Searching Electronic Databases for Information on Soil Remediation: The Interview and the Bibliography

Ronald Jantz
Rutgers, the State University of New Jersey

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Abstract

As society has become more aware of environmental issues, America's businesses and institutions have sought cost-effective methods for cleaning up the results of environmentally unsound practices. Government, research institutions, and private corporations have provided much technology to help remove pollutants from our air, water, and soil. This paper describes the author's interview and information search process, as well as the use of electronic databases in helping a client find research articles on soil remediation in New Jersey. The interaction between client and information specialist is described. The methods that are used to find information are described and evaluated. A substantial bibliography of journal articles is included below. This paper first provides a description of the user and the situation and then discusses the results of the four interviews with the client with emphasis on how the information search process was modified as new information was obtained. The final section is a detailed analysis of the search process. All searching was done using the Knight-Ridder Dialog service.

Introduction – The Client and the Situation

The client, an environmental manager at a New Jersey institution, was seeking information on processes that could be used to remove pollutants such as dieldrin from soil. The client's institution was selling a parcel of land which would be used as a continuing care retirement community consisting of a nursing home, an assisted living facility and a medical clinic. A plant and flower nursery, not affiliated with the institution, had leased and farmed the land in question since the early 1940s. Through downsizing in their cultivation operations, the nursery was making this parcel of land, about 45 acres, available for sale.

Analysis by an environmental consulting agency has shown that dieldrin levels for the 45 acre plot are, on average, about 100 ppb (parts per billion). However, the New Jersey Department of Environmental Protection has established that concentrations of dieldrin in the soil must be at 42 ppb or less for residential living. This high level of dieldrin found in the client's soil had resulted from many years of agricultural use in which dieldrin was applied to plants in order to destroy Japanese beetles. To sell the land in question, dieldrin levels had to be reduced to 42 ppb or less and a plan of action needed to be developed addressing the processes to be used for soil remediation, schedules, and overall cost targets.

In an initial phone interview with the client, a problem statement for the information search task was developed as follows:

Find economic, low-cost methods or techniques for lowering the dieldrin (aldrin, endrin) concentrations in the 45 acre plot from 100 ppb to 42 ppb or less.

At this stage, the client was looking for broad coverage of the soil remediation field as opposed to finding articles on one or two specific processes. If an efficient, cost-effective process could be found, the client would recommend the process to the consulting firm for use in the detoxification of the soil.

The First Interview

In preparation for the first interview and based on the telephone discussion, Pollution Abstracts (Dialog File 41) was selected for a preliminary search in order to become familiar with some of the literature and to uncover keywords and descriptors. Based on the telephone interview, an initial set of categories and search terms was identified as follows:

Type of toxin: dieldrin (CAS registry number 60-57-1), aldrin, endrin, pesticides, insecticides.
Application of toxin: spraying of insects and Japanese beetles.
Generic process: remediation, waste management, waste disposal, soil technology
Result of application: soil pollution, environmental pollution, hazardous wastes, toxic sites, environmental impact
Generic terms: methods, techniques, approaches
Organizations: Environmental Protection Agency (EPA), New Jersey Department of Environmental Protection (NJ DEP), Shell Oil (producer of dieldrin)

Interview and Discussion. The first interview led to significant additional information that was beneficial to the search process. In particular, the client suggested a number of agencies and organizations that could possibly provide information: Chemical Industry Council; Farm Bureau; EPA Research Labs; State DEP agencies particularly in New Jersey, Florida, Massachusetts, New York, and California; RCRA - Resource Conservation Recovery Act; Departments of Energy and Defense; Horticultural societies; TSCA - Toxic Substance Control Act which regulated PCBs in 1976; Reactor kinetics - a term for bench scale testing of soil cleaning processes.

In addition to the above specific terms, the client suggested that one might pursue the search from other angles, such as contacting rose bush growers who frequently use dieldrin to kill Japanese beetles and states that have many nurseries that raise flowers. It was also agreed to organize the search results by type of process and to include special categories that cover reviews and reports, vendors, and patents.

Search Strategy and Tactics

To develop an overall search strategy, a review of the DIALOG catalog (1996) was conducted and DIALINDEX was also used to select a set of databases. Databases that dealt with pollution, chemistry, agriculture, and the environment were primary candidates for selection. The pollution and environment databases provided articles that specifically dealt with the practical task of cleaning up polluted soil. The chemistry databases dealt more with research aspects that could lead to some new or innovative techniques. The agricultural perspective was to provide a view from those who manufacture or use the various toxins and therefore share in the responsibility of cleaning up the resulting pollution. From the initial interview, it was clear that several concepts would be involved in the search, which resulted in the associated concept blocks.

Concept Blocks. In order to find material on techniques and processes for soil remediation, four major concept blocks were created from the initial discussion and are displayed in the following table. In the search process, the primary concept is "soil" combined with the various terms for the actions, toxins, and the generic process as shown in the table below. In general, the terms in the table are organized to flow from the more specific to the more general. For example, the term **dieldrin** is a specific toxin whereas **insecticides** are a general class of toxins to be used on a wide variety of insects.

Concept Blocks - To Find Soil Remediation Techniques

Primary Object	Action	Toxin	Generic Process
soil	Remediation	dieldrin	soil technology
	Decontamination	aldrin	hazardous waste removal
	Detoxification	endrin	waste disposal
	Washing	pesticide	waste management
	Cleaning	insecticides	

Table 1

Databases. Given these concepts and an initial selection of databases from the DIALOG catalog, a further verification of databases was conducted by ranking journals in the Pollution Abstracts database and using Journal Name Finder (JNF) to find databases that frequently referenced the most popular journals. The results of the journal ranking process are shown below:

Rank	Journal
1.	Journal of Hazardous Materials
2.	Remediation
3.	Environmental Science and Technology
4.	Journal of Soil Contamination
5.	Environmental Progress
6.	Journal of Environmental Engineering

Using these journals and the search phrase "soil(3n)remediation" in JNF, two more databases, H.W. Wilson Science and Technology and INSPEC, were discovered and added to the list. Further, the BIOSIS database was confirmed as a significant source in this field although it has a significant focus on biology and medicine. The database selection process culminated in the following initial databases being identified.

Chemical: Chem Abstracts, chemtox online, toxline, chemical safety newsbase, pesticide fact file

Environmental: Pollution Abstracts, Environmental bibliography, Geobase

Agricultural/medical: Agricola, Embase, Biosis

Technology and related areas: H.W.Wilson Science and Technology, INSPEC, SciCit Index

After review of the candidate databases with the client, it was decided to focus initially on the three databases - Pollution Abstracts, Chem Abstracts, and Environmental Bibliography - as having the most potential and to develop the search tactics around the sample query below. The initial search tactic scope was to link the primary object, "soil", with terms from the "action" and "toxin" concept blocks as shown in Table 1. Note that various wild card techniques were used to insure retrieval of as many relevant documents as possible. For example, remediat? and decontam? were used in the actual search process.

Sample Generic Query #1

"ss soil and (remediation or decontamination or detoxification or washing or cleaning) and (dieldrin or aldrin or endrin)"

Using the above query across all three databases quickly revealed that only Chem Abstracts provided significant sources when the explicit toxin was used (i.e. dieldrin). The query was therefore modified to add the more generic terms "pesticides or insecticides". In addition, for searching of the Chem Abstracts database, the registry number (RN=60-57-1) for dieldrin was used. With these modifications, significant results from all three of the databases were obtained.

The Second Interview - Search Strategy and Tactics

In preparation for the second interview, the searches as described in the previous section were performed and the results organized by either the type of clean-up process or by a special category for documents that included reviews, comparisons, or surveys (see Appendix 1 for a complete list of citations provided to the client). In the interview, the client judged 19 of 32 citations to be relevant and the remainder to be either partially relevant or non-relevant. The partially relevant category was reserved primarily for articles of background nature or when the client had significant prior knowledge of the process. In addition, it was learned that certain processes would not work well for the specific site in question. In particular, remediation processes for sandy loams were not appropriate since the site was mostly clay soil. Also, the technique of incinerating soil appears to not be very appropriate because of continued air pollution concerns.

Search Modification. From the interview discussion, the following additional points emerged which resulted in modifying and narrowing the search strategy.

The Troxler article (1993) appeared to be highly relevant since it reported on several laboratory scale and full-scale studies with results as to how effective the desorption technique was in removing dieldrin. **Search strategy modification**: Follow-up on Troxler as author and also pursue the references in this article.

The client wanted to engage a vendor that would undertake the cleaning process for $10 per ton or less. Noted that the Troxler article cited treatment costs of $150 to $225 per ton. Also, the client was interested in innovative companies willing to try a new technique at low costs in turn for testing and marketing value. **Search strategy modification**: Searched for articles that dealt with cost savings or cost benefits.

At this stage in the search process, the client felt that the following three approaches were the most effective: 1) soil washing, 2) thermal desorption, and 3) planting and compost. **Search strategy modification**: Narrowed search to focus on these three areas, but remained observant of other relevant processes. Noted also that incineration and "in situ" techniques did not seem to be very promising.

The type of soil at the nursery site was a clay-silt loam, so techniques that focused on sandy soils could be eliminated. Also, one non-relevant article dealt with leaching into the ground water and treated contamination at much lower ground levels than was a problem at this site. **Search strategy modification:** Eliminated these articles by scanning or using "not sand" in the search query.

The Third Interview - Search Strategy and Tactics

Given the above comments, the search strategy shifted focus to a few select soil cleaning processes with the additional objective of finding vendors who could provide the service relatively inexpensively. Some primary issues that were of concern at this stage were the cost of the cleanup and the time it would take. Assuming the following factors of soil density for clay (112 lbs/cu.ft), 1 acre is equivalent to 43,560 sq. ft., and that two feet of top soil would have to have been cleaned, a quick calculation showed that approximately 170,000 tons of soil would have to have been processed. Several articles showed rates of only about 100 tons per day (GeoSafe, 1990) and costs that were in the vicinity of $200 per ton. In spite of these statistics, the client's institution wanted to pursue the search for better processes and reduced costs.

For this interview, an additional 38 citations were retrieved. The citations that were discussed covered new processes such as white rot fungi. Also, many of the articles focused on such items as decision criteria, vendors, patents, and costs of cleanup. The client selected 21 or the 34 articles as relevant.

Search Modification. The search strategy was modified to include additional databases and search terms and another major set of concept blocks was developed to handle the shift to finding appropriate vendors. In this discussion, the client indicated that he was interested in additional processes, but that it was also important to focus on vendors and costs. However, he was not interested in articles that dealt with decision criteria or methods for making decisions, since the consulting company would manage that aspect of the problem. The second set of major concepts was created to enable the search for a cost-effective vendor. These concepts are shown in Table 2 below, followed by the associated sample query.

Concept Blocks - To Find Cost Effective Vendors		
Generic Process	**Object**	**Generic Type**
Waste management	Savings	Vendors
Soil technology	Cost-savings	Contractors
Soil remediation	Cost/Benefit	engineering firms

Table 2

Sample Generic Query #2

"ss soil (3n) remediation and (savings or cost-savings or cost/benefit) and (vendors or contractors)"

In addition, the following modifications and additional databases were added to the search strategy in order to find more relevant articles that would provide information on cost savings and also to develop a list of potential vendors.

Examined business and reference databases to get information on potential vendors. Used DIALINDEX and the category BIOBUS to locate databases that might provide vendors who are in the soil remediation service. In particular, IAC Trade & Industry (#148), Business & Industry (#9), and Company Intelligence (#479) were selected from this process. Duns Market Identifiers (#516) was also selected to provide specific information on vendors.

Searched NTIS (file 6) for government reports. Used "sp" to find reports sponsored by the EPA.

Examined key files, Pollution Abstracts and Chem Abstracts, for the author noted above (au=troxler, wl) to see if he had written other relevant articles.

Pursued Troxler references, specifically the one that surveyed contractors.

Examined databases not directly associated with issues such as pollution or environment (e.g. BIOSIS and H.W.Wilson Science and Technology).

The Fourth Interview

This final interview focused on discussing the results from the above search modifications with specific emphasis on the vendor search and the results from BIOSIS and H.W. Wilson databases. The discussion also focused on remaining issues, how the search process might be continued and evaluation of the process as to effectiveness and efficiency.

Two separate searches were conducted using the concept blocks described in Table 2 above. First, a list of vendors in the United States that provided soil remediation services was generated from Duns Market Identifiers database (#516). This list was sorted by the most recent total sales and it also included telephone numbers for each vendor (see Appendix 2 for a partial list). Using the same concept blocks, a search of the BIOBUS group of databases was also conducted to develop a list of recent (1995-1997) business related articles. It was hoped that this list would provide insight into companies or processes that represent recent innovations and possible approaches for reducing the costs of soil remediation at the site in question. The bibliography for these citations is also shown in Appendix 1 of this report (items XVII.A - O) along with a brief one-statement description of the vendor or process. Vendors who offer potential cost-savings or new processes are included in this section of the attachment.

With respect to the recently added databases, it was noted that both BIOSIS and the H.W. Wilson sources were quite productive. These two databases did not yield a large number of citations, however several relevant articles resulted from the search. Of the 13 citations from these databases, the client judged 9 of them to be relevant and one of the articles from BIOSIS was considered to be in the excellent category. However, INSPEC turned out to be a disappointment in that the single article produced was not relevant. Most of the citations from INSPEC dealt with radioactive pollution of soils.

In this interview, the overall utility of the results was also discussed. The client provided valuable insight and feedback as to the value of the results received to date. This feedback is summarized in the next section of this report.

Results and Analysis of the Search Experience

This section presents the results of the search process and provides an analysis of the strategy and tactics used. The table below summarizes the citations that were provided to the client.

Results Presented	Relevant Articles	Partially Relevant	Non-Relevant
2nd Interview	19	5	8
3rd Interview	21	4	13
4th Interview	51	6	19
Total	91	15	40

Table 3 - Number of Citations Provided to User

We can calculate the precision of the total search process from the above table. The total number of articles (T) presented to the client is 146. In this case, we will calculate relevance as judged by the user to include both the relevant and partially relevant citations. Hence, the number of relevant articles (R) is 106. Precision (P) is the number of relevant documents divided by the total number of documents retrieved or P = R/T = 73%. Although this is a relatively high precision, it should be noted that relevance was judged in most cases by a review of the article title or accompanying abstract. It is likely that the user would reassess relevance after having thoroughly read the articles, resulting in a possible reduction in the precision. All relevant article citations are listed in Appendix 1 and organized by major process, reviews, patents, and noteworthy vendor articles.

User's Evaluation. The client indicated that, in general, he was highly satisfied with the results of the search process. In terms of a financial metric, he thought that the citations and articles that he received could be valued in the range of $5000 to $8000. His assessment was based on working with various consulting companies and what he estimated would be charged by the consulting firm for a similar service. He provided further feedback in the following specific areas:

Topic: The client felt that the retrieved articles were very relevant to the general topic of soil remediation and the specific problem task as stated:

Find economic, low-cost methods or techniques for lowering the

dieldrin (aldrin, endrin) concentrations in the 35 acre plot from 100 ppb to 42 ppb or less.

Situation: The client felt that the articles would significantly increase his knowledge of the area of soil remediation. This benefit is extremely useful in working with consultants and vendors to establish reasonable prices. The knowledge also has a very important qualitative aspect of enhancing the user's credibility in working with people in the industry and specifically being able to demonstrate that the client's institution has knowledgeable managers who understand the major soil remediation issues.

Impact: In this area, the client was not able to state that any of the articles had changed his mind or that they might have significant impact as to the current direction. This observation must be qualified with the fact that the client had not had time to read and digest many of the articles. However, throughout the interview process, he was able to identify key articles that looked promising.

Search Strategy. Relevant documents were retrieved from many different databases. The key DIALOG databases that were consulted in this search process are identified below:

AG = Agricola (#10)

BA = BioTech Abstracts (#358)

BI = Biobusiness (#285)

BO = BIOSIS (#55)

BS = Business and Industry (#9)

CA = Chem Abstracts (#399)

CB = Chem Business Newsbase (#319)

CI = Company Intelligence (#479)

EB = Environmental Bibliography (#68)

GB = GeoBase (#292)

HW = H.W.Wilson Science & Technology (#99)

IA = IAC Trade and Industry (#148)

IN = INSPEC (#2)

MI = D&B Market Identifiers (#516)

NT = NTIS (#6)

PA = Pollution Abstracts (#41)

PE = API Petroleum (#257)

PF = USPatFull (#654)

PM = IAC PROMT (#16)

PT = US PatFull (#654)

SC = SciCit Database (#434)

However, in reviewing the relevancy analysis as judged by the client, it is clear that the most useful databases in terms of number of articles were Chem Abstracts, Pollution Abstracts, IAC Trade & Industry, Environmental Bibliography, and BIOSIS as shown in the table below:

Database Source	**No. of Relevant Articles**
Chem Abstracts	25
Pollution Abstracts	18
IAC Trade & Industry	7
Environmental Bibliography	6
BIOSIS	6

Table 4 - Major Database Sources for Relevant Articles

At this point, however, we cannot jump to a conclusion about the ultimate utility of the articles that were retrieved from these five key databases. For example, there were three articles that were judged as excellent by the client: those by Troxler (item XIV.E in Appendix 1), by Kuritz (item IX.F), and by Felsot (item VIII.A). The first article used an excellent quantitative methodology to compare the results of the thermal desorption process from actual cleanup situations. In addition, Troxler is fairly well known in the environmental area and hence adds some credibility to the results. Further, the Troxler article yielded a reference that provided an analysis of various vendors and contractors in the soil remediation business.

The second article by Kuritz represented a new process and the abstract provided to the client started with the following quotation: "Biodegradation is increasingly being considered as a less expensive alternative to physical and chemical means of decomposing organic pollutants." The process emphasis and the phrase "less expensive" were very important.

The third article by Felsot stressed testing of an actual process with results reported in the article. In retrospect, given the different focus of these three articles, it made sense to use a fairly broad strategy in the search process to pull in different types of articles.

The strategy of searching for vendors and cost-savings yielded relevant results but clearly did not produce any dramatic results that cited significantly lower costs for soil remediation. This part of the strategy also produced somewhat of a dead-end in the sense that the user did not find the vendor list provided in Attachment 2 very useful although he requested the results be included as background information. Part of the reason for this misunderstanding was the fact that it took several interviews to actually understand the relationship between the client and the consulting firm. Although the client was advising the consulting firm and had an objective of providing an informed balance to any decision they would eventually make, the responsibility of selecting the actual soil remediation service rested with the consulting firm.

Finally, it should be observed that seemingly unrelated databases such as BIOSIS and H.W.Wilson did produce very good results. The lesson learned here is that excellent information can be obtained from databases outside of the specific discipline and searchers should not prematurely narrow their search. In a different vein, it was thought that searching various newspapers might produce some relevant recent articles from some of the larger newspapers. Although I did find numerous articles on soil remediation, generally these articles dealt with some community impact issue such as increased taxes.

Search Tactics. In general, the queries shown below with appropriate wild card use produced many relevant articles.

Sample Generic Query #1

"ss soil and (remediation or decontamination or detoxification or

washing or cleaning) and (dieldrin or aldrin or endrin)"

Sample Generic Query #2

"ss soil (3n) remediation and (savings or cost-savings or cost/benefit) and (vendors or contractors)"

The specific queries were used as a starting point and modified to become either more general or more specific in order to generate useful results.

The articles judged non-relevant dealt with three areas: 1) decision processes or methodology, 2) the type of soil (i.e. sand not of interest) and 3) certain low priority processes such as incineration. The primary tactic in dealing with this situation was to seek advice from the client and/or visually scan the output and selectively remove the articles rather than risk using the "not" operator in the search process. However, there was a rich variety of search tactics that were actually used throughout the searching process. These different approaches and associated analysis are discussed in the following sections.

Search Logic and Scope. The basic concept blocks that are shown in Table 1 and 2, and connected as shown in the queries above, seemed to work quite well. It was found that ANDing in the generic processes shown in Table 1 with "soil remediation" was counter-productive and tended to retrieve many non-relevant articles. For example, terms like "hazardous waste removal" pulled in articles dealing with contamination from nuclear power plants. Terms like "waste management" and "waste disposal" would frequently generate articles dealing with cleanup of Superfund cites.

Exhaustivity. The user had indicated that aldrin and endrin were similar compounds and could be used as synonyms in the search process. Frequently, however, narrowing the search to the three specific toxins yielded zero results. Including both "insecticides" and "pesticides" as related terms using the OR connector proved to be a reasonable strategy. Using the CAS registry number for dieldrin in the Chem Abstracts database also pulled in more articles than just ORing the specific toxins in the search query.

Term Specificity. The terms presented in Tables 1 and 2 show the most specific terms in the first several rows. Frequently it was possible to generate more specific terms by examining the descriptors of relevant articles. In particular, using the generic query #1 in the Agricola database did not yield very useful results. However, the descriptor, **microbial degradation** did produce several good articles on this specific remediation process. Similarly, the use of **phytoremediation** produced additional relevant articles from Chem Abstracts. In Pollution Abstracts, the thesaurus revealed a related term, **cleaning process**, which also generated several relevant articles.

Although the INSPEC database did not generate much useful in terms of citations the thesaurus was helpful in narrowing the search to some very specific terms. For example, **soil (clay)** was selected from the thesaurus. Also, a descriptor, **contaminated soils,** generated many articles but, as mentioned previously, most of these articles dealt with radioactive contamination.

Selection of Terms and Techniques. Early in the search process, a technique was used to expand on either "soil remediation" or "remediation", noting that the key databases had descriptors that matched the primary areas of interest. This approach enabled the selection of a range of e#’s (expanded items) that typically covered terms like "remediation process" and also showed misspellings that appeared to cover the same area.

Several of the advanced DIALOG techniques were used in this search process, some of which were very useful. DIALINDEX proved useful in selecting databases or confirming an initial strategy based on the general descriptions provided by DIALOG. OneSearch was also useful in quickly sampling several databases and then proceeding with a detailed search in a specific database.

In generating the vendor list, sorting on SA (most recent total sales) and formatting the output using REPORT was very useful. In searching selected full text newspaper files, both Boolean and TARGET approaches were used in the DIALOG databases. The results were found to be quite similar, in part due to the fact that both "soil" and "remediation" were required to be terms that must be present in the output. This strategy narrowed the difference between the Boolean and TARGET approaches. Using the special field CT (concept term) in D&B Market Identifiers database to find market size and market share in the soil remediation business helped reduce the number of vendors to a more manageable list. Finally, this search experience was the first occasion the author had to use the DIALOG Journal Name Finder (file #414) to locate related databases. This strategy led to the retrieval of relevant articles in what might be considered unrelated databases.

Concluding Remarks and Lesson Learned

This section offers some concluding remarks about this search experience. First, evaluating articles on their utility, of necessity, has to be a process that extends over time. For example, one of the processes could be used by the consulting firm to detoxify the contaminated site, at a considerable cost savings. We will not know the answer to this particular question of utility for many months. Many of the articles will increase the client's knowledge, however information from relatively few of the articles will actually impact the cleanup process.

Secondly, the search intermediary really needs to allow the end user time to read and absorb the information provided. Given the client's busy schedule and the limited duration of the course project, a longer time frame was not possible. As a result, many of the judgments as to relevance were based on the abstract or title of the article. After reading the articles closely, the client may decide that many of these articles are not relevant.

The search process has underscored the need for the intermediary to understand more than just the basic information need. As mentioned previously, it took several interviews to understand the relationship that the client had with the consultant. An earlier assumption indicated that vendor selection would be a critical decision for the client when, in fact, he was primarily interested in broadening his knowledge base in order to be able to advise the consulting company. Understanding the broader context and situation is therefore important to better meet the client's needs.

After several interview sessions, it was possible to understand the types of articles that were relevant. For example, articles that were of a general nature and did not provide quantitative results were generally deemed to be non-relevant. However, the client also used other criteria to judge articles as relevant or non-relevant. These criteria included being familiar with the particular author's writings or already having an understanding of a particular process and not needing any more information about that process. These criteria are based on extensive knowledge and experience and can rarely be described or presented to an intermediary. The intermediary must, therefore, be very cautious in trying to do a preliminary screening that might eliminate a useful document.

In looking at the user's environment, there are many opportunities for an information specialist to carry this work further. An information specialist could analyze and summarize the key points of the research articles and present these to the client who does not have time to do this work. This process could lead to selecting a few processes and vendors to pursue in considerable more detail in order to make a selection that would in fact provide the lowest costs, shortest time for cleanup, and the best process for the institution.

This project and the process of interviewing, searching, and making changes based on user feedback had very significant practical value. The following points encapsulate the experience in a summary of lessons that will, along with the bibliography, be valuable to information professionals.

Lessons Learned

User and Intermediary:

The user has much knowledge that bears on relevancy and is difficult to extract.

Several interviews were required to understand the situation.

The intermediary schedule should synchronize with the user's schedule for best results.

The intermediary can make broad judgments about relevancy but should beware of assumptions that might eliminate good articles.

The ultimate utility of the citations can only be judged after the documents are used.

The situation typically offers opportunities for the intermediary to provide services beyond information retrieval (e.g. analysis, summary, and presentation).

Techniques:

Databases outside of specific disciplines were very useful.

Broad terms improved recall, however use of certain specific terms produced unique articles.

Thesauri from several databases were used, although this approach rarely produced additional relevant articles.

Use of Journal Name Finder and special DIALOG tags such as CT and SA helped improve database selection and generate custom reports for the user.

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Hazardous Substances in Soil: A Bibliography. Cincinnati, OH: Municipal Environmental Research Laboratory, U.S. Environmental Protection Agency.

GeoSafe Corp. (1990, Oct. 16). GeoSafe receives first hazardous waste removal contract. *PR Newswire.*

Knight-Ridder. (1996). *Knight-Ridder Information Database Catalog – Spring, 1996.*

Kuritz, T. & Wolk, C.P. (1995). Use of filamentous cyanobacteria for biodegradation of organize pollutants. *Applied Environmental Microbiology,* 61, (1), 234 - 238.

Troxler, W.L., Goh, S.K. & Dicks, L.W.R. (1993). Treatment of pesticide-contaminated soils with thermal desorption. *Journal of the Air Waste Management Association,* 43, (12), 1610 - 1619.

Appendix 1 - Bibliography of Relevant Sources Provided to the Client

(Organized by Major Process, Reviews, Patents, and Vendors. The two-letter designations at the end of each citation indicate the DIALOG database.)

I. Aeration

A. Kempton, H. and Davis, A. (1992). Remediation of solvent-contaminated soils by aeration. *Journal of Environmental Quality*, 21, (1), 121- 128. (BO)

I. Carbon Dioxide

A. Hunter, G.B. (1992). Extraction of pesticides from contaminated soil using supercritical carbon dioxide. *U.S EPA.* 100 - 110. (CA)

B. Laitinen, A.; Michaux, A.; & Aaltonen, O. (1994). Soil cleaning by carbon dioxide: A review. *Environmental Technology*, 15, (8), 715 - 727. (PA)

II. Chemical

A. Bicki, T.J. & Felsot, A.S. (1994). Remediation of pesticide contaminated soil at agrichemical facilities. *American Chemical Society Meeting.* Atlanta, GA. (BO)

B. Chang, S., Hu, K. & Wang, Y. (1994). The use of yellow phosphorus to destroy toxic organic compounds. *Journal of Environmental Science*, 6, (1), 1 - 12. (PA)

C. Miller, C., Valentine, R.L. & Roehl, R.L. (1996). Chemical and microbiological assessment of pendimethalin-contaminated soil after treatment with Fenton's agent. *Water Research*, 30, 2579 - 2586. (HW)

D. Pendergrass, S. & Prince, J. (1991). Chemical dechlorination of pesticides at a Superfund site in Region II. *Proceedings of Annual Meeting of Air and Waste Management Association*, 84, (11), pp. 14. (CA)

E. Wentz, J.A. & Taylor, M.L. (1990). APEG treatment process and results for chemically degrading PCBs, PCDDs, and pesticides in contaminated soil. *Proceedings of National Conference on Hazardous Waste Material*, 7th, 392 - 396. (CA)

III. Extraction Agents

A. Raghavan, R.; Coles, E.; & Dietz, D. (1991). Cleaning excavated soil using extraction agents: A state of the art review. *Journal of Hazardous Materials*, 26, (1), 81 -87. (PA)

IV. Fluid/Solvent Extraction

A. Meckes, M.C., Engle, S.W., & Kosco, B. (1996). Site demonstration of Terra-Kleen response group's mobile solvent extraction process. *Journal of the Air and Waste Management Association*, 46, 971 - 977. (PA)

B. Mohr, D.H. & Merz, P.H. (1995). Application of a 2D air flow model to soil vapor extraction and bioventing case studies. *Ground Water*, 33, (3), 433 - 444. (CA)

C. Sahle-Demessie, E., Meckes, M.C. & Richardson, T.L. (1996). Remediating pesticide contaminated soils using solvent extraction. *Environmental Progress*, 15, (4), 293 - 300. (CA)

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Attachment 2 - Soil Remediation Vendors (Sorted by most recent total sales)

Company Name	State	Sales Dollars	Telephone Number
Veco Corporation	AK	500,000,000	907-277-5309

Eif Holdings Inc	CA	31,692,328	818-330-7221
Global Spill Management, Inc	NY	19,217,195	718-482-7878
Parson, Jack B Companies Inc	UT	11,800,000	801-479-9400
Waste Abatement Technology, LP	GA	11,534,941	770-427-1947
Excel Machinery Company, Inc.	TX	11,500,000	806-335-3737
Terra Therm Inc	TX	10,000,000	281-544-4551
Cleansoils Inc	MN	8,960,613	612-483-4500
Adwest Technologies, Inc	CA	8,000,000	714-997-8722
Marcor Environmental, Inc	MD	8,000,000	410-785-0001

Ronald Jantz <rjantz@rci.rutgers.edu>, is a Government and Social Sciences Data Librarian at Alexander Library, Rutgers University, New Brunswick, NJ 08901-1163, USA. TEL: 732-932-8573, x180.