtain source waste quantity (WQ) values at sites with multiple sources.

***To determine WC for sites with only one source:***

1. *Identify source type (see descriptions opposite page 4).*
2. *Examine all waste quantity data available.*
3. *Estimate the mass and/or dimensions of the source.*
4. *Determine which quantity tiers to use based on available source information.*
5. *Convert source measurements to appropriate units for each tier you can evaluate for the source.*
6. *Identify the range into which the total quantity falls for each tier evaluated (PA Table 1a).*
7. *Determine the highest WC score obtained for any tier (18, 32, or 100, at top of PA Table 1a columns 3, 4, and 5, respectively).*
8. *Use this WC score for all pathways.**

***To determine WC for sites with multiple sources:***

1. *Identify each source type (see descriptions opposite page 4).*
2. *Examine all waste quantity data available for each source.*
3. *Estimate the mass and/or dimensions of each source.*
4. *Determine which quantity tiers to use for each source based on the available information.*
5. *Convert source measurements to appropriate units for each tier you can evaluate for each source.*
6. *For each source, use the formulas in column 6 of PA Table 1a to determine the WQ value for each tier that can be evaluated. The highest WQ value obtained for any tier is the WQ value for the source.*
7. *Sum the WQ values for all sources to get the site WQ total.*
8. *Use the site WQ total from step 7 to assign the WC score from PA Table 1b.*
9. *Use this WC score for all pathways.**

---

* The WC score is considered in all four pathways. However, if a primary target is identified for the grour water, surface water, or air migration pathway, assign the determined WC or a score of 32, whichever greater, as the WC score for that pathway.

## PA TABLE 1: WASTE CHARACTERISTICS (WC) SCORES

### PA Table 1a: WC Scores for Single Source Sites and Formulas for Multiple Source Sites

| TIER | SOURCE TYPE | SINGLE SOURCE SITES (assigned WC scores) | | | MULTIPLE SOURCE SITES |
|---|---|---|---|---|---|
| | | *WC = 18* | *WC = 32* | *WC = 100* | Formula for Assigning Source WQ Values |
| CONSTITUENT | N/A | ≤100 lb | >100 to 10,000 lb | >10,000 lb | *lb ÷ 1* |
| WASTESTREAM | N/A | ≤500,000 lb | >500,000 to 50 million lb | >50 million lb | *lb ÷ 5,000* |
| VOLUME | Landfill | ≤6.75 million ft³<br>≤250,000 yd³ | >6.75 million to 675 million ft³<br>>250,000 to 25 million yd³ | >675 million ft³<br>>25 million yd³ | *ft³ ÷ 67,500*<br>*yd³ ÷ 2,500* |
| | Surface impoundment | ≤6,750 ft³<br>≤250 yd³ | >6,750 to 675,000 ft³<br>>250 to 25,000 yd³ | >675,000 ft³<br>>25,000 yd³ | *ft³ ÷ 67.5*<br>*yd³ ÷ 2.5* |
| | Drums | ≤1,000 drums | >1,000 to 100,000 drums | >100,000 drums | *drums ÷ 10* |
| | Tanks and non-drum containers | ≤50,000 gallons | >50,000 to 5 million gallons | >5 million gallons | *gallons ÷ 500* |
| | Contaminated soil | ≤6.75 million ft³<br>≤250,000 yd³ | >6.75 million to 675 million ft³<br>>250,000 to 25 million yd³ | >675 million ft³<br>>25 million yd³ | *ft³ ÷ 67,500*<br>*yd³ ÷ 2,500* |
| | Pile | ≤6,750 ft³<br>≤250 yd³ | >6,750 to 675,000 ft³<br>>250 to 25,000 yd³ | >675,000 ft³<br>>25,000 yd³ | *ft³ ÷ 67.5*<br>*yd³ ÷ 2.5* |
| | Other | ≤6,750 ft³<br>≤250 yd³ | >6,750 to 675,000 ft³<br>>250 to 25,000 yd³ | >675,000 ft³<br>>25,000 yd³ | *ft³ ÷ 67.5*<br>*yd³ ÷ 2.5* |
| AREA | Landfill | ≤340,000 ft²<br>≤7.8 acres | >340,000 to 34 million ft²<br>>7.8 to 780 acres | >34 million ft²<br>>780 acres | *ft² ÷ 3,400*<br>*acres ÷ 0.078* |
| | Surface impoundment | ≤1,300 ft²<br>≤0.029 acres | >1,300 to 130,000 ft²<br>>0.029 to 2.9 acres | >130,000 ft²<br>>2.9 acres | *ft² ÷ 13*<br>*acres ÷ 0.00029* |
| | Contaminated soil | ≤3.4 million ft²<br>≤78 acres | >3.4 million to 340 million ft²<br>>78 to 7,800 acres | >340 million ft²<br>>7,800 acres | *ft² ÷ 34,000*<br>*acres ÷ 0.78* |
| | Pile* | ≤1,300 ft²<br>≤0.029 acres | >1,300 to 130,000 ft²<br>>0.029 to 2.9 acres | >130,000 ft²<br>>2.9 acres | *ft² ÷ 13*<br>*acres ÷ 0.00029* |
| | Land treatment | ≤27,000 ft²<br>≤0.62 acres | >27,000 to 2.7 million ft²<br>>0.62 to 62 acres | >2.7 million ft²<br>>62 acres | *ft² ÷ 270*<br>*acres ÷ 0.0062* |

1 ton = 2,000 lb = 1 yd³ = 4 drums = 200 gallons

* Use area of land surface under pile, not surface area of pile.

### PA Table 1b: WC Scores for Multiple Source Sites

| *WQ Total* | *WC Score* |
|---|---|
| >0 to 180 | 18 |
| >180 to 10,000 | 32 |
| >10,000 | 100 |

## GROUND WATER PATHWAY

**Ground Water Use Description:** Provide information on ground water use in the vicinity. Present the general stratigraphy, aquifers used, and distribution of private and municipal wells.

**Calculations for Drinking Water Populations Served by Ground Water:** Provide populations from private wells and municipal supply systems in each distance category. Show apportionment calculations for blended supply systems.

## GROUND WATER PATHWAY
## GROUND WATER USE DESCRIPTION

**Describe Ground Water Use Within 4-miles of the Site:**
(Describe stratigraphy, information on aquifers, municipal and/or private wells)

**Calculations for Drinking Water Populations Served by Ground Water:**

## GROUND WATER PATHWAY CRITERIA LIST

This "Criteria List" helps guide the process of developing hypotheses concerning the occurrence of a suspected release and the exposure of specific targets to a hazardous substance. The check-boxes record your professional judgment in evaluating these factors. Answers to all of the listed questions may not be available during the PA. Also, the list is not all-inclusive; if other criteria help shape your hypotheses, list them at the bottom of the page or attach an additional page.

The "Suspected Release" section identifies several site, source, and pathway conditions that could provide insight as to whether a release from the site is likely to have occurred. If a release is suspected, use the "Primary Targets" section to evaluate conditions that may help identify targets likely to be exposed to a hazardous substance. Record responses for the well that you feel has the highest probability of being exposed to a hazardous substance. You may use this section of the chart more than once, depending on the number of targets you feel may be considered "primary."

Check the boxes to indicate a "yes," "no," or "unknown" answer to each question. If you check the "Suspected Release" box as "yes," make sure you assign a Likelihood of Release value of 550 for the pathway.

## GROUND WATER PATHWAY CRITERIA LIST

### *SUSPECTED RELEASE*

| Yes | No | Unk | |
|---|---|---|---|
| ☐ | ☐ | ☐ | Are sources poorly contained? |
| ☐ | ☐ | ☐ | Is the source a type likely to contribute to ground water contamination (e.g., wet lagoon)? |
| ☐ | ☐ | ☐ | Is waste quantity particularly large? |
| ☐ | ☐ | ☐ | Is precipitation heavy? |
| ☐ | ☐ | ☐ | Is the infiltration rate high? |
| ☐ | ☐ | | Is the site located in an area of karst terrain? |
| ☐ | ☐ | ☐ | Is the subsurface highly permeable or conductive? |
| ☐ | ☐ | ☐ | Is drinking water drawn from a shallow aquifer? |
| ☐ | ☐ | ☐ | Are suspected contaminants highly mobile in ground water? |
| ☐ | ☐ | ☐ | Does analytical or circumstantial evidence suggest ground water contamination? |
| ☐ | ☐ | | Other criteria?_____ |
| ☐ | ☐ | | **SUSPECTED RELEASE?** |

**Summarize the rationale for Suspected Release (attach an additional page if necessary):**

### *PRIMARY TARGETS*

| Yes | No | Unk | |
|---|---|---|---|
| ☐ | ☐ | ☐ | Is any drinking water well nearby? |
| ☐ | ☐ | ☐ | Has any nearby drinking water well been closed? |
| ☐ | ☐ | ☐ | Has any nearby drinking water user reported foul-tasting or foul-smelling water? |
| ☐ | ☐ | ☐ | Does any nearby well have a large drawdown or high production rate? |
| ☐ | ☐ | ☐ | Is any drinking water well located between the site and other wells that are suspected to be exposed to a hazardous substance? |
| ☐ | ☐ | ☐ | Does analytical or circumstantial evidence suggest contamination at a drinking water well? |
| ☐ | ☐ | ☐ | Does any drinking water well warrant sampling? |
| ☐ | ☐ | | Other criteria?_____ |
| ☐ | ☐ | | **PRIMARY TARGET(S) IDENTIFIED?** |

**Summarize the rationale for Primary Targets (attach an additional page if necessary):**

## GROUND WATER PATHWAY SCORESHEET

Pathway Characteristics

Answer the questions at the top of the page. Refer to the Ground Water Pathway Criteria List (page 7) to hypothesize whether you suspect that a hazardous substance associated with the site has been released to ground water. Record depth to aquifer (in feet): the difference between the deepest occurrence of a hazardous substance and the depth of the top of the shallowest aquifer at (or as near as possible) to the site. Note whether the site is in karst terrain (characterized by abrupt ridges, sink holes, caverns, springs, disappearing streams). Record the distance (in feet) from any source to the nearest well used for drinking water.

Likelihood of Release (LR)

1. **Suspected Release:** Hypothesize based on professional judgment guided by the Ground Water Pathway Criteria List (page 7). If you suspect a release to ground water, use only Column A for this pathway and do not evaluate factor 2.

2. **No Suspected Release:** If you do not suspect a release, determine score based on depth to aquifer or whether the site is in an area of karst terrain. If you do not suspect a release to ground water, use only Column B to score this pathway.

Targets (T)

This factor category evaluates the threat to populations obtaining drinking water from ground water. To apportion populations served by blended drinking water supply systems, determine the percentage of population served by each well based on its production.

3. **Primary Target Population:** Evaluate populations served by all drinking water wells that you suspect have been exposed to a hazardous substance released from the site. Use professional judgment guided by the Ground Water Pathway Criteria List (page 7) to make this determination. In the space provided, enter the population served by any wells you suspect have been exposed to a hazardous substance from the site. If only the number of residences is known, use the average county residents per household (rounded up to the next integer) determine population served. Multiply the population by 10 to determine the Primary Target Population scor Note that if you do not suspect a release, there can be no primary target population.

4. **Secondary Target Population:** Evaluate populations served by all drinking water wells within 4 miles that you do not suspect have been exposed to a hazardous substance. Use PA Table 2a or 2b (for wells drawing from non-karst and karst aquifers, respectfully) (page 9). If only the number of residences is known, use the average county residents per household (rounded to the nearest integer) to determine population served. Circle the assigned value for the population in each distance category and enter it in the column on the far-right side of the table. Sum the far-right column and enter the total as the Secondary Target Population factor score.

5. **Nearest Well** represents the threat posed to the drinking water well that is most likely to be exposed to a hazardous substance. If you have identified a primary target population, enter 50. Otherwise, assign the score from PA Table 2a or 2b for the closest distance category with a drinking water well population.

6. **Wellhead Protection Area (WHPA):** WHPAs are special areas designated by States for protection under Section 1428 of the Safe Drinking Water Act. Local/State and EPA Regional water officials can provide information regarding the location of WHPAs.

7. **Resources:** A score of 5 can generally be assigned as a default measure. Assign zero only if ground water within 4 miles has no resource use.

Sum the target scores in Column A (Suspected Release) or Column B (No Suspected Release).

Waste Characteristics (WC)

8. **Waste Characteristics:** Score is assigned from page 4. However, if you have identified any primary target for ground water, assign either the score calculated on page 4 or a score of 32, whichever is greater.

Ground Water Pathway Score: Multiply the scores for LR, T, and WC. Divide the product by 82,500. Round the result to the nearest integer. If the result is greater than 100, assign 100.

## GROUND WATER PATHWAY SCORESHEET

| Pathway Characteristics | |
|---|---|
| Do you suspect a release (see Ground Water Pathway Criteria List, page 71)? | Yes ___ No ___ |
| Is the site located in karst terrain? | Yes ___ No ___ |
| Depth to aquifer: | _____ ft |
| Distance to the nearest drinking water well: | _____ ft |

| | A Suspected Release | B No Suspected Release | References |
|---|---|---|---|
| **LIKELIHOOD OF RELEASE** | | | |
| 1. SUSPECTED RELEASE: If you suspect a release to ground water (see page 7), assign a score of 550. Use only column A for this pathway. | | | |
| 2. NO SUSPECTED RELEASE: If you do not suspect a release to ground water, and the site is in karst terrain or the depth to aquifer is 70 feet or less, assign a score of 500; otherwise, assign a score of 340. Use only column B for this pathway. | | | |
| LR = | | | |
| **TARGETS** | | | |
| 3. PRIMARY TARGET POPULATION: Determine the number of people served by drinking water wells that you suspect have been exposed to a hazardous substance from the site (see Ground Water Pathway Criteria List, page 7). _____ people x 10 = | | | |
| 4. SECONDARY TARGET POPULATION: Determine the number of people served by drinking water wells that you do NOT suspect have been exposed to a hazardous substance from the site, and assign the total population score from PA Table 2. Are any wells part of a blended system? Yes ___ No ___ If yes, attach a page to show apportionment calculations. | | | |
| 5. NEAREST WELL: If you have identified a primary target population for ground water, assign a score of 50; otherwise, assign the Nearest Well score from PA Table 2. If no drinking water wells exist within 4 miles, assign a score of zero. | | | |
| 6. WELLHEAD PROTECTION AREA (WHPA): If any source lies within or above a WHPA, or if you have identified any primary target well within a WHPA, assign a score of 20; assign 5 if neither condition holds but a WHPA is present within 4 miles; otherwise assign zero. | | | |
| 7. RESOURCES | | | |
| T = | | | |
| **WASTE CHARACTERISTICS** | | | |
| 8. A. If you have identified any primary target for ground water, assign the waste characteristics score calculated on page 4, or a score of 32, whichever is GREATER; do not evaluate part B of this factor. | | | |
| B. If you have NOT identified any primary target for ground water, assign the waste characteristics score calculated on page 4. | | | |
| WC = | | | |

**GROUND WATER PATHWAY SCORE:** $\dfrac{LR \times T \times WC}{82{,}500}$ (subject to a maximum of 100)

## PA TABLE 2: VALUES FOR SECONDARY GROUND WATER TARGET POPULATIONS

### PA Table 2a: Non-Karst Aquifers

| Distance from Site | Population | Nearest Well (choose highest) | Population Served by Wells Within Distance Category | | | | | | | | | | Population Value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 to 10 | 11 to 30 | 31 to 100 | 101 to 300 | 301 to 1,000 | 1,001 to 3,000 | 3,001 to 10,000 | 10,001 to 30,000 | 30,001 to 100,000 | Greater than 100,000 | |
| 0 to ¼ mile | _____ | 20 | 1 | 2 | 5 | 16 | 52 | 163 | 521 | 1,633 | 5,214 | 16,325 | _____ |
| > ¼ to ½ mile | _____ | 18 | 1 | 1 | 3 | 10 | 32 | 101 | 323 | 1,012 | 3,233 | 10,121 | _____ |
| > ½ to 1 mile | _____ | 9 | 1 | 1 | 2 | 5 | 17 | 52 | 167 | 522 | 1,668 | 5,224 | _____ |
| > 1 to 2 miles | _____ | 5 | 1 | 1 | 1 | 3 | 9 | 29 | 94 | 294 | 939 | 2,938 | _____ |
| > 2 to 3 miles | _____ | 3 | 1 | 1 | 1 | 2 | 7 | 21 | 68 | 212 | 678 | 2,122 | _____ |
| > 3 to 4 miles | _____ | 2 | 1 | 1 | 1 | 1 | 4 | 13 | 42 | 131 | 417 | 1,306 | _____ |
| Nearest Well = | | | | | | | | | | | | Score = | |

### PA Table 2b: Karst Aquifers

| Distance from Site | Population | Nearest Well (use 20 for karst) | Population Served by Wells Within Distance Category | | | | | | | | | | Population Value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 to 10 | 11 to 30 | 31 to 100 | 101 to 300 | 301 to 1,000 | 1,001 to 3,000 | 3,001 to 10,000 | 10,001 to 30,000 | 30,001 to 100,000 | Greater than 100,000 | |
| 0 to ¼ mile | _____ | 20 | 1 | 2 | 5 | 16 | 52 | 163 | 521 | 1,633 | 5,214 | 16,325 | _____ |
| > ¼ to ½ mile | _____ | 20 | 1 | 1 | 3 | 10 | 32 | 101 | 323 | 1,012 | 3,233 | 10,121 | _____ |
| > ½ to 1 mile | _____ | 20 | 1 | 1 | 3 | 8 | 26 | 82 | 261 | 816 | 2,607 | 8,162 | _____ |
| > 1 to 2 miles | _____ | 20 | 1 | 1 | 3 | 8 | 26 | 82 | 261 | 816 | 2,607 | 8,162 | _____ |
| > 2 to 3 miles | _____ | 20 | 1 | 1 | 3 | 8 | 26 | 82 | 261 | 816 | 2,607 | 8,162 | _____ |
| > 3 to 4 miles | _____ | 20 | 1 | 1 | 3 | 8 | 26 | 82 | 261 | 816 | 2,607 | 8,162 | _____ |
| Nearest Well = | | | | | | | | | | | | Score = | |

## SURFACE WATER PATHWAY

Migration Route Sketch: Sketch the surface water migration pathway (freehand is acceptable) illustrating the drainage route and identifying water bodies, probable point of entry, flows, and targets.

## SURFACE WATER PATHWAY
## MIGRATION ROUTE SKETCH

**Suface Water Migration Route Sketch:**
**(include runoff route, probable point of entry, 15-mile target distance limit, intakes, fisheries, and sensitive environments)**

## SURFACE WATER PATHWAY CRITERIA LIST

This "Criteria List" helps guide the process of developing hypotheses concerning the occurrence of suspected release and the exposure of specific targets to a hazardous substance. The check-boxes record your professional judgment in evaluating these factors. Answers to all of the listed questions may not be available during the PA. Also, the list is not all-inclusive; if other criteria help shape your hypotheses, list them at the bottom of the page or attach an additional page.

The "Suspected Release" section identifies several site, source, and pathway conditions that could provide insight as to whether a release from the site is likely to have occurred. If a release is suspected, use the "Primary Targets" section to guide you through evaluation of some conditions that may help identify targets likely to be exposed to a hazardous substance. Record responses for the target that you feel has the highest probability of being exposed to a hazardous substance. You may use this section of the chart more than once, depending on the number of targets you feel may be considered "primary."

Check the boxes to indicate a "yes," "no," or "unknown" answer to each question. If you check the "Suspected Release" box as "yes," make sure you assign a Likelihood of Release value of 550 for the pathway.

If the distance to surface water is greater than 2 miles, do not evaluate the surface water migration pathway. Document the source of information in the text boxes below the surface water criteria list.

## SURFACE WATER PATHWAY CRITERIA LIST

### *SUSPECTED RELEASE*

| Yes | No | Unk | |
|---|---|---|---|
| ☐ | ☐ | ☐ | Is surface water nearby? |
| ☐ | ☐ | ☐ | Is waste quantity particularly large? |
| ☐ | ☐ | ☐ | Is the drainage area large? |
| ☐ | ☐ | ☐ | Is rainfall heavy? |
| ☐ | ☐ | ☐ | Is the infiltration rate low? |
| ☐ | ☐ | ☐ | Are sources poorly contained or prone to runoff or flooding? |
| ☐ | ☐ | ☐ | Is a runoff route well defined (e.g., ditch or channel leading to surface water)? |
| ☐ | ☐ | ☐ | Is vegetation stressed along the probable run-off route? |
| ☐ | ☐ | ☐ | Are sediments or water unnaturally discolored? |
| ☐ | ☐ | ☐ | Is wildlife unnaturally absent? |
| ☐ | ☐ | ☐ | Has deposition of waste into surface water been observed? |
| ☐ | ☐ | ☐ | Is ground water discharge to surface water likely? |
| ☐ | ☐ | ☐ | Does analytical or circumstantial evidence suggest surface water contamination? |
| ☐ | ☐ | | Other criteria?_____ |
| ☐ | ☐ | | **SUSPECTED RELEASE?** |

### *PRIMARY TARGETS*

| Yes | No | Unk | |
|---|---|---|---|
| ☐ | ☐ | ☐ | Is any target nearby? If yes: |
| | | | ☐ Drinking water intake<br>☐ Fishery<br>☐ Sensitive environment |
| ☐ | ☐ | ☐ | Has any intake, fishery, or recreational area been closed? |
| ☐ | ☐ | ☐ | Does analytical or circumstantial evidence suggest surface water contamination at or downstream of a target? |
| ☐ | ☐ | ☐ | Does any target warrant sampling? If yes: |
| | | | ☐ Drinking water intake<br>☐ Fishery<br>☐ Sensitive environment |
| ☐ | ☐ | | Other criteria?_____ |
| ☐ | ☐ | | **PRIMARY INTAKE(S) IDENTIFIED?** |
| ☐ | ☐ | | **PRIMARY FISHERY(IES) IDENTIFIED?** |
| ☐ | ☐ | | **PRIMARY SENSITIVE ENVIRONMENT(S) IDENTIFIED?** |

**Summarize the rationale for Suspected Release (attach an additional page if necessary):**

**Summarize the rationale for Primary Targets (attach an additional page if necessary):**

## SURFACE WATER PATHWAY LIKELIHOOD OF RELEASE AND DRINKING WATER THREAT SCORESHEET

**Pathway Characteristics**

The surface water pathway includes three threats: Drinking Water Threat, Human Food Chain Threat, and Environmental Threat. Answer the questions at the top of the page. Refer to the Surface Water Pathway Criteria List (page 11) to hypothesize whether you suspect that a hazardous substance associated with the site has been released to surface water. Record the distance to surface water (the shortest overland drainage distance from a source to a surface water body). Record the flood frequency at the site (e.g., 100-yr, 200-yr). If the site is located in more than one floodplain, use the most frequent flooding event. Identify surface water use(s) along the surface water migration path and their distance(s) from the site.

**Likelihood of Release (LR)**

1. **Suspected Release:** Hypothesize based on professional judgment guided by the Surface Water Pathway Criteria List (page 11). If you suspect a release to surface water, use only Column A for this pathway and do not evaluate factor 2.

2. **No Suspected Release:** If you do not suspect a release, determine score based on the shortest overland drainage distance from a source to a surface water body. If distance to surface water is 2,500 feet or less, assign a score of 500. If distance to surface water is greater than 2,500 feet, determine score based on flood frequency. If you do not suspect a release to surface water, use only Column B to score this pathway.

**Drinking Water Threat Targets (T)**

3. List all drinking water intakes on downstream surface water bodies along the surface water migration path. Record the intake name, the type of water body on which the intake is located, the flow of the water body, and the number of people served by the intake (apportion the population if part of a blended system).

4. **Primary Target Population:** Evaluate populations served by all drinking water intakes that you suspect have been exposed to a hazardous substance released from the site. Use professional judgment guided by the Surface Water Pathway Criteria List (page 11) to make this determination. In the space provided, enter the population served by all intakes you suspect have been exposed to a hazardous substance from the site. If only the number of residences is known, use the average county residents per household (rounded up to the next integer) to determine population served. Multiply by 10 to determine the Primary Target Population score. Remember, if you do not suspect a release, there can be no primary target population.

5. **Secondary Target Population:** Evaluate populations served by all drinking water intakes within the target distance limit that you do not suspect have been exposed to a hazardous substance. Use PA Table 3 (page 13) and enter the population served by intakes for each flow category. If only the number of residences is known, use the average county residents per household (rounded to the nearest integer) to determine population served. Circle the assigned value for the population in each flow category and enter it in the column on the far-right side of the table. Sum the far-right column and enter the total as the Secondary Target Population factor score.

Gauging station data for many surface water bodies are available from USGS or other sources. In the absence of gauging station data, estimate flow using the list of surface water body types and associated flow categories in PA Table 4 (page 13). The flow for lakes is determined by the sum of flows of streams entering or leaving the lake. Note that the flow category "mixing zone of quiet flowing rivers" is limited to 3 miles from the probable point of entry.

6. **Nearest Intake** represents the threat posed to the drinking water intake that is most likely to be exposed to a hazardous substance. If you have identified a primary target population, enter 50. Otherwise, assign the score from PA Table 3 (page 13) for the lowest-flowing water body on which there is an intake.

7. **Resources:** A score of 5 can generally be assigned as a default measure. Assign zero only if surface water within the target distance limit has no resource use.

Sum the target scores in Column A (Suspected Release) or Column B (No Suspected Release).

## SURFACE WATER PATHWAY
## LIKELIHOOD OF RELEASE AND DRINKING WATER THREAT SCORESHEET

| *Pathway Characteristics* | |
|---|---|
| Do you suspect a release (see Surface Water Pathway Criteria List, page 111)? | Yes ___ No ___ |
| Distance to surface water: | _____ ft |
| Flood frequency: | _____ yrs |
| What is the downstream distance to the nearest drinking water intake? | _____ miles |
| Nearest fishery? _____ miles | Nearest sensitive environment? _____ miles |

| LIKELIHOOD OF RELEASE | A *Suspected Release* | B *No Suspected Release* | *References* |
|---|---|---|---|
| 1. SUSPECTED RELEASE: If you suspect a release to surface water (see page 11), assign a score of 550. Use only column A for this pathway. | 550 | | |
| 2. NO SUSPECTED RELEASE: If you do not suspect a release to surface water, use the table below to assign a score based on distance to surface water and flood frequency. Use only column B for this pathway. | | | |
| Distance to surface water ≤ 2,500 feet | | 500 | |
| Distance to surface water > 2,500 feet, and | | | |
| Site in annual or 10-year floodplain | | 500 | |
| Site in 100-year floodplain | | 400 | |
| Site in 500-year floodplain | | 300 | |
| Site outside 500-year floodplain | | 100 | |
| LR = | | | |

| DRINKING WATER THREAT TARGETS | | | | |
|---|---|---|---|---|
| 3. Record the water body type, flow (if applicable), and number of people served by each drinking water intake within the target distance limit. If there is no drinking water intake within the target distance limit, factors 4, 5, and 6 each receive zero scores. | | | | |
| *Intake Name* | *Water Body Type* | *Flow* | *People Served* | |
| _____ | _____ | _____ cfs | _____ | |
| _____ | _____ | _____ cfs | _____ | |
| _____ | _____ | _____ cfs | _____ | |
| 4. PRIMARY TARGET POPULATION: If you suspect any drinking water intake listed above has been exposed to a hazardous substance from the site (see Surface Water Pathway Criteria List, page 11), list the intake name(s) and calculate the factor score based on the total population served. _____, _____. | | | | |
| _____ people x 10 = | | | | |
| 5. SECONDARY TARGET POPULATION: Determine the number of people served by drinking water intakes that you do NOT suspect have been exposed to a hazardous substance from the site, and assign the total population score from PA Table 3. Are any intakes part of a blended system? Yes ___ No ___ If yes, attach a page to show apportionment calculations. | | | | |
| 6. NEAREST INTAKE: If you have identified a primary target population for the drinking water threat (factor 4), assign a score of 50; otherwise, assign the Nearest Intake score from PA Table 3. If no drinking water intake exists within the target distance limit, assign a score of zero. | | | | |
| 7. RESOURCES | | | | |
| T = | | | | |

## PA TABLE 3: VALUES FOR SECONDARY SURFACE WATER TARGET POPULATIONS

| Surface Water Body Flow (see PA Table 4) | Population | Nearest Intake (choose highest) | Population Served by Intakes Within Flow Category | | | | | | | | | | | Population Value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 to 30 | 31 to 100 | 101 to 300 | 301 to 1,000 | 1,001 to 3,000 | 3,001 to 10,000 | 10,001 to 30,000 | 30,001 to 100,000 | 100,001 to 300,000 | 300,001 to 1,000,000 | Greater than 1,000,000 | |
| <10 cfs | _____ | 20 | 2 | 6 | 18 | 52 | 163 | 521 | 1,633 | 5,214 | 16,325 | 52,136 | 163,246 | _____ |
| 10 to 100 cfs | _____ | 2 | 1 | 1 | 2 | 6 | 18 | 52 | 163 | 521 | 1,633 | 5,214 | 16,325 | _____ |
| >100 to 1,000 cfs | _____ | 1 | 0 | 0 | 1 | 1 | 2 | 6 | 18 | 52 | 163 | 521 | 1,633 | _____ |
| >1,000 to 10,000 cfs | _____ | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 5 | 18 | 52 | 163 | _____ |
| >10,000 cfs or Great Lakes | _____ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 5 | 18 | _____ |
| 3-mile Mixing Zone | _____ | 10 | 1 | 3 | 8 | 28 | 92 | 281 | 818 | 2,607 | 8,162 | 26,068 | 81,663 | _____ |
| Nearest Intake = | | | | | | | | | | | | | Score = | |

## PA TABLE 4: SURFACE WATER TYPE / FLOW CHARACTERISTICS WITH DILUTION WEIGHTS FOR SECONDARY SURFACE WATER SENSITIVE ENVIRONMENTS

| Type of Surface Water Body | | | Dilution Weight |
|---|---|---|---|
| Water Body Type | OR | Flow | |
| minimal stream | | < 10 cfs | 1 |
| small to moderate stream | | 10 to 100 cfs | 0.1 |
| moderate to large stream | | > 100 to 1,000 cfs | N/A |
| large stream to river | | > 1,000 to 10,000 cfs | N/A |
| large river | | > 10,000 cfs | N/A |
| 3-mile mixing zone of quiet flowing streams or rivers | | 10 cfs or greater | N/A |
| coastal tidal water (harbors, sounds, bays, etc.), ocean, or Great Lakes | | N/A | N/A |

## SURFACE WATER PATHWAY HUMAN FOOD CHAIN THREAT SCORESHEET

Likelihood of Release (LR)

LR is the same for all surface water pathway threats. Enter LR score from page 12.

Human Food Chain Threat Targets (T)

8. The only human food chain targets are fisheries. A fishery is an area of a surface water body from which food chain organisms are taken or could be taken for human consumption on a subsistence, sporting, or commercial basis. Food chain organisms include fish, shellfish, crustaceans, amphibians, and amphibious reptiles. Fisheries are delineated by changes in surface water body type (i.e., streams and rivers, lakes. coastal tidal waters, and oceans/Great Lakes) and whenever the flow characteristics of a stream or river change.

In the space provided, identify all fisheries within the target distance limit. Indicate the surface water body type and flow for each fishery. Gauging station flow data are available for many surface water bodies from USGS or other sources. In the absence of gauging station data, estimate flow using the list of surface water body types and associated flow categories in PA Table 4 (page 13). The flow for lakes is determined by the sum of flows of streams entering or leaving the lake. Note that, if there are no fisheries within the target distance limit, the Human Food Chain Threat Targets score is zero.

9. Primary fisheries are any fisheries within the target distance limit that you suspect have been exposed to a hazardous substance released from the site. Use professional judgment guided by the Surface Water Pathway Criteria List (page 11) to make this determination. If you identify any primary fisheries, list them in the space provided, enter 300 as the Primary Fisheries factor score, and do not evaluate Secondary Fisheries. Note that if you do not suspect a release, there can be no primary fisheries.

10. Secondary fisheries are fisheries that you do not suspect have been exposed to a hazardous substance. Evaluate this factor only if fisheries are present within the target distance limit, but none is considered a primary fishery.

A. If you suspect a release to surface water and have identified a secondary fishery but no primary fishery, assign a score of 210.

B. If you do not suspect a release, evaluate this factor based on flow. In the absence of gauging station flow data, estimate flow using the list of surface water body types and associated flow categories in PA Table 4 (page 13). Assign a Secondary Fisheries score from the table on the scoresheet using the lowest flow at any fishery within the target distance limit. (Dilution weight multiplier does not apply to PA evaluation of this factor.)

Sum the target scores in Column A (Suspected Release) or Column B (No Suspected Release).

## SURFACE WATER PATHWAY (continued)
## HUMAN FOOD CHAIN THREAT SCORESHEET

| LIKELIHOOD OF RELEASE | | A Suspected Release | B No Suspected Release | References |
|---|---|---|---|---|
| Enter Surface Water Likelihood of Release score from page 12. | LR = | | | |

### HUMAN FOOD CHAIN THREAT TARGETS

8. Record the water body type and flow (if applicable) for each fishery within the target distance limit. If there is no fishery within the target distance limit, assign a Targets score of 0 at the bottom of the page.

| Fishery Name | Water Body Type | Flow |
|---|---|---|
| | | ____ cfs |
| | | ____ cfs |
| | | ____ cfs |
| | | ____ cfs |
| | | ____ cfs |

9. PRIMARY FISHERIES: If you suspect any fishery listed above has been exposed to a hazardous substance from the site (see Surface Water Criteria List, page 11), assign a score of 300 and do not evaluate Factor 10. List the primary fisheries:

_____, _____,
_____, _____.

10. SECONDARY FISHERIES

A. If you suspect a release to surface water and have identified a secondary fishery but no primary fishery, assign a score of 210.

B. If you do not suspect a release, assign a Secondary Fisheries score from the table below using the lowest flow at any fishery within the target distance limit.

| Lowest Flow | Secondary Fisheries Score |
|---|---|
| < 10 cfs | 210 |
| 10 to 100 cfs | 30 |
| > 100 cfs, coastal tidal waters, oceans, or Great Lakes | 12 |

T =

## SURFACE WATER PATHWAY ENVIRONMENTAL THREAT SCORESHEET

Likelihood of Release (LR)

LR is the same for all surface water pathway threats. Enter LR score from page 12.

Environmental Threat Targets (T)

11. PA Table 5 (page 16) lists sensitive environments for the Surface Water Pathway Environmental Threat. In the space provided, identify all sensitive environments located within the target distance limit. Indicate the surface water body type and flow at each sensitive environment. Gauging station flow data for many surface water bodies are available from USGS or other sources. In the absence of gauging station data, estimate flow using the list of surface water body types and associated flow categories in PA Table 4 (page 13). The flow for lakes is determined by the sum of flows of streams entering or leaving the lake. Note that if there are no sensitive environments within the target distance limit, the Environmental Threat Targets score is zero.

12. Primary sensitive environments are surface water sensitive environments within the target distance limit that you suspect have been exposed to a hazardous substance released from the site. Use professional judgment guided by the Surface Water Pathway Criteria List (page 11) to make this determination. If you identify any primary sensitive environments, list them in the space provided, enter 300 as the Primary Sensitive Environments factor score, and do not evaluate Secondary Sensitive Environments. Note that if you do not suspect a release, there can be no primary sensitive environments.

13. Secondary sensitive environments are surface water sensitive environments that you do not suspect have been exposed to a hazardous substance. Evaluate this factor only if surface water sensitive environments are present within the target distance limit, but none is considered a primary sensitive environment. Evaluate secondary sensitive environments based on flow.

- In the table provided, list all secondary sensitive environments on surface water bodies with flow of 100 cfs or less.

  1) Use PA Table 4 (page 13) to determine the appropriate dilution weight for each.

  2) Use PA Tables 5 and 6 (page 16) to determine the appropriate value for each sensitive environment type and for wetlands frontage.

  3) For a sensitive environment that falls into more than one of the categories in PA Table 5, sum the values for each type to determine the environment value (e.g., a wetland with 1.5 miles frontage (value of 50) that is also a critical habitat for a Federally designated endangered species (value of 100) would receive a total value of 150).

  4) For each sensitive environment, multiply the dilution weight by the environment type (or length of wetlands) value and record the product in the far-right column.

  5) Sum the values in the far-right column and enter the total as the Secondary Sensitive Environments score. Do not evaluate part B of this factor.

- If all secondary sensitive environments are on surface water bodies with flows greater than 100 cfs, assign 10 as the Secondary Sensitive Environments score.

Sum the target scores in Column A (Suspected Release) or Column B (No Suspected Release).

## SURFACE WATER PATHWAY (continued)
## ENVIRONMENTAL THREAT SCORESHEET

| LIKELIHOOD OF RELEASE | | A Suspected Release | B No Suspected Release | References |
|---|---|---|---|---|
| Enter Surface Water Likelihood of Release score from page 12. | LR = | | | |

### ENVIRONMENTAL THREAT TARGETS

11. Record the water body type and flow (if applicable) for each surface water sensitive environment within the target distance limit (see PA Tables 4 and 5). If there is no sensitive environment within the target distance limit, assign a Targets score of 0 at the bottom of the page.

| Environment Name | Water Body Type | Flow |
|---|---|---|
| | | cfs |
| | | cfs |
| | | cfs |
| | | cfs |
| | | cfs |

12. PRIMARY SENSITIVE ENVIRONMENTS: If you suspect any sensitive environment listed above has been exposed to a hazardous substance from the site (see Surface Water Criteria List, page 11), assign a score of 300 and do not evaluate factor 13. List the primary sensitive environments:

_____, _____.
_____, _____.

13. SECONDARY SENSITIVE ENVIRONMENTS: If sensitive environments are present, but none is a primary sensitive environment, evaluate Secondary Sensitive Environments based on flow.

A. For secondary sensitive environments on surface water bodies with flows of 100 cfs or less, assign scores as follows, and do not evaluate part B of this factor:

| Flow | Dilution Weight (PA Table 4) | Environment Type and Value (PA Tables 5 and 6) | Total |
|---|---|---|---|
| cfs | x | = | |
| cfs | x | = | |
| cfs | x | = | |
| cfs | x | = | |
| cfs | x | = | |
| | | Sum = | |

B. If all secondary sensitive environments are located on surface water bodies with flows > 100 cfs, assign a score of 10.

T =

## PA TABLE 5: SURFACE WATER AND AIR PATHWAY SENSITIVE ENVIRONMENTS VALUES

| *Sensitive Environment* | *Assigned Value* |
|---|---|
| Critical habitat for Federally designated endangered or threatened species<br>Marine Sanctuary<br>National Park<br>Designated Federal Wilderness Area<br>Ecologically important areas identified under the Coastal Zone Wilderness Act<br>Sensitive Areas identified under the National Estuary Program or Near Coastal Water Program of the Clean Water Act<br>Critical Areas identified under the Clean Lakes Program of the Clean Water Act (subareas in lakes or entire small lakes)<br>National Monument (air pathway only)<br>National Seashore Recreation Area<br>National Lakeshore Recreation Area | 100 |
| Habitat known to be used by Federally designated or proposed endangered or threatened species<br>National Preserve<br>National or State Wildlife Refuge<br>Unit of Coastal Barrier Resources System<br>Federal land designated for the protection of natural ecosystems<br>Administratively Proposed Federal Wilderness Area<br>Spawning areas critical for the maintenance of fish/shellfish species within a river system, bay, or estuary<br>Migratory pathways and feeding areas critical for the maintenance of anadromous fish species in a river system<br>Terrestrial areas utilized for breeding by large or dense aggregations of vertebrate animals (air pathway) or semi-aquatic foragers (surface water pathway)<br>National river reach designated as Recreational | 75 |
| Habitat known to be used by State designated endangered or threatened species<br>Habitat known to be used by a species under review as to its Federal endangered or threatened status<br>Coastal Barrier (partially developed)<br>Federally designated Scenic or Wild River | 50 |
| State land designated for wildlife or game management<br>State designated Scenic or Wild River<br>State designated Natural Area<br>Particular areas, relatively small in size, important to maintenance of unique biotic communities | 25 |
| State designated areas for protection/maintenance of aquatic life under the Clean Water Act | 5 |
| Wetlands | See PA Table 6 (Surface Water Pathway) or PA Table 9 (Air Pathway) |

## PA TABLE 6: SURFACE WATER PATHWAY WETLANDS FRONTAGE VALUES

| *Total Length of Wetlands* | *Assigned Value* |
|---|---|
| Less than 0.1 mile | 0 |
| 0.1 to 1 mile | 25 |
| Greater than 1 to 2 miles | 50 |
| Greater than 2 to 3 miles | 75 |
| Greater than 3 to 4 miles | 100 |
| Greater than 4 to 8 miles | 150 |
| Greater than 8 to 12 miles | 250 |
| Greater than 12 to 16 miles | 350 |
| Greater than 16 to 20 miles | 450 |
| Greater than 20 miles | 500 |

## SURFACE WATER PATHWAY WASTE CHARACTERISTICS, THREAT, AND PATHWAY SCORES

### Waste Characteristics (WC)

14. **Waste Characteristics:** Score is assigned from page 4. However, if a primary target has been identified for any surface water threat, assign either the score calculated on page 4 or a score of 32, whichever is greater.

### Surface Water Pathway Threat Scores

Fill in the matrix with the appropriate scores from the previous pages. To calculate the score for each threat: multiply the scores for LR, T, and WC; divide the product by 82,500; and round the result to the nearest integer. The Drinking Water Threat and Human Food Chain Threat are each subject to a maximum of 100. The Environmental Threat is subject to a maximum of 60. Enter the rounded threat scores in the far-right column.

### Surface Water Pathway Score

Sum the individual threat scores to determine the Surface Water Pathway Score. If the sum is greater than 100, assign 100.

## SURFACE WATER PATHWAY (concluded)
## WASTE CHARACTERISTICS, THREAT, AND PATHWAY SCORE SUMMARY

| WASTE CHARACTERISTICS | A *Suspected Release* | B *No Suspected Release* |
|---|---|---|
| 14. A. If you have identified any primary target for surface water (pages 12, 14, or 15), assign the waste characteristics score calculated on page 4, or a score of 32, whichever is GREATER; do not evaluate part B of this factor. | | |
| B. If you have NOT identified any primary target for surface water, assign the waste characteristics score calculated on page 4. | | |
| WC = | | |

### SURFACE WATER PATHWAY THREAT SCORES

| Threat | *Likelihood of Release (LR) Score (from page 12)* | *Targets (T) Score (pages 12, 14, 15)* | *Pathway Waste Characteristics (WC) Score (determined above)* | *Threat Score LR x T x WC / 82,500* |
|---|---|---|---|---|
| Drinking Water | | | | |
| Human Food Chain | | | | |
| Environmental | | | | |

**SURFACE WATER PATHWAY SCORE**
**(Drinking Water Threat + Human Food Chain Threat + Environmental Threat)**

## SOIL EXPOSURE PATHWAY CRITERIA LIST

Areas of surficial contamination can generally be assumed. This "Criteria List" helps guide the process of developing a hypothesis concerning the exposure of specific targets to a hazardous substance at the site. Use the "Resident Population" section to evaluate site and source conditions that may help identify targets likely to be exposed to a hazardous substance. The check-boxes record your professional judgment. Answers to all of the listed questions may not be available during the PA. Also, the list is not all-inclusive; if other criteria help shape your hypothesis, list them at the bottom of the page or attach an additional page.

Check the boxes to indicate a "yes," "no," or "unknown" answer to each question.

## SOIL EXPOSURE PATHWAY CRITERIA LIST

| *SUSPECTED CONTAMINATION* | *RESIDENT POPULATION* |
|---|---|
| Surficial contamination can generally be assumed. | Yes ☐ No ☐ Unk ☐ Is any residence, school, or daycare facility on or within 200 feet of an area of suspected contamination?<br>☐ ☐ ☐ Is any residence, school, or daycare facility located on adjacent land previously owned or leased by the site owner/operator?<br>☐ ☐ ☐ Is there a migration route that might spread hazardous substances near residences, schools, or daycare facilities?<br>☐ ☐ ☐ Have onsite or adjacent residents or students reported adverse health effects, exclusive of apparent drinking water or air contamination problems?<br>☐ ☐ ☐ Does any neighboring property warrant sampling?<br>☐ ☐ Other criteria?_____<br>☐ ☐ **RESIDENT POPULATION IDENTIFIED?** |

Summarize the rationale for Resident Population (attach an additional page if necessary):

## SOIL EXPOSURE PATHWAY SCORESHEET

Pathway Characteristics

Answer the questions at the top of the page. Identify people who may be exposed to a hazardous substance because they work at the facility, or reside or attend school or daycare on or within 200 feet of an area of suspected contamination. If the site is active, estimate the number of full and part-time workers. Note that evaluation of targets is based on current site conditions.

Likelihood of Exposure (LE)

1. Suspected Contamination: Areas of surficial contamination are present at most sites, and a score of 550 can generally be assigned as a default measure. Assign zero, which effectively eliminates the pathway from further consideration, only if there is no surficial contamination; reliable analytical data are generally necessary to make this determination.

Resident Population Threat Targets (T)

2. Resident Population corresponds to "primary targets" for the migration pathways. Use professional judgment guided by the Soil Exposure Pathway Criteria List (page 18) to determine if there are people living or attending school or daycare on or within 200 feet of areas of suspected contamination. Record the number of people identified as resident population and multiply by 10 to determine the Resident Population factor score.

3. Resident Individual: Assign 50 if you have identified a resident population; otherwise, assign zero.

4. Workers: Estimate the number of full and part-time workers at this facility and adjacent facilities where contamination is also suspected. Assign a score for the Workers factor from the table.

5. Terrestrial Sensitive Environments: In the table provided, list each terrestrial sensitive environment located on an area of suspected contamination. Use PA Table 7 (page 20) to assign a value for each. Sum the values and assign the total as the factor score.

6. Resources: A score of 5 can generally be assigned as a default measure. Assign zero only if there is no land resource use on an area of suspected contamination.

Sum the target scores.

Waste Characteristics (WC)

7. Enter the WC score determined on page 4.

Resident Population Threat Score: Multiply the scores for LE, T, and WC. Divide the product by 82,500. Round the result to the nearest integer. If the result is greater than 100, assign 100.

Nearby Population Threat Score: Do not evaluate this threat if you gave a zero score to Likelihood of Exposure. Otherwise, assign a score based on the population within a 1-mile radius (use the same 1-mile radius population you evaluate for air pathway population targets):

| Population Within One Mile | Nearby Population Threat Score |
|---|---|
| < 10,000 | 1 |
| 10,000 to 50,000 | 2 |
| >50,000 | 4 |

Soil Exposure Pathway Score: Sum the Resident Population Threat score and the Nearby Population Threat score, subject to a maximum of 100.

## SOIL EXPOSURE PATHWAY SCORESHEET

| *Pathway Characteristics* | |
|---|---|
| Do any people live on or within 200 ft of areas of suspected contamination? | Yes ___ No ___ |
| Do any people attend school or daycare on or within 200 ft of areas of suspected contamination? | Yes ___ No ___ |
| Is the facility active? Yes ___ No ___ If yes, estimate the number of workers: ___ | |

| LIKELIHOOD OF EXPOSURE | *Suspected Contamination* | *References* |
|---|---|---|
| 1. SUSPECTED CONTAMINATION: Surficial contamination can generally be assumed, and a score of 550 assigned. Assign zero only if the absence of surficial contamination can be confidently demonstrated. LE = | | |

**RESIDENT POPULATION THREAT TARGETS**

2. RESIDENT POPULATION: Determine the number of people occupying residences or attending school or daycare on or within 200 feet of areas of suspected contamination (see Soil Exposure Pathway Criteria List, page 18).
___ people x 10 =

3. RESIDENT INDIVIDUAL: If you have identified a resident population (factor 2), assign a score of 50; otherwise, assign a score of 0.

4. WORKERS: Use the following table to assign a score based on the total number of workers at the facility and nearby facilities with suspected contamination:

| *Number of Workers* | *Score* |
|---|---|
| 0 | 0 |
| 1 to 100 | 5 |
| 101 to 1,000 | 10 |
| > 1,000 | 15 |

5. TERRESTRIAL SENSITIVE ENVIRONMENTS: Use PA Table 7 to assign a value for each terrestrial sensitive environment on an area of suspected contamination:

| *Terrestrial Sensitive Environment Type* | *Value* |
|---|---|
| | |
| | |

*Sum* =

6. RESOURCES

T =

**WASTE CHARACTERISTICS**

7. Assign the waste characteristics score calculated on page 4. WC =

**RESIDENT POPULATION THREAT SCORE:** $\frac{LE \times T \times WC}{82,500.}$

**NEARBY POPULATION THREAT SCORE:**

**SOIL EXPOSURE PATHWAY SCORE:**
**Resident Population Threat + Nearby Population Threat**

## PA TABLE 7: SOIL EXPOSURE PATHWAY
## TERRESTRIAL SENSITIVE ENVIRONMENT VALUES

| *Terrestrial Sensitive Environment* | *Assigned Value* |
|---|---|
| Terrestrial critical habitat for Federally designated endangered or threatened species<br>National Park<br>Designated Federal Wilderness Area<br>National Monument | 100 |
| Terrestrial habitat known to be used by Federally designated or proposed threatened or endangered species<br>National Preserve (terrestrial)<br>National or State terrestrial Wildlife Refuge<br>Federal land designated for protection of natural ecosystems<br>Administratively proposed Federal Wilderness Area<br>Terrestrial areas utilized by large or dense aggregations of animals (vertebrate species) for breeding | 75 |
| Terrestrial habitat used by State designated endangered or threatened species<br>Terrestrial habitat used by species under review for Federal designated endangered or threatened status | 50 |
| State lands designated for wildlife or game management<br>State designated Natural Areas<br>Particular areas, relatively small in size, important to maintenance of unique biotic communities | 25 |

## AIR PATHWAY CRITERIA LIST

This "Criteria List" helps guide the process of developing a hypothesis as to whether a release to the air is likely to be detected. The check-boxes record your professional judgment. Answers to all of the listed questions may not be available during the PA. Also, the list is not all-inclusive; if other criteria help shape your hypothesis, list them at the bottom of the page or attach an additional page.

The "Suspected Release" section identifies several conditions that could provide insight as to whether a release from the site is likely to be detected. If a release is suspected, primary targets are any residents, workers, students, and sensitive environments on or within ¼ mile of the site.

Check the boxes to indicate a "yes," "no," or "unknown" answer to each question. If you check the "Suspected Release" box as "yes," make sure you assign a Likelihood of Release value of 550 for the pathway.

## AIR PATHWAY CRITERIA LIST

| SUSPECTED RELEASE | | | | PRIMARY TARGETS |
|---|---|---|---|---|
| Yes | No | Unk | | |
| ☐ | ☐ | ☐ | Are odors currently reported? | If you suspect a release to air, evaluate *all* populations and sensitive environments within 1/4 mile (including those onsite) as primary targets. |
| ☐ | ☐ | ☐ | Has release of a hazardous substance to the air been directly observed? | |
| ☐ | ☐ | ☐ | Are there reports of adverse health effects (e.g., headaches, nausea, dizziness) potentially resulting from migration of hazardous substances through the air? | |
| ☐ | ☐ | ☐ | Does analytical or circumstantial evidence suggest a release to the air? | |
| ☐ | ☐ | | Other criteria?_____ | |
| ☐ | ☐ | | **SUSPECTED RELEASE?** | |

Summarize the rationale for Suspected Release (attach an additional page if necessary):

## AIR PATHWAY SCORESHEET

**Pathway Characteristics**
Answer the questions at the top of the page. Refer to the Air Pathway Criteria List (page 21) to hypothesize whether you suspect that a hazardous substance release to the air could be detected. Due to dispersion, releases to air are not as persistent as releases to water migration pathways and are much more difficult to detect. Develop your hypothesis concerning the release of hazardous substances to air based on "real time" considerations. Record the distance (in feet) from any source to the nearest regularly occupied building.

**Likelihood of Release (LR)**

1. **Suspected Release:** Hypothesize based on professional judgment guided by the Air Pathway Criteria List (page 21). If you suspect a release to air, use only Column A for this pathway and do not evaluate factor 2.

2. **No Suspected Release:** If you do not suspect a release, enter 500 and use only Column B for this pathway.

**Targets (T)**

3. **Primary Target Population:** Evaluate populations subject to exposure from release of a hazardous substance from the site. If you suspect a release, the resident, student, and worker populations on and within ¼ mile of the site are considered primary target population. If only the number of residences is known, use the average county residents per household (rounded up to the next integer) to determine the population. In the space provided, enter this population. Multiply the population by 10 to determine the Primary Target Population score. Note that if you do not suspect a release, there can be no primary target population.

4. **Secondary Target Population:** Evaluate populations in distance categories not suspected to be subject to exposure from release of a hazardous substance from the site. If you suspect a release, residents, students, and workers in the ¼- to 4-mile distance categories are secondary target population. If you do not suspect a release, all residents, students, and workers onsite and within 4 miles are considered secondary target population.

Use PA Table 8 (page 23). Enter the population in each secondary target population distance category, circle the assigned value, and record it on the far-right side of the table. Sum the far-right column and enter the total as the Secondary Target Population factor score.

5. **Nearest Individual** represents the threat posed to the person most likely to be exposed to a hazardous substance release from the site. If you have identified a primary target population, enter 50. Otherwise, assign the score from PA Table 8 (page 23) for the closest distance category in which you have identified a secondary target population.

6. **Primary Sensitive Environments:** If a release is suspected, all sensitive environments on or within ¼ mile of the site are considered primary targets. List them and assign values for sensitive environment type (from PA Table 5, page 16) and/or wetland acreage (from PA Table 9, page 23). Sum the values and enter the total as the factor score.

7. **Secondary Sensitive Environments:** If a release is suspected, sensitive environments in the ¼- to ½-mile distance category are secondary targets; greater distances need not be evaluated because distance weighting greatly diminishes the impact on site score. If you do not suspect a release, all sensitive environments on and within ½ mile of the site are considered secondary targets. List each secondary sensitive environment on PA Table 10 (page 23) and assign a value to each using PA Tables 5 and 9. Multiply each value by the indicated distance weight and record the product in the far-right column. Sum the products and enter the total as the factor score.

8. **Resources:** A score of 5 can generally be assigned as a default measure. Assign zero only if there is no land resource use within ½ mile.

Sum the target scores in Column A (Suspected Release) or Column B (No Suspected Release).

**Waste Characteristics (WC)**

9. **Waste Characteristics:** Score is assigned from page 4. However, if you have identified any primary target for the air pathway, assign either the score calculated on page 4 or a score of 32, whichever is greater.

**Air Pathway Score:** Multiply the scores for LR, T, and WC. Divide the product by 82,500. Round the result to the nearest integer. If the result is greater than 100, assign 100.

## AIR PATHWAY SCORESHEET

| Pathway Characteristics | |
|---|---|
| Do you suspect a release (see Air Pathway Criteria List, page 21)? | Yes ___ No ___ |
| Distance to the nearest individual: | _____ ft |

| | A Suspected Release | B No Suspected Release | References |
|---|---|---|---|
| **LIKELIHOOD OF RELEASE** | | | |
| 1. SUSPECTED RELEASE: If you suspect a release to air (see page 21), assign a score of 550. Use only column A for this pathway. | | | |
| 2. NO SUSPECTED RELEASE: If you do not suspect a release to air, assign a score of 500. Use only column B for this pathway. | | | |
| LR = | | | |
| **TARGETS** | | | |
| 3. PRIMARY TARGET POPULATION: Determine the number of people subject to exposure from a suspected release of hazardous substances to the air. _____ people x 10 = | | | |
| 4. SECONDARY TARGET POPULATION: Determine the number of people not suspected to be exposed to a release to air, and assign the total population score using PA Table 8. | | | |
| 5. NEAREST INDIVIDUAL: If you have identified any Primary Target Population for the air pathway, assign a score of 50; otherwise, assign the Nearest Individual score from PA Table 8. | | | |
| 6. PRIMARY SENSITIVE ENVIRONMENTS: Sum the sensitive environment values (PA Table 5) and wetland acreage values (PA Table 9) for environments subject to exposure from a suspected release to the air. | | | |
| Sensitive Environment Type / Value: _____ / _____; _____ / _____ | | | |
| Sum = | | | |
| 7. SECONDARY SENSITIVE ENVIRONMENTS: Use PA Table 10 to determine the score for secondary sensitive environments. | | | |
| 8. RESOURCES | | | |
| T = | | | |
| **WASTE CHARACTERISTICS** | | | |
| 9. A. If you have identified any Primary Target for the air pathway, assign the waste characteristics score calculated on page 4, or a score of 32, whichever is GREATER; do not evaluate part B of this factor. | | | |
| B. If you have NOT identified any Primary Target for the air pathway, assign the waste characteristics score calculated on page 4. | | | |
| WC = | | | |

**AIR PATHWAY SCORE:** $\dfrac{LR \times T \times WC}{82{,}500}$

## PA TABLE 8: VALUES FOR SECONDARY AIR TARGET POPULATIONS

| Distance from Site | Population | Nearest Individual (choose highest) | Population Within Distance Category | | | | | | | | | | | Population Value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 to 10 | 11 to 30 | 31 to 100 | 101 to 300 | 301 to 1,000 | 1,001 to 3,000 | 3,001 to 10,000 | 10,001 to 30,000 | 30,001 to 100,000 | 100,001 to 300,000 | 300,001 to 1,000,000 | Greater than 1,000,000 | |
| Onsite | _____ | 20 | 1 | 2 | 5 | 16 | 52 | 163 | 521 | 1,633 | 5,214 | 16,325 | 52,136 | 163,246 | _____ |
| >0 to ¼ mile | _____ | 20 | 1 | 1 | 1 | 4 | 13 | 41 | 130 | 408 | 1,303 | 4,081 | 13,034 | 40,811 | _____ |
| > ¼ to ½ mile | _____ | 2 | 0 | 0 | 1 | 1 | 3 | 9 | 28 | 88 | 282 | 882 | 2,815 | 8,816 | _____ |
| > ½ to 1 mile | _____ | 1 | 0 | 0 | 0 | 1 | 1 | 3 | 8 | 26 | 83 | 261 | 834 | 2,612 | _____ |
| > 1 to 2 miles | _____ | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 8 | 27 | 83 | 266 | 833 | _____ |
| > 2 to 3 miles | _____ | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 4 | 12 | 38 | 120 | 376 | _____ |
| > 3 to 4 miles | _____ | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 7 | 23 | 73 | 229 | _____ |
| Nearest Individual = | | | | | | | | | | | | | Score = | | |

## PA TABLE 9: AIR PATHWAY VALUES FOR WETLAND AREA

| Wetland Area | Assigned Value |
|---|---|
| Less than 1 acre | 0 |
| 1 to 50 acres | 25 |
| Greater than 50 to 100 acres | 75 |
| Greater than 100 to 150 acres | 125 |
| Greater than 150 to 200 acres | 175 |
| Greater than 200 to 300 acres | 250 |
| Greater than 300 to 400 acres | 350 |
| Greater than 400 to 500 acres | 450 |
| Greater than 500 acres | 500 |

## PA TABLE 10: DISTANCE WEIGHTS AND CALCULATIONS FOR AIR PATHWAY SECONDARY SENSITIVE ENVIRONMENTS

| Distance | Distance Weight | Sensitive Environment Type and Value (from PA Table 5 or 9) | Product |
|---|---|---|---|
| Onsite | 0.10 | x | |
| | | x | |
| 0-1/4 mi | 0.025 | x | |
| | | x | |
| | | x | |
| 1/4-1/2mi | 0.0054 | x | |
| | | x | |
| | | x | |
| | | x | |
| | | | Total Environments Score = |

## SITE SCORE CALCULATION

In the column labeled S, record the Ground Water Pathway score, the Surface Water Pathway score, the Soil Exposure Pathway score, and the Air Pathway score. Square each pathway score and record the result in the $S^2$ column. Sum the squared pathway scores. Divide the sum by 4, and take the square root of the result to obtain the Site Score.

## SUMMARY

Answer the summary questions, which ask for a qualitative evaluation of the relative risk of targets being exposed to a hazardous substance from the site. You may find your responses to these questions a good cross-check against the way you scored the individual pathways. For example, if you scored the ground water pathway on the basis of no suspected release and secondary targets only, yet your response to question #1 is "yes," this presents apparently conflicting conclusions that you need to reconsider and resolve. Your answers to the questions on page 24 should be consistent with your evaluations elsewhere in the PA scoresheets package.

## SITE SCORE CALCULATION

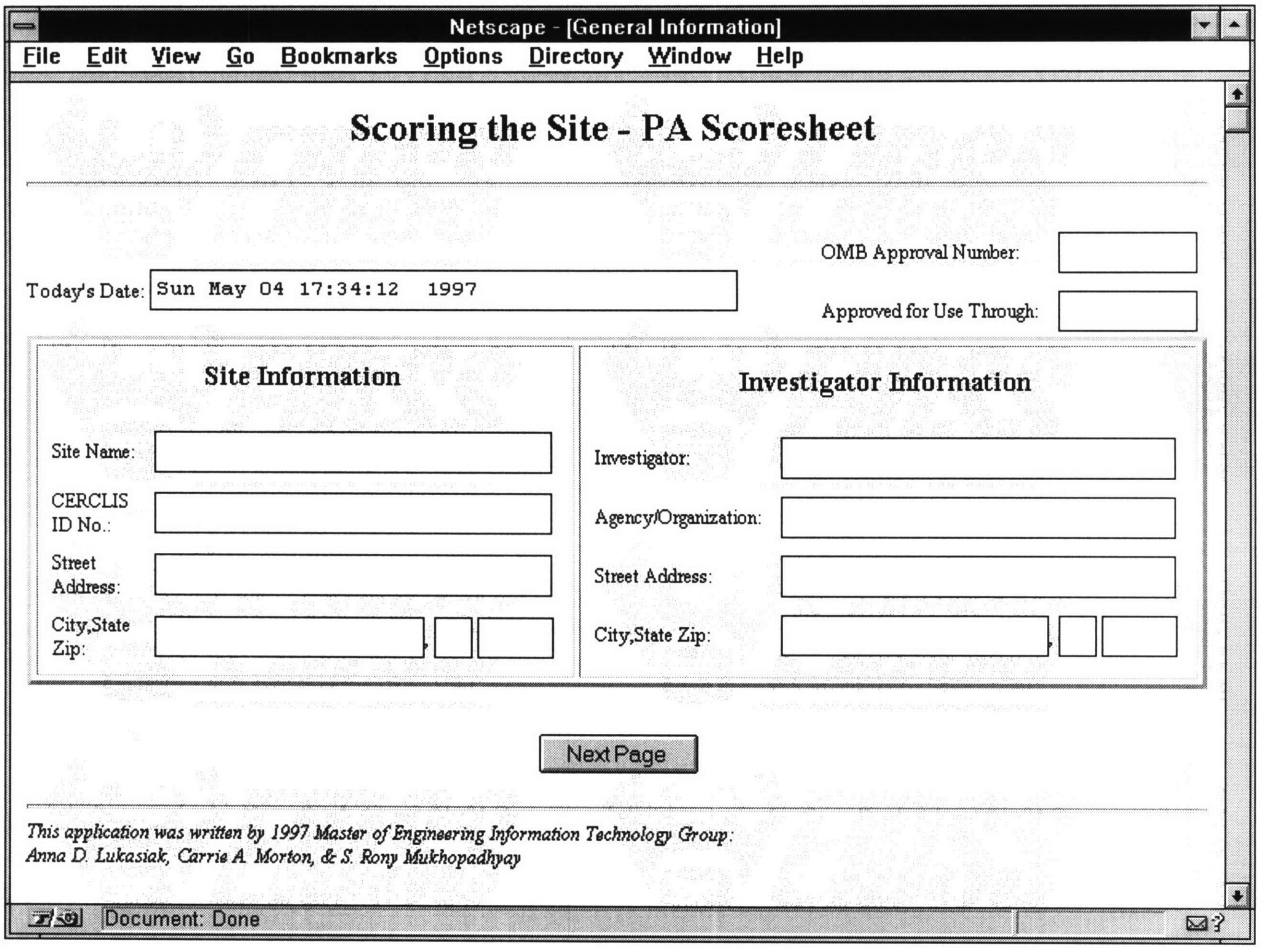
| | S | $S^2$ |
|---|---|---|
| GROUND WATER PATHWAY SCORE ($S_{gw}$): | | |
| SURFACE WATER PATHWAY SCORE ($S_{sw}$): | | |
| SOIL EXPOSURE PATHWAY SCORE ($S_s$): | | |
| AIR PATHWAY SCORE ($S_a$): | | |
| SITE SCORE: $\sqrt{\frac{S_{gw}^2+S_{sw}^2+S_s^2+S_a^2}{4}}$ | | |

**SUMMARY**

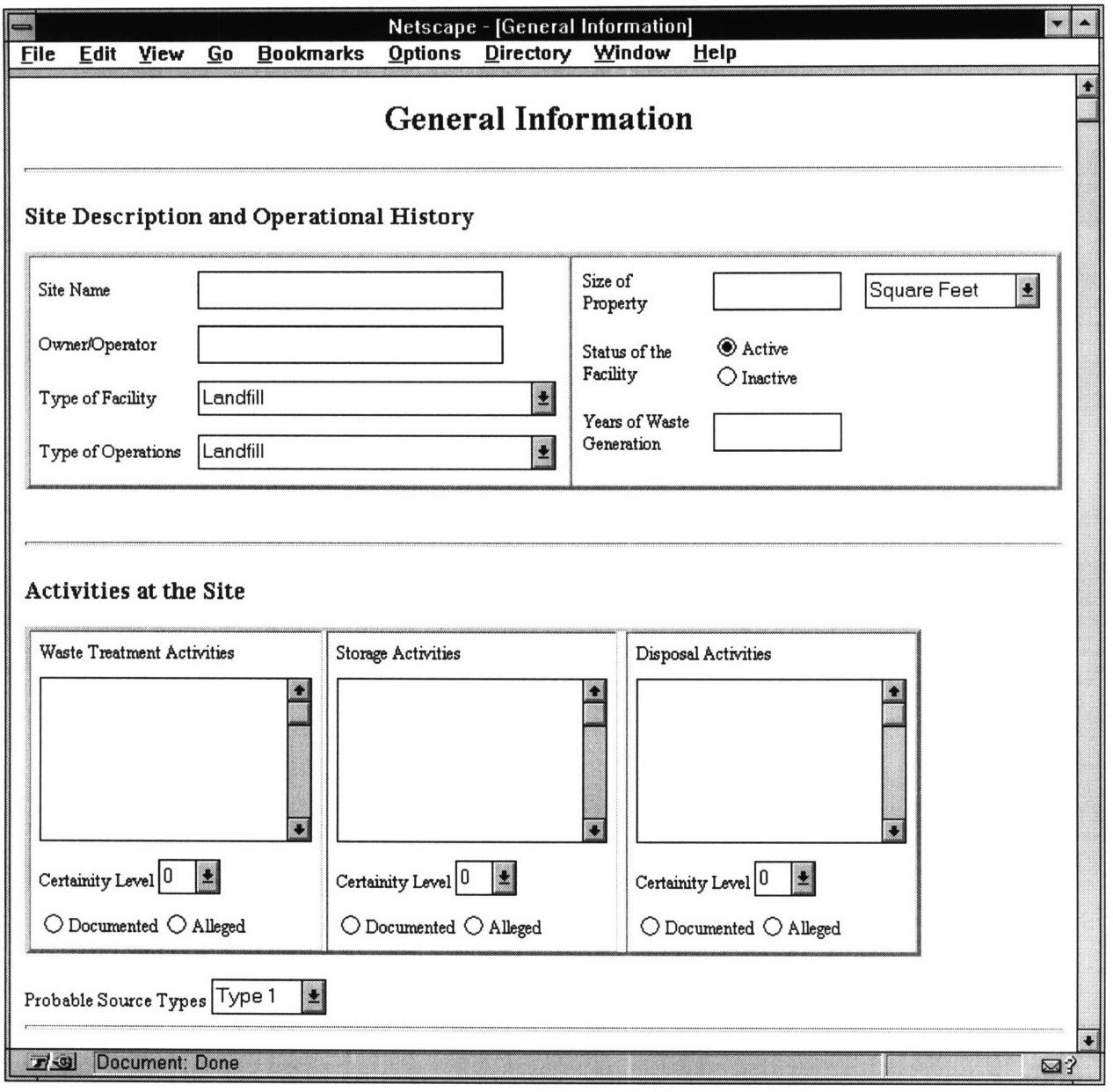
| | YES | NO |
|---|---|---|
| 1. Is there a high possibility of a threat to any nearby drinking water well(s) by migration of a hazardous substance in ground water? | ☐ | ☐ |
| A. If yes, identify the well(s). _____ | | |
| B. If yes, how many people are served by the threatened well(s)? _____ | | |
| 2. Is there a high possibility of a threat to any of the following by hazardous substance migration in surface water? | | |
| A. Drinking water intake | ☐ | ☐ |
| B. Fishery | ☐ | ☐ |
| C. Sensitive environment (wetland, critical habitat, others) | ☐ | ☐ |
| D. If yes, identify the target(s). _____ | | |
| 3. Is there a high possibility of an area of surficial contamination within 200 feet of any residence, school, or daycare facility? | ☐ | ☐ |
| If yes, identify the property(ies) and estimate the associated population(s). _____ | | |
| 4. Are there public health concerns at this site that are not addressed by PA scoring considerations? If yes, explain: _____ | ☐ | ☐ |

# Appendix E: Electronic PA Scoresheet

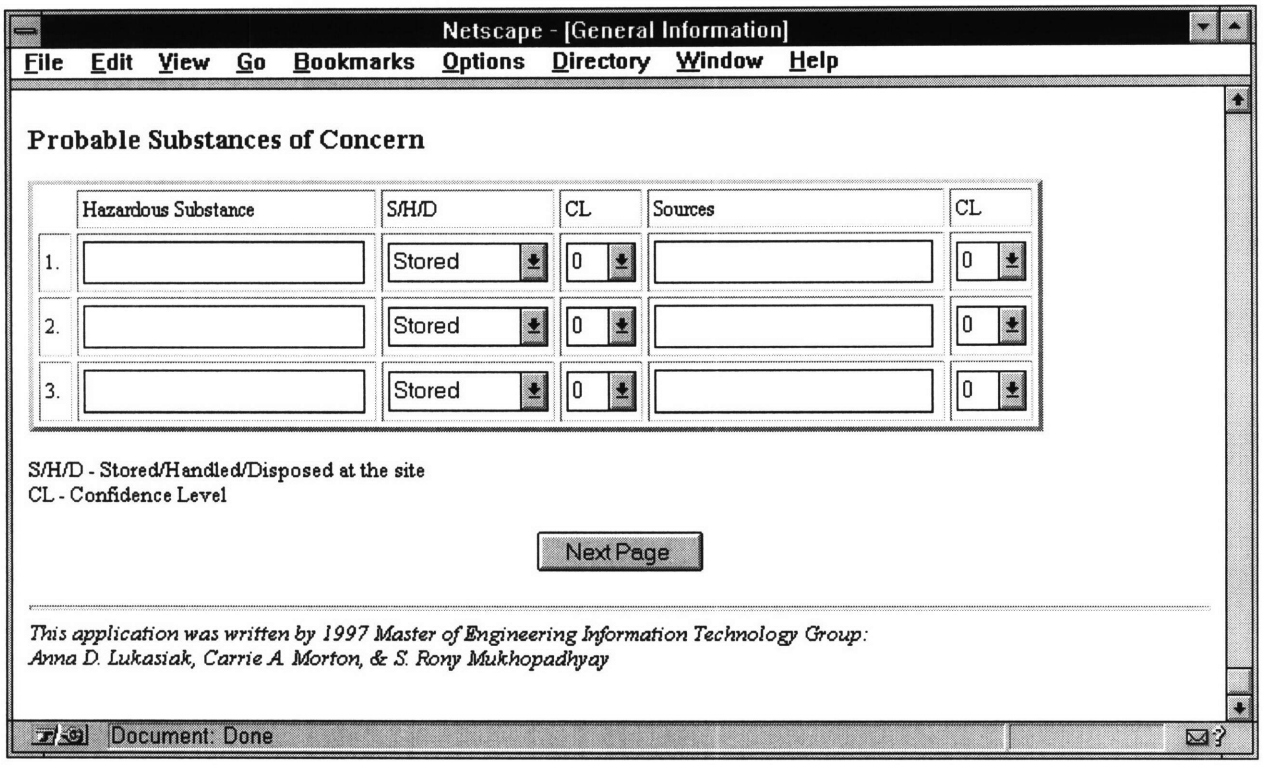
## E.1 Title Page



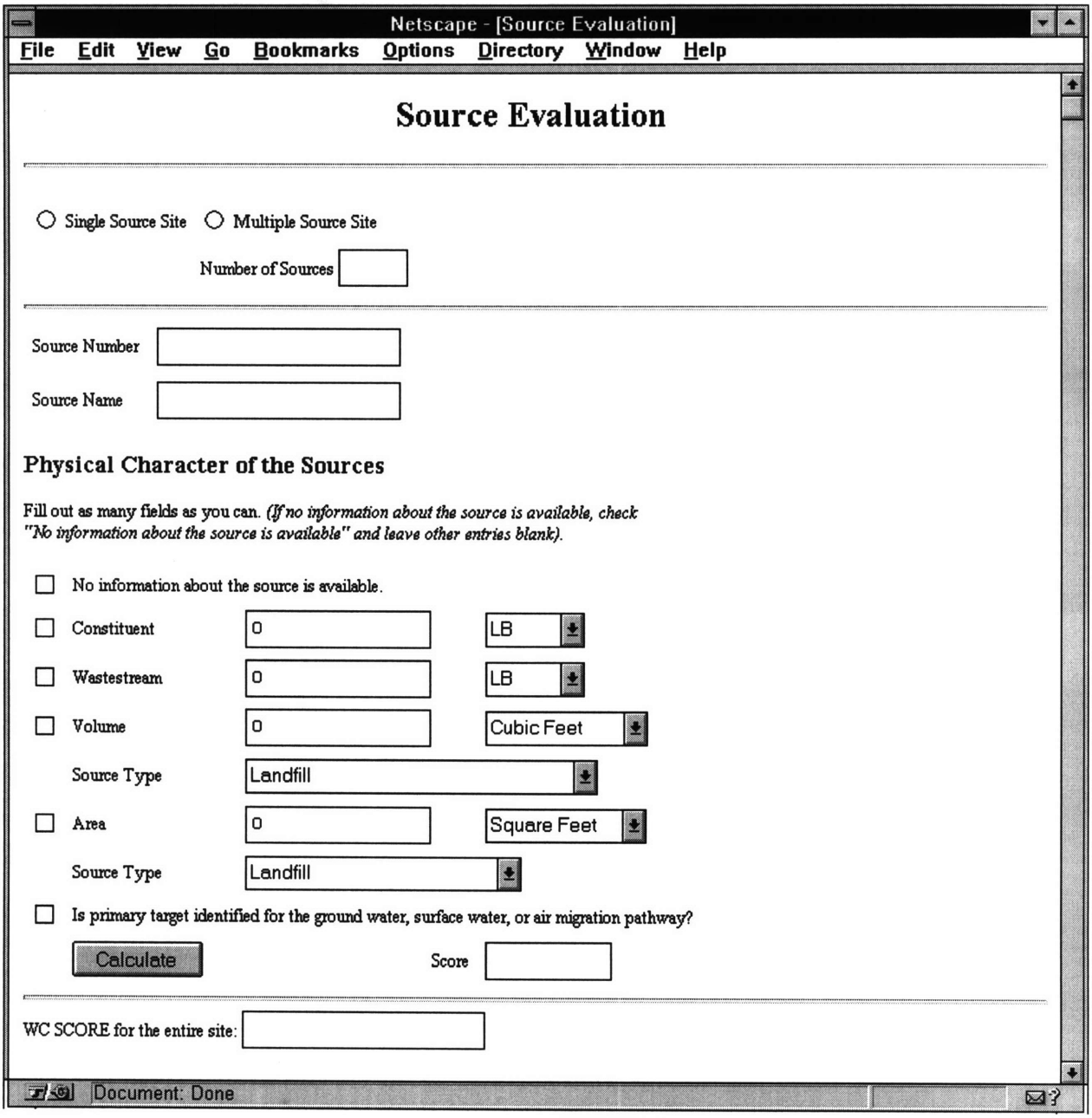
## E.2 General Information



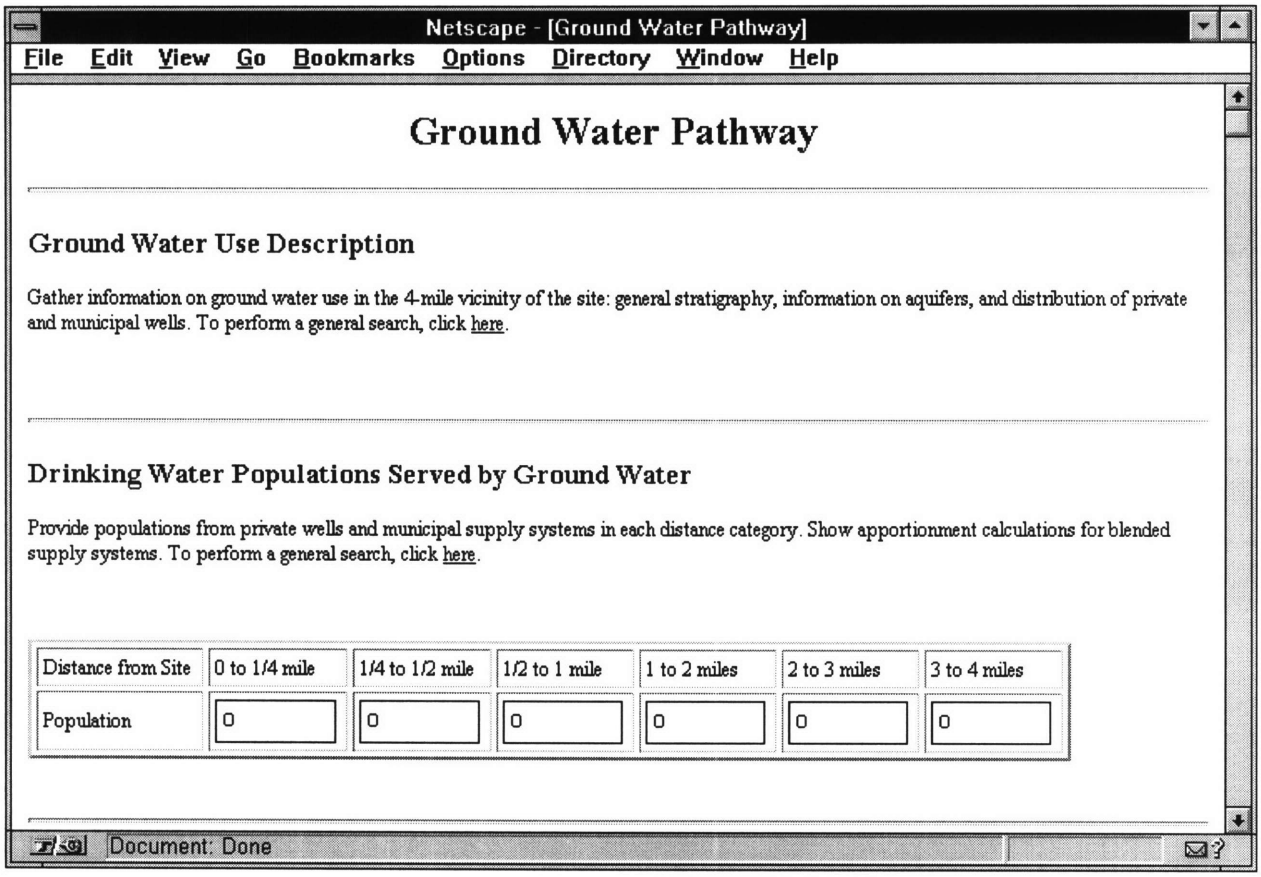
## E.2 General Information, cont.



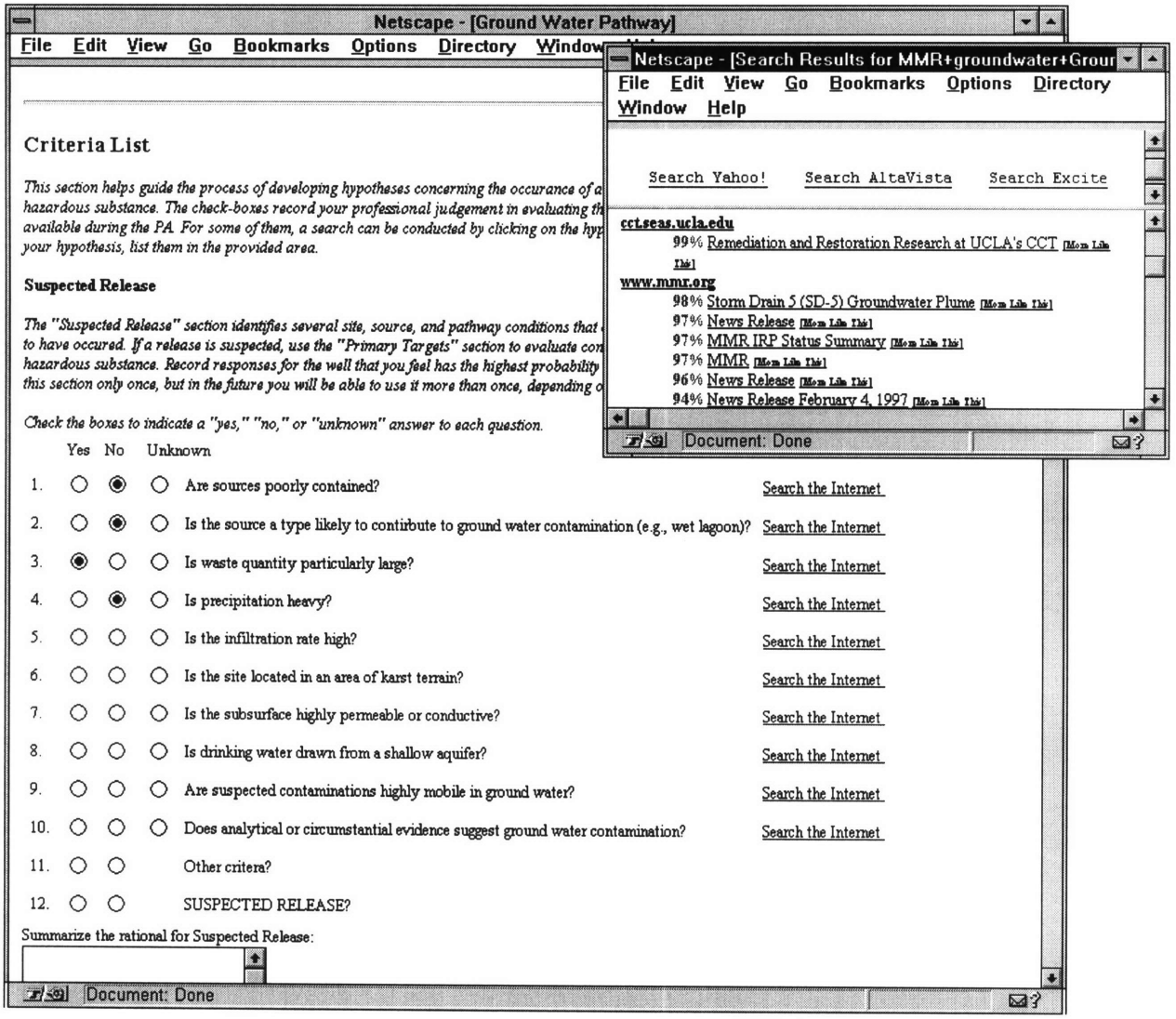
## E.3 Source Evaluation



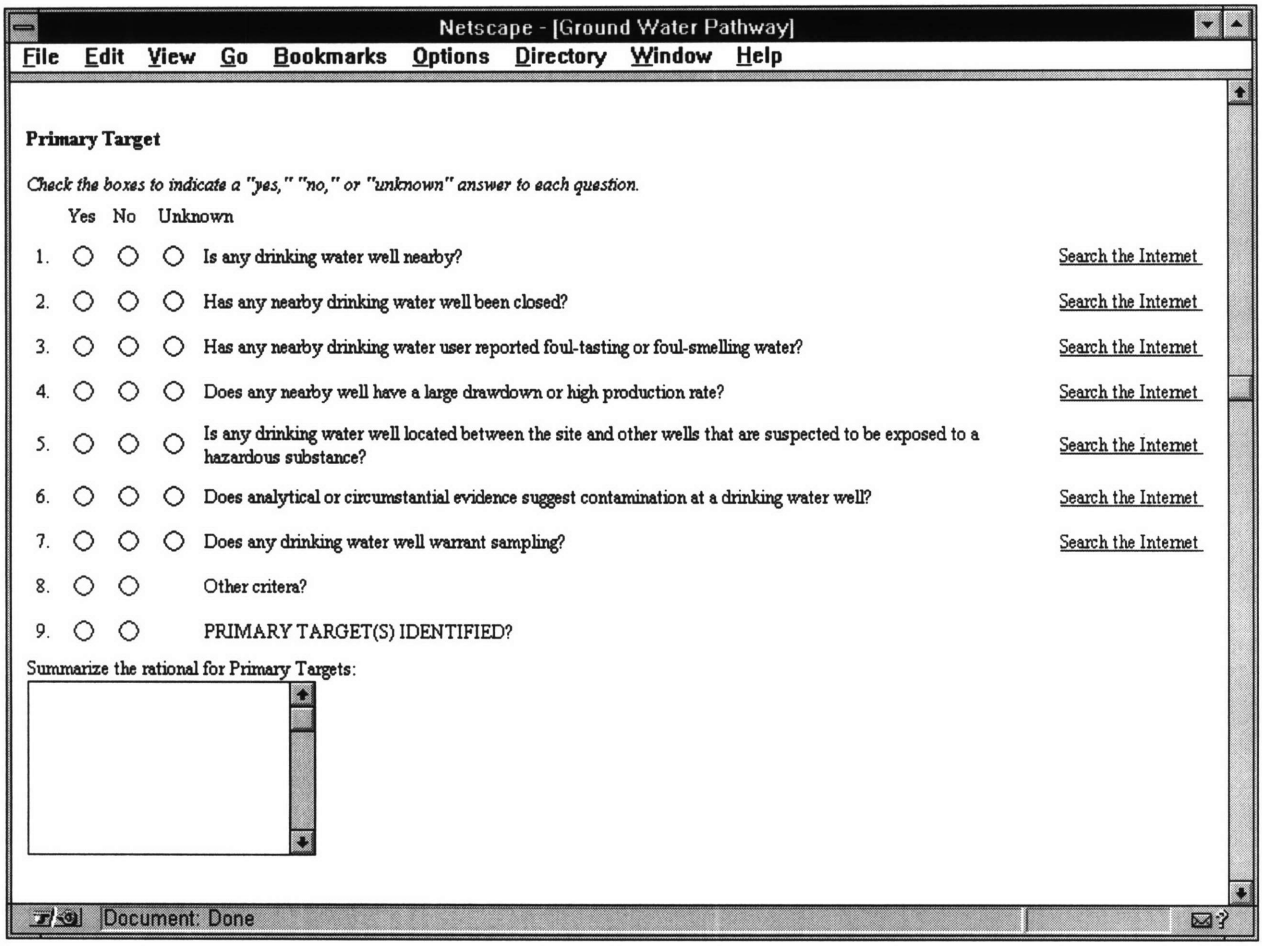
## E.4 Ground Water Pathway



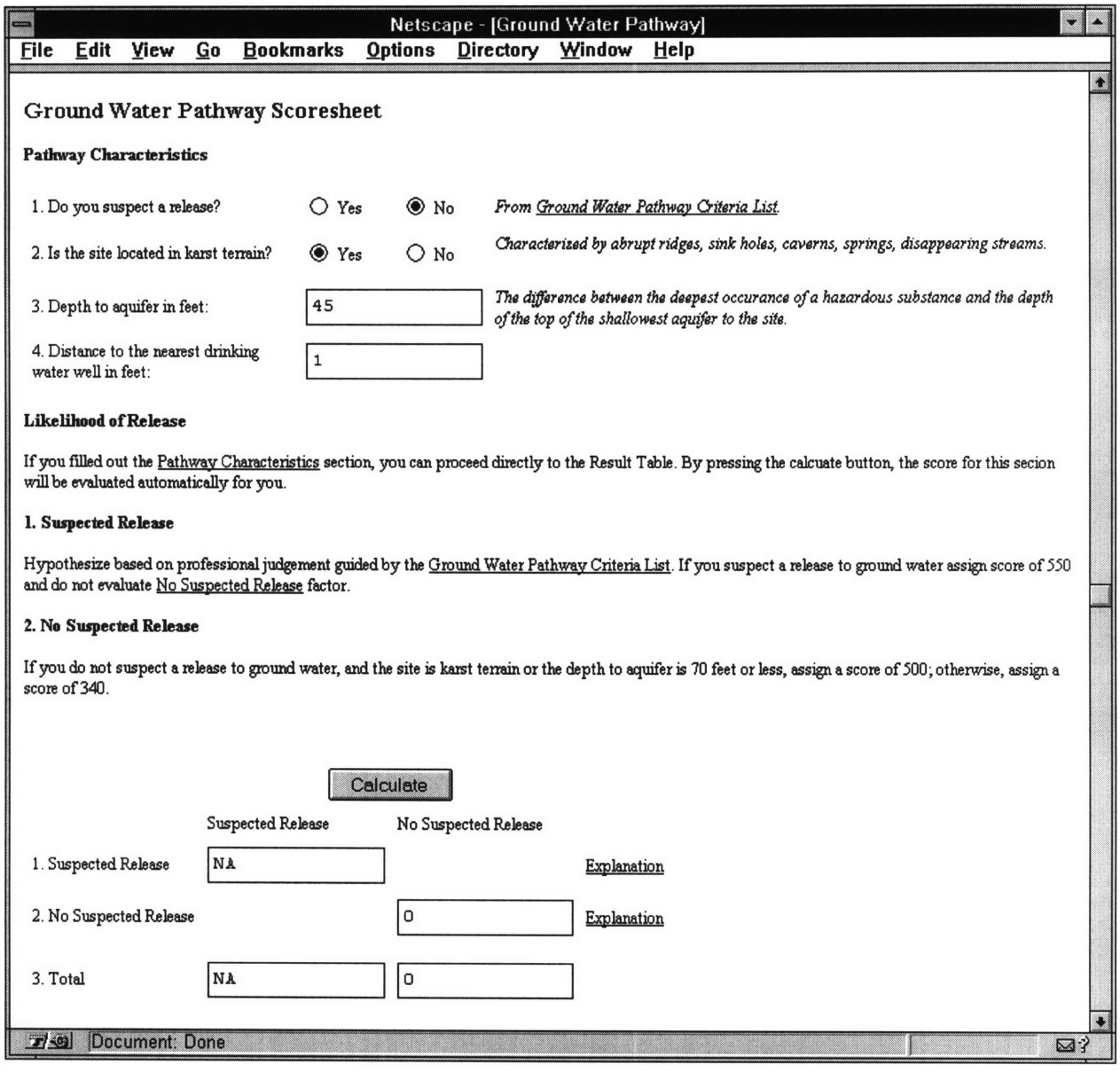
## E.4 Ground Water Pathway, cont.



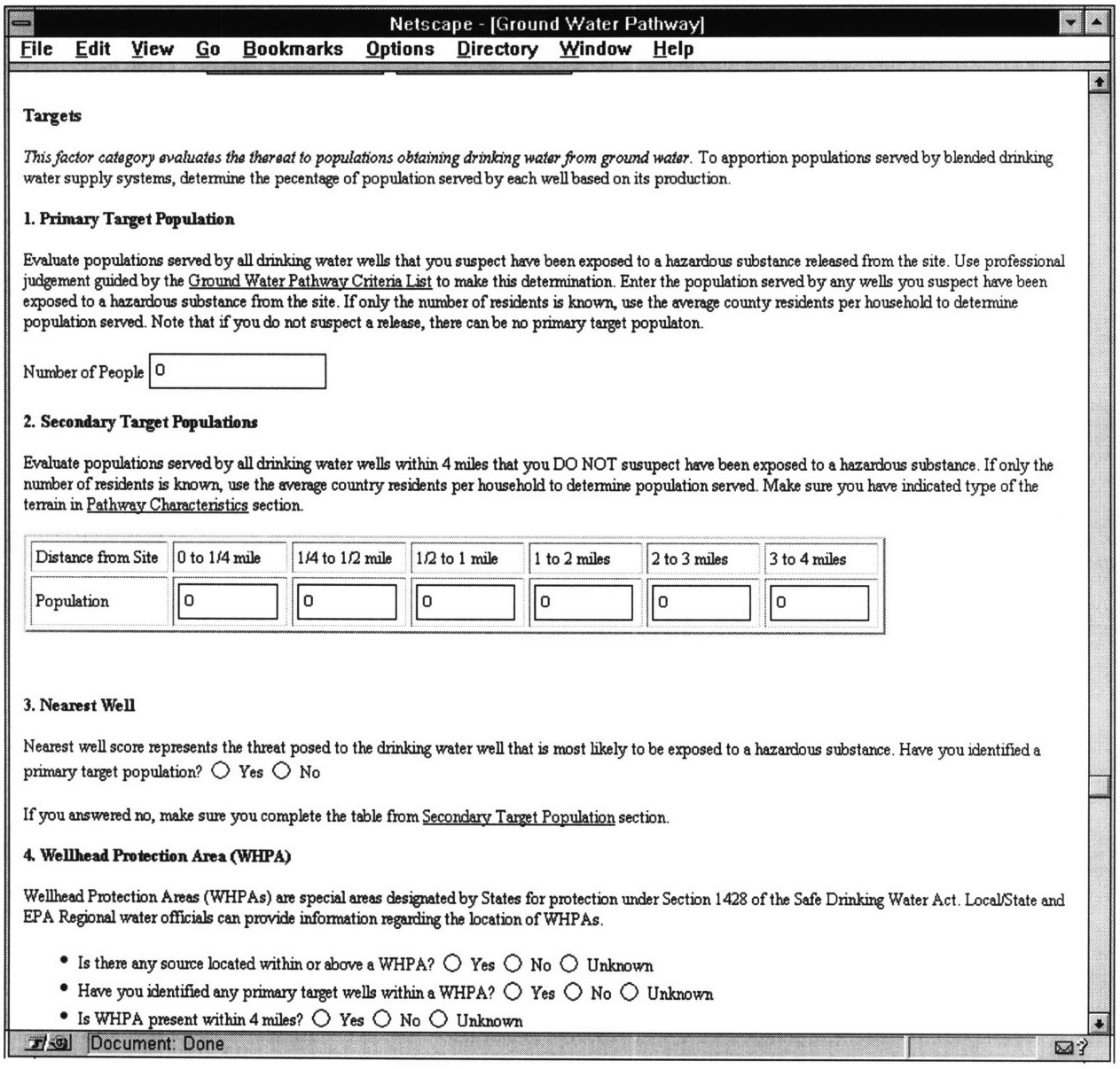
## E.4 Ground Water Pathway, cont



## E.4 Ground Water Pathway, cont.



## E.4 Ground Water Pathway, cont.




**Targets**

*This factor category evaluates the threat to populations obtaining drinking water from ground water.* To apportion populations served by blended drinking water supply systems, determine the pecentage of population served by each well based on its production.

**1. Primary Target Population**

Evaluate populations served by all drinking water wells that you suspect have been exposed to a hazardous substance released from the site. Use professional judgement guided by the Ground Water Pathway Criteria List to make this determination. Enter the population served by any wells you suspect have been exposed to a hazardous substance from the site. If only the number of residents is known, use the average county residents per household to determine population served. Note that if you do not suspect a release, there can be no primary target populaton.

Number of People [0]

**2. Secondary Target Populations**

Evaluate populations served by all drinking water wells within 4 miles that you DO NOT susupect have been exposed to a hazardous substance. If only the number of residents is known, use the average country residents per household to determine population served. Make sure you have indicated type of the terrain in Pathway Characteristics section.

| Distance from Site | 0 to 1/4 mile | 1/4 to 1/2 mile | 1/2 to 1 mile | 1 to 2 miles | 2 to 3 miles | 3 to 4 miles |
|---|---|---|---|---|---|---|
| Population | 0 | 0 | 0 | 0 | 0 | 0 |

**3. Nearest Well**

Nearest well score represents the threat posed to the drinking water well that is most likely to be exposed to a hazardous substance. Have you identified a primary target population? ○ Yes ○ No

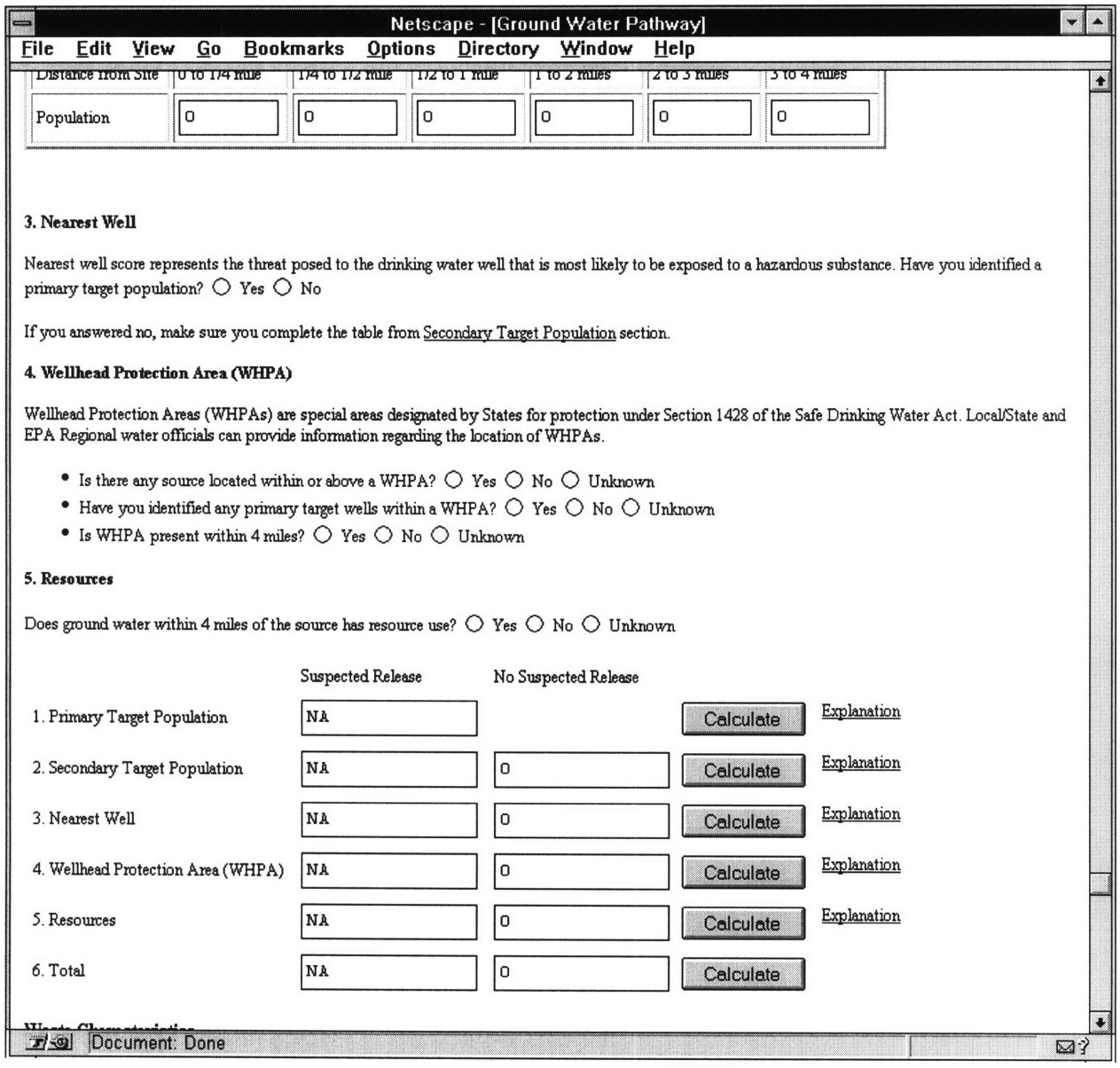
If you answered no, make sure you complete the table from Secondary Target Population section.

**4. Wellhead Protection Area (WHPA)**

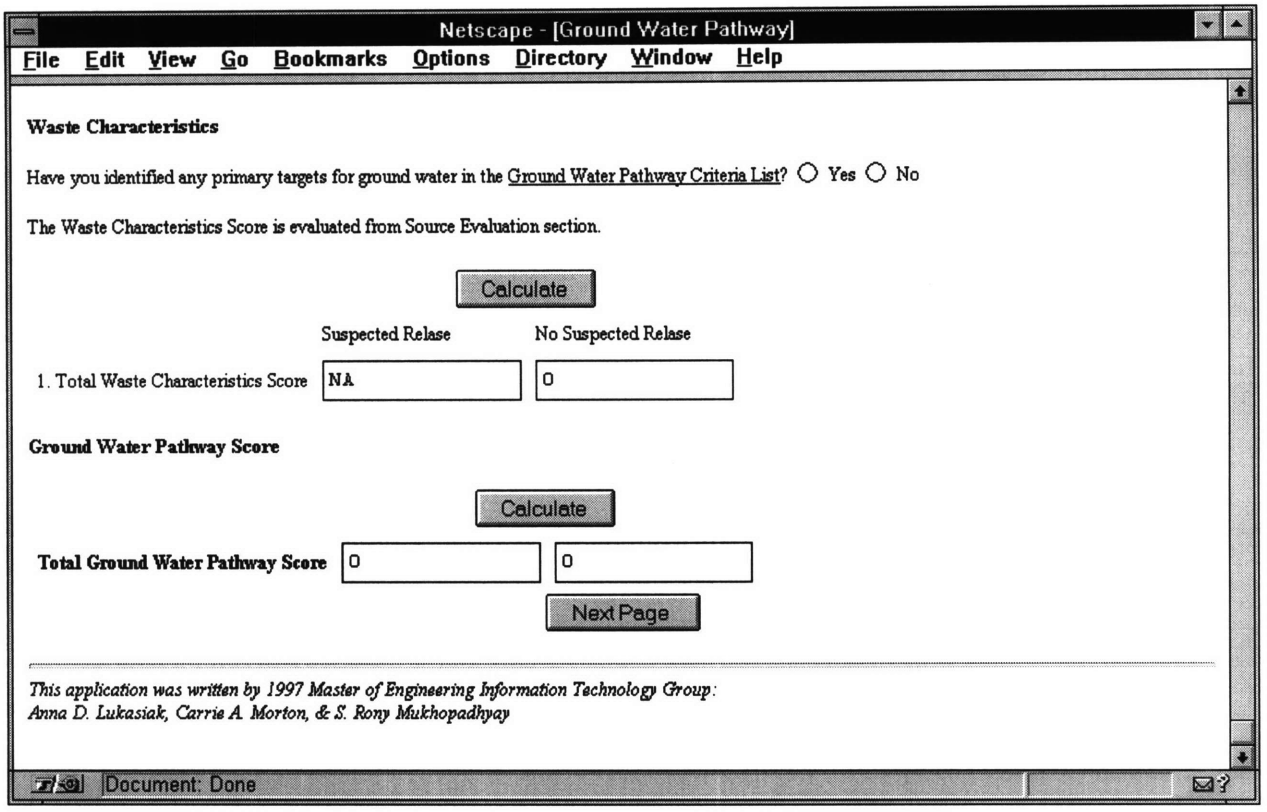
Wellhead Protection Areas (WHPAs) are special areas designated by States for protection under Section 1428 of the Safe Drinking Water Act. Local/State and EPA Regional water officials can provide information regarding the location of WHPAs.

- Is there any source located within or above a WHPA? ○ Yes ○ No ○ Unknown
- Have you identified any primary target wells within a WHPA? ○ Yes ○ No ○ Unknown
- Is WHPA present within 4 miles? ○ Yes ○ No ○ Unknown

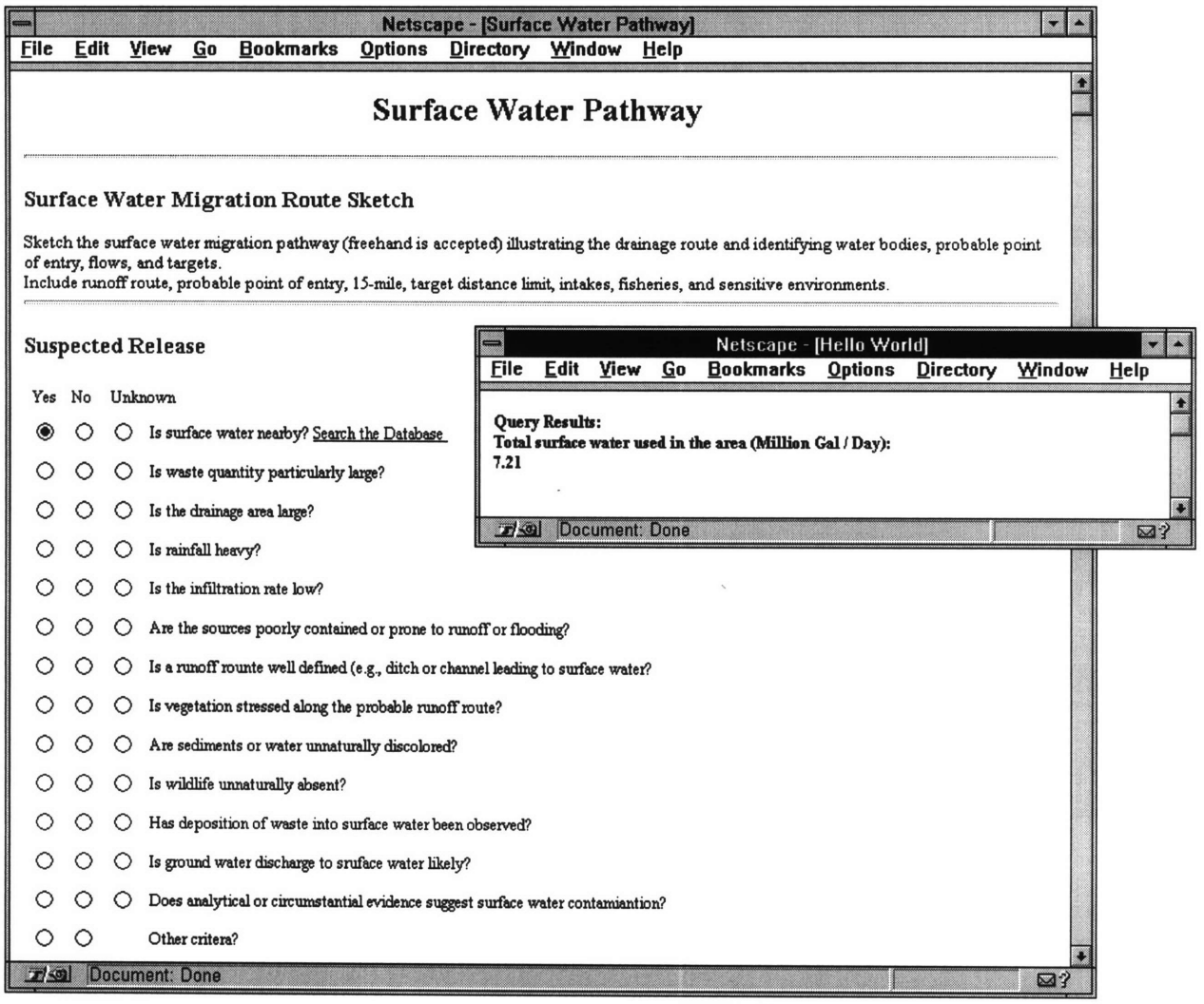
## E.4 Ground Water Pathway, cont.



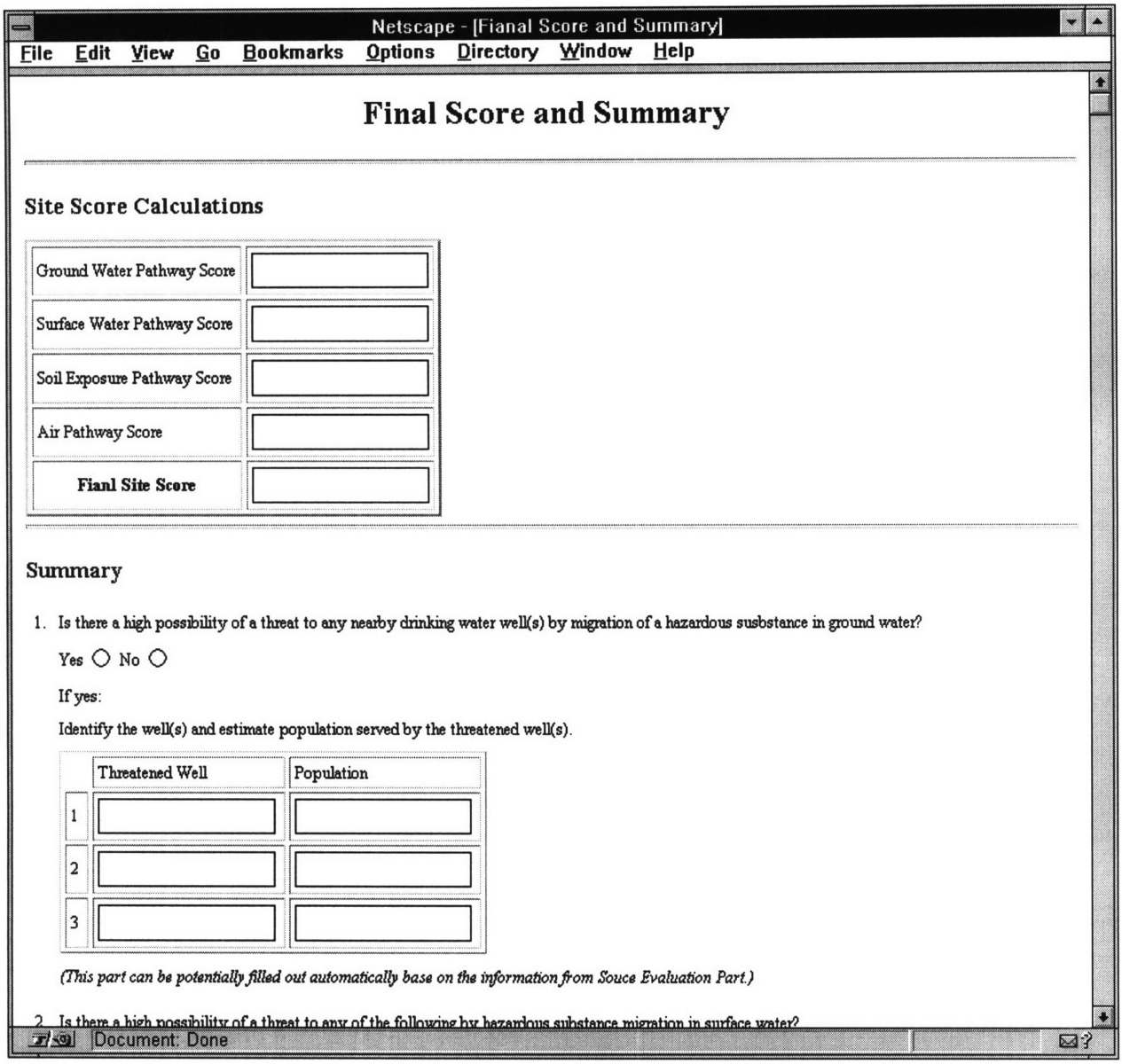
## E.4 Ground Water Pathway, cont.



## E.5 Surface Water Pathway



## E.6 Summary


Netscape - [Fianal Score and Summary]
File Edit View Go Bookmarks Options Directory Window Help
Final Score and Summary
Site Score Calculations
Ground Water Pathway Score
Surface Water Pathway Score
Soil Exposure Pathway Score
Air Pathway Score
Fianl Site Score
Summary
1. Is there a high possibility of a threat to any nearby drinking water well(s) by migration of a hazardous susbstance in ground water?
Yes ○ No ○
If yes:
Identify the well(s) and estimate population served by the threatened well(s).
Threatened Well
Population
1
2
3
(This part can be potentially filled out automatically base on the information from Souce Evaluation Part.)
2. Is there a high possibility of a threat to any of the following by hazardous substance migration in surface water?
Document: Done