MALCOLM PIRNIE

In Association With

GERAGHTY & MILLER, INC.

Technical Proposal

REMEDIAL INVESTIGATION / FEASIBILITY STUDY BREWSTER WELL FIELD SITE VILLAGE OF BREWSTER, PUTNAM COUNTY

Presented to

Division of Solid and Hazardous Waste

New York State Department of Environmental Conservation

Albany, New York

July 1984

PR4-333-739

MALCOLM PIRNIE

MALCOLM PIRNIE, INC.
ENVIRONMENTAL ENGINEERS, SCIENTISTS & PLANNERS

July 16, 1984

Norman H. Nosenchuck, P.E.
Director, Division of Solid
and Hazardous Waste
New York State Department of
Environmental Conservation
50 Wolf Road, Room 209
Albany, New York 12233

Re: Request for Proposal
Brewster Well Field Site
Remedial Investigation/Feasibility Study
Village of Brewster, Putnam County, New York

Dear Mr. Nosenchuck:

We are pleased to submit this technical proposal for consideration on the referenced project. As a New York State firm, we are committed to a cost-effective resolution of this serious environmental concern. To that end, several unique qualifications are availed to the DEC by our project team. They include:

1. The Malcolm Pirnie corporate office in White Plains located only 30 miles from Brewster. This will greatly enhance coordination and minimize travel and subsistence costs.

2. A very strong project team of Malcolm Pirnie and Geraghty & Miller personnel. The team has extensive expertise in ground water investigations, ground water treatment and RI/FS preparation.

3. Geraghty & Miller's understanding of site conditions. This information will be invaluable in the refinement of source determination, the extent of contamination, and hydrogeologic conditions.

4. Malcolm Pirnie's volatile organic contaminant treatment design capabilities. We have designed more than 10 systems ranging in size from 100 gpm to 5 mgd.

5. An in-depth knowledge of NYSDEC procedures and documentation requirements for Superfund projects.

100 EISENHOWER DR. P.O. BOX 36 PARAMUS, NJ 07652 201-845-0400 TELEX 137364

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The proposal has been organized in accordance with your Request for Proposal into the following sections:

- Scope
- Project Management
- Key Personnel
- Schedule
- Work Plan
- Office/Officer Designation
- Disclosure Statements

We hope that this document meets your requirements and that we have the opportunity to work with you on this project.

Very truly yours,

MALCOLM PIRNIE, INC.

John C. Henningson
Vice President

Michael J. Mann, P.E.
Manager, Hazardous Waste

dc

Enclosure

PR4-333-739

BREWSTER WELL FIELD SITE RI/FS
TECHNICAL PROPOSAL

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SCOPE OF PROJECT

The NYSDEC and the USEPA have entered into a Cooperative Agreement to investigate, study, design and implement a remedial action program at the Brewster Well Field Site.

THIS PROPOSAL, HOWEVER, WILL INCLUDE SERVICES FOR TASKS I AND II OF THE AGREEMENT.

Task I will consist of the following subtasks:

- Subtask 1: Review of Existing Information will include a review of previous work, an update of the well inventory, and the development and use of a preliminary model to assist in well site selection.
- Subtask 2: Field Investigation will address the development and approval of the Health and Safety Plan (HASP), the QA/QC Plan and the on-site activities including surveying, surface investigations, work and subsurface activities.
- Subtask 3: Laboratory Analysis will specify the procedures to be used in the analysis of collected samples.
- Subtask 4: Preparation of the RI Report involve will be the development of the remedial investigation (RI) report. This report will summarize and analyze developed data. It will define active sources and detail ground water dynamics.

Task II, the Feasibility Study, will consist of four subtasks. They are:

- Subtask 1: The Hazard Assessment which will identify active sources, assess the relative toxicity, persistence and mobility of defined hazardous wastes and overlay that information on the pathways of migration and impact on vulnerable receptors.
- Subtasks 2: Development and Evaluation of Remedial Alternatives will be performed consistent with Subpart F of the National Contingency Plan and will include the review of available technologies, the performance of an initial screening, a detailed development of alternatives, and an evaluation in terms of constructability, environmental impacts, and cost effectiveness. The output of this task will be a Draft Feasibility Report.
- Subtask 3: The Preparation of the Recommended Remedial Program will include the conceptual design of the recommended program, the compliance with environmental regulations, permit requirements and a refined cost estimate. The output of this subtask will be the Final RI/FS Report.
- Subtask 4: Community Relations the project team will assist and support the NYSDEC in this program.

PROJECT MANAGEMENT

The project organization is detailed on Figure 1. Malcolm Pirnie and Geraghty & Miller will stare responsibility for the remedial investigation. Mr. Michael Mann, the Project Manager, will be responsible for ensuring that positive coordination is effected. This will be facilitated through daily communication among project members and weekly telephonic coordination with the DEC Project Manager. Monthly status reports will be submitted to document project technical and financial status.

Billings will be fully documented to support potential litigation. A coordination meeting will be conducted between Malcolm Pirnie and the NYSDEC to ensure full compliance with current documentation requirements.

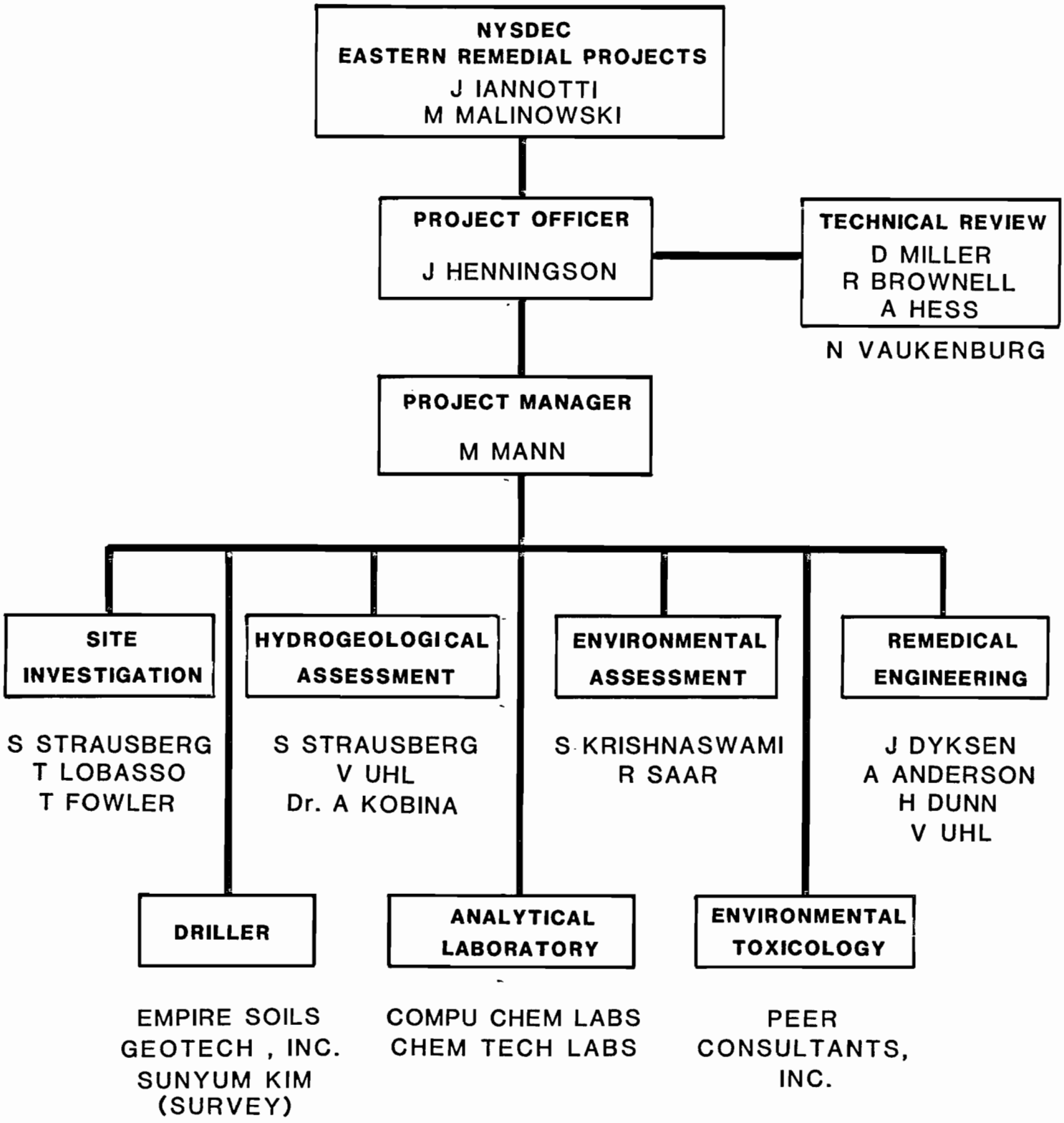
All communications will be supported by our two in-house Prime computers, our full MIS system and integrated IBM PCs and Displaywriters.

MBEs

We have addressed the small, women's, and minority business goal in the following manner:

- Surveying will be performed by the firm of Sun Yum Kim, a minority firm located in Albany, New York.
- Supplementary laboratory services will be provided by the firm of ChemTech in New York City, a minority owned enterprise.
- Support in the areas of environmental toxicology and environmental assessment will be provided by the woman owned business enterprise of Peer Consultants located in Rockville, Maryland.

In aggregate we will meet or exceed the goal of 12 percent.



PROJECT ORGANIZATION

BREWSTER RI/FS

FOR

NYSDEC

KEY PERSONNEL

Name	PL	Project Title	Qualifications	Experience	Special Expertise
MALCOLM PIRNIE					
John C. Henningson	4	Officer	BS, MS	16 years	Responsible corporate officer
Richard P. Brownell	4	Technical Reviewer	BS, MS, MBA, PE	17 years	Hazardous waste
Alan F. Hess	4	Technical Reviewer	BS, MS, PE	19 years	Water treatment
Michael J. Mann	3	Project Manager	BS, MS, PE	15 years	Hazardous waste management
Sanford I. Strausberg	3	Leader, Hydrogeology	BS, MS, Cert. Geologist	29 years	Ground water investigation
Joseph Minster	3	Technical Reviewer	BS, Cert. Geologist	25 years	Ground water assessment
S. Kris Krishnaswami	3	Public Health Specialist	BS, MS, MSPH	30 years	Risk assessment
John E. Dyksen	3	Leader, Remedial Engineering	BS, MS, PE	11 years	VOC removal
Andrew R. Anderson	2	Project Engineer	BS, MS, PE	12 years	Remedial engineering
Thomas W. Fowler	2	Project Hydrogeologist	BS	10 years	Ground water investigation
Howard J. Dunn	1	Engineer	BS, MS	2 years	VOC removal
GERAGHTY & MILLER					
David W. Miller	4	Technical Reviewer	BA, MS, Cert. Geologist	33 years	Principal of firm and Technical Reviewer
Vincent W. Uhl, Jr.	3	Co-leader, Hydrogeology	BS, MS, Cert. Geologist	15 years	Ground water assessment
Nicholas Valkenburg	3	Technical Reviewer	BS, MS, Cert. Geologist	13 years	Ground water assessment
Robert A. Saar	2	Hazard Assessment	BA, Ph.D.	10 years	Geochemistry
Kobina Atobrah	2	Hydrogeologic Modeler	BS, MS, Ph.D.	5 years	Ground water modeling
Thomas Lobasso	2	Project Hydrogeologist	BS, MS, Cert. Geologist	7 years	Project leader for the G&M Brewster Study in 1981

Detailed resumes shown in Attachment A.

ESTIMATED
LEVEL OF EFFORT ANALYSIS

Task	Person-Days							
	PL 4	PL 3	PL 2	PL 1	TL 3	TL 2	TL 1	Total
Compile Data	10	20	170	0	0	40	20	260
Prepare Work and Safety Plans	10	20	100	0	0	0	20	150
Focused Feasibility Study	20	100	100	50	0	40	40	350
Subsurface Investigations	40	200	1,000	1,000	500	50	50	2,840
Laboratory Analysis	10	350	50	0	0	0	30	440
Hazard Assessment	20	300	300	100	50	30	30	830
Recommendations for Future Actions	20	100	500	100	0	20	0	740
Engineering Evaluation/ Report Preparation	50	100	250	50	0	50	50	550
Quality Assurance; Project Management; Meetings and Community Relations	100	300	40	0	0	30	20	490
Total	280	1,490	2,510	1,300	550	260	260	6,650

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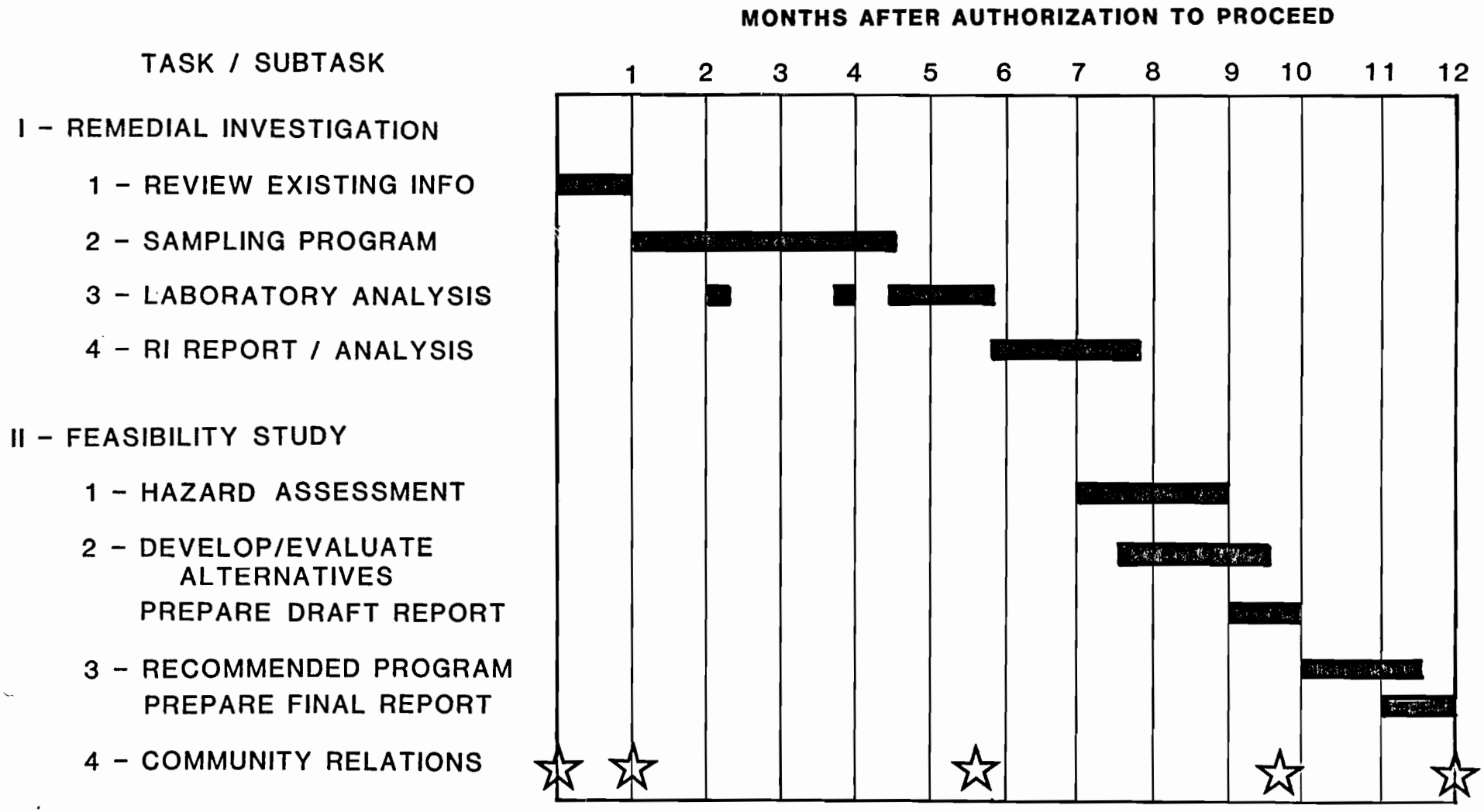
REMEDIAL INVESTIGATION / FEASIBILITY STUDY
BREWSTER WELL FIELD SITE
VILLAGE OF BREWSTER , PUTNAM COUNTY



WORK PLAN

Background Information

History of the Brewster Well Field and Summary of Previous Studies

The Village of Brewster obtains its water supply from a series of wells which tap shallow sand and gravel deposits adjacent to the East Branch Croton River (Figure 1). The well field is located about 0.25 miles east of Interstate Route 84 and contains 22 production wells screened at depths between 20 and 50 feet below land surface, and two wells which tap the crystalline bedrock aquifer. Nine wells were installed in 1954 (Well Field 1). And when the demand for water increased, nine more were added in 1967 (Well Field 2) when the demand for water increased. The well field serves approximately 2,000 residents, and a number of business establishments in the Village of Brewster and the Town of Southeast and produces approximately 350,000 gallons per day.

During a routine survey carried out by the NYSDEC in 1978, volatile organic compounds (tetrachloroethylene and trichloroethylene) were detected in ground water being drawn from the well field. Concentrations in excess of 100 ug/l were found in the original nine wells (Well Field 1) and these wells were ordered closed by New York State Health Department (NYSHD). The shortage created by the closing of Well Field 1 is being met with water from the East Branch Croton River and two newly added bedrock wells. Volatile organic compounds were also detected in the nine wells in Well Field 2, but concentrations did not exceed the NYSHD's 100 ug/l maximum limit at that time. The NYSHD determined soon after the discovery of the contamination that it was necessary to treat the Village's water supply and to seek alternative sources. A summary of average and maximum concentrations detected in ground water samples is shown in Table 1.

Several attempts were made to isolate the source(s) of volatile organic contamination. In 1978, the Putnam County Health Department conducted a survey of local industries, their waste products and disposal practices. However, no source was identified. A hydrogeologic field investigation was undertaken by the NYSDEC and the consulting firm of Davis & Kernan in 1979, which also did not define the source(s) of ground water contamination. Potential sources are shown on Figure 2.

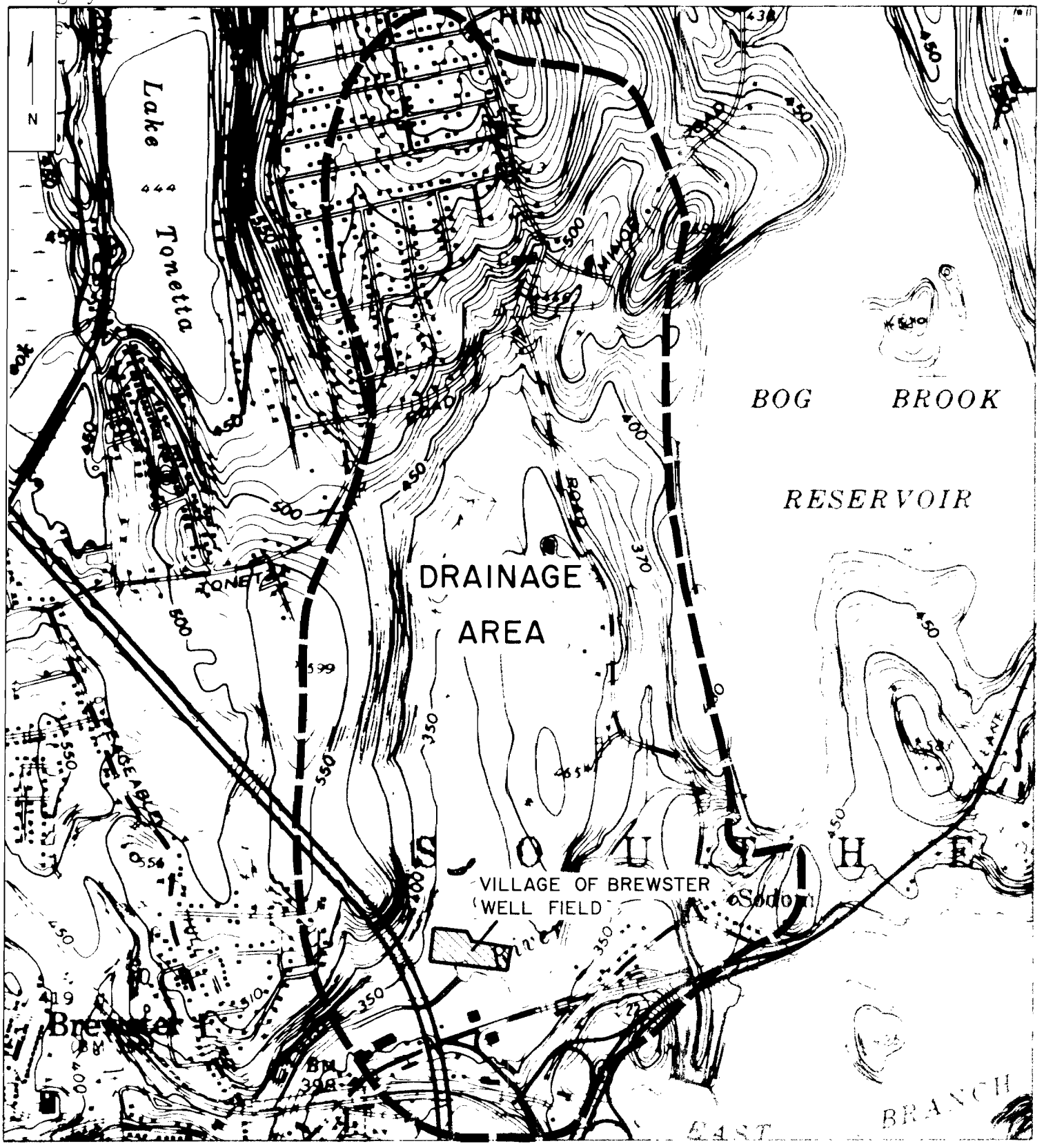


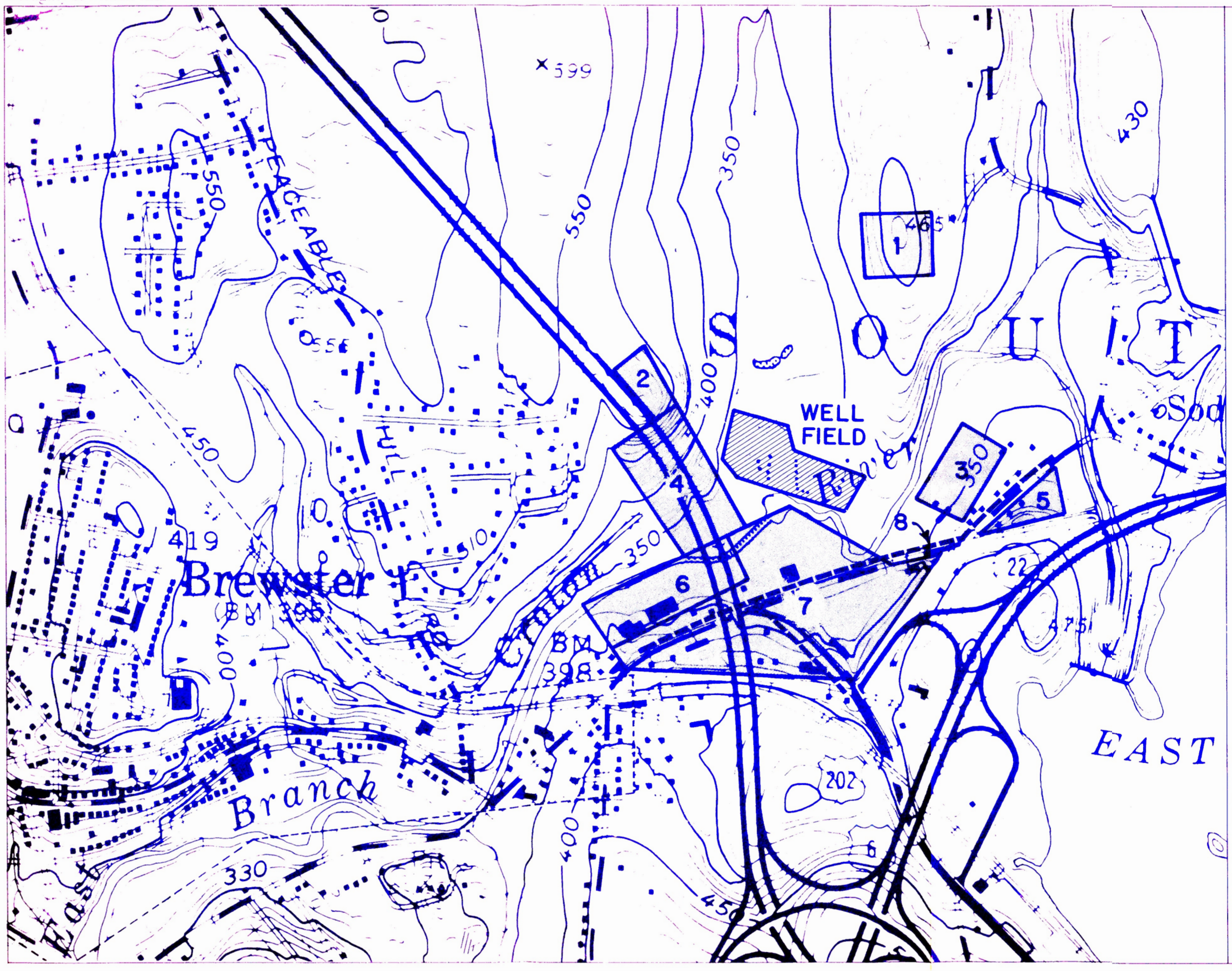
FIGURE 1 - DRAINAGE AREA FOR THE VILLAGE OF BREWSTER WATER SUPPLY AND WELL FIELD, Village of Brewster, Brewster, New York

In 1980, the Village of Brewster retained Geraghty & Miller, Inc. to explore alternative sources of ground water in the vicinity of the village. The Geraghty & Miller study was limited to areas where ground water supplies could be economically connected to the existing water supply distribution system, and involved a comprehensive research of available geologic and well data and an exploratory drilling program. Both unconsolidated (sand and gravel) deposits and the bedrock were explored without success.

As a last resort, the village requested that Geraghty & Miller reevaluate supplies in the village well field area. Ground water exploration had been avoided in this area since the extent of contamination was unknown, and there was the possibility that new wells would become contaminated. The results of Geraghty & Miller, Inc.'s exploration of the village well field area indicated that contamination was more extensive than had been expected. Concentrations of volatile organic compounds were detected in two exploratory wells (S&G1 and S&G2) at the eastern edge of the property several hundred feet from the Well Fields 1 and 2. Test wells S&G1 and S&G2 were later used to supplement the village water supply, each produced approximately 50 gallons per minute and were later replaced with permanent supply wells 3 and 4 in 1984.

The Geraghty & Miller study also concluded that the Brewster well field area is the only reliable source of ground water within a reasonable distance or the village. Surface water is available, but it would have to be purchased from New York City or pumped from the East Branch Croton River, which would require treatment.

It was decided at the conclusion of the Geraghty & Miller study to treat ground water from the well field and in 1981, the firm of Nathan L. Jacobson Associates began designing and pilot testing air stripping techniques. A full-scale treatment system (air stripping column) was designed in 1982 and is scheduled to begin operation in the summer of 1984. In December 1982, the Village of Brewster well field was included on the USEPA Proposed National Priority List.



EXPLANATION

1 PRIVATE DUMPING GROUNDS

2 N.Y.D.O.T. STORAGE AREA

3 POSSIBLE SCAVENGER DUMP

4 INTERSTATE 84 FILL AREAS

5 FORMER GAS STATION AND SALT STORAGE AREA

6 POSSIBLE FORMER LANDFILL

7 COMMERCIAL DISTRICT

8 POSSIBLE LEAKY SEWER LINES

TABLE 1

BREWSTER WELL FIELD

AVERAGE AND MAXIMUM VALUES OF
VHO GROUND WATER CONTAMINATION (ug/l)

Contaminant	Maximum Reported Concentration	Average of Reported Concentrations	Number of Reported Concentrations
Tetrachloroethylene	1,800	163.7	83
Cis-1,2-dichloroethylene	950	103.5	44
Trichloroethylene	550	38.4	66
Chloroform	404	46.2	50
Bromodichloromethane	49	14.2	41
Trans-1,2-dichloroethylene	46	14.6	8
1,1,1-trichloroethane	23	6.8	10
1,1-dichloroethylene	25	12.5	4
Vinyl Chloride	10	3.4	23
1,2-dichloropropane	10	2.6	18
Chlorodibromomethane	13	5.6	37
Dichloromethane	7	3.5	4
Bromoform	5	2	5
Trans-1,3-dichloropropene	4	2	3
Carbon Tetrachloride	5	5	1
1,2-dichloroethane	3	3	1

Adequacy of Existing Data Base

The subsurface and sampling investigations conducted at Brewster Well Field have not defined the extent of contamination. To date there has been no conclusion as to the source(s) of contamination or the size and shape of the contaminated plume(s). Current data gaps appear to exist in the areas of:

Air - There are no reported data. Air monitoring should be a part of the remedial investigation as part of worker ambient exposure.

Soil and Rock - Except for river sediments from East Branch Croton River, no soil has been analyzed.

Ground Water - Existing data gives no clear pattern of the extent or dynamics of the system. The ground water flow pattern should be established.

Surface Water - No information is available on surface water quality other than East Branch Croton River water sample analysis. The stream flowing through the village property from the swampy area to the north has not been sampled.

Conclusion

Previous studies by Geraghty & Miller, Inc. and others have determined that the shallow sand and gravel deposits adjacent to the East Branch Croton River (current well field area) comprise the most viable aquifer system in the Brewster area. Investigations in both the unconsolidated deposits and consolidated bedrock units did not identify any other areas with a signficant development potential.

It is imperative that an investigation of this nature accomplish several factors which we have delineated in our proposal, specifically:

- Determine The sustained yield of the aquifer system for periods of normal and below normal precipitation
- Identify all ground water contamination sources within the basin
- Assess future land use considerations and aquifer protection mechanisms
- Develop methodology for dealing with potential future water quality threats such as highway runoff, accidental spills, illegal dumping and leaky underground tanks

In Task I, we will develop a sustained yield analysis for the aquifer system and in Task II, along with our recommendations for remedial actions at known source areas, we will recommend the planning elements for an aquifer protection program.

Task I: Field Investigation to Define the Nature and Extent of Contamination and Need for Long-Term Remedial Actions at the Brewster Well Field Site

A key point brought out by Geraghty & Miller, Inc.'s investigation of alternative ground water supplies is that the Village of Brewster will most likely have to rely on the existing well field in the future. As such, it is important that a remedial investigation define both the extent and source(s) of contamination, and develop a long-term and environmentally sound remedial program to protect the watershed area from potential contamination in the future. The design of a ground water protection and land management program will be an important part of our proposed work and will focus on the entire watershed area as well as the well fields.

In order to accomplish each task in an efficient and thorough manner, it will be necessary to conduct the proposed work in distinct phases with the results of each phase governing the scope of work in subsequent phases. The proposed work is as follows:

Subtask 1: Review of Previous Studies and Information About the Site

Previous studies indicate that there are many potential sources of ground water contamination in the vicinity of the well field. These include automobile repair shops, dry cleaning establishments, gasoline stations, private dumps which may have accepted sewage sludge, a landfill, road salt storage areas, farmlands where fertilizers and pesticides may have been used, sewer systems, septic tanks, and surface runoff from roadways (Figure 2). The fact that these potential sources exist in a sensitive and important watershed area make it imperative that they be examined.

We will further investigate potential sources of ground water contamination during Phase I of the preliminary investigation. This work will include reviewing and updating the Putnam County Health Department's 1978 survey of industries considered potential sources of ground water contamination, those which use or have used, stored, or disposed of solvent wastes. Several dumping grounds including the Village of Brewster's municipal landfill will be further studied. We will conduct a field reconnaissance of all potential source areas, examine historical aerial photographs for former waste disposal sites, research documented spills in the area, examine the potential surface

runoff from nearby roadways, research the use of pesticides and fertilizers at farmlands, and make an inventory of septic tanks in the watershed area.

Once all potential sources are located and plotted on the map, each potential source will be ranked according to its potential for ground water contamination based on the following criteria:

- Type and quantity of wastes, including past record of violations
- Distance and location in relation to the village well fields
- Topographic setting and hydrologic
- Geologic environment

Our ground water monitoring program and field investigation will concentrate on source areas considered to have the highest contaminant potential.

In addition to a study of potential ground water contamination sources, we will compile and examine available information concerning the hydrogeologic conditions in the watershed. The preliminary investigation will include a review of existing data concerning surface and ground water hydrology, geology, water quality, and an inventory of wells in the watershed. After the Subtask 1 data have been reviewed, we will develop the elements of a monitoring well location plan and a rationale for well location.

During this data review phase, we will investigate the practicality of developing an analytical, digital, or conceptual ground water model for application in the selection of monitoring well locations. It is important to note that the model cannot be calibrated as aquifer hydraulic characteristics have not been defined in any detail for the aquifer system.

Subtask 2: Field Investigation

A field investigation to determine the source(s), extent, nature, and dynamics of ground water contamination of the village well field will begin upon completion of the preliminary investigation and after its goals and scope have been approved by the NYSDEC. The field investigation will also include a water budget analysis, which will be used to assess current and future ground water availability as part of our overall program to evaluate the long-term viability and protection of the village's ground water supply. Monitoring wells will be installed and sampled, soil samples may be collected in the vicinity of potential sources of ground water contamination, and at least two one-week aquifer pumping tests will be performed to establish aquifer hydraulic characteristics and ground water flow conditions when the aquifer is stressed.

Monitoring Well Installation

The drilling program for this investigation will be conducted in two phases. During the first phase, approximately 30 wells will be installed; the principal objective of the Phase 1 drilling program will be to identify which of the contaminant sources are impacting ground water and to develop a general understanding of ground water flow conditions and contaminant distribution within the aquifer. The information developed from the Phase 1 drilling and sampling program will be used to develop the elements of a rationale for the Phase 2 drilling program. We estimate that approximately 50 monitoring wells will be required in Phase 2 to isolate contamination screen and refine the vertical and lateral extent of contaminant plumes.

Most of the monitoring wells will be constructed with 2-inch diameter PVC casing and screen. In addition, several 6-inch diameter wells (at about four locations throughout the drainage area) will also be installed to collect detailed water level data and to serve as pumping wells for aquifer pumping tests. The 2-inch diameter wells will be installed in clusters where two or more wells are screened at different depths. Aquifer pumping tests will be run on the 6-inch wells to determine aquifer characteristics in the contaminated areas and pumping effects in surrounding areas. Water level recorders will be installed on the 6-inch diameter weirs to obtain a continuous record of water level fluctuations during the study.

During this field program, we recommend the installation of several bedrock monitoring wells so that the quality, hydrologic properties, and interaction between bedrock and the glacial deposits can be determined, particularly under pumping conditions.

Field work, necessary to perform a water budget analysis, will be conducted concurrently with the subsurface investigation. Precipitation and stream gaging stations will be set up and monitored during the course of the field program.

All phases of the field investigation will be supervised by a qualified field hydrogeologist. The 2-inch diameter monitoring wells will be installed by the hollow-stem auger method. Split-spoon soil samples will be collected at 5-foot intervals or at changes of formation from ground surface to refusal. Samples will be collected in sealed jars, logged, and stored for geologic interpretation using unified soil classification criteria.

Blow counts will also be recorded at each site using standard penetration criteria. Wells will be constructed with ±10 feet of screen. The annular space between the bore hole and well screen will be backfilled with a graded sand pack. One foot of bentonite (pellets) will be placed in the annular space above the well screen to seal off the screened interval in the formation for sampling. The remaining space above the annulus will be backfilled with a cement bentonite mixture placed with a tremie pipe to prevent surface runoff from entering the well.

The 6-inch diameter wells will be installed using cable tool equipment. The advantage of both hollow-stem auger and cable tool drilling in ground water contamination investigation is that these techniques do not utilize drilling fluid, which could introduce contaminants to ground water samples. In the event water is necessary to keep the bore hole open during drilling, it will be taken from a source approved by the NYSDEC and tested for chemical quality prior to its use. An augered test hole will be completed at each 6-inch well location initially to obtain good geologic control.

The bedrock monitoring wells will be installed by coring 15 feet into the rock using standard NX rock coring equipment which will be installed through the hollow-stem augers. Ten feet of 1-1/2-inch diameter PVC screen will be placed at the bottom of the core hole and the annular space surrounding the screen will be backfilled with graded sand. The annular space remaining between the open core hole and 1-1/2-inch PVC well casing will be filled with bentonite several feet above the bedrock surface and into the overburden to prevent ground water movement between the two formations. The rock cores collected during drilling will be examined for hydrogeologic and engineering properties.

Each monitoring well will be developed with a centrifugal pump (if water levels are within the suction limits) or submersible pump and/or compressed air to ensure a good hydraulic connection between the well and the formation and to minimize turbidity in the pumped water. A protective casing and locking cap will be cemented in place around the riser pipe aboveground.

All drilling and sampling equipment will be steam cleaned between each well location to prevent cross contamination. A specific cleaning area will be designated for this purpose. Details of drilling and sampling protocol will be submitted to the NYSDEC for approval prior to the field investigation.

After all wells have been installed, a licensed surveyor will take elevations of well casings. The actual point and elevation on the casing will be permanently marked by the surveyor.

Water Sampling

We anticipate that two surface and ground water sampling rounds will be necessary during the course of the field investigation. The first sampling round will be designed to isolate volatile organic contamination in the well field area. Ground water samples will be collected for analyses after the Phase I well drilling is completed. Water levels in all wells will be measured at least weekly for potentiometric maps, individual and composite hydrographs. This data is essential to determine ground water flow directions, gradients, and storage.

Pumping Tests

Several short-term and at least two extended (one week) aquifer/interference tests will be performed at selected locations in the study area. The purpose the pumping tests will be to determine hydraulic coefficients in the well field and surrounding areas, for ground water velocity determinations provide information for a comprehensive modeling study, give insight to future ground water production and availability in the drainage basin, and provide information to aid in the development of a comprehensive and environmentally sound remediation program (Task II).

Short-term aquifer pumping tests will be completed during the ground water sampling surveys. As ground water is being evacuated from each well before a sample is taken, measurements of drawdown in the pumping well and nearby observation wells will be made in order to determine aquifer coefficients of transmissivity and permeability throughout the study area.

Two extended aquifer pumping tests will be performed: one in a 6-inch well installed in the sand and gravel deposits and the other using an existing Village well. The tests will be run for one week each, water level measurements will be collected at all nearby surface and ground water monitoring stations. The pumping test data will be used to determine hydraulic parameters in the well field and surrounding areas, leaky aquifer conditions, dis-

tance drawdown effects (cone of influence), geologic and hydrologic boundary conditions, effects of precipitation, and induced infiltration from the East Branch Croton River. The effect of pumping in the overburden will also be monitored in the bedrock aquifer to note hydraulic interconnection.

Ground water samples will be collected at various times during the course of each test from the pumping well(s) to determine changes in the chemical quality of the ground water caused by extensive pumpage. The fully outfitted sampling van will be used for the sampling.

If the ground water quality in the pumping well is found to be poor prior to testing, arrangements will be made to treat the discharge water before it is released into the environment. Several ways to treat the water will be considered depending on the severity and nature of the problem, including the use of: existing treatment facilities at the well field, portable air stripping columns (minimum 50 gallons per minute capacity), or containment of ground water discharge in tanks for off-site treatment. The treatment technique will be approved by the NYSDEC prior to its implementation.

Activities and procedures used during all phases of the field investigation will be documented in detail by the hydrogeologists assigned to the project. Water level, aquifer test and chemical data will be stored on computer and the appropriate statistical analyses will be performed as part of the data management program. This information can be made available to the NYSDEC at any time during the course of the project.

Surface Geophysics - We have not proposed surface geophysical work for a number of reasons; the principal factor being the varying degrees of uncertainty associated with any type of surface geophysical work related to contamination incidents.

Surface Investigation - In addition to the extensive ground water sampling program, we propose to address surface water hydrology with respect to flow characteristics of tributaries to the East Branch Croton River, ground water/surface water interaction, and surface water quality. Of particular importance will be an assessment of surface/ground water interaction as a result of extended pumping.

Subtask 3: Laboratory Analysis

The samples collected during the field investigation will be prepared for delivery to the laboratory in preservative-prepared cold containers utilizing full chain-of-custody procedures. The samples will be delivered expeditiously to the laboratory to prevent degradation of organics.

A volatile organic "screen" will be performed at the Malcolm Pirnie laboratory in White Plains. This screen will utilize EPA Method 601 and by gas chromatography quantitate concentrations nominally in the range of 1 ppb. It is assumed that 200 samples will be so analyzed.

For those samples for which any volatile compound exceeds 10 ppb, a full priority pollutant quantitation will be performed. 40 samples are assumed for this program.

Those samples designated for priority pollutant analysis will undergo a full USEPA Priority Pollutant Scan Analysis with confirmation of detectable organic compounds by the following EPA GC/MS methodologies:

For Water and Wastewater:

1. Method 624: Purgeables
2. Method 625: Acid and base/neutral extractables
3. Method 608: Pesticides and PCBs
4. Methods for Chemical Analysis of Water and Waste: Priority pollutant metals, CN, and total phenols
5. "Standard Methods for the Examination of Water and Wastewater (15th Edition)": Priority pollutant metals, CN, total phenols

For Soil, Sediment, and Waste:

1. GC Screen, GC/MS Analysis of Organic Compounds: Invitation for bid WA-83-A064, January 1983
2. Test Methods for Evaluating Solid Waste, USEPA SW-846 7/82 for metals and other RCRA parameters and organochlorine pesticides and PCBs

Primary and secondary drinking water parameters will be analyzed on specific samples. Specific sensitive well field locations will be identified for this assessment since drinking water use is of primary importance. It is assumed 40 will be analyzed in this manner.

Subtask 4: Preparation of the RI Report

After the field data have been gathered, we will proceed with a data analysis phase which will involve:

- An overall assessmentof the aquifer system functioning in the watershed which will include:
  - An assessment of the aquifer's extent and recharge/discharge characteristics
  - An assessment of ground water flow conditions (pumping and nonpumping)
  - Development of a water budget and sustained yield of the aquifer system under normal precipitation and drought conditions
  - The analysis of pumping test data to determine the spatial distribution of aquifer permeability and transmissivity
- The analysis of water quality data vis a vis suspected ground water contamination sources. Of particular importance will be contaminant travel times, concentrations and ultimate discharge points for contaminants (pumping wells and/or surface water bodies).
- The development of a model and model simulations for present and anticipated future pumping conditions. The model will serve as a predictive tool to assess:
  - Ground water flow dynamics
  - Contaminant transport

Aquifer System Functioning - The overall assessment of hydrogeologic conditions in the watershed will involve an analysis of the geologic and hydrogeologic data collected during the field program and the development of a physical model with respect to the aquifer system functioning and aquifer hydraulic characteristics.

Of particular importance will be the definition of ground water flow conditions under pumping and nonpumping conditions. Water level contour maps and associated flow direction vectors will be developed from real world data (i.e., field measurements of water levels).

The real world physical model of flow will in all likelihood provide the best "model" of the ground water system functioning under stressed and non-stressed conditions; and as such during Subtask 2, we have scheduled several synotpic water level measurements events.

Water Quality Data Assessment - The basic philosophy of the proposed analytical sampling approach was outlined in Subtask 3. The principal areas that will be covered in the review of the water quality data include:

- Assessment of laboratory QA/QC program
- Distribution (vertical-lateral) of various contaminants
- Mobility, persistence, biodegradation, etc., of contaminants in the subsurface environment
- Variations (if data base permits) in concentrations of particular constituents over time at selected sampling locations
- Assessment, to the extent possible, of the lateral and vertical extent of contaminant plumes, associated source(s) and movement dynamics
- Recommended future sampling needs

Model Development - The principal reasons for the development of a model for the study area relate to the availability of a predictive tool to assess:

- Ground water flow conditions and the principal directions of ground water flow
- Contaminant transport dynamics
- Changes in flow conditions as a function of changes in pumping rates and pumping locations

Several methods can be used to simulate the response of an aquifer system to sustained pumpage. They range from digital computer models that can accommodate and manipulate a complex data base to analytical models that are applicable to single valued estimates of aquifer coefficients and boundaries to actual water level contour maps for different pumping stresses.

The latter "physical model" (water level contoutr maps) is certainly the most practical tool to use in any type of ground water resource investigation.

However, the decision as to the most practical and efficient modeling approach will have to be made after the field data have been collected and reviewed.

Task II: Feasibility Study

Subtask 1: Hazard Assessment

Upon the completion of the remedial investigation, we will evaluate all developed data and prepare a site assessment. This assessment is the primary link between the field data and the development of a meaningful course of remedial action. This assessment defines the type and extent of surface water, ground water and soil contamination. Subpart F of the National Contingency Plan (NCP) requires that the following factors be considered in such an assessment:

- Population at risk
- Amount/form of substances present
- Hazardous properties of substances
- Hydrogeological factors
- Climate
- Extent of migration
- Experiences and approaches used in similar situations by state/federal/private parties
- Environmental effects
- Welfare concerns

The extent of this assessment will be clearly keyed to the level of detail necessary to determine appropriate remedial actions. We have employed two distinct methods: the environmental fate technique which looks at the life cycle of observed contaminants will be employed since the key concerns at Brewster are potential impacts to the drinking water supply.

The baseline for evaluating the quality of ground water supplies used for drinking purposes consists of regulations mandated by the U.S. Environmental Protection Agency (USEPA). These drinking water regulations are covered by Title 40, Parts 141 and 143 of the Safe Drinking Water Act (SDWA). Maximum allowable levels for inorganic and organic chemicals, radiological parameters, coliform bacteria and turbidity are included in this act. Currently, maximum levels have been set for only six organic chemicals and total trihalomethanes (TTHMs).

The USEPA has approved proposed rulemaking under the Safe Drinking Water Act which would establish Recommended Maximum Contaminant Levels (RMCLs), which are nonenforceable health goals for nine volatile synthetic organic chemicals (VOCs) in drinking water. The proposed RMCLs for the following substances considered to be carcinogenic are zero:

- Trichloroethylene
- Tetrachloroethylene
- Carbon Tetrachloride
- 1,2-Dichloroethane
- Vinyl Chloride
- 1,1-Dichloroethylene
- Benzene

The proposed RMCLs for the following substances considered to be chronically toxic are:

- 1,1,1-Trichloroethane: 0.2 mg/L
- p-Dichlorobenzene (1,4-Dichlorobenzene): 0.75 mg/L

The MCLs will be set as close to the RMCLs as feasible, and will probably fall in the range of 5 to 50 ug/L for most of these VOCs.

Subtask 2: Development and Evaluation of Remedial Alternatives

Technologies - We will develop and evaluate alternatives for ground water remediation in accordance with rules and regulations put forth in the Federal Register, Vol. 47, No. 137 (July 16, 1982), as well as other techniques, not mentioned. Included will be:

- Impermeable barriers such as slurry walls, grout curtains and sheet pilings
- Permeable treatment beds
- Ground water pumping for water table adjustment and plume containment
- Leachate control to regulate surface seeps and seepage of leachate to ground water; these technologies may include subsurface drains, ditches and/or rivers
- No action and/or alternate methods based on source(s)

Initial Screening of Alternatives - To narrow the list of potential remedial actions for further detailed analysis of alternatives, three broad criteria will be utilized. These are:

- Cost of installing or implementing the remedial action, including operation and maintenance

- Effects of each alternative regarding adverse environmental impacts as well as the adequacy of the remedial action to mitigate the pollution problem

- Acceptable engineering practices regarding technical feasibility considering the pollution problem

Detailed Analyses of Alternatives - Of the limited number of alternatives remaining after the initial screening, a more detailed evaluation will be conducted.

The detailed analysis of each alternative will consider:

- Use of established technology

- Detailed cost estimation

- Constructability considering engineering implementation

- Assessment of the effectiveness to mitigate and minimize damage to and provide adequate protection of public health, welfare and the environment relative to the other alternatives analyzed

- Adverse environmental impacts, methods for mitigating these impacts and costs of mitigation

It is recognized that it may be necessary to gather additional data to complete the analysis.

One of the more attractive alternatives may be pumping polluted ground water and treatment before returning the water to be environment. Series of pumping wells, sumps or drains may be deemed appropriate to create elongated sinks into which polluted ground water will be drawn. Pumping would thus change ground water flow patterns and lead to capture of sizeable bodies of polluted ground water that would otherwise flow from the site to streams or even potable water wells. Ground water divides would be changed and seeps and springs, and even leachate ponds, may be eliminated by lowering the water table. Pumpage may also have the advantage of more quickly eliminating a sizeable quantity of polluted ground water by inducing flow to pumping sources.

Treatment Alternatives - Treatment methods which have been considered to date for removing volatile organic compounds (VOCs) from ground water supplies include:

- Conventional treatment
- Boiling
- Reverse osmosis
- Aeration
- Adsorption

Of these techniques, two treatment methods have received the most attention to date for removing VOCs from ground water supplies: aeration and adsorption. These alternatives will be evaluated in detail for remediation of the Brewster Well Field.

Aeration equipment presently employed in water treatment may be classified into two general categories: 1) diffused aerators, and 2) waterfall aerators, such as packed columns.

Diffused Aeration - Air stripping is accomplished in the diffused-air type equipment by injecting bubbles of air (usually compressed air) into the water by means of submerged diffusers or porous plates. Bubbles of air are passed up through the water, thereby providing contact between the air and water to remove organics. The diffused-air basin maybe a newly constructed concrete tank, or an existing tank such as a clearwell or a storage tank. The use of an existing tank would help to reduce construction costs for using diffused aeration for VOC removal.

Diffused aeration has not been utilized as often as packed column aeration for VOC removal. The use of diffused aeration may be a feasible technique for VOC removal at wells with existing storage tanks at the well site. Raw water from the wells would be pumped to the storage tank, which would be used as the diffused air basin. Diffuser equipment would be installed in the tank to provide sufficient air for VOC removal. Treated water would be pumped from the tank, using booster pumps, to the distribution syste.

Packed Column Aeration - In constrast to diffused aeration, packed column aeration accomplishes the same end results by causing the water to fall through the air and break into small drops or thin films. Water would be pumped from the wells to the top of the column(s). Air would be blown up through the column to provide a countercurrent flow of air and water. Treated water would be collected in a clearwell located directly under the column.

Booster pumps would be used to pump the water back into the system. The use of packed column aeration for VOC removal is considered to be feasible at Brewster.

Over the past five years, packed columns have been used successfully to remove VOCs from ground waters at several locations in the northeastern United States. In addition, pilot-scale studies at numerous locations have demonstrated excellent removals of VOCs using the packed column aeration process. Based on experimental and full-scale results to date, high removal efficiencies (greater than 99 percent) can be achieved through the optimum design of packed column systems.

Adsorption - The use of adsorption techniques for removing organic chemicals from drinking water has received much attention to date in the United States, especially for treating large surface water supply systems. In contrast, the treatment of affected ground water supplies using adsorption techniques has only recently been the subject of pilot and full-scale plant projects. Three adsorption techniques which have been considered for removing organics from ground waters are:

- Powdered activated carbon (PAC)
- Synthetic resins
- Granular activated carbon (GAC)

The use of GAC for removing pesticides or VOCs from ground water supplies has been evaluated to a greater extent than the use of PAC or synthetic resins.

The effectiveness of GAC for treating affected ground water depends on the types and concentrations of the organic compounds present in the ground water. As a result, pilot-scale carbon column tests are generally required to develop the necessary design criteria.

Based on the results of the initial screening, we will evaluate the most feasible options to determine the most efficient and cost-effective process for Brewster. Evaluation of the treatment processes will include consideration of the following factors:

- VOC removal efficiency
- Process reliability
- Capital and operating costs
- Operational complexity

- Site aesthetics and constraints (including air discharge conditions)
- Flexibility to adapt to changing water quality conditions
- Monitoring requirements

Subtask 3: Recommended Remedial Program

We will evaluate the alternatives identified and recommend the selected course of action. The evaluation of each alternative will be based upon the evaluation criteria and will include:

- Environmental analysis
- Implementability
- Cost-effectiveness analysis of alternatives
- Operation and maintenance requirements

Recommendation of Selected Alternatives/Preliminary Report - Malcolm Pirnie will prepare a preliminary report to NYSDEC presenting the results of the feasibility study. Based on comments from NYSDEC, Malcolm Pirnie will prepare a final report to NYSDEC cross-referencing all work conducted to date.

Prepare Conceptual Design - Upon the acceptance of the report, Malcolm Pirnie will prepare a conceptual design of the remedial alternatives selected. The conceptual design will include, but is not limited to:

- The selected engineering approach with implementation schedule
- Any special implementation requirements such as measures to mitigate potential impacts or legal constraints
- Applicable design criteria
- Preliminary site layouts
- Budget cost estimates including operation and maintenance figures
- Operation and maintenance requirements
- Safety plan including costs
- Preparation of applicable NJPDES permit applications and other regulatory agency required documentation

Prepare Final Report - Any additional information required as the basis for the completion of the final remedial design will also be included. The revision of portions of the Community Relations Plan, to reflect the results of the conceptual design, may also be required.

Subtask 4: Community Relations

The project team will support the NYSDEC in the Community Relations program by attending meetings, preparing, and presenting technical information. Five meetings are assumed.

OFFICE/OFFICER DESIGNATION

Mr. John C. Henningson will be the corporate officer who will be directly responsible for all activities of the project team. The Malcolm Pirnie corporate office in White Plains will be the designated project office and will be supported by the Malcolm Pirnie office in Paramus, New Jersey.

Mr. David W. Miller is the designated principal for Geraghty & Miller and will provide senior technical review. The Geraghty & Miller headquarters office in Syosset, New York, will be supported by the regional office in Hackensack, New Jersey.

DISCLOSURE STATEMENT

To the best knowledge of the undersigned, designated as responsible for signing the designated forms, there is no relationship of parent companies, subsidiaries, affiliates, or subcontractors who have been identified as potentially responsible parties at the site.

Further, the members of the project team will immediately disclose any such information that may be discovered after the submission of the proposal.

FOR MALCOLM PIRNIE, INC.

FOR GERAGHTY & MILLER, INC.

MALCOLM PIRNIE

MALCOLM PIRNIE, INC. RESUMES

JOHN C. HENNINGSON
Vice President,
Environmental Sciences and Planning

EDUCATION

BA (Biology) 1966; Syracuse University
MS (Environmental Engineering) 1973; Rensselaer Polytechnic Institute

REGISTRATION

Certified Ecologist (ESA)

SOCIETIES

American Society of Civil Engineers
The Ecological Society of America
American Society of Limnology and Oceanography

SUMMARY OF EXPERIENCE

Mr. Henningson has been responsible for most of the firm's environmental assessment of toxic/ hazardous waste disposal projects. He has worked on several Superfund sites, including Love Canal, directed ecological field surveys of both terrestrial and aquatic ecosystems, participated in site selection studies, and participated in public hearings for numerous projects.

DETAILED EXPERIENCE

1973 to Date — Malcolm Pirnie, Inc.

As Vice President:

- Responsible for all environmental analysis studies, including projects addressing the investigation, removal and disposal of hazardous wastes; groundwater evaluations and monitoring programs.

- In charge of Remedial Action Program at Love Canal including determining contamination and developing remedial measures for sewers, creeks, and stormwater outfalls surrounding the Canal.

- Served as an expert witness for the U.S. Attorney's Office on Superfund site with PCB contamination in Waukegan Harbor, IL.

- Responsible for design of a containment site for PCB-contaminated material from the Hudson River for New York State Department of Environmental Conservation.

- Directed work on PCB contamination of Acushnet Estuary for the State of Massachusetts.

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DETAILED EXPERIENCE (continued)

1973 to Date — Malcolm Pirnie, Inc.

As Manager: (continued)

- Directed the preparation of wastewater facilities plans for: Valley Shore, CT; Ringwood, NJ; and Somerset County, NJ.

- Managed the preparation of environmental impact statements for the U.S. Corps of Engineers Maintenance Dredging in the Lower Hudson River, NY, and the Peekskill Resource Recovery Facility for Westchester County, NY.

- Directed the environmental analyses for facility planning in Zarqa and Ruseifa, Jordan and Suez, Egypt.

As Senior Environmental Analyst:

- Coordinated the technical aspects of numerous environmental analysis studies for various projects including regional wastewater facilities plan, channel maintenance dredging, local sanitary sewers, water supply intake, HUD urban renewal project, and industrial site evaluations.

1972-73 — Ebasco Services, Inc.
New York City

As Biologist/Environmental Engineer: Environmental assessment of proposed electric power facilities and surface coal mining operations.

1971-72 — Rensselaer Polytechnic Institute
Troy, New York

As Water Quality Trainee: Field surveys and toxic bioassays of macroinvertebrates in Lake George, NY.

1968-71 — United States Army

Lieutenant, Field Artillery, U.S. Army.

PUBLICATIONS

"Preparation of an environmental assessment for a wastewater facility, Saratoga Co., NY - a case study", Henningson, J.C., NYSDEC Environmental Analysis Conference, Bergamo East, Utica, NY/March 1974.

"The responsibilities of environmental consultants", Henningson, J.C., NAEP Seminar on Environmental Assessment/February 1977.

JOHN C. HENNINGSON
Vice President,
Environmental Sciences and Planning

PUBLICATIONS (Cont'd)

"Clarifying the role of environmental analysts", Henningson, J.C., Engineering Issues, ASCE/January 1978.

"Hudson River Cleanup", Henningson, J.C., Thomas, R.F., Decontamination Workshop, Oak Ridge, TN/December 1979.

RICHARD P. BROWNELL
Vice President

EDUCATION

BS (Civil Engineering) 1966; Rensselaer Polytechnic Institute
MS (Civil Engineering) 1967; Stanford University
MBA 1976; New York University

REGISTRATION

Professional Engineer

SOCIETIES

American Society of Civil Engineers
Water Pollution Control Federation

SUMMARY OF EXPERIENCE

As Vice President in charge of Malcolm Pirnie's industrial waste group, Mr. Brownell's involvement bridges the areas of problem identification and problem solving. He has directed projects on site evaluation, groundwater pollution, remedial measures for hazardous waste problems, leachate, wastewater process design, and detailed design for hazardous and industrial wastewaters and landfill closure. All significant private sector hazardous waste work performed by the firm is reviewed by Mr. Brownell.

DETAILED EXPERIENCE

1969 to Date — Malcolm Pirnie, Inc.

As Vice President:

- Project Officer on environmental evaluations for portions of the Upper Hudson River PCB project and bench scale and pilot treatability studies on PCB wastes for the New York State Department of Environmental Conservation.

- Developed remedial measures for Superfund sites in New England (gas emissions from waste piles, groundwater contamination) and in the southern U.S. (extensive pesticide contamination of river sediments).

- Directed studies of new processes for treating various types of industrial wastes for numerous companies such as Olin Chemical Group, The Upjohn Company, Pfizer, Inc., Textron, Inc., Colgate-Palmolive, Scott Paper, and Gulf + Western.

- Directed an appraisal of PBB contamination at an industrial site for Ameribrom, Inc.; directed many groundwater and/or site investigations for industrial clients where remedial measures considered included:

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DETAILED EXPERIENCE (continued)

1969 to Date — Malcolm Pirnie, Inc. (continued)

relining lagoons, groundwater, soil and sludge recovery, air stripping, activated carbon treatment, landfill closure, slurry walls, surface water diversions.

- Directed multiplant, regional industrial/hazardous waste disposal evaluations for two major industrial corporations.

As Project Manager:

- Managed a testing and feasibility study for disposal of alum sludges from Scott Paper Company and treatability, feasibility and engineering design reports for approximately 20 corporations in the chemical processing, private utility, computer, and metal finishing industries.

As Project Engineer:

- Responsible for major pilot/prototype studies at Akron and Cleveland, OH, and studies of high purity oxygen activated sludge for several corporations including American Cyanamid Company (Lederle Laboratories Division).

1967-1969 — U.S. Army Corps of Engineers
California and Republic of Korea

As Lieutenant: Deputy Post Engineer for 1,500-man organization; responsible for all facility planning; small project design and planning.

1966 — J. Kenneth Fraser and Associates
Rensselaer, New York

As Engineer: Comprehensive report for wastewater treatment facilities.

PUBLICATIONS

"Hazardous Waste Overview", Brownell, R.P.; Seminar at Rensselaer Polytechnic Institute, Troy, NY/February 1980

"Real World Solutions to Hazardous Waste Problems", Brownell, R.P.; Columbus Industrial Association, Plant Engineers Council, Columbus, OH/December 1980

"Hazardous Waste Management", Brownell, R.P. and Brunner, C.R.; Seminar with D'Appolonia Consultants, Dallas, TX/January 1980

MICHAEL J. MANN
Manager, Hazardous Wastes

EDUCATION

BS (Civil Engineering) 1968; U.S. Military Academy, West Point
MS (Environmental Engineering) 1977; Rensselaer Polytechnic Institute

REGISTRATION

Professional Engineer: New York, New Jersey, California
Diplomate, American Academy of Environmental Engineers
Certified Hazard Control Manager (Master)
New York State, Grade III, Wastewater Treatment Plant Operator

SOCIETIES

American Society of Civil Engineers
American Water Works Association
Water Pollution Control Federation

SUMMARY OF EXPERIENCE

Mr. Mann has a diverse background in environmental engineering which includes experience in water supply, wastewater treatment, solid wastes, air pollution, radiological health and hazard response management. He has worked closely with federal and state agencies on many of these issues.

Mr. Mann is currently responsible for investigations, studies, and designs relating to management of hazardous materials and remediation of hazardous waste sites, including the firm's recent efforts at Love Canal; Woburn, Massachusetts and Triana, Alabama. Mr. Mann has managed over 25,000 man-hours of remedial action activities at seven Superfund sites.

DETAILED EXPERIENCE

1982 to Date — Malcolm Pirnie, Inc.

As Project Manager:

- Managing Malcolm Pirnie's efforts at Love Canal for the New York State Department of Environmental Conservation. The work includes determining the extent of contamination, identifying contaminant pathways, assessing effects of contaminant migration, and developing remedial measures for contamination of sewers and creeks. The study was completed on time and within budget.

- Coordinated and construction of a major hazardous waste landfill in Indiana. Consistent with Final Part 264 regulations. He prepared the RCRA Part B application, including the detailed engineering and design requirements, and negotiated input with the state and FEMA.

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DETAILED EXPERIENCE (Continued)

1982 to Date — Malcolm Pirnie, Inc. (continued)

- Developed a computerized system of risk assessment being used in assessing alternative solutions for contamination in the five areas surrounding the Love Canal.

- Managing development of remedial measures for a Superfund site in Woburn, Massachusetts with gaseous emissions, ground water contamination and contamination of soils.

- Managing a multi-year remedial action program at Triana, Alabama, involving extensive contamination of a very complex hydrogeologic regime.

- Responsible for safety and quality assurance programs in connection with the extensive sampling and analysis at Superfund sites.

- Provided expert testimony for the U.S. Senate Committee on the Environment as well as having presented many papers at professional conferences concerning various aspects of hazardous waste.

1980-1982 — Ralph M. Parsons Co.

As Chief Design Engineer: Responsible for the design and construction management of a large water and wastewater project in Dacca, Bangladesh. Forty-seven deep tube wells, 500 Km of water distribution piping, 50,000 metered connections, 350 Km of sanitary sewers, an 80-acre aerated treatment lagoon and 6 multi-storied office buildings were completed. The project involved the direct supervision of over 100 local employees as well as daily contact and negotiations with the Government of Bangladesh. He prepared and presented the status of expenditures to the World Bank on this $100 million loan.

1973-1980 — The General Electric Company

As Environmental Engineer:

- Designed and supervised construction activities on a 10 mgd industrial wastewater facility in Schenectady, New York. Prepared industrial water supply designs for power plants in Mecca and Jeddah, Saudi Arabia. Designed and supervised construction of an electroplating wastewater facility at GE's consumer products facility in Tyler, Texas. Prepared wastewater treatment feasibility study for GE's consumer products facility in Chicago. Designed reverse osmosis water treatment systems for five isolated sites along the Hasi R'Mel-Oran natural gas pipeline in Algeria and spent six months in country supervising start-up. Prepared alternative energy designs in computer modeled co-generations systems, bio-mass to ethanol, wind power and ocean thermal energy conversion. Presented a number of papers on alternate energy at professional conferences.

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DETAILED EXPERIENCE (Continued)

1973-1980 — The General Electric Company (Continued)

- Served as the first environmental officer at the Kesselring Site of the Knolls Atomic Power Laboratory, which houses four operational nuclear reactors. Developed and implemented programs relating to water and wastewater, air pollution control, radioactive waste disposal, hazardous materials, and monitoring systems. Coordinated with state and federal agencies to obtain the first EPA discharge permits and prepared an extensive manual for environmental activities. Prepared the first RCRA reporting documents and began the RCRA compliance program for the site.

- Designed and supervised operation of a large sanitary landfill and of a hazardous materials landfill. Supervised handling and shipment of radioactive solid wastes. Prepared the Environmental Impact Statements for site permit applications and site expansion activities. Directed emergency response to a spill of 500 gallons of concentrated sulfuric acid to a nearby trout stream and another to a spill of 50,000 gallons of No. 6 Fuel Oil.

1968-1973 — U.S. Army

As Captain: Served in Vietnam as infantry officer and then in West Germany as engineer officer in troop units and as facility engineer. Responsible for compliance with local environmental regulations in West Germany and designed and operated small on-site pollution abatement systems.

SANFORD I. STRAUSBERG
Senior Project Hydrogeologist

EDUCATION

BS (with Honors in Geology) 1953; Brooklyn College of City University of New York
MS (Geology) 1955; University of Michigan

REGISTRATION

Registered Geologist and Certified Engineering Geologist, California
Certified Professional Geological Scientist - American Institute of Professional Geologists
Registered Consultant - Asian Development Bank, Manila, Philippines

SOCIETIES

Association of Engineering Geologists (Member)
Geological Society of America (Fellow)
National Water Well Association (Member, Technical Division)
Sigma Gamma Epsilon

RECOGNITION

Author of published papers on water quality, ground water geology and hydrology
Expert witness for testimonies and litigation in several states
Member of United Nations Panel of Experts advising Government of India about national water utilization
Who's Who in the East (18th Edition)

SUMMARY OF EXPERIENCE

Mr. Strausberg has been providing utilities, industries, developers, international organizations, consultants, attorneys and governmental agencies with quantitative ground water expertise in virtually all hydrogeologic and climatic regimes. He has carried out field projects in 28 states and 7 foreign countries. These investigations have involved, planning, exploration, facility design, development, management, control, and/or upgrading of ground water. Project purposes include development of fresh water supplies for municipal, industrial, irrigation and domestic usages; water resources planning; definition of subsurface contamination from wastes and natural pollutants; aquifer protection resulting from environmental impacts; evaluation of seepage potentials at six large dam sites and other civil works; and dewatering of construction sites and mines.

DETAILED EXPERIENCE

1984 to date — Malcolm Pirnie, Inc.

As Senior Project Hydrogeologist, Mr. Strausberg is responsible for evaluation and development of ground water supplies and the collection and interpretation of hydrogeologic data for a wide variety of engineering and environmental problems.

DETAILED EXPERIENCE (Continued)

1982-1984 Consulting Hydrogeologist

Project Manager for U. S. Environmental Protection Agency "Superfund" subcontract at Moyer Landfill Site near Philadelphia, Pennsylvania, to identify extent of ground water and surface water pollution and to develop alternatives for remediation of site.

As Consultant: Performed office and field studies to develop 3000,000 gallons per day peak ground water supply for proposed Shawanga Village condominium complex and hotel near Wurtsboro, New York.

1979-1982 Leggette, Brashears, & Graham, Inc.
Consulting Ground Water Geologists
Wilton, Connecticut

As Vice President: Directed water supply and ground water pollution projects for water company and industrial clients.

Project highlights included:

- Studying ground water potential by field testing in buried glacial valley downstream of Bargh Dam on Mianus River, Connecticut for Connecticut American Water Company, Greenwich, Connecticut.

- Determining the amount of ground water that could be developed from a sandstone bedrock aquifer at the Swansea Reservoir, Massachusetts for Bristol County Water Company, Rhode Island.

- Conducting preliminary office study for developing a two million gallons per day ground water supply from stratified glacial drift and the underlying shale aquifer near Robinson's Branch Reservoir, Union County, New Jersey. Also gave testimony before New Jersey Water Policy and Supply Council for Middlesex Water Company, New Jersey.

- Directing initial feasibility study for a three to six million gallons per day ground water supply from deep coastal plain sand aquifers near Red Bank, New Jersey for Monmouth Consolidated Water Company, Shrewsbury, New Jersey.

- Performing evaluation of causes of high iron and hardness in certain plant wells, used for industrial cooling, that are open to the Silurian carbonate rock aquifer in northwestern Ohio, for Vistron Corporation, Lima, Ohio.

- Supervising drilling completion and testing five monitoring wells to determine flow directions, discharge rate and velocity of shallow ground water underlying plant for Hooker Chemicals and Plastics

DETAILED EXPERIENCE (Continued)

1979-1982 — Leggette, Brashears, & Graham, Inc.
Consulting Ground Water Geologists
Wilton, Connecticut (Cont'd)

Corporation, Plating Systems Division, Sel-Rex Plant, Nutley, New Jersey.

- Managing field investigation to determine the amount of shallow ground water flowing from plant site to adjoining South River. Seventeen monitoring wells were drilled, constructed and aquifer tested. Problem involved mercury contamination and study was requested by the Virginia State Water Control Board. Client was E. I. duPont de Nemours and Company, Inc., Waynesboro, Virginia.

- Supervising extensive field and office investigations regarding contamination of ground water by heavy metals (especially lead). Included were drilling, geologic and geophysical logging, constructing, developing, pump testing and water sampling of 11 monitoring wells, for N. L. Industries, Inc., Pedricktown, New Jersey.

- Directing digital computer study to define effects on the Blennerhassett Island well field from proposed dredging of gravel in the bed of the surrounding Ohio River, for E. I. duPont de Nemours and Company, Inc., Parkersburg, West Virginia.

- Estimating the safe yield and well spacings in the Triassic aquifer in western Fairfax County, Virginia, covering 75 square miles for water supply planning. Performed for Fairfax County Water Authority, Virginia.

- Evaluating the feasibility of siting a lake in a reclaimed limestone quarry. The environmental impact on the local and regional hydrologic regimes from future quarrying at a nearby site was also predicted, for General Portland, Inc. Paulding, Ohio.

1973-1979 — Harza Engineering Company
Chicago, Illinos

Head, Ground Water Studies Department, Urban and Environmental Engineering Branch, 1977-1979. Senior Hydrogeologist, Geotechnical Branch 1973-1977.

Project highlights included:

- Project Manager for seven field projects involving ground water contamination from volatile organic compounds and development of three million gallons per day clean ground water supply for industrial process at Brandenburg, Kentucky.

DETAILED EXPERIENCE (Continued)

1973-1979 — Harza Engineering Company
Chicago, Illinos (Cont'd)

- Project Manager/Consultant to develop ground water for Lae, Madang and Wewak municipal water supplies, Papua New Guinea, for Asian Development Bank, Manila, Philippines.

- Project Manager for field study involving mercury pollution, for Olin Corporation, Saltville, Virginia.

- Hydrogeologist to determine source of brine emissions along Cimarron and Salt Fork of the Arkansas Rivers, north central Oklahoma, for chloride control project, Corps of Engineer, Tulsa, Oklahoma District.

- Hydrogeologist to direct pump and recharge testing and developing aquifer protection design parameters at parts of Tunnel and Reservoir Project, Chicago, Illinois, Metropolitan Sanitary District of Greater Chicago.

- Hydrogeologist for field inspection to define seepage potential at Reza Shah Kabir Dam (Karun River Dam), Kuzistan, Iran.

- Hydrogeologist for field permeability testing to evaluate seepage potential between upper and lower reservoir at Bath County, Pumped Storage Project, Virginia, Virginia Electric and Power Company, Virginia.

- Project Manager for conducting hydrogeological field reconnaissance on seven ground and surface water development programs concerning municipal and agricultural usages in Honduras.

- Hydrogeologist to carry out field reconnaissance and evaluation of regional hydrogeology for water resources planning study, Atacama Desert, Norte Grande, Chile, for United Nations.

- Hydrogeologist to lead drilling and aquifer testing program concerning environmental impacts from strip coal mining at two mines in Powder River Basin, Wyoming, Carter Mining Company (subsidiary of Exxon Corporation) Gillette, Wyoming.

- Hydrogeologist to perform mathematical analysis concerning the effects of dewatering a proposed excavation at the Weston Generating Plant, Wasau, Wisconsin, for Wisconsin Public Service Corporation, Green Bay, Wisconsin.

- Project Manager for hydrogeological field investigations to define mercury and volatile organic compound migration in ground water at two plant sites in Niagara Falls, New York, for Olin Corporation.

DETAILED EXPERIENCE (Continued)

1973-1979 — Harza Engineering Company
Chicago, Illinos (Cont'd)

Project Manager for initial ground water pollution control study of 40 acre landfill in Gratiot County, Michigan, for Michigan Department of Natural Resources.

Hydrogeologist to direct aquifer testing and permeability analysis of deep alluvium, for designing dam foundation, San Lorenzo Hydroelectric Project, El Salvador.

Project Manager for drilling and monitoring well installations to determine occurrence of ground water pollution from volatile organic compounds near industrial plant lagoons, Ashtabula, Ohio.

Hydrogeologist to perform mathematical analysis of seepage from cooling water reservoir at Braidwood Nuclear Power Plant, Illinois, Commonwealth Edison Company, Illinois.

1969-1973 — United Nations
New Delhi, India

As Hydrogeologist: Managed hydrologic and geologic field operations on water resources surveys in the Thar (Great Indian) Desert and semi-arid regions of western India. Responsibilities also included advising and training Indian professional personnel in ground water exploration, development and management.

1967 to 1969 — Consulting Engineering Geologist and Hydrologist
Palo Alto, California

As Consultant: Supervised and conducted field engineering geological investigations for development operations in San Francisco Bay area, California. Responsibilities included evaluation of properties of geologic media in regard to seepage, drainage, land subsidence and waste disposal.

1965 to 1967 — Hazelton-Nuclear Science Corporation
(a Teledyne Company)
Palo Alto, California

As Scientist-Hydrogeologist: Conducted research and evaluation on hydrologic safety program of the U. S. Atomic Energy Commission. Responsibilities included determination and definition of parameters causing and controlling contamination of ground water by underground nuclear testing at the Nevada Test Site and other locations.

DETAILED EXPERIENCE (Continued)

1957 to 1965 — Leggette, Brashears & Graham
Consulting Ground Water Geologists
New York, New York

As Ground Water Geologist: Participated in and supervised numerous test drilling, construction, well development and test pumping operations. Worked on water supplies, salt water encroachment, artificial recharge, waste water disposal, dewatering and litigation support. Responsibilities included collection and evaluation of hydrogeologic and geophysical data on projects mostly in eastern United States and the Bahamas. Clients included industries, water companies, housing developers and governmental agencies.

1955-1957 — U. S. Geological Survey
Memphis, Tennessee

As Geologist (Ground Water): Participated in and supervised field investigations of occurrence and utilization of ground water in western Tennessee. Responsibilities included geologic mapping of coastal plain deposits and hydrologic evaluation of the Mississippi Alluvial Valley of Tennessee.

JOSEPH MINSTER
Senior Hydrogeologist

EDUCATION

M.S. Degree in Hydrogeology and Engineering Geology, Institute of Geology, Moscow, USSR, 1953.

Two-week Ground Water Contamination Course at Princeton University, Princeton, New Jersey, 1979.

Ten-month course at the Chubb Institute of Computer Technology, Short Hills, New Jersey, 1980.

REGISTRATION

Certified Professional Geological Scientist, AIPG
Professional Geologist in the State of Delaware

SOCIETIES

American Society of Civil Engineers
National Water Well Association

RECOGNITION

Author: Eight Works on Engineering and Applied Hydrogeology

SUMMARY OF EXPERIENCE

Mr. Minster has had more than 25 years of increasingly responsible experience in the investigation, design and implementation of ground water supply systems, contaminated ground water remediation and construction dewatering. He has designed and installed slurry walls and other ground water flow cutoff systems, conducted ground water contamination assessments, evaluated treatment alternatives and provided expert testimony for the State of New Jersey in studies and litigation regarding contamination of ground water at the CPS/Madison Industries site in Middlesex County, NJ.

DETAILED EXPERIENCE

1984 to Date — Malcolm Pirnie, Inc.

As Senior Hydrogeologist, Mr. Minster is responsible for the evaluation of ground water contamination, development of monitoring and water supply well specifications, and the design of ground water flow interception and detention systems.

1978 to 1984 — Dames and Moore

- Project Manager and Principal Investigator for several major hydrogeological contamination surveys.

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DETAILED EXPERIENCE (Cont'd)

- As Principal Investigator conducted a major study on feasibility and advisability of remedial measures in a contaminated aquifer and open water bodies and provided expert testimony for the Middlesex County Superior Court, New Jersey for the CPS/Madison Industries problem.

- Analyzed and summarized a 17-month long experience in decontamination of an aquifer by means of wells, air stripping in a cooling tower and an aerated lagoon and recharging to the aquifer via spray irrigation at a confidential client's site in the Dayton, New Jersey area.

- Conducted an on-site study and recommended remedial measures to liquidate seepage into an alumina shed for Interalumina, Ciudad-Guayana, Venezuela; and Alusuiss, Zurich, Switzerland.

- Principal Investigator for an aquifer decontamination study by means of mutant bacteria for a confidential client in Upstate New York.

- Provided consultation on remedial measures for an oil leachate case at the Amoco Oil Company, Mandban, North Dakota facility.

- Provided consultation on slurry wall cutoff installation to contain a plume of contaminated ground water for Pratt and Whitney, Florida.

- Provided consultation on slurry cutoff wall inspection techniques for Florida Power and Light Company.

- Provided consulation on dewatering, drainage, and permanent flow cutoff installation (steel sheet piling and slurry wall) for DBS/I.M. Pei, Singapore.

- Evaluated the feasibility of slurry wall, dewatering, and grouting to minimize seepage from a tailing dam for Rossing Uranium Limited, South Africa.

- Evaluated various schemes of a permanent dewatering system to prevent a plume of contaminated ground water from reaching the river for Velsicol Chemical Corporation, St. Louis, Missouri.

- Designed a horizontal drainage system to collect leachate from a landfill for a confidential client in the Essex Junction, Vermont area.

- Supervised drilling operation, short-term three-step aquifer pump test, long-term pump test, and analyzed the results for a water supply well for Cedar Grove Township, New Jersey.

DETAILED EXPERIENCE (Cont'd)

- Performed the analysis and evaluation of field and laboratory permeability tests and seepage losses from proposed reservoirs at Hackettstown, New Jersey for the New Jersey State Geological Service.

- Evaluated and rated potential sites on the basis of their hydrogeologic suitability for Atlantic City Electric Company, New Jersey.

- Provided a method of calculating horizontal drains in the slopes of an excavation for the Fostago Mine Project, Brazil.

- Provided a design and estimate of a permanent dewatering system to meet NRC's requirements on stability of the plant against earthquakes for Dairyland Power Cooperative, LaCrosse, Wisconsin.

- Evaluated the dewatering operations at Yaphank County Center's Pump Station in a contractor's claim for Suffolk County, Long Island, New York.

- Technical reviewer of report on Class 9 accident liquid pathway assessment for the Wolf Creek Nuclear Generation Station, KG&E Company.

- Technical reviewer for ground water section of report, FSAR, Nine Mile Point Nuclear Station, Unit 2, Scriba, New York.

- Conducted field permeability tests to determine the recharge capability of the uppermost aquifer for a confidential client in the East Fishkill, New York area.

- Conducted pump tests for a confidential client in the Yorktown Heights, New York area.

- Designed a 700 gpm water supply well for Monroe Municipal U.A., New Jersey.

- Performed analysis of pump test for the BASF Wyandotte Corporation at Rensselaer, New York.

- Supervised drilling operation, short-term three-step aquifer pump test, long-term pump test, and analyzed the results for a water supply well for Cedar Grove Township, New Jersey.

1975 to 1978 — Moretrench American Corporation
Ground/Water Technology, Inc.

- Designed, provided consulting services and technically supervised the installation of construction dewatering systems for nuclear power plants (Hope Creek and Forked River, New Jersey; Matagorda, Texas; St. Lucie,

THOMAS FOWLER
Project Hydrogeologist

EDUCATION

BS (Geological Engineering) 1972; Princeton University

SUMMARY OF EXPERIENCE

Mr. Fowler has been involved in all phases of ground water development and pollution control, including evaluation of chemical contamination and recovery of floating hydrocarbons, pumping tests, well logging, drilling supervision, and water budgets for water-supply development and monitoring water quality.

DETAILED EXPERIENCE:

1983 to date — Malcolm Pirnie, Inc.

As Project Hydrogeologist: Involved in a variety of ground water evaluations and remedial actions related to water supply development and water quality.

- Investigated contaminated oil and developed methods for its recovery at a landfill for the New York City Department of Sanitation.
- Developed ground water monitoring program in connection with RCRA Part B permit for Adams Center Landfill, Fort Wayne, Indiana.
- Conducted hydrogeologic and geologic studies as part of detailed siting study of two potential landfill sites in Broward County, Florida.

1979 to 1983 — Leggette Brashears & Graham, Inc.
Wilton, Connecticut

As Ground-Water Geologist:

- Involved in hydrocarbon recovery projects including design and installation of monitor wells, recovery wells and maintenance of system, for various Mobil Oil facilities.
- Evaluated special problems involving hydrocarbons in a regional confined aquifer as well as the perched water-table aquifer for Mobil/Brooklyn.
- Hydrocarbon recovery from 11 different sites in Minnesota. Unusual problems include very low water-table and very low permeability for Williams Pipe Line Co, Minnesota.
- Evaluated TCE contamination of ground water for Faria Corporation, Uncasville, CT.

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DETAILED EXPERIENCE: (continued)

- Regular geophysical logging service; salt-water intrusion problems; well-field design; agricultural pollution assessments for Suffolk County Water Authority.

- Assessed water supply from carbonate rocks; periodic reports assessing the total ground-water situation for Philadelphia Suburban Water Co.

1973 to 1983 — Leggette Brashears & Graham, Inc. (continued)

- Evaluated water supply from large fractures in poor water-bearing formation for Boucher & James/Golden Acres, Newtown, PA.

- Evaluated water-supply from fractures overlain by alluvium for Greenwich (CT) Water Co.

1976 - 1978 — B-J Hughes, Inc. (subsidiary of Hughes Tool Company) Houston, TX

As Member of Engineering Staff: Conducted water analysis, and tested and selected cement slurries for thickening times, comprehensive strength, gel strength and viscosity for Gulf Coast installations.

1973 - 1976 — Geophysical Services, Inc. (subsidiary of Texas Instruments, Inc.) Houston, TX

As Geophysical Engineer: Engaged in data gathering and analysis in seismic exploration at various field sites in Kentucky and Wyoming. Progressed from Junior Geophysical Engineer and Operation Trainee.

ALAN F. HESS
Senior Principal Engineer,
Water Treatment

EDUCATION

BS (Civil Engineering) 1963; Pennsylvania State University
BS (Sanitary Engineering) 1963; Pennsylvania State University
MS (Civil Engineering) 1971; University of Pennsylvania

REGISTRATION

Professional Engineer
Water Works Operator

SOCIETIES

American Water Works Association
American Society of Civil Engineers
Water Pollution Control Federation
International Ozone Association
Water Works Operators' Association of Pennsylvania
New England Water Works Association

RECOGNITION

AWWA Research Foundation:

Chairman, "State-of-the-Art" Handbook on Volatile Organic Contaminants in Association with the Netherlands Water Research Institute (KIWA)

AWWA:

Chairman, Organic Contaminants Committee; Coordinator, Seminar on Control of Inorganic Contaminants, June 1983; Trustee, Water Quality Monitoring Committee; Trustee, Inorganic Contaminants Committee

ASCE:

Chairman, Groundwater Contamination Session -- 1983 National Conference on Environmental Engineering

SUMMARY OF EXPERIENCE

Mr. Hess, with over 19 years of experience in a broad spectrum of water supply and water quality projects, possesses special expertise in control of organic chemical contaminants. He is responsible for technical direction of the firm's drinking water supply activities, which include numerous studies, investigations, design projects and operation of water supply, treatment and distribution facilities.

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ALAN F. HESS
Senior Principal Engineer,
Water Treatment

DETAILED EXPERIENCE

1978 to Date — Malcolm Pirnie, Inc.

As Senior Principal Engineer, Water Treatment:

- Managed a study for USEPA to determine feasible treatment techniques and costs to remove volatile organic compounds and trihalomethanes from drinking water.

- Directed pilot and plant-scale studies to control trihalomethanes at water treatment plants in Florida and New York.

- Directed investigations, pilot studies and design of facilities to control volatile organic compounds in groundwater supplies in New Haven (CT) Water Company, Camden (NJ), Scottsdale (AZ); Boonton (NJ); Fair Lawn (NJ), Township of Rockaway and Fairfield (NJ), and for confidential clients in Pennsylvania and Arizona.

- Managing the design of a granular activated carbon treatment facility with on-site regeneration for the 220 mgd California Water Treatment Plant of the Cincinnati (OH) Water Works.

- Directed studies of high-rate filtration, direct filtration and high-rate pretreatment, as well as pilot studies to determine all process design parameters for several new water treatment plants.

- Directed studies of treatment and disposal of water treatment plant wastes for numerous facilities up to 240 mgd.

1971-1978 — Philadelphia Water Department

As Chief, Water Treatment: Responsible for the management and operation of the City's Water Treatment Section, including three large water treatment plants, two quality control laboratories; and seven distribution system reservoirs. Major areas of responsibility included: control of chemical treatment processes, pollution control on watersheds, sanitary protection in water distribution systems, research on water treatment methods and problems, bacteriological and microscopical studies of water sources and treatment results.

1965-1971 — Philadelphia Water Department

Torresdale Water Treatment Plant: Responsible for the administration and management of the operations and maintenance of a 284 mgd water supply treatment plant, including operating practices, equipment performance, laboratory analysis, chemical treatment, and cost control.

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DETAILED EXPERIENCE (continued)

1963-1965 Philadelphia Water Department

As Staff Engineer, Water Pollution Control Division: Feasibility study of alternative methods of wastewater sludge disposal.

PUBLICATIONS AND PAPERS

Author: Over 30 papers on water filtration, water supply treatment plant instrumentation and control, water treatment quality control, trace organic removal by activated carbon and aeration, design of granular activated carbon systems and control of trihalomethanes in drinking water. Most current are:

"Groundwater Contamination -- Challenge of the 80's," Hess, A. F.; 1983 ASCE National Conference on Environmental Engineering, in preparation.

"Control Strategy - Aeration Treatment Technique," Hess, A. F., J. E. Dyksen and H. J. Dunn; in Occurrence and Removal of Volatile Chemicals from Drinking Water, AWWA Research Foundation and Keuringsinstituut Voor Waterleidinggartikelen (KIWA), in preparation.

"Volatile Organic Chemical Contamination of Ground Water," Hess, A. F.; National Association of Water Companies Annual Conference, October 1982.

"Control of Trihalomethanes," Hess, A. F., M. J. Barnes and D. J. Hiltebrand; Alabama-Mississippi Section AWWA, September 1982.

"Alternatives for Controlling Organics in Ground Water Supplies," Dyksen, J. E., and A. F. Hess; Journal AWWA, August 1982.

JOHN E. DYKSEN
Senior Project Engineer

EDUCATION

BS (Civil Engineering) 1973; New Jersey Institute of Technology
MS (Environmental Engineering) 1979; New Jersey Institute of Technology

REGISTRATION

Professional Engineer

SOCIETIES

American Water Works Association
American Society of Civil Engineers
National Water Well Association

RECOGNITION

Recipient of David M. Greer Award (1972) sponsored by Woodward-Moorhouse & Associates, Inc., for a technical paper entitled "Ground Water Resources."

Author and lecturer on removal of organics from ground water by activated carbon and aeration, water treatment, and water plant sludge treatment and disposal.

RELATED EXPERIENCE

Mr. Dyksen has specialized in pilot and plant scale water treatment process studies especially in regard to removal of trace organics. His work has addressed granular activated carbon adsorption, air stripping, water supply, and facilities for handling, treating and disposing of water treatment plant wastes. He also has been involved in projects regarding cost-effective analysis, wastewater collection and treatment facilities planning, and stormwater drainage and flood control.

He has been responsible for several studies of volatile organic chemical (VOC) removal from ground water supplies including pilot-scale studies and design of aeration and granular activated carbon (GAC) adsorption systems for the City of Scottsdale, Arizona, the Township of Fairfield, New Jersey, the Elizabethtown Water Company, New Jersey, and the Jamaica Water Supply Company, New York. He also has been responsible for a plant-scale evaluation of an existing aeration unit at the 3.6 mgd Parkside Water Treatment Plant of the City of Camden, New Jersey; pilot-scale studies of a packed column air stripping process for two industrial clients in Ohio and New Jersey with high levels of trichloroethylene in their well supplies; technical evaluation of a full-scale packed column facility for removal of several ether compounds from the 1.5 mgd well supply of the Township of Rockaway, New Jersey; pilot-scale testing of packed column aeration at the North and South Cheshire Wellfields of the New Haven (Connecticut) Water Company; and

RELATED EXPERIENCE (continued)

pilot testing and design of a GAC facility for Boonton, New Jersey; and pilot testing of packed column aeration, diffused aeration and GAC adsorption for the Borough of Fair Lawn, New Jersey.

Mr. Dyksen also has been responsible for a major study for the USEPA Office of Drinking Water, involving the technical and financial analysis of alternative treatment techniques for removing volatile organics and trihalomethanes from drinking water. He also has been responsible for pilot-scale process studies, including trihalomethane removal, for a new water source for Baltimore, Maryland and preliminary design for the addition of granular activated carbon facilities to the 65 mgd Patuxent Filtration Plant of the Washington Suburban Sanitary Commission, Maryland.

HOWARD J. DUNN
Engineer

EDUCATION

BS (Civil and Environmental Engineering) 1980; Clarkson College of Technology
MS (Environmental Engineering) 1982; University of North Carolina at Chapel Hill
Undergraduate Studies (Chemical Engineering) New Jersey Institute of Technology

REGISTRATION

Engineer-in-Training: New York

SOCIETIES

American Water Works Association
Water Pollution Control Federation
American Society of Civil Engineers

RECOGNITION

Recipient of John W. Graham, Jr., Phalanx Award for the Outstanding Sophomore Civil and Environmental Engineering Student (1978)

SUMMARY OF EXPERIENCE

Mr. Dunn has participated in a number of environmental and civil engineering projects with an emphasis on water treatment and supply. He has been involved with several pilot-scale studies of treatment processes as well as the evaluation of full-scale facilities including trace organics removal studies and design, investigation of treatment techniques for inorganics control, conceptual and preliminary design for two water treatment plants, treatment and disposal of water treatment plant sludges, and process design for a granular activated carbon (GAC) facility treating a river water source. Mr. Dunn has experience in the usage of computer programing as an aid in design and data evaluation. This experience includes computer-aided procedures for packed column aeration design as well as data evaluation and presentation for a hazardous waste project in Niagara Falls, New York and a water quality evaluation for the City of New York.

DETAILED EXPERIENCE

1982 to Date — Malcolm Pirnie, Inc.

As Engineer:

- Participated in several studies of volatile organic chemical (VOC) removal from ground water supply systems. These studies included pilot-scale testing of aeration and GAC adsorption as well as the design of packed

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DETAILED EXPERIENCE (continued)

tower stripping facilities for clients in New Jersey, Ohio, Arizona and New York. Responsibilities included assisting in the development of packed column aeration design procedures and the implementation of a computer-aided scale-up procedure for the design of full-scale facilities, as well as operating the pilot-scale air stripping unit at several sites.

- Participated in providing the USEPA with design criteria and cost estimates for the removal of fluoride from drinking water as part of the agency's regulatory program. Information was provided covering potable water systems ranging in size from 0.01 to over 700 mgd.

- Involved in conceptual assessment and preliminary designs of a 40 mgd water treatment plant for the Elizabethtown Water Company (NJ) and a 120 mgd facility for the City of Baltimore, Maryland.

- As part of a water quality study for the City of New York, appropriate code was developed and utilized to assist in data evaluation and presentation. This evaluation was coordinated with the in-house computer graphics facilities to allow computer generated plots to be produced.

- Field engineering for the design of wastewater collection systems and investigation of sludge treatment, handling and disposal options for the Elizabethtown Water Company.

- Participated in the process evaluation of a GAC facility for Cincinnati, OH.

- Involved with an industrial pretreatment survey for the Two Bridges Sewerage Authority (NJ) wastewater treatment plant.

1980-1982 — University of North Carolina at Chapel Hill

As Research Assistant: Conducted pilot-scale, direct filtration experiments to determine the feasibility of employing direct filtration for the prevention of reverse osmosis membrane fouling. Particle size analysis was employed and interpreted as an aid in monitoring the effectiveness of direct filtration for particulate removal. This was part of a project investigating alternative pretreatment processes for sea water at the Wrightsville Beach (NC) Desalination Test Facility.

PUBLICATIONS

1. "Monitoring and Evaluation of Particle Removal Processes for the Prevention of Reverse Osmosis Membrane Fouling," Kukshtel, N. S., P. C. Singer, and H. J. Dunn, Proceedings of Water Reuse Symposium II, American Water Works Association, 1981.

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PUBLICATIONS (Continued)

2. "Control Strategy -- Aeration Treatment Technique," Hess, A. F., J. E. Dyksen and H. J. Dunn, in Occurrence and Removal of Volatile Organic Chemicals from Drinking Water, AWWA Research Foundation and Keuringsinstituut Voor Waterleidinggartikelen (KIWA), 1983.

3. "Declining - Rate Filters: Regulatory Aspects and Operating Results," Cornwell, D. A., M. Bishop and H. J. Dunn, AWWA National Conference, June 1983.

4. "Groundwater Contamination: Challenge of the 80's," Hess, A. F. J. E. Dyksen and H. J. Dunn, Water Technology, 1983.

5. "Direct Filtration Pretreatment for Sea Water Desalination by Reverse Osmosis," Singer, P. C. and H. J. Dunn, presented at the fall meeting of the Filtration Society - Dixie Chapter, 1983.

6. "Is Your Community's Ground Water Safe to Drink?," Hess, A. F., J. E. Dyksen and H. J. Dunn, Public Works, 1983.

SRIRANGAM K. KRISHNASWAMI
Manager, Environmental Sciences and Planning

EDUCATION

BSc (Biology) 1954; University of Madras, India
MA (Biology) 1959; University of Madras, India
MS (Environmental Science) 1961; University of the Pacific
MSPH (Public Health) 1964; University of California, Los Angeles

RECOGNITION

Fulbright Scholar, 1960-63
UCLA Distinguished Scholar, 1962-64
National Institutes of Health Fellow, 1961-62
Fellow, American Public Health Association, elected 1969
Member, Health Aspects Committee of the U.S.A.-Canada International Joint Commission, 1974-78
Member, AWWA International Wastewater Reclamation Committee
Member, ISO Techical Committees on Water Quality
Author of numerous publications on public health and related topics, including papers on waterborne parasites, wastewater reclamation, waterborne viral diseases, disinfection, water pollution control, algae, water quality criteria, acid rain and drinking water standards.

SUMMARY OF EXPERIENCE

Mr. Krishnaswami has extensive experience in the assessment of environmental and socio-economic impacts of chemical contaminants in the environment, water and wastewater systems, resource recovery systems, hazardous waste site remediation, river engineering, coastal zone revitalization, land application of wastes and large-scale industrial and energy development projects. He has been responsible for developing and directing a number of environmental programs for federal agencies in Canada, including programs in water pollution, solid wastes management, ecological impact and energy-environmental impact assessments, and the Canadian Drinking Water Standards. Co-author of "Protecting the Source", published in the March 1982 issue of Water/Engineering & Management, Mr. Krishnaswami is thoroughly familiar with and a noted critic of contemporary literature on the public health effects of environmental contaminants.

DETAILED EXPERIENCE

1980 to Date — Malcolm Pirnie, Inc.

As Manager, Environmental Sciences and Planning:

- Completed an environmental impact statement on reactivation of the Chelsea Pumping Station to pump water from the Hudson River into New York City's water supply during droughts. Presence of toxic organics in the river was a major concern and public involvement was stressed during the planning process.

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DETAILED EXPERIENCE (continued)

1980 to Date — Malcolm Pirnie, Inc. (continued)

- Responsible for coordinating and conducting environmental assessment studies for a variety of projects including hazardous waste evaluation, wastewater and solid waste disposal, river engineering, etc.

- Directed contamination assessment of Love Canal, Niagara Falls, NY, which determined potential health hazards in the area.

1973-79 — National Energy Board
Government of Canada

As Director of the Environment Group: In charge of development, organization, and direction of the Board's environmental impact assessment and evaluation policy and program including: regulatory control requirements, standards, regulations, monitoring and surveillance. Projects evaluated included Arctic gas pipelines, LNG, coal conversion, interprovincial gas and oil pipelines, power generation and international electric power lines.

1971-73 — Environmental Protection Service
Department of the Environment
Government of Canada

As Head of the Ecological Impact Appraisal and Control Program: Responsible for development and management of a program for assessing a variety of industrial development projects, including mining of minerals and oil sands. Directed a study on mining land activities with particular reference to the dynamics of pollutants movements on land, in water and air. Developed ecological protection policies, regulations, and standards and provided advisory services on ecologically related environmental concerns. Served on a steering committee, directing environmental impact assessment of an industrial complex involving an LNG terminal, a power plant, a steel mill and others.

1970-71 — National Research Council of Canada

As Research Council Officer of the Environmental Secretariat: Conducted research on and developed scientific criteria for environmental quality with particular reference to the aquatic environment and ecosystem interactions.

DETAILED EXPERIENCE (continued)

1966-70 — Department of National Health and Welfare, Government of Canada

As Environmental Health Consultant with the Public Health Engineering Division: Involved with programs of water pollution survey and control, solid waste management, water treatment and supply, wastewater treatment and disposal, and water quality criteria and standards. He served as Principal Investigator for development of the first Canadian Drinking Water Standards promulgated in 1968. He served on the Interdepartmental Committee which developed the Canadian National Water Quality Criteria and Objectives.

1965-66 — Department of Health, Alberta Government

As Water Pollution Control Engineer with the Division of Sanitary Engineering: Responsible for implementation and management of field surveys, evaluation and control of water pollution, water quality, waste disposal, and preparation of official reports.

1954-65

During this period Mr. Krishnaswami held several academic and research positions at UCLA, Rice University, University of the Pacific, King Institute of Preventive Medicine, India, and Madras University, India.

ANDREW R. ANDERSON
Project Engineer

EDUCATION

BS (Mechanical Engineering) 1970; Union College
ME (Environmental Engineering) 1976; Manhattan College
Seminars on Hazardous Waste Regulations, Ground Water Contamination, and Technical Writing

REGISTRATION

Professional Engineer

SOCIETIES

Water Pollution Control Federation
Hazardous Materials Control Research Institute
Sigma Xi, The Scientific Research Society

RECOGNITION

Author: Articles on wastewater treatment, runoff, and contaminant inputs to coastal waters.
Member of panel on waste sources for the NOAA Workshop on "Assimilative Capacities of U.S. Coastal Waters".

SUMMARY OF EXPERIENCE

Mr. Anderson has participated in a broad variety of projects within the environmental field. He has conducted studies of hazardous waste sites, industrial and municipal wastewater treatment, urban and industrial runoff, effects of river dredging, and mathematical modeling of marine systems.

DETAILED EXPERIENCE

1980 to Date — Malcolm Pirnie, Inc.

As Project Engineer:

- Currently developing remedial investigation/feasibility study for a Superfund site in New England consisting of a landfill which accepted industrial and municipal waste.

- Developed remedial measures for extensive pesticide contamination of river sediments and soils at a Superfund Site in the Southern U.S. Recommended actions include stabilization of contaminated material, dredging, stream diversion, and low-level dams.

- Conducted preliminary assessment of effects of proposed deepening of channels in New York Harbor to allow deep draft vessels access to coal, oil, and other bulk harbor terminals, for U.S. Army Corps of Engineers.

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DETAILED EXPERIENCE (continued)

1980 to Date — Malcolm Pirnie, Inc. (continued)

- Assisted in design of modifications to wastewater collection and treatment system for soft drink bottling plant.

- Developed supplemental wastewater facility plans for Pequannock and Lincoln Park (NJ), including field inspection of septic systems, coordination of soils and groundwater analyses, analysis of questionnaires and field data, development of alternative wastewater plans, and participation in public meetings.

1978-80 — Hydroscience, Inc.

As Treatment Process Engineer: Representative projects included development of processes to remove heavy metals and toxic organics from leachate and incinerator wastewater at the Old Bethpage Landfill, NY (Superfund site) and conceptual design of facilities to treat the effluent from a municipal sewage plant for reuse in a polyethylene plant as process water and boiler feed water. Unit treatment processes studied include precipitation, carbon adsorption, filtration, reverse osmosis, and demineralization.

He evaluated runoff control and wastewater collection and treatment systems at a metal refining plant, including ditches and lagoons handling process wastes and runoff containing high levels of heavy metals. This project included a statistical evaluation of lagoon overflow probabilities with various alternatives. He also developed laboratory experiments of heavy metal adsorption to particulates in connection with the modeling of metals in a midwest river with heavy industrial imputs. Other work included economic and technical comparison of sewage treatment processes including those for toxics, field evaluation of disinfection equipment, in-plant industrial wastewater surveys, study of industrial lagoon odors, and fish bioassays.

1974-78 — Manhattan College
Environmental Engineering and
Science Program

As Research Engineer: Research projects included estimation of contaminant inputs to New York Bight, development of a mass balance method for estimation of combined sewer overflow from sewage treatment plant data, and mathematical modeling of carbon-oxygen-nitrogen distribution in New York Bight.

1971-73 — Otis Elevator Company

As Designer and Estimator: Duties included review of architectural drawings, layout of elevator and escalator equipment, ordering of equipment, estimation of material and labor costs, review of general terms and conditions, review of specifications.

GERAGHTY & MILLER, INC. RESUMES

DAVID W. MILLER

Principal

CREDENTIALS/REGISTRATION

B.A. Geology, Colby College, 1951
M.S. Geology, Columbia University, 1953
Registered Geologist: Arizona, Idaho, Delaware, Maine, Indiana
Certified Professional Geologist: American Institute of Professional Geologists, Past President, Northeast Section
Certified Professional Hydrogeologist: American Institute of Hydrology, Member-Board of Review

PROFESSIONAL AFFILIATIONS

National Water Well Association, Past Chairman-Technical Division, Member - Board of Directors
American Water Works Association, Past Chairman, Ground-water Committee
Science Advisor to Office of Technology Assessment
Board Member of several National Science Foundation committees
Technical Association of Pulp & Paper Industry, Past Chairman of Water Resources Committee
American Geophysical Union

AWARDS

National Water Well Association Technical Division, Science Award in recognition of contributions to the science of ground water
New England Water Works Association, Dexter Brackett Memorial Medal

FIELDS OF SPECIALIZATION

- Organization of plans for development, management, and protection of ground water
- Organization and presentation of expert testimony
- Assessment of water resources availability
- Participation in programs to determine long-term impact of contamination of ground-water supplies
- National spokesman for the ground-water industry on ground-water issues

EXPERIENCE SUMMARY

Mr. Miller has carried out ground-water investigations throughout the United States and has served as a technical advisor on numerous water-supply and water-quality problems abroad. His work has involved development of ground-water resources for municipalities, private water companies, and industry. He has carried out water management studies for agencies at all levels of government and has investigated ground-water contamination incidents at industrial facilities, spill locations, and abandoned disposal sites in a wide variety of geologic environments. Mr. Miller's professional activities have required the development of an extensive knowledge of federal, state, and local programs related to ground-water quality protection and he has represented both the private sector and government at hearings, in litigation proceedings, and at public meetings. In addition, Mr. Miller has created an ongoing series

EXPERIENCE SUMMARY (Cont'd.)

of national seminars designed to provide training in ground-water management for industrial engineers, regulatory personnel, and environmental consultants.

KEY PROJECTS

- Special lecturer for the Chemical Manufacturers's Association (in addition to Petroleum, Aluminum, Steel and Paper industrial organizations) on industry response to ground-water protection requirements under SDWA and RCRA. Presentations given to several thousand corporate representatives.

- Supervised the exploration for and development of numerous large-scale ground-water supplies for major municipalities across the country.

- Directed the investigation of hundreds of industrial ground-water contamination incidents related to hydrocarbon and chemical discharges and was responsible for development and implementation of the remedial action plan.

- Inventoried and prioritized ground-water contamination problems in 26 states for USEPA Kerr Laboratory, Ada, Oklahoma.

- Directed nationwide compilation of data and prepared The Report to Congress, Waste Disposal Practices and Their Effects on Ground Water (USEPA, January 1977).

- Directed for USEPA the first national assessment of the importance of land disposal of hazardous waste as a threat to ground-water quality.

- Created the ground-water portion of the New Jersey Water Plan; providing the state with a long-term program for development, management, and protection of the resource.

- Developed a ground-water management plan for the state of Delaware.

- Served as ground-water policy manager on the $5.2 million Long Island 208 Study under contract to the Nassau-Suffolk Regional Planning Board.

SELECTED PUBLICATIONS

Water Atlas of the U.S., Library of Congress Catalog Card No. 63-11, Water Information Center, Inc., 1963.

Development of Ground Water in the Greater New York Metropolitan Area, American Society of Sanitary Engineering Bulletin, November-December 1967, January 1968.

SELECTED PUBLICATIONS (Cont'd.)

Hydrologic and Geologic Principles of Land Disposal of Wastes, Water Pollution Control Federation, 1972.

Ground-Water Contamination in the Northeast States, USEPA, Environmental Protection Technology Series, June 1974.

Ground-Water Zoning - Fact or Fiction, National Water Well Assn., Ground Water, 1978.

Planning of Site Investigations, California Manufacturers Assn., 1980.

Principles of Ground-Water Management, National Water Quality Symposium, 1980.

Geohydrological Surveys at Chemical Disposal Sites, Proceedings of the Rockefeller University Symposium, Assessment of Health Effects at Chemical Disposal Sites, June 1-2, 1981, New York City.

Protection of Ground-Water Quality, Proceedings of the AAAS Symposium, Groundwater Pollution, An Emerging Threat to a Natural Resource, January 3-8, 1982, Washington, D.C.

Cleanup and Containment of Ground-Water Contamination Incidents, Testimony before the Toxic Substances and Environmental Oversight Subcommittee, U.S. Senate, Washington, D.C., 1982.

Introduction to Ground-Water, Pollution Equipment News, October, 1983.

Principles and Framework of Ground-Water Hydrology, Proceedings of the Cornell University NE Water Management Conference, Ithaca, New York, 1983.

VINCENT W. UHL, JR.

Senior Scientist and Manager of New Jersey Office
Member of the firm from 1977 to 1982 and since 1984

CREDENTIALS/REGISTRATION

B.S. Mechanical Engineering, University of Notre Dame, 1966
M.S. Agricultural Engineering, Oklahoma State University, 1970
M.S. Hydrogeology, University of Arizona, 1976
Certified Professional Geologist: AIPG No. 6519

PROFESSIONAL AFFILIATIONS

American Geophysical Union
National Water Well Association

FIELDS OF SPECIALIZATION

- Hydrology of fractured rock aquifer systems
- Analysis of aquifer pumping tests
- Assessment and development of ground-water resources
- Conductance of test well and production well drilling programs
- Regional water resource and water-quality assessments
- Ground-water contamination assessments
- Design, installation, and operation of abatement well systems
- Investigation related to landfill siting and impacts associated with municipal and industrial landfills
- Injection well evaluation and installation
- Ground-water heat pump applications

EXPERIENCE SUMMARY

Mr. Uhl specializes in the investigation of ground-water contamination incidences and in the development of ground-water resources for public and industrial uses. He has supervised projects that involved both the definition and remediation of contaminant sources and problems. While with Geraghty & Miller, Inc. he has been involved with water-supply development projects for industrial and municipal clients in all parts of the country. He has directed a number of international projects including water development studies in Malaysia, India, and Saudi Arabia.

Mr. Uhl managed the hydrogeology group at Malcolm Pirnie, Inc. from 1982 to 1984 and was responsible for the execution of many water-supply developments and ground-water contamination projects throughout the United States and overseas.

Mr. Uhl set up and started a water-development project in Central India in 1970 and was project manager through 1977. The activities of the project include ground-water exploration, well drilling, aquifer pumping tests, water-quality analysis, well and pump rehabilitation, and ground-water resource evaluation. To date, the project has installed more than 3,000 wells in central and southern India.

Mr. Uhl has taught graduate level courses in hydrogeology at the University of Maryland and at the University of Akola in India. He is a consultant to the World Bank and VITA (Volunteers in Technical Assistance).

KEY PROJECTS

- Investigated ground-water development potential for the City of Virginia Beach including the use of brackish ground water for desalination.

- Conducted a water-supply development project for the Borough of Fairlawn, New Jersey, which resulted in the development of a 1 mgd potable water supply from the Brunswick Formation.

- Conducted a ground-water resource study for Jack Nicklaus Associates (St. Andrews Golf Club), which entailed a detailed assessment of ground-water availability for irrigation purposes.

- Assisted in the development of a ground-water heat pump system for the Enterplex Complex in Princeton, New Jersey.

- Supervised a test injection well project for the Rural Utilities Board in Gainesville, Florida.

- Investigated, formulated, and implemented a remedial program for a Superfund site in Rhode Island.

- Conducted numerous ground-water investigations at municipal and industrial landfills.

NICHOLAS VALKENBURG

Senior Scientist
Member of the firm since 1976

CREDENTIALS/REGISTRATION

B.S. Geology, State University of New York at Stony Brook, 1971
M.S. Geology, University of Toledo, 1973
Registered Professional Geologist: Georgia No. 403, Indiana No. 585, Virginia No. 401
Certified Professional Geologist No. CPG 4404: American Institute of Professional Geologists
Certified Professional Hydrogeologist: American Institute of Hydrology, No. 254

PROFESSIONAL AFFILIATIONS

National Water Well Association
American Association for the Advancement of Science
New York Academy of Sciences

FIELDS OF SPECIALIZATION

- Investigation and evaluation of ground-water contamination incidents
- Development and management of ground-water resources
- Site evaluations and sequencing and ordering of work tasks necessary to complete field investigations
- Management of projects related to well drilling, sampling, and testing
- Client representation at administrative and judicial proceedings

EXPERIENCE SUMMARY

Mr. Valkenburg is an expert hydrogeologist. He was employed by the Geological Survey of Alabama as principal investigator in the Office of Water Resources Technology project related to iron bacteria. He was also with Ebasco Services, Inc. as an environmental scientist where he analyzed data on geology and ground-water hydrology for power plant sites and prepared environmental impact assessments. Since joining Geraghty & Miller, Inc. he has supervised field services in numerous projects where drilling water sampling, resistivity surveys, and modeling were required to evaluate the impact of waste disposal sites on ground-water resources. He also developed ground-water supplies from bedrock aquifers and glacial deposits in the northeastern United States as well as the midwest. As project manager, he has been responsible for conducting investigations at several waste disposal sites, analyzing geologic and water-quality data, preparing reports, contacts with regulatory agencies and providing expert testimony. Mr. Valkenburg was also an adjunct faculty member of Adelphi University in 1981 and 1982 where he was responsible for organizing and teaching courses in introductory hydrogeology and graduate courses in ground-water management.

KEY PROJECTS

- Responsible for assessment of ground-water quality impacts of septic tanks, industrial storage areas and disposal sites, and municipal landfills in Middlesex County, New Jersey.

KEY PROJECTS (Continued)

- Supervised hydrogeological field services required to determine the impact of construction, dewatering and waste/disposal practices at an industrial site in New York.

- Supervised hydrogeological field services required to construct and test large-capacity production wells at an industrial site in the Mississippi River Valley, Missouri.

- Responsible for evaluating the probable ground-water impacts of large-scale sewering projects on Cape Cod, Massachusetts.

- Responsible for field investigations of organics contamination in industrial and municipal production wells at three sites in Ohio and West Virginia.

- Supervised projects involving the design, construction, development and testing of large-capacity production wells at a site in central Connecticut.

- Supervised projects to determine the magnitude and extent of ground-water contamination at eight industrial sites in Ohio, New York, New Jersey, Illinois, and Indiana.

- Supervised projects designed to develop ground water from fractured bedrock aquifers at two sites in New York and New Jersey.

- Supervised projects designed to alleviate ground-water contamination and prevent further migration of contaminants from hazardous waste sites at five sites in New York, New Jersey, Illinois, and Indiana.

- Supervised project to determine the magnitude and extent of ground-water contamination affecting a large municipal well field in Massachusetts and to provide expert testimony on client's behalf.

SELECTED PUBLICATIONS

Valkenburg, Nicholas, 1973, Water Quality and Mineral Solubilities in Surface and Ground Water, Oak Openings Community, Lucas County, Ohio, National Technical Information Service No. PB-224014/1GT.

Shade, J.W., and Nicholas Valkenburg, 1976, Comparison of Base Flow and Ground-Water Chemistry, Oak Openings Sand, Lucas County, Ohio. Ohio Journal of Science, Vol. 75, No. 3, pp. 138-146.

Valkenburg, Nicholas, M. Green, and R. Christian, 1975, Iron Bacteria in Ground-Water Supplies of Alabama. Geological Survey of Alabama, Circular 96, 108 p.

ROBERT A. SAAR, Ph.D.

Senior Scientist
Member of the firm since 1981

CREDENTIALS/REGISTRATION

B.A. Chemistry, Yale University 1973
Ph.D. Soil & Natural Water Chemistry, University of New Hampshire 1980

PROFESSIONAL AFFILIATIONS

American Chemical Society
American Geophysical Union
Geochemical Society
New York Academy of Sciences

FIELDS OF SPECIALIZATION

- Determination of the nature and extent of subsurface chemical contamination
- Development of field techniques and quality assurance programs for water quality sampling
- Trace metal complexation by soil organic matter
- Development of methods for evaluating water quality data and assessing laboratory performance
- Public presentation and meetings (both technical and non-technical)

EXPERIENCE SUMMARY

Dr. Saar is responsible for the evaluation of chemical data obtained in studies of ground-water quality. He establishes and supervises protocols for the sampling and analysis of ground-water and geologic samples. He has had considerable experience with ground-water monitoring projects, many of which were in response to state and Federal (RCRA, Superfund) hazardous waste regulations or compliance orders.

Dr. Saar supervised the development of a Geraghty & Miller field sampling service which included the training of field personnel and the development of quality assurance protocols. He is responsible for maintaining this program. Dr. Saar also manages a number of projects involving evaluation of ground-water contamination, for which he has designed and carried out programs for sampling and tracing ground-water contaminants from their points of origin. He has prepared and delivered numerous lectures and training programs on contamination assessment and ground-water monitoring for industrial and regulatory groups.

KEY PROJECTS

- Assisted in the development of a subsurface contamination mapping project and groundwater model for a major New Jersey chemical firm.

- Prepared geochemical section of modeling study to determine the migration of methanol in ground water.

- Investigated ground-water chemistry and potential significance of contaminant migration in the vicinity of the Ocean County and Jackson Township Landfills in New Jersey.

KEY PROJECTS (Continued)

- Prepared a lecture series on ground water chemistry for presentation to the mining group of a major oil company.

- Managed a major investigation of the source of organic contamination in a well field in Connecticut, which included extensive quality-control measures to assure the reliability of the conclusions.

- Manager for the subsurface investigation (both saturated and unsaturated zones) of natural gas under a housing development in New Jersey.

SELECTED PUBLICATIONS

Co-author of text A Study Guide to Accompany Chemistry, The Universal Science published by Addison-Wesley, Reading, Massachusetts, 1979.

Saar, R.A., and J.H. Weber, "Complexation of cadmium (11) with water- and soil-derived fulvic acids: effect of pH and fulvic acid concentration." Canadian Journal of Chemistry, 57, 1963-1268 (1979).

Saar, R.A., and J.H. Weber, "Lead (11) complexation by fulvic acid: How it differs from copper (11) - and cadmium (11) - fulvate complexation," Geochimica et Cosmochimica Acta 44, 1381-84 (1980).

Saar, R.A., and J.H. Weber, "Comparison of spectrofluorometry and ion-selective electrode potentiometry for determination of complexes between fulvic acid and heavy metal ions," Analytical Chemistry 52, 2095-2100 (1980).

Saar, R.A., and O.C. Braids, "Groundwater," Jour. Water Pollution Control Federation, 53, 921-925 (1981).

Saar, R.A., and J.H. Weber, "Fulvic acid: modifier of metal-ion chemistry," Environmental Science & Technology, 16, 510A-517A (1982).

Saar, R.A., and O.C. Braids, "Chemical indicators of leachate contamination in groundwater near municiple landfills," in Environmental and Solid Wastes: Characterization, Treatment, and Disposal (Proceedings of the Fourth Oak Ridge National Laboratory Life Sciences Symposium, Gatlinburg, Tennessee, October 4-8, 1981), Ann Arbor Science Publishers, Ann Arbor, Michigan, 1983, pp. 315-328.

KOBINA ATOBRAH, Ph.D.

Senior Scientist
Member of the firm since 1981

CREDENTIALS/REGISTRATION

M.S. Hydrogeology/Earth Sciences--University of Waterloo, Ontario, Canada, 1977
Ph.D. Hydrology--Princeton University, 1983

PROFESSIONAL AFFILIATIONS

American Geophysical Union
Association of Geoscientists for International Development
International Association of Engineering Geology
Sigma Xi Scientific Society (Princeton Chapter)

FIELDS OF SPECIALIZATION

- Hydrology of crystalline fractured rock
- Field tracer testing
- Geophysical logging
- Surface geophysical methods
- Solute transport modeling
- Quantitative hydrology
- Groundwater resource planning

EXPERIENCE SUMMARY

Dr. Atobrah participates in the planning and development of ground-water resource investigations and in the evaluation of field data. He provides quality assurance services to Geraghty & Miller project teams concerning the evaluation of ground-water quality and hydrogeological data project sites.

He is responsible for forecasting the movement and distribution of ground-water contaminants for monitoring and compliance purposes.

Dr. Atobrah has had 10 years of international experience in all areas of ground-water hydrology including well drilling, sampling, geological mapping, resource evaluations and geophysical surveys. His projects in Canada, Ghana and the United States have required him to collaborate with engineers, biological, chemical and physical scientists. He has substantial experience in evaluating political and legal issues in connection with resource planning decisions.

Since joining Geraghty & Miller Dr. Atobrah has developed a number of computer programs for groundwater resource evaluation and the mapping of subsurface contamination. He has assisted in the development of a generic model for estimating the migration of specific organic chemicals.

KEY PROJECTS

- Development of generic solute transport model for risk assessment evaluation for a major petroleum company.

KEY PROJECTS (Continued)

- Modeled the effects of surface water drainage diversions in the vicinity of a hazardous waste site.

- Development of a model for a major chemical sector client to demonstrate compliance with RCRA Part B standards.

- Conducted extensive geological and hydrogeological investigations for the Ghana Geological Survey.

- Developed techniques for modeling groundwater flow through fractured rock media in Ontario, Canada.

- Organized and delivered a special course to the U.S. Army Hazardous Waste Group on ground-water modeling.

SELECTED PUBLICATIONS

Bannerman, R.R., K. Atobrah, and B.H. Nerquaye-TETTEH (1973): Introduction a une carte des eaux souterraines du Ghana. Bull. Laisison Comite Inter. Afr. Et. Hydraul. Haute-Volta.

Amuzu, A.T., and K. Atobrah (1974): Subterranean seepage investigation in Accra. Paper presented at 9th Biennial Conf. Ghana Sci. Assoc. WRRU (CSIR) ISBN 9964-85-016-6.

Quist, L.G., and K. Atobrah (1975): Report on resistivity investigation for ground-water availability at Juapong Textiles Factory. WRRU (CSIR) ISBN 9664-85-021-2.

Atobrah, K., L.G. Quist, and A.T. Amuzu (1975): Groundwater supply for Obom Clinic. WRRU (CSIR) ISBN 9964-85-022-0. Editor of Geonews, The official newsletter of the Geological Society of Ghana (1973 to 1975).

Atobrah, K. (1977): Analysis of flow in fractured rocks. Research Seminar Dept. Earth Sciences, Univ. of Waterloo, Waterloo, Ontario, Canada.

Atobrah, K. (1978): Evaluation of finite element methods for fold prediction. Research Seminar Structural Geology, Dept. Geological and Geophysical Sciences, Princeton University, Princeton, New Jersey.

Atobrah, K. (1979): Flow system in fractured porous media. Res. Seminar, Water Res. Program, Dept. Civil Eng., Princeton University, Princeton, New Jersey 08540.

Atobrah, K. (1980): Finite element simulation of the crystalline rock reservoir of the Accra Plains, Water Resources Research Unit (CSIR) Pub. Accra, Ghana, West Africa.

Atobrah, K., and J. P. Greenhouse (1981): An application of a digital geophysical shallow well log system (In Press).

THOMAS LOBASSO

Staff Scientist
Member of the firm since 1979

CREDENTIALS/REGISTRATION

B.S. Geology, SUNY at Stony Brook, 1977
M.S. Environmental Engineering, SUNY at Stony Brook, 1981
Certified Professional Geologist: American Institute of Professional Geologists
Registered Professional Geologist: Indiana, Virginia

PROFESSIONAL AFFILIATIONS

American Association for the Advancement of Science
American Geophysical Union
National Water Well Association

FIELDS OF SPECIALIZATION

- Investigation and evaluation of ground-water contamination incidents
- Assessment and development of ground-water resources
- Preparation and review of technical documents for regulatory agencies and litigation purposes
- Supervising projects related to well drilling, sampling, and testing
- Development of techniques for monitoring gaseous and liquid hydrocarbons in the subsurface

EXPERIENCE SUMMARY

Mr. Lobasso has participated in projects concerning the investigation, evaluation, and reporting of ground-water contamination incidents and in the development and management of ground-water resources. He has designed and supervised subsurface investigations in diverse geologic environments utilizing various well drilling methods. Prior to joining Geraghty & Miller, Inc., Mr. Lobasso was employed by the U.S. Geological Survey where he participated in the design and implementation of surface and ground-water monitoring programs on Long Island, New York.

KEY PROJECTS

- Participated in the design and implementation of hydrogeological field programs to determine the extent and impact of liquid and gaseous hydrocarbon spills in the subsurface and remedial programs to remove and recover spilt product.

- Evaluated ground-water resource development in consolidated and unconsolidated aquifers and has participated in the design, testing, and renovation of large capacity production wells.

- Prepared and evaluated technical documents for litigation and state and federal compliance purposes.

- Aided in the design and supervised field services in a study to determine the extent and impact of a subsurface propane gas leak which affected both the unsaturated zone and ground-water system in a residential community. He also participated in the design of a gas removal system as part of remedial action in the unsaturated zone.

KEY PROJECTS (Cont'd.)

- Assessed the ground-water quality impacts of industrial hazardous waste storage and disposal sites, and sanitary landfill sites on ground-water supolies.

- Participated in assessing hydrogeologic conditions as part of feasibility and siting studies for hazardous waste disposal and storage facilities.

PUBLICATIONS

Lobasso, T., and A.J. Barber, 1983, A Monitoring and Removal Program for Leaked Propane Gas in the Vadose (Unsaturated) Zone: A Case Study, Proceedings from the National Water Well Association Conference, Characterization and Monitoring of the Vadose (Unsaturated) Zone, Las Vegas, Nevada, December 1983.