APPENDICES

Appendix A: Workshop Participants List

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Appendix B: Discussion Group Focus Issues

A. Hydrogeologic Data Collection

1. What data are needed to estimate or document temporal changes in ground-water discharges to various surface water bodies? When and at what frequency should the data be collected?

2. How do the methods of measuring ground-water discharge to surface water depend on hydrogeologic setting and surface water regime?

3. What are the best methods of measuring ground-water discharges to various surface water bodies?

    a. How should measurements be made?
    b. Where should measurement be made?
    c. Over what area should measurements be made?
    d. When should measurements be made?

4. How do we determine the relative proportion of contaminated ground-water flux as a proportion of the total ground-water flux and/or mass balance for a given area?

B. Chemical Data Collection

1. What are the relevant chemical processes?

2. How should chemical concentrations be measured when determining the flux of contaminated ground water to a surface water body?

    a. Where should the measurements be taken?
    b. How should samples be obtained?
    c. Over what area should measurements be taken?
    d. Over what time period and at what frequency should samples be taken?

3. What are the data quality objectives needed to support an ecological impacts assessment? What are the proper methods of collecting water and sediment samples to determine ecological impacts? What is the role of moisture and organic carbon data?

4. How should samples be collected to determine contaminant retention in the biologically active zone?

5. How should contaminant retention be evaluated in the hyporheic zone and bottom sediments?

C. Biological Data Collection

1. Is the hyporheic zone considered an ecological habitat to be protected or a “treatment opportunity” zone for restoration of contaminated ground water discharging into surface water?

    a. How can the hyporheic zone be defined biologically? [*]

    b. What are the ecological endpoints in the discharge or hyporheic zones? What ecosystem functions occur in these zones? *

    c. What are the appropriate scales to measure adverse effects to ecological endpoints in riverine, estuarine, and lacustrine hyporheic systems? *

    d. What modifications to existing Guidance or creation of new Guidance are needed to account for the unique ecological and hydrological aspects (receptors, functions, and routes of exposure) of the hyporheic zone? *

2. What is the appropriate biological information (data) needed to assess ecological impacts?

    a. What should be the structure for evaluating adverse impacts to key ecological endpoints?

        (1) What biological monitoring should be performed? Which ecological structures and functions should be evaluated and why? *

        (2) Should it be phased and if so how should priorities be set for the data gathering?

    b. How can screening numbers be developed for the hyporheic zone that are protective of ecological endpoints of concern? Are AWQC and NOAA Sediment Effects Criteria (ER-L and ER-M data) sufficient as screening numbers for protection of ecological endpoints; or, should other levels be used or developed for hyporheic zone screening for protection of ecological endpoints?

3. How should physical biological data be collected?

    a. What are the best sampling methods to characterize the biological endpoints and then measure these for unacceptable impacts? Under what circumstances should filtered or unfiltered water samples (groundwater and surface water) be taken for environmental purposes? *

    b. What sampling locations are appropriate for biological data collection?

    c. When should interstitial water samples from sediment (using semi-permeable membrane devices or other techniques) or whole sediment samples be collected for environmental purposes? Is there a role for sediment elutriate to be sampled?

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[*] Asterisks represent priority issues for the biology discussion group.

4. Which ecological endpoints are at risk within the ground water/surface water mixing zone for different surface water regimes?

D. Monitoring Goals and Objectives

1. Identify and characterize zones of interest associated with surface water bodies susceptible to impact by contaminated groundwater.

2. Determine if discharge of contaminated groundwater is impacting surface water quality or biota in the zones of interest.

   a. Characterize existing impacts.
   b. Evaluate the effect of contaminant loading (including seasonal and temporal variations) on water quality and ecology.
   c. Absent current impact on water quality, determine if long-term contaminant loading within a discharge zone poses a threat to future surface water quality and/or biota.

3. Determine the impact that different hydrogeologic settings and surface water regimes have on the selection of monitoring methods.

4. Identify prescriptive standards that must be attained.

   a. Evaluate the applicability of applicability of a 'mixing zone' to the surface water body
   b. Establish regulatory-based (chemical) and/or biota-based compliance standards.

5. Determine the sources of impacts.

Appendix C: Case Study Summaries

Workshop participants submitted 14 case study summaries of ground water/surface water investigations for inclusion in this report. The purpose of providing these summaries is two-fold. First, to provide a resource for further information on the various monitoring methods. The case study summaries represent a range of contaminated media and contaminants within different hydrogeologic landscapes. Contact names are provided for further information on the use of such monitoring methods and their utility in obtaining the desired site data. The case studies are also provided as part of an informal assessment of what techniques are and are not commonly used. The following four tables provide this assessment.

Table 1 lists the case study sites and the main contaminant types present as well as the type of monitoring done at each site (physical, geochemical, or biological). Tables 2, 3, and 4 expand on the type of physical, geochemical, and biological monitoring being done, to summarize in some detail the type and number of sites using a given monitoring procedure. The tables include a total for the types of methods used and the number of total different places all the methods have been used at. They show that physical and geochemical methods are about equally distributed in use, but bioassays (and related biological monitoring) are much less widely used at the sites.

This appendix is not meant to be a comprehensive list of sites having ground water/surface water interaction and contamination problems, but simply a tabulation of the types of sites which were represented through those attending the Workshop, and also a listing of the types of methods which have been used in the field when dealing with this type of complex ground water/surface water interaction and contamination sites. It is interesting to note that while the most used monitoring methods are wells and piezometers, that there are many other monitoring options that have been used at sites where there is a ground water to surface water transition zone.

Table 1
GW/SW Case Studies Summary:
Contaminants Studied and Monitoring Methods Used

	Contaminants Monitored							Monitoring Methods		
Site Name	EcoRisk	VOCs	NO_3	Metals	PAHs	PCBs	Pesticides or Herbicides	Physical	Geochemical	Bioassay
Alcoa/Lavaca Bay	√			√	√			√	√	
Angus, Ontario	√	√						√	√	
Everglades National Park	√		√	√				√	√	√
Hertel Landfill	√	√		√			√	√	√	
I-85 Manufacturing	√	√						√		
BMI Complex		?						√	√	
Ledbetter Cr.	√		√				√	√	√	√
Peconic Estuary	√	√	√				√	√	√	√
Pinal Creek	√			√				√	√	
St. Joseph	√	√						√	√	√
Union Pacific	√	√			√			√	√	√
Wyckoff Eagle Harbor	√	√			√		√	√	√	√

Table 2
Case Studies Summary of Data Collection Techniques Used

Data Collection Techniques	Total	Site Names
Current meters	2	Everglades National Park Pinal Creek
Diffusion sampler	1	I-85 Manufacturing
Direct Push Samples	2	I-85 Manufacturing Wyckoff Eagle Harbor
Geophysical Measurements	2	Peconic Estuary Wyckoff Eagle Harbor
Geoprobe	1	Wyckoff Eagle Harbor
GW Water level surveys	2	Angus, Ontario Wyckoff Eagle Harbor
GW Mini-piezometer	5	Angus, Ontario Ledbetter Cr. Peconic Estuary Pinal Creek Wyckoff Eagle Harbor
(Continued)...		
Ground water monitoring wells	8	Alcoa/Lavaca Bay Hertel Landfill BMI Complex Ledbetter Cr. Peconic Estuary Pinal Creek Union Pacific Wyckoff Eagle Harbor
Ground water multilevel sampling device	2	Angus, Ontario St. Joseph
Ground water Waterloo Profiler	1	Angus, Ontario
Ground water piezometers	3	Alcoa/Lavaca Bay Everglades National Park Hertel Landfill
In-stream solute tracer	1	Pinal Creek
In-stream auto sampler	1	Pinal Creek
NAPL studies	3	Alcoa/Lavaca Bay Union Pacific Wyckoff Eagle Harbor
Potentiomanometer	1	Angus, Ontario
SCAPS survey	1	Wyckoff Eagle Harbor

Table 2
Case Studies Summary of Data Collection Techniques Used

Data Collection Techniques	Total	Site Names
Sediment sampling	4	Angus, Ontario I-85 Manufacturing, Union Pacific Wyckoff Eagle Harbor
Sediment probe	2	Angus, Ontario Ledbetter Cr.
Seepage meters	5	Everglades National Park Ledbetter Cr. Peconic Estuary Pinal Creek Wyckoff Eagle Harbor
Slug testing	1	Angus, Ontario
Soil cores onshore	2	Angus, Ontario Wyckoff Eagle Harbor
(Continued)...		
Soil cores offshore	3	Angus, Ontario St. Joseph Wyckoff Eagle Harbor
Streambed temperature survey	2	Angus, Ontario Wyckoff Eagle Harbor
Surface water monitoring	2	BMI Complex Wyckoff Eagle Harbor
Time Domain Reflectrometry	1	Angus, Ontario
Tracer	1	Pinal Creek
Velocity and tracer-dilution gaging	1	Pinal Creek
27	62	

Table 3
Case Studies Summary of Geochemical Techniques Used

Geochemistry	Total	Site Names
Age-dating of GW	1	Pinal Creek
Alkalinity	2	Hertel Landfill Pinal Creek
Ammonia	1	Hertel Landfill
Biochemical Oxygen Demand (BOD-5)	1	Hertel Landfill
Cation/Anion	1	Angus, Ontario
Chemical Oxygen Demand (COD)	2	Hertel Landfill Wyckoff Eagle Harbor
Chloride	2	Hertel Landfill Wyckoff Eagle Harbor
Chlorophyll	1	Peconic Estuary
CO_2	1	Ledbetter Cr.
Ethene, ethane, methane	3	Everglades National Park Ledbetter Cr. Angus, Ontario
Field chemistry tests	1	St. Joseph
(Continued)...		
Field Parameters (pH, Temp., EH, DO, Elec. Cond.)	9	Alcoa/Lavaca Bay Angus, Ontario BMI Complex Ledbetter Cr. Peconic Estuary Pinal Creek St. Joseph Union Pacific Wyckoff Eagle Harbor
Hydrogen Gas—Dissolved	1	St. Joseph
Isotopes	1	Pinal Creek
Major ions	2	Pinal Creek St. Joseph
NAPL studies	2	Wyckoff Eagle Harbor Union Pacific
Nitrogen–Dissolved	3	Hertel Landfill Ledbetter Cr. St. Joseph
Nitrogen–Total	1	Ledbetter Cr.

Table 3
Case Studies Summary of Geochemical Techniques Used

Geochemistry	Total	Site Names
Nutrients	4	Everglades National Park Ledbetter Cr. Peconic Estuary Pinal Creek
Organic Carbon--Dissolved	2	Angus, Ontario Hertel Landfill
Phosphate	2	Hertel Landfill Ledbetter Cr.
Radium isotopes	1	Everglades National Park
Radon-222	1	Everglades National Park
Redox-sensitive metals	1	Everglades National Park
Salinity	1	Wyckoff Eagle Harbor
Sediment chemistry	2	Hertel Landfill Wyckoff Eagle Harbor
Sulfate	2	Hertel Landfill Ledbetter Cr.
(Continued)...		
Sulfide	3	Angus, Ontario Hertel Landfill St. Joseph
Total Dissolved Solids	2	Hertel Landfill Wyckoff Eagle Harbor
Total Suspended Solids	1	Hertel Landfill Wyckoff Eagle Harbor
31	57	

Table 4
Case Studies Summary of Biological Techniques Used

Biological Data	Total	Site Names
Bacteriophages	1	Everglades National Park
Benthic macroinvertebrate	1	Ledbetter Creek
Benthic community analysis	2	Wyckoff Eagle Harbor Ledbetter Creek
Biofilm colonization chambers	1	Ledbetter Creek
Biomonitoring of plant effluent	1	Wyckoff Eagle Harbor

Table 4
Case Studies Summary of Biological Techniques Used

Biological Data	Total	Site Names
Brown tide cell counts	1	Peconic Estuary
Diver surveys	1	Wyckoff Eagle Harbor
Fish pathology	1	Wyckoff Eagle Harbor
Laboratory cultures	1	Wyckoff Eagle Harbor St. Joseph
Laboratory bioassays	1	Wyckoff Eagle Harbor
Sediment chemistry	1	Wyckoff Eagle Harbor
Sediment vertical profiler	1	Wyckoff Eagle Harbor
Trawls	1	Wyckoff Eagle Harbor
WET testing of plant effluent	1	Union Pacific
14	15	

Case Studies

1) SITE NAME: Alcoa (Point Comfort)/ Lavaca Bay		
2) City/State: Point Comfort, Texas	**5) Surface Water Body:** Lavaca and Matagorda Bays	**8)Contaminants:** ***Ground Water*** Hg, PAHs, DNAPL (Hg and tar) ***Soil*** Creosote compounds, PAHs, Hg ***Surface Water*** Rarely detected ***Pore Water*** Hg, MeHg, PAHs ***Sediment*** PAHs, Hg
3) Regulatory Authority: CERCLA	**6) Range of Tidal Variation:** 0.5-1.5 ft	
4) Contact: Ron Gouguet Coastal Resource Coordinator U.S. EPA, Region 6 1445 Ross Avenue Suite # 1200 Dallas, TX 75202-2733 Phone: 214-665-2232 Gouguet.Ron@noaa.gov Gary Baumgarten Remedial Project Manager U.S. EPA, Region 6 1445 Ross Avenue Suite # 1200 Dallas, TX 75202-2733 Phone: 214-665-6749 Baumgarten.Gary@epa.gov	**7) Risk:** ***Human Health*** Fish consumption ***Ecological*** Fish Benthos Shell fish	
9) Monitoring Methods:		
Physical Measurements	***Geochemical Parameters***	***Bioassays***
Monitoring wells, piezometers, water level surveys, DNAPL studies	Field parameters, DNAPL studies, salinity	Unknown at this time

10) COMMENTS:

Contributions of contaminated groundwater appear to be responsible for maintaining Hg and PAH concentrations in surficial bay sediment above risk based levels of concern. Also, this appears to be the case for maintaining tissue concentration at levels of concern. The remedy (CERCLA) is expected to curtail the GW release, remove some sediment and stabilize sources.

1) SITE NAME: Angus Ontario		
2) City/State: Angus, Ontario, Canada	**5) Surface Water Body:** Pine River	**8)Contaminants:** ***Ground Water*** Chlorinated VOC-tetrachloroethylene ***Soil*** tetrachloroethylene ***Surface Water*** Rare detections of very low tetrachloroethylene concentrations ***Pore Water*** tetrachloroethylene, trichloroethylene, cis-1,2-dichloroethylene, *trans*-1,2-dichloroethylene, vinyl chloride ***Sediment*** tetrachloroethylene, trichloroethylene, *cis*-1,2-dichloroethylene
3) Regulatory Authority: Ontario Ministry of Environment and Energy	**6) Range of Tidal Variation:** Not applicable	
4) Contact: Brewster Conant Jr. Hydrogeologist Department of Earth Sciences University of Waterloo Waterloo, Ontario N2L 3G1 Phone: 519-885-1211 x 2973 bconantj@sciborg.uwaterloo.ca Dr. John A. Cherry Professor of Earth Sciences University of Waterloo Waterloo, Ontario N2L 3G1 Phone: 519-885-1211 x4516 cherryja@sciborg.uwaterloo.ca	**7) Risk:** ***Human Health*** Drinking water (groundwater) Sediment contact ***Ecological*** Benthic and hyporheic aquatic life	
9) Monitoring Methods:		
Physical Measurements Drivepoint wells, mini-piezometers, Waterloo Profiler and mini-profiler, multilevel GW sampling devices, soil cores (on and off shore), ground penetrating radar (GPR), time domain reflectometry (TDR), sediment probe (conductance), streambed temperature surveys, water level surveys, potentiomanometer	***Geochemical Parameters*** Field parameters, dissolved oxygen, sulfide, cations/anions, ammonia, dissolved organic carbon, chlorinated VOCs (PCE, TCE, DCEs, and VC), ethene, ethane, methane	***Bioassays*** None

10) COMMENTS:

Data collected primarily as part of Mr. Conant’s PhD research. Pine River typically flows at 1.5 to 2.9 cubic meters per second.

<table>
<tr><td colspan="3">1) SITE NAME: Everglades National Park/ Florida Bay</td></tr>
<tr><td>2) City/State:
South Florida</td><td>5) Surface Water Body:
Wetland, estuary, bay</td><td rowspan="3">8)Contaminants:
<i>Ground Water</i>
Nutrients
Metals?
<i>Soil</i>
<i>Surface Water</i>
Nutrients
<i>Pore Water</i>
Nutrients
Metals?
<i>Sediment</i>
Nutrients
Metals?</td></tr>
<tr><td>3) Regulatory Authority:</td><td>6) Range of Tidal Variation:
<10 cm</td></tr>
<tr><td>4) Contact:
Dr. Peter W. Swarzenski
USGS-GD
600 4th Street South
Petersburg, FL 33701
Phone: 727-803-8747 x3072
Dr. Judson W. Harvey
USGS-WRD (NRP)
12201 Sunrise Valley Drive
MS 430
Reston, VA 20192
Phone: 703-648-5876</td><td>7) Risk:
<i>Human Health</i>
Injection wells?
<i>Ecological</i>
Eutrophication-related issues</td></tr>
<tr><td colspan="3">9) Monitoring Methods:</td></tr>
<tr><td><i>Physical Measurements</i>
Current meters, piezometers, seepage meters</td><td><i>Geochemical Parameter</i>
Radium isotopes, radon-222, CH_4, nutrients, redox-sensitive metals</td><td><i>Bioassays</i>
Bacteriophages</td></tr>
</table>

10) COMMENTS:

A great overview of USGS projects related to South Florida can be found at http://sflwww.er.usgs.gov/

1) SITE NAME: Exxon Refinery

2) City/State:
Billings, Montana

3) Regulatory Authority:
RCRA

4) Contact:

Tina Diebold
Region 8-Montana Office
Phone: 406-441-1130 x227

5) Surface Water Body:
Yellowstone River

6) Range of Tidal Variation:

Not applicable

7) Risk:
Human Health

Ecological
Do not know yet

8)Contaminants:
Ground Water
Hydrocarbons
BTEX, SVOC, VOC

Soil

Hydrocarbons
BTEX, SVOC, VOC

Surface Water

Benzene

Pore Water

Benzene

Sediment

Benzene

Monitoring Methods:

Physical Measurements	***Geochemical Parameters***	***Bioassays***
Wells, laser induced fluorescence, grab samples	None	None

10) COMMENTS:

1) SITE NAME: Hertel Landfill Superfund Site		
2) City/State: Plattekill, New York	**5) Surface Water Body:** Wetlands	**8)Contaminants:** ***Ground Water*** Primarily arsenic, chromium, iron, manganese VOCs and CVOCs Pesticides ***Soil*** Arsenic, chromium, VOCs ***Surface Water*** Iron, manganese, pesticides ***Pore Water*** ***Sediment*** Pesticides, metals
3) Regulatory Authority: CERCLA	**6) Range of Tidal Variation:** Not applicable	
4) Contact: Dean Maraldo Hydrogeologist U.S. EPA, Region 2 ERRD/PSB/TST 290 Broadway New York, NY 10007-1866 Phone: 212-637-3260 maraldo.dean@epa.gov Sharon Trocher RPM U.S. EPA, Region 2 EPA/ERRD/NYRB 290 Broadway New York, NY 10007-1866 Phone: 212-637-3965 trocher.sharon@epa.gov	**7) Risk:** ***Human Health*** Touching or drinking contaminated well water or accidentally ingesting contaminated soil ***Ecological*** Pollutants have seeped into on-site wetlands, posing a threat to ecologically sensitive resources, wildlife, or aquatic biota.	
9) Monitoring Methods:		
Physical Measurements	***Geochemical Parameter***	***Bioassays***
Monitoring wells, piezometers	Surface and ground water: phosphate, COD, nitrate-nitrite, TOC, ammonia, alkalinity, BOD-5, TKN, sulfide, sulfate, chloride, TDS, TSS	None

10) COMMENTS:

Capping of this 13-acre municipal landfill was completed in the fall of 1998. At this time the primary COCs are metals in the groundwater and surface. The 1991 ROD remedy included a pump-and-treat component for groundwater which has been put on hold pending post-cap data evaluation.

1) SITE NAME: I-85 Manufacturing and Distribution Center		
2) City/State: Spartanburg, South Carolina	**5) Surface Water Body:** Tributary to Fairforest Creek	**8)Contaminants:** ***Ground Water*** Tetrachloroethylene ***Soil*** Tetrachloroethylene ***Surface Water*** Tetrachloroethylene ***Pore Water*** Unknown ***Sediment*** Pending
3) Regulatory Authority: State Superfund	**6) Range of Tidal Variation:** Not applicable	
4) Contact: Judy Canova Project Manager SCDHEC 2600 Bull St. Columbia, SC 29201 Phone: 803- 896-4046 canovajl@ columb34.dhec.state.sc.us	**7) Risk:** ***Human Health*** Contact Inhalation Ingestion ***Ecological*** Fish Invertebrates	
9) Monitoring Methods:		
Physical Measurements	***Geochemical Parameters***	***Bioassays***
Diffusion samplers, direct push samplers, grab samples	None	None

10) COMMENTS:

The unusual characteristic of this site is the high concentration of tetrachloroethylene observed in surficial samples from the tributary - up to 10 ppm. It is suspected that NAPL is discharging to the base of the stream based on groundwater quality data. At the location of highest contamination within the stream, there is no visible aquatic life, vertebrate or invertebrate. Contamination persists above ambient water quality criteria for over half a mile. The length of the discharge coupled with extreme topographic variation reduces possible remedial options for the stream.

1) SITE NAME: Kerr-McGee Chemical/ BMI Complex		
2) City/State: Henderson, Nevada	**5) Surface Water Body:** Lake Mead, Colorado River	**8)Contaminants:** ***Ground Water*** Ammonium perchlorate ***Soil*** Not analyzed ***Surface Water*** Ammonium perchlorate ***Pore Water*** Not analyzed ***Sediment*** Not analyzed
3) Regulatory Authority: State	**6) Range of Tidal Variation:** Not applicable	
4) Contact: Mitch Kaplan Environmental Scientist U.S. EPA, Region 9 75 Hawthorne Street San Francisco, CA 94105 Phone: 415- 744-2063 Kaplan.Mitch@epa.gov Doug Zimmerman Chief, Bureau of Corrective Action Nevada Dept. of Environmental Protection Phone: 775- 687-4670 x3127	**7) Risk:** ***Human Health*** Ingestion ***Ecological*** Unknown (under investigation)	
9) Monitoring Methods:		
Physical Measurements	***Geochemical Parameters***	***Bioassays***
Monitoring wells, surface water monitoring	Field parameters	None

10) COMMENTS:

1) SITE NAME: Ledbetter Creek		
2) City/State: Murray, Kentucky	**5) Surface Water Body:** Kentucky Lake Reservoir	**8)Contaminants:** ***Ground Water*** Nitrates, herbicides, pesticides, fecal coliforms ***Soil*** Nitrates, herbicides, pesticides ***Surface Water*** Nitrates, herbicides, pesticides, fecal coliforms ***Pore Water*** Nitrates, herbicides, pesticides, fecal coliforms ***Sediment*** Nitrates, herbicides, pesticides, fecal coliforms
3) Regulatory Authority: State of Kentucky	**6) Range of Tidal Variation:** Hydroelectric/Flood Control Dam operations result in 2-6 ft change in water depth at stream site**.**	
4) Contact: Susan P. Hendricks Hancock Biological Station 561 Emma Drive Murray, KY 42071 Phone: 502-474-2272 susan.hendricks@murraystate.edu David S. White Hancock Biological Station 561 Emma Drive Murray, KY 42071 Phone: 502-474-2272 david.white@murraystate.edu	**7) Risk:** ***Human Health*** Contact ***Ecological*** Surface-subsurface microbial communities Surface-subsurface macroinvertebrate communities Fish community Habitat degradation from high sedimentation/siltation, reduced surface-subsurface exchange	
9) Monitoring Methods:		
Physical Measurements	***Geochemical Parameters***	***Bioassays***
Monitoring wells, water table heights, mini-piezometers, sediment temperature probes, seepage meters	Dissolved oxygen, turbidity, pH, ORP, specific conductance, NO_3+NO_2,NH_4,SRP, Total N, Total P,SO_4,CO_2, CH_4	Biofilm colonization chambers for bacterial productivity, activity, and diversity; benthic and hyporheic macroinvertebrate community structure.

10) COMMENTS:

1) SITE NAME: Peconic Estuary System		
2) City/State: Suffolk County, New York	**5) Surface Water Body:** EPA National Estuary Program-Peconic Estuary System	**8)Contaminants:** ***Ground Water*** VOCs, nitrates, pesticides ***Soil*** ***Surface Water*** VOCs, nitrates, pesticides ***.Pore Water*** Nitrates, VOCs ***Sediment***
3) Regulatory Authority: National Estuary Program-Peconic Bay Estuary, Suffolk County, New York	**6) Range of Tidal Variation:** Approximately 2.5-3.5 ft	
4) Contact: Ron Paulsen Hydrogeologist Suffolk County Health Services-Bureau of Water Resources Phone: 516-853-2220 Ronald.paulsen@co.suffolk.ny.us Christopher Smith Cornell University Cooperative Extension Marine Program Leader Phone: 516-727-3910 Csmith@cce.cornell.edu	**7) Risk:** ***Human Health*** Estuary is receiving water body for groundwater discharges that contains pesticides, VOCs and elevated nitrates ***Ecological*** The Peconic Estuary System has been subjected to the harmful alga blooms. The HAB known as brown tide (*Aureococcus anophaefferens*) has plagued the estuary since 1985. Excessive nutrients, metals, and possibly pesticides from groundwater seepage are thought to contribute to the onset and proliferation of HABs in the System	
9) Monitoring Methods:		
Physical Measurements Installation of monitoring well and mini-piezometers with percussion drill and hollow augers; geophysical measurements using logging techniques including natural gamma, induction and resistivity logging; direct contact resistivity measurements of bay bottom to map out groundwater seepage faces; groundwater seepage measurements using time	***Geochemical Parameters*** Field parameters (conductivity, temperature, dissolved oxygen, chlorophyll, pH); nutrient species including inorganic and organic forms of nitrogen; metals; volatile organic compounds; pesticides	***Bioassays*** Brown tide (*Aureococcus anophaefferens*) cell counts

10) COMMENTS:

The Peconic Estuary System is a large estuary system on Long Island, New York that received National Estuary Status in 1994. Associated with the estuary program are numerous ongoing investigations and studies. These investigations include studies on the ecological, chemical and physical properties of the Peconic Bay Estuary. One property being studied is the effect of groundwater seepage on the chemical and biological conditions in the bay. Direct measurements of groundwater seepage along with the chemical analysis of coastal groundwater and bay bottom pore water in the estuary are being made. This information is being used to develop a surface water model and a groundwater model for the estuary system. The modelling results are being used to developed guidelines for nutrient loading to the bay especially as they pertain to chlorophyll and dissolved oxygen levels in the bay.

1) SITE NAME: Pinal Creek Basin, Arizona		
2) City/State: Globe, Arizona	**5) Surface Water Body:** Pinal Creek, Salt River, Roosevelt Lake (reservoir for Phoenix)	**8) Contaminants:** ***Ground Water*** Dissolved iron, aluminum, copper, manganese, cobalt, nickel, zinc pH<4 in some portions of ground water contamination plume ***Soil*** ***Surface Water*** Manganese, nickel, cobalt, zinc, aluminum pH generally > 6 in surface water. ***Pore Water*** ***Sediment***
3) Regulatory Authority: State- Arizona Dept. of Environmental Quality (WQARF) Federal-CERCLA	**6) Range of Tidal Variation:** Not applicable	
4) Contact: Judson Harvey USGS 430 National Center Reston, VA 20192 Phone: 703-648-5876 jwharvey@usgs.gov Martha Conklin Dept. of Hydrology University of Arizona Harshbarger Bldg P.O. Box 210011 Tucson, AZ, 85721 Phone: 520-621-5829 martha@hwr.arizona.edu Christopher C. Fuller USGS 345 Middlefield Road, MS465 Menlo Park, CA 94025 Phone: 650-329-4479 ccfuller@usgs.gov James Brown USGS 520 N. Park Avenue Tucson, AZ 85719 Phone: 520-670-6671x280 jgbrown@usgs.gov	**7) Risk:** ***Human Health*** Probably minimal. The major concern is for the small number of families living in the northern part of the basin that withdraw their water from wells emplaced in the aquifer. For the most part the affected wells were moved away from contaminated areas years ago. There continues to be concern about downstream effects of metal pollution in the basin on water quality in the Salt River and Roosevelt Lake, although studies to date suggest that metals are not reaching the Lake in appreciable quantities. Remedial actions are being undertaken to intercept the groundwater plume. ***Ecological*** Largely unstudied at this location and therefore unknown. However, the perennial is within the Tonto National Forest with abundant wildlife. Poor in-stream water quality and manganese oxide deposits on the stream bed doubtless are affecting aquatic and terrestrial organisms that use the stream and riparian zone.	

9) Monitoring Methods:

Physical Measurements	***Geochemical Parameters***	***Bioassays***
Velocity and tracer-dilution gaging of stream discharge; in-stream solute-tracer experiments to determine surface and hyporheic-zone water exchange; in-stream auto-samplers; USGS mini drivepoint sampler; seepage meters; stainless-steel drivepoints; conventional wells; identification of ground water source areas using water stable isotopes; age-dating of ground water using CFCs.	pH, DO, temperature, alkalinity, major ions, dissolved metals, particulate and colloidal metals, dissolved organic carbon, nutrients	

10) COMMENTS:

USGS and the University of Arizona have identified natural attenuation processes that remove metal contaminants due to interactions between surface water and ground water. Hydrologic exchange between the stream that receives the contaminated ground water and the hyporheic zone beneath the stream delays the downstream movement of contaminants, and also exposes the contaminants to unique microbial processes that enhance removal of contaminants in the hyporheic zone. USGS and the University of Arizona have published more than fifteen journal papers and reports on this topic. Interested readers are encouraged to contact the lead scientists listed above for reprints and more information.

871) SITE NAME: St. Joseph, Michigan		
2) City/State: Stevensville, Michigan	**5) Surface Water Body:** Lake Michigan	**8)Contaminants:** ***Ground Water*** Chlorinated VOCs (TCE; cis-1,2-DCE; *trans*-1,2-DCE; 1,1-DCE, VC, ethene) ***Soil*** Not sampled ***Surface Water*** None detected ***Pore Water*** Chlorinated VOCs (TCE; *cis*-1,2-DCE; *trans*-1,2-DCE; 1,1-DCE, VC, ethene) ***Sediment*** Not sampled
3) Regulatory Authority: CERCLA/State	**6) Range of Tidal Variation:** <1ft	
4) Contact: John M. Lendvay Research Fellow University of Michigan 217 EWRE Building 1351 Beal Avenue Ann Arbor, MI 48109-2125 Phone: 734-764-6350 lendvay@engin.umich.edu Peter Adriaens Associate Professor University of Michigan 181 EWRE Building 1351 Beal Avenue Ann Arbor, MI 48109-2125 Phone: 734-763-1464 adriaens@engin.umich.ed	**7) Risk:** ***Human Health*** Contact ***Ecological*** Fish Shell Fish	
Monitoring Methods:		
Physical Measurements	***Geochemical Parameters***	***Bioassays***
Multi-level sample points, cores, field chemistry tests	Cations / Anions, dissolved hydrogen gas, dissolved iron, dissolved nitrogen, dissolved oxygen, dissolved sulfide, field parameters (O_2, E_h, pH, temperature, specific conductance)	Laboratory cultures

10) COMMENTS:

Spatial and temporal studies conducted to evaluate the effect of storm activity on the transformation potential of contaminants.

1) SITE NAME: Union Pacific Railroad Laramie Tie Plant Site		
2) City/State: Laramie, Wyoming	**5) Surface Water Body:** None- The Contaminant Isolation System prevents releases to the Laramie River	**8)Contaminants:** ***Ground Water*** Residuum oil, PAHs, pentachlorophenol (PCP), benzene, ethylbenzene, toluene, xylene, DNAPL ***Soil*** PAHs, PCP, dioxin, furans ***Surface Water*** Not applicable ***Pore Water*** Residuum oil, PAHs, pentachlorophenol benzene, ethylbenzene, toluene, xylene ***Sediment*** Not applicable
3) Regulatory Authority: RCRA, CERCLA, State	**6) Range of Tidal Variation:** Not applicable	
4) Contact: Marisa Latady Wyoming Department of Environmental Quality/Soil & Hazardous Waste 122 West 25th Street Cheyenne, WY 82002 Phone: 307-777-7752 mlatad@missc.state.wy.us Felix Flechas US EPA Region VIII 999 18th Street Denver, CO 80202 Phone: 303-312-6014 felix.flechas@epa.gov	**7) Risk:** ***Human Health*** Dermal contact Incidental ingestion Inhalation of particulates ***Ecological*** Direct exposures via soil ingestion Direct exposures via dermal contact with soil Indirect exposures via ingestion of contaminated food items Inhalation of particulate dust (considered less significant the others described above)	
9) Monitoring Methods:		
Physical Measurements Monitoring wells; piezometers; sediment sampling; monitoring of the containment systems for hydraulic control; DNAPL thickness	***Geochemical Parameters*** Field parameters	***Bioassays*** WET testing of the water treatment plant effluent under an NPDES permit

10) COMMENTS:

UPRR operated the Laramie Tie Plant Site for the treatment of railroad ties and other wood preserving operations on an intermittent basis from 1886 to 1983.The site borders the Laramie River just south of the city of Laramie, Wyoming. Waste management practices, such as allowing treated ties to drip dry onto the ground and discharging wastewater generated in the treating process to an unlined surface impoundment, are believed to be the causes of contaminated soils and ground water at the site. The primary contaminants identified at the site include creosote, pentachlorophenol and other residuum oils.

Contamination at the site was discovered in 1981, and in 1983 the Environmental Protection Agency (EPA) and UPRR signed a CERCLA Administrative Order on Consent (AOC) to continue the remedial investigation already in progress and to conduct site cleanup. The investigation identified contamination in surface soils and ground water contamination, including the presence of oil in the subsurface [i.e., Dense Non-Aqueous Phase Liquid (DNAPL)].Some of the early activities conducted by UPRR to address the contamination identified include:

1. In 1983, UPRR decommissioned the facility, including demolition of on-site buildings and shipment of unused wood treatment materials to another facility.
2. In 1984, UPRR partially closed the unlined Surface Impoundment that received wastewater. The Surface Impoundment is a regulated unit as defined by the WDEQ/HWRR Chapter 10, Section 6(a) .
3. In 1987, UPRR installed the Contaminant Isolation System (CIS) to prevent migration of contaminants to the Laramie River. The CIS consists ofrelocation of the Laramie River to an uncontaminated channel; construction of a cutoff wall; installation of a water management system consisting of horizontal drain lines along the exterior and interior of the cutoff wall to maintain an inward hydraulic gradient; construction of a water treatment plant to remove dissolved contaminants and implementation of a monitoring program to ensure the effectiveness of the CIS.
4. In 1988, UPRR installed ground water extraction wells, referred to as the Morrison Contaminant Withdrawal System (MCWS), outside the western site boundary to address a small area of contaminated ground water in Morrison bedrock.

In 1991, EPA and UPRR entered into an AOC under RCRA that required UPRR to conduct a Corrective Measure Study (CMS) to identify long-term remedies for implementation at the site, including pilot tests of various techniques to remove DNAPL from the subsurface.

In 1994, EPA selected the remedy to address contamination at the site. The remedy included continued operation of the CIS and MCWS systems, removal of DNAPL using the waterflood oil recovery method, covering a portion of the site with topsoil to address contaminated surface soils, installing a RCRA cap over the former Surface Impoundment area, and maintaining restricted access to the site. Nine criteria were selected to evaluate the performance of the final remedy. Detailed descriptions of these criteria can be found in EPA's September, 1994, "Final Decision and Response to Comments.

In 1995, the RCRA AOC was amended to require UPRR to submit an application for a RCRA Permit for post-closure care and corrective action by September 1, 1995. UPRR submitted an application for a post-closure care and corrective action permit on September 1, 1995, and revised that application in May 1996, August 1997 and March 1998.The amendment to the AOC also required UPRR to implement the final remedy selected by EPA in 1994. The final remedy was amended in 1995 to include the use of a Corrective Action Management Unit (CAMU) to consolidate contaminated concrete debris and soils in the partially closed unlined Surface Impoundment. The CAMU currently has an interim soil cover of six inches.

That portion of the final remedy that requires closure (i.e., installation of a RCRA cap) and post-closure care of the Surface Impoundment, as described in Section A of this Fact Sheet, is deferred to allow implementation and evaluation of phytoremediation, an innovative technology, designed for in-situ remediation of waste, contaminated soils and contaminated ground water. Phytoremediation test plots will be established over a portion of the Surface Impoundment and the western portion of the facility to determine the effectiveness of this technology. Review of this corrective action program will be conducted every five (5) years as part of the technical impracticability (TI) determination. The TI determination is made when ground water restoration to applicable cleanup standards is unattainable from an engineering perspective. If WDEQ determines, based on the five (5) year review process, that phytoremediation does not meet the remediation criteria specified in the Permit, UPRR will be required to implement the closure and post-closure care requirements established in the Permit. Those portions of the final remedy that are not deferred include continued oil recovery operations in the Surface Impoundment area until all recovery units have achieved the endpoint criteria, and implementation of the ground water corrective action program.

As of December 1998 UPRR has recovered approximately 1,500,000 gallons of oil from the subsurface through the waterflood oil recovery method.

1) SITE NAME: West Branch Canal Creek, Aberdeen Proving Ground		
2) City/State: Edgewood, Maryland	**5) Surface Water Body:** Wetland and stream	**8)Contaminants:** ***Ground Water*** Chlorinated VOCs Possible DNAPL ***Soil*** None ***Surface Water*** Infrequently detected, low concentrations of chlorinated VOCs ***Pore Water*** Chlorinated VOCs ***Sediment*** Chlorinated VOCs in wetland sediment
3) Regulatory Authority: CERCLA	**6) Range of Tidal Variation:** About 2 ft change in stage in creek; affects ground-water flow direction and plume distribution	
4) Contact: Michelle Lorah U.S. Geological Survey 8987 Yellow Brick Road Baltimore, MD 21237 Phone: 410-238-4301 Fax: 410-238-4210 mmlorah@usgs.gov	**7) Risk:** ***Human Health*** Air transport of VOCs ***Ecological*** Air transport of VOCs Possible exposure of benthic organisms to VOCs in water and sediment	
Monitoring Methods:		
Physical Measurements Nested piezometers, diffusion samplers, cores, field chemistry tests, salinity, pressure transducers and tide gage	***Geochemical Parameters*** VOCs; ethane; ethene; dissolved organic carbon; total organic carbon redox species-methane, sulfide, Fe(II)/Fe(III), manganese, dissolved oxygen, nitrate, ammonia; field parameters (pH, alkalinity, temperature, conductance, salinity, turbidity); major cations and anions; selected trace metals	***Bioassays*** Microcosms to measure biodegradation rates and daughter products; DNA/RNA analysis of microbial communities in wetland sediment

10) COMMENTS:

USGS WRIR 97-4171: Report on project results through 1997 available online: http://md.usgs.gov/publications/online.html

1) SITE NAME: Wyckoff Eagle Harbor		
2) City/State: Bainbridge Island, Washington	**5) Surface Water Body:** Eagle Harbor Puget Sound	**8)Contaminants:** ***Ground Water*** Creosote compounds, PAHs, pentachlorophenol, fuel oil, LNAPL, DNAPL ***Soil*** Creosote compounds, PAHs, pentachlorophenol ***Surface Water*** Rarely detected ***Pore Water*** Creosote compounds, PAHs, ***Sediment*** Creosote compounds, PAHs, DNAPL
3) Regulatory Authority: CERCLA	**6) Range of Tidal Variation:** 14 ft	
4) Contact: René Fuentes Hydrogeologist U.S. EPA, Region 10 1200 Sixth Avenue Seattle, WA 98101 Phone: 206-553-1599 fuentes.rene@epa.gov Hahn Gold Remedial Project Manager U.S. EPA, Region 10 1200 Sixth Avenue Seattle, WA 98101 Phone: 206-553-0171 gold.hahn@epa.gov	**7) Risk:** ***Human Health*** Contact Inhalation Fish consumption ***Ecological*** Fish Shell fish DNAPL contact	
9) Monitoring Methods:		
Physical Measurements	***Geochemical Parameters***	***Bioassays***
Monitoring wells, mini-piezometers, sediment probe (temperature and electrical conductivity), seepage meter, off-shore cores, diver surveys (NAPL), water level surveys, LNAPL and DNAPL studies	Field parameters, LNAPL and DNAPL studies, salinity	Biomonitoring of treatment plant effluent

10) COMMENTS:

Appendix D: MHE Push Point Sampling Tools

by Mark A. Henry[*]

A new tool and sampling methodology have been devised for collecting pore water samples from beneath beaches and surface water bodies. The use of this technology enables a single investigator or small team to rapidly gather pore water samples at or near the interface between groundwater and receiving bodies of water. From a research perspective, the information gained in analyzing these samples may be very helpful in understanding the geochemical nature of this transition zone and the biological processes at work.

This methodology has been used very successfully to locate the expression of contaminated groundwater venting into several lakes in Michigan. The technique involves the use of an MHE 27-inch push-point sampling device (PP27), ¼-inch outer diameter by ⅛-inch inner diameter Tygon tubing, and 50 mℓ, 100% polyethylene syringes or a peristaltic pump. The PP27 is a rigid ⅛-inch diameter stainless steel probe that is screened at one end and ported at the other to allow the collection of pore water with a syringe or peristaltic pump. In this method’s simplest form, the investigator would walk along a beach or in shallow water paralleling the beach, and at periodic intervals push (by hand) a decontaminated PP27 into the sand or sediments with a twisting motion until refusal (usually 6-18-inches). Then the screened zone is exposed and pore water samples are withdrawn at “low-flow sampling” collection rates using a disposable syringe connected by a length of Tygon tubing. Usually, only 30-50 mℓ of water withdrawal is necessary to develop this miniature well; this equates to approximately 20-35 volume exchanges through the PP27 . Subsequently drawn water is usually non-turbid and suitable for dispensing directly into sample containers or instruments. A 3-dimensional sampling array is possible within the sediments and the water column. The PP27 is easily decontaminated in the field but if the investigator has several of the inexpensive sampling devices on-hand, sample collection along a transect can be very rapid. When 100% polyethylene syringes are employed, samples may be collected and stored temporarily within the syringe by placing the full, sealed syringe in a cooler. Once the sample collection has been completed, the investigator can process the samples in a controlled environment. As an added benefit, it is possible to use the sample-filled syringes for on-site headspace analysis of VOC’s using a field GC—information that be used to direct an investigation in real time. If the syringe is half-dispensed and refilled with air, resealed, and agitated, the headspace in the syringe above a known volume of water can be quickly analyzed.

The Michigan Department of Environmental Quality (MDEQ) uses an enhanced variation of this method. As samples are being collected, some of the pore water is immediately dispensed into field analytical equipment for measurement of “stabilization parameters” such as dissolved oxygen, pH, conductivity, redox, and temperature, or analytes such as dissolved iron, sulfide, etc. The MDEQ investigators were able identify and map the expression of a groundwater plume venting into Lake Michigan and several inland lakes using this methodology and/or these techniques and SCUBA gear. Furthermore, the MDEQ couples its sampling with location information obtained using sub-meter accuracy global positioning system (GPS) equipment. Plotting the geochemical data onto an accurate GPS representation of the sampling locations and predominant local features produces a precise plume expression map. GPS technology allows investigators to reliably relocate previous sampling locations for additional study and accurately combine and compare data from multiple sampling events.

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[*] Editor’s Note: Mark Henry presented this material at a meeting of the Ground Water Forum in April 2000.

What follows is found in the MHE PP-27 sampler instruction manual. It is presented as additional information about the sampler and to provide a few practical hints.

MHE PP27" Push-Point Sampling device (Patent Pending)
Operators Manual, Ver. 1.02, May 13, 2000

INTRODUCTION

The groundwater/surface water interface has been a research interest of mine for the past decade. This transitional zone is usually rich in biomass and may play a predominant role in the bioattenuation of contaminated groundwater entering surface water bodies. Usually these biologic processes have limited effectiveness in attenuating highly contaminated groundwater, leaving a plume of parent contamination and metabolic byproducts that eventually expresses itself in receiving waters—usually classified as non-point sources of pollution because of the uncertainty of the discharge area. Part of the problem in the detection and study of these plumes is that there were no devices on the market for the rapid, discrete collection of pore water samples. Reliance on conventional technology and techniques to perform a detailed investigation required extensive effort and burdensome equipment.

Through several iterations, I have evolved a simple device for collecting pore water samples from beneath surface water bodies or the beach areas surrounding them. Pore water sampling using the PP27 becomes a simple and efficient process, generating a wealth of information and very little waste. The effective working depth is up to 26 inches below the land or sediment surface. If one collects groundwater samples in a transect perpendicular to groundwater flow in the suspected area of plume discharge to an open water body, their analysis yields information about the areal extent of contaminant discharge to the water body. At this point, additional sampling can complement the initial data and provide the information necessary to map the plume expression in both magnitude and areal distribution. This is becoming increasingly important to regulators as they decide the ecological impacts of discharging contaminant plumes.

Sampling at each location usually takes five minutes, allowing a small crew to collect dozens of samples in an afternoon. These samples can be analyzed in the field for real-time information useful in directing field investigations and research. The work that I have conducted at several contamination sites indicates that many groundwater plumes discharge in surface water bodies in 2-3 feet of water depth—accessible to investigators wearing hip boots or waders. Many plumes, especially light non-aqueous phase liquid (LNAPL) plumes can be delineated by collection of samples in very shallow water or from under beaches. My initial experience has shown that dense non-aqueous phase liquid (DNAPL) contaminant plumes express themselves in the shallow, near-shore water as well, even though the onshore depth of the contaminant mass was deep in the aquifer.

DIRECTIONS

As shown in Figure 1, the PP27 device is a very simple, precisely machined tool consisting of a tubular body fashioned with a screened zone at one end and a sampling port at the other. The bore of the PP27 body is fitted with a guard rod that gives structural support to the PP27 and prevents plugging and deformation of the screened zone during insertion into sediments. The PP27 is made of 316 stainless steel assuring compatibility with most sampling environments. The screened zone consists of a series of interlaced machined slots which form a short screened zone with approximately 20% open area.

Operation of the PP27 is not difficult. Simply hold the device in a manner that squeezes the two handles towards each other to maintain the guard rod fully inserted in the PP27 body during the insertion process (as shown in Figure 2). Holding the device in this manner, push the PP27 into the sediments or beach to the desired depth using a gentle twisting motion. When the desired depth or refusal is reached remove the guard rod from the PP27 body without disturbing the position of the deployed sampler. Once the guard rod has been removed from the PP27, it SHOULD NOT be reinserted into the device until the bore of the PP27 has been thoroughly cleansed of all sand, silt, etc.

Attach a syringe or (peristaltic) pump to the PP27 sample port (see Figure 3) and withdraw water at a low-flow sampling rate (50-200 mℓ/min.). Once non-turbid aliquots have been withdrawn, representative samples can be collected for on-site and off-site analysis.

HELPFUL HINTS, INFORMATION, AND CAUTIONS

- Multiple depths can be sampled in one hole if samples are collected from deepest to shallowest. Insert the sampler using a twisting motion until you reach refusal. Remove the guard rod. **Do not push the sampler further into the sediments once the guard rod has been removed as this may damage the screened zone and plug the PP27 with sediment**. Once sampling has been completed at this deepest depth, the PP27 can be partially pulled from the hole to a new sampling elevation. Remember not to insert the PP27 into the sediments without the guard rod inserted to prevent screened zone damage. Alternately, multiple holes can be used to collect samples from multiple depths at a particular sampling location. It is recommended that some type be device be used to prevent lateral movement and slippage of the PP27 as sampling is conducted near the top of the hole (see Figure 3). This offsets the leverage of the instrument and reduces hole degeneration. MHE offers an 8-inch diameter., heavy-duty steel sampling platform engineered for precise sampling depth requirements of field research. A plate of steel with a 3/16-inch diameter. hole through its center would serve the fundamental purpose of maintaining a rigid hole opening . If repeated shallow sampling is to be conducted, it may be more convenient to use a shorter sampler (MHE - PP15”).

- If you wish to reuse the PP27 sampler at a particular sampling location and want to clean the bore quickly while you’re there so that the guard rod may be safely reinserted, you can use a syringe filled with surface water or deionized water to backflush the bore several times before reinserting the guard rod. Use at least 100 mℓ of water. If you have too much trouble reinserting the guard rod (e.g., due to grit), it will be necessary to use the standard cleaning procedures with cleaning rod and soap solution.

- If the screened zone of the PP27 becomes plugged while inserted in the sediments, it is frequently possible to hydraulically/pneumatically shock the screened zone free of adhering material while it is inserted into the sediments. Attach a large-volume syringe to the sampling port. In a quick motion, pull the syringe plunger most of the way back (creating a vacuum) and then immediately release the plunger—the plunger will slam to a neutral position, sending a shock wave through the bore of the PP27 and may alleviate the problem.

- The PP27 can be used as a piezometer to determine the static head of the groundwater and hence, the potential direction of groundwater movement. To do this, a tube is connected to the sample port as shown in Figure 5. A continuous stream of water is established from the syringe (or pump) to the screened zone by pumping out any air remaining in the PP27and tubing. When the tube is disconnected from the syringe, the static water level in the tube will represent the static water level at the depth that the screened zone occupies.

- It is frequently possible to push the PP27 through thin lenses of low-permeability material and collect samples from below them and gather valuable geochemical samples. At many of the sites where the PP27 has been used, sampling from just below a layer of fine sand, silt, or clay, one occasionally encounters seemingly large pockets of gas that seem to have coalesced and collected under this less permeable stratum. Analysis of these pockets may provide additional insight to predominant biological processes. It may true that the concentration of volatile organic compounds (VOCs) in the groundwater has equilibrated with these bubbles (i.e., steady state), which means that their presence in a sampling stream or syringe would not significantly affect the concentration of dissolved VOCs. In fact, if one assumes that steady-state conditions exist, the concentration of VOCs in the bubbles is directly related the concentration in the surrounding groundwater. An alternate condition may exist if the groundwater is supersaturated with bacterial metabolic waste gases and the negative pressure exerted by the pump (or syringe) is initiating a degassing of dissolved gases from the groundwater. In this instance, VOCs would partition from the groundwater to the bubbles as they are formed in the sampling tubing (this is fairly evident if occurring). The consequence is that part of the dissolved contaminant mass has partitioned into the gas phase; unless the gas-phase is captured, quantified, and accounted for, the native VOC concentration of the groundwater is not reflected by analysis of the groundwater alone. If this condition exists, the degassing effect can be minimized by decreasing the sampling rate to a rate more easily yielded by the sampled formation. With experience, it is easy to distinguish which of these conditions (or combination of conditions) exist and to what extent they affect sample quality.

- The internal volume of a PP27 is approximately 1.5 mℓ. A 50 mℓ syringe full of distilled water, decontamination water, methanol, etc. will push about 33 volumes through the bore.

- When straightening the screened zone it is sometimes helpful to wash out the bore of the device and then insert the guard rod or the cleaning rod to the area of the bend in the screened zone. Gently unbend the portion of the screened zone nearest the rod and carefully advance the rod to the next bend. After the rod has been fully inserted into the screened zone perform the final screened zone straightening fine-tuning until the guard rod slides freely through it.

- If the sampling port of the PP27 is above the static level of the water body, each time you remove the syringe or pump from the PP27 sampling port, air will fill the bore of the PP27 allowing the water level in the bore to reach its static head. To avoid this plug of air from entering the subsequent syringe, attach a clamp adapter and or a three-way valve between the sampling port and the syringe or pump inlet as shown in Figure 7.

- I have conducted dye tests by injecting concentrated uradine dye under a perforated 1.5-foot diameter disk through which the PP27 was inserted 3-12-inches into sediments. The goal of these tests was to determine whether or not surface water and dye is drawn into samples collected in near surface sediments (i.e., whether a cone of depression is formed). The results indicated that no surface water is drawn into samples even though sampling was conducted with a peristaltic pump at a rate of 600 mℓ/min.

- I usually couple my field investigations with GPS location of the sampling point. If conditions permit, a pin flag can be placed at the sampling point for later location by GPS. I usually use sub-meter grade GPS for this surveying; GPS can then be used to relocate previously sampled point even if certain site physical characteristics have changed (eroding shorelines, etc.).

- Sampling by syringe has many advantages. This is my preferred field method due to its simplicity and versatility. It is useful to be able to collect several 50 mℓ syringes full of groundwater, store them on ice, and perform the sample transfer to a VOA vial, etc. under more controlled conditions. To transfer sample to a VOA vial, place the end of the transfer tube (Figure 8) to the bottom of the VOA vial. Dispense sample into the VOA vial and slowly withdraw the transfer tube from the vial maintaining the mouth of the transfer tube just below the sample surface. When the transfer tube is almost out of the vial, continue to dispense sample and leave an “anti-meniscus” of sample above the rim of the vial. Add several drops of HCl (which will displace a few drops of sample) and cap. If VOC samples are to be collected and stored temporarily in a syringe, I recommend using 100% polyethylene (“two piece”) syringes such as those made by Henke Sass Wolf GMBH (NormJect®, 50 mℓ)) configured as shown in Figure 8. From personal experience I have found that small amounts of aromatic compounds (BTEX) can leach from the rubber parts of the rubber-tipped plunger found in common medical syringes. Rubber-tipped plunger syringes have less side-wall resistance and work much smoother than the 100% polyethylene syringes so I use medical syringes for “development” of the PP27. Standard medical syringes also work well for collecting samples for non-VOC analysis. I utilize handheld meters for pH, conductivity, redox, dissolved oxygen, etc. One can dispense sample from the syringe into these types of instruments for field measurements.

- The 50 mℓ, 100% polyethylene syringes mentioned above can be purchased directly from MHE, configured with tubing as was the example syringe included with your order, or customized to suit your individual needs. If you would to make your own, the syringes that I am currently using are purchased from National Scientific Company. The tubing is Tygon ¼-inch outer diameter and ⅛-inch inner diameter. Be sure to use some type of clamp at the tubing mouth to ensure a good seal at the sampler port.

- Headspace GC analysis of VOCs can be easily accomplished using 100% polyethylene syringes. Dispense all but 20 mℓ of the sampled groundwater from the syringe. Refill the syringe to the 40 mℓ mark with ambient air (and heat the syringe in a water bath if desired) as shown in Figure 9. Insert a GC syringe needle through the transfer tube into the syringe headspace and withdraw a sample for GC analysis.

- Occasionally a small amount of sand and silt is withdrawn into the syringe or pump sampling stream, even after proper development of the PP27. This may be due to the nature of the geologic formation. This fine material is probably already at equilibrium with the surrounding groundwater and should not influence analysis of VOCs in the groundwater sample. The sample can be transferred to its shipping container without this silt if the syringe is dispensed in a way that lets the solid material settle out in the syringe and not carry over to the shipping vial.

- The PP27 has been used very successfully for underwater investigations using SCUBA equipment and a series of 100% polyethylene syringes. Once again, GPS equipment was used for location of the position that the divers collected groundwater samples of contaminant plume expression in the lake. Underwater notes (temperature, depth, observations, etc.) can be written directly on the sample syringes if they are pre-prepared with a strip of Scotch Magic Transparent Tape applied down the syringe body and writing is done with a soft pencil.

- The PP27 may be used to inject nutrients or dyes into the sediments for field trials of biologic or geochemical testing or tracing groundwater paths. Simply insert the PP27 to the desired depth and after the guard rod has been removed, connect a syringe or pump and slowly inject the desired fluid into the sediments, perhaps followed by a small amount of native groundwater to flush the instrument.

- These devices can be dedicated as semi-permanent underwater monitoring devices. If a PP-27 is inserted to the desired depth through a plate (such as the sampling platform mentioned earlier) that can lock the sampler at the correct insertion depth, a vinyl cap can be placed over the mouth of the sampler, and the sampler can be dedicated to that location so that future samples can be withdrawn when desired.

- It has been useful to carry several samplers in “quivers” made of 2-inch PVC tubing: one tube for 10-15 clean and assembled samplers, and one tube for used samplers and their separated guard rods. This arrangement protects both the investigators and the instruments.

I hope that users will find many useful and innovative uses for this device. If you have other helpful information, uses, and advice concerning these samplers, please write or e-mail suggestions to me for inclusion in future manual revisions. I will be forming a website soon, and posting much of my GSI research with links to as much GSI field research and related topics as I can find.
Thanks.

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Figure 1

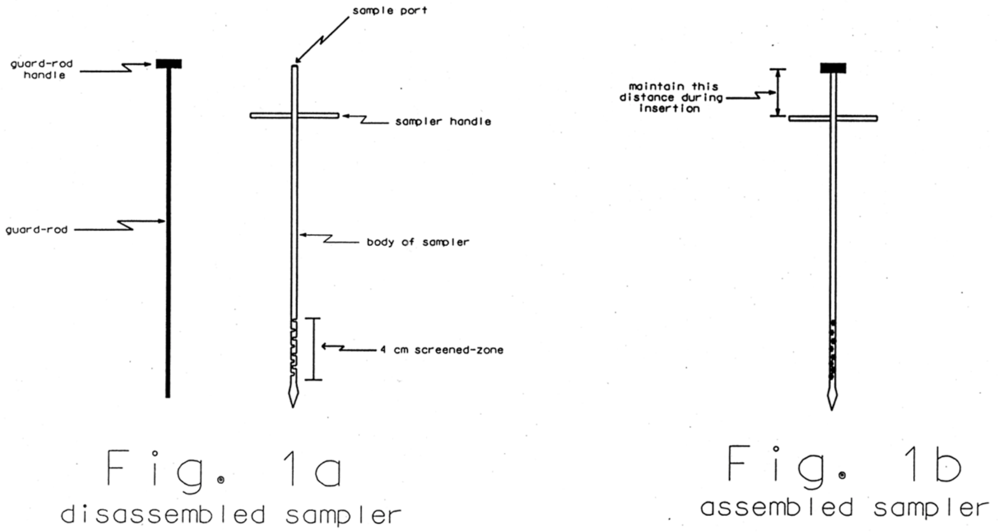
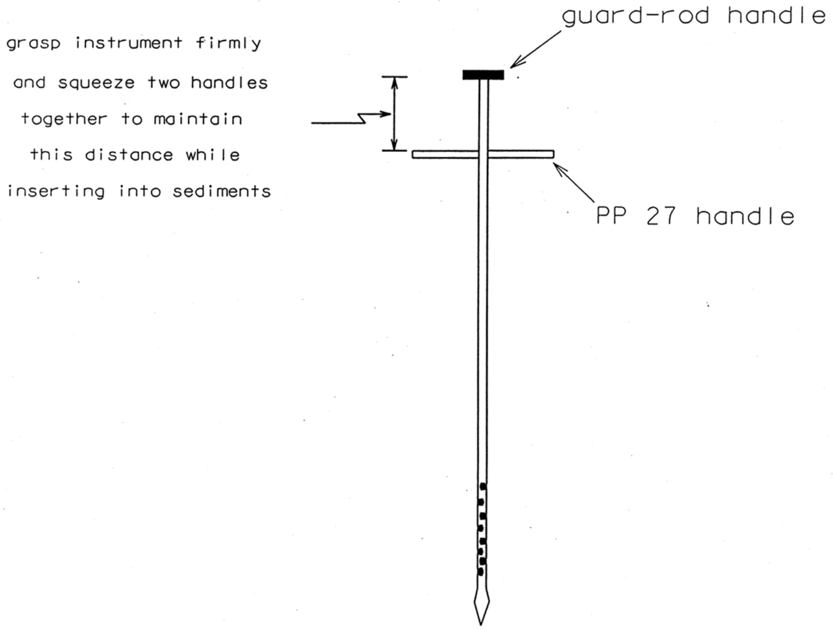


Fig. 1a
disassembled sampler

Fig. 1b
assembled sampler

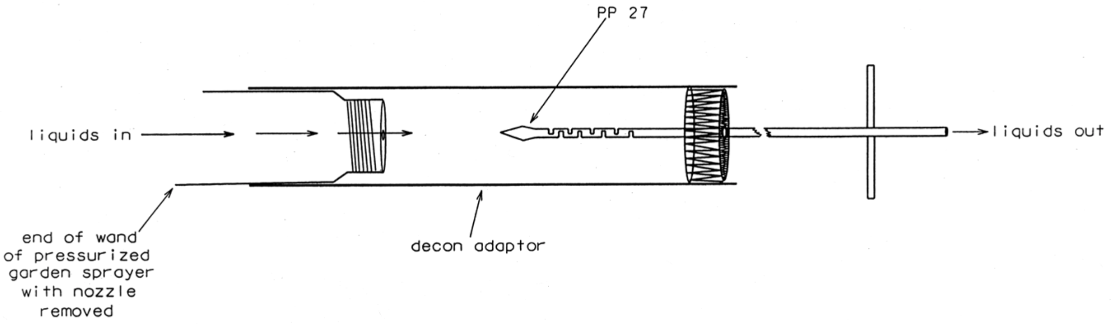
Figure 2



grasp instrument firmly and squeeze two handles together to maintain this distance while inserting into sediments

Figure 4

attachment of decon adaptor



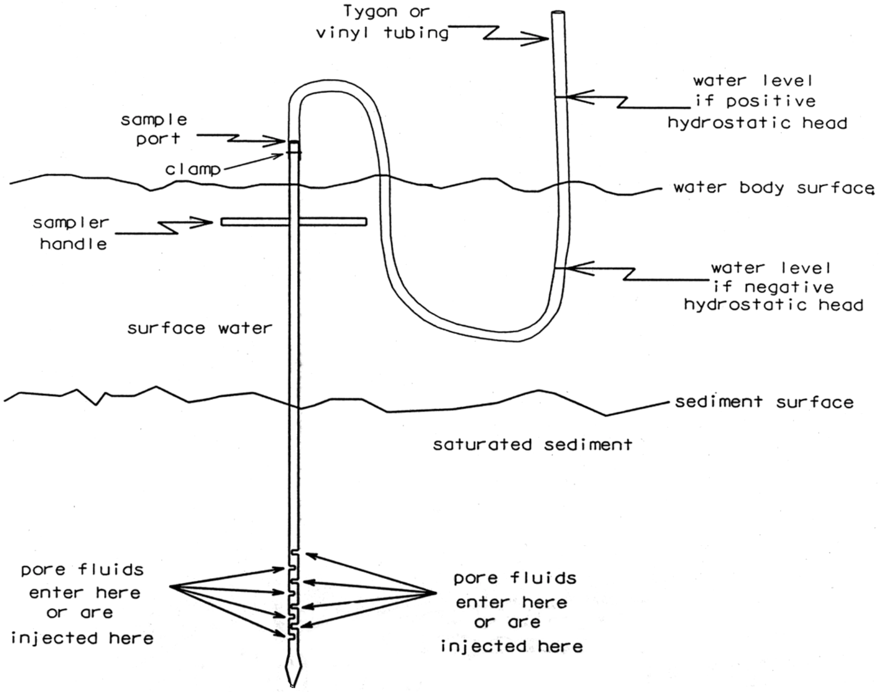


Figure 5

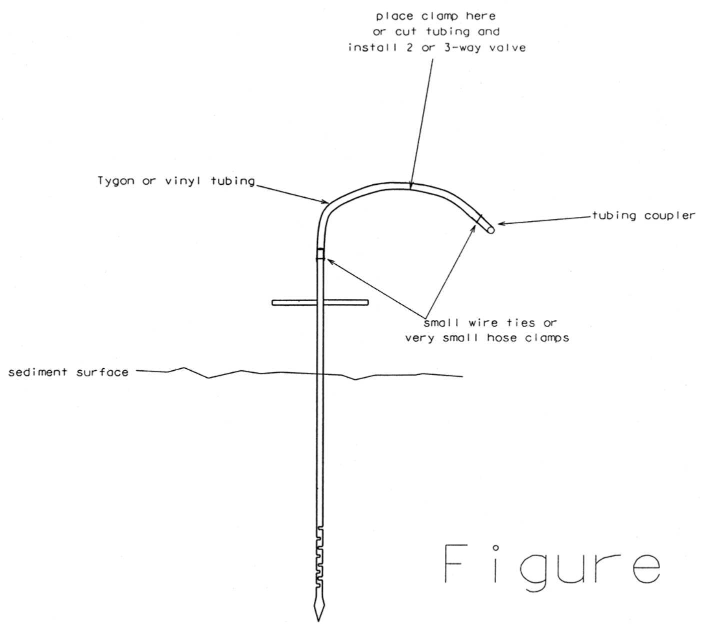


Figure 6

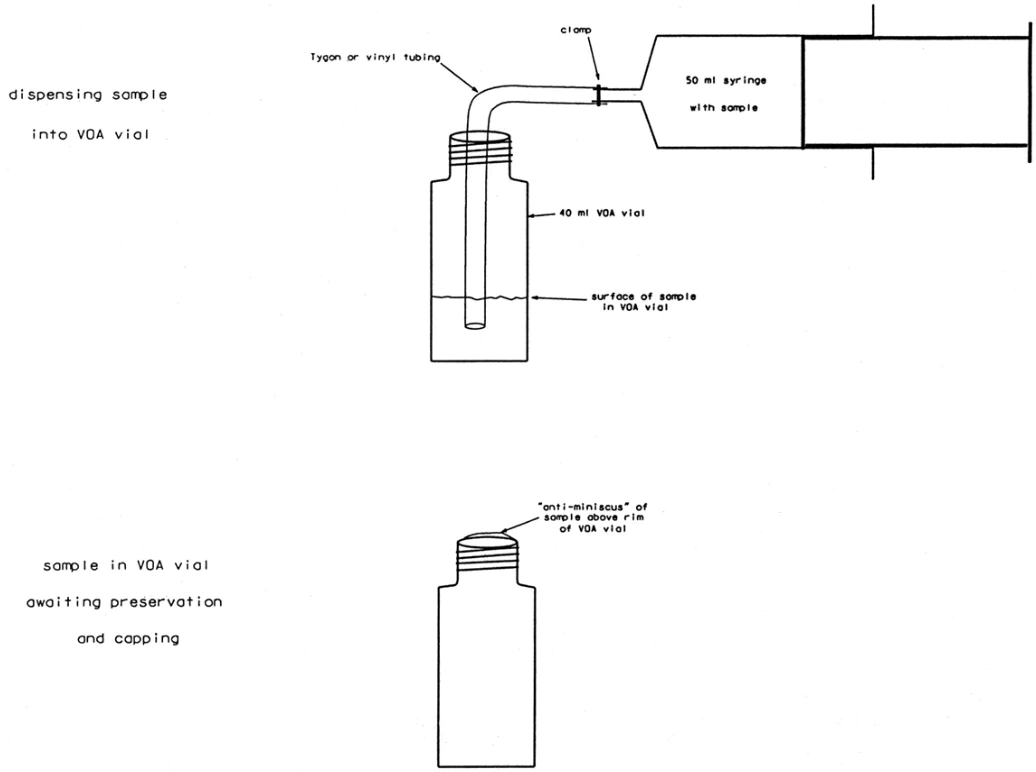


Figure 7

filling VOA vial "headspace free"

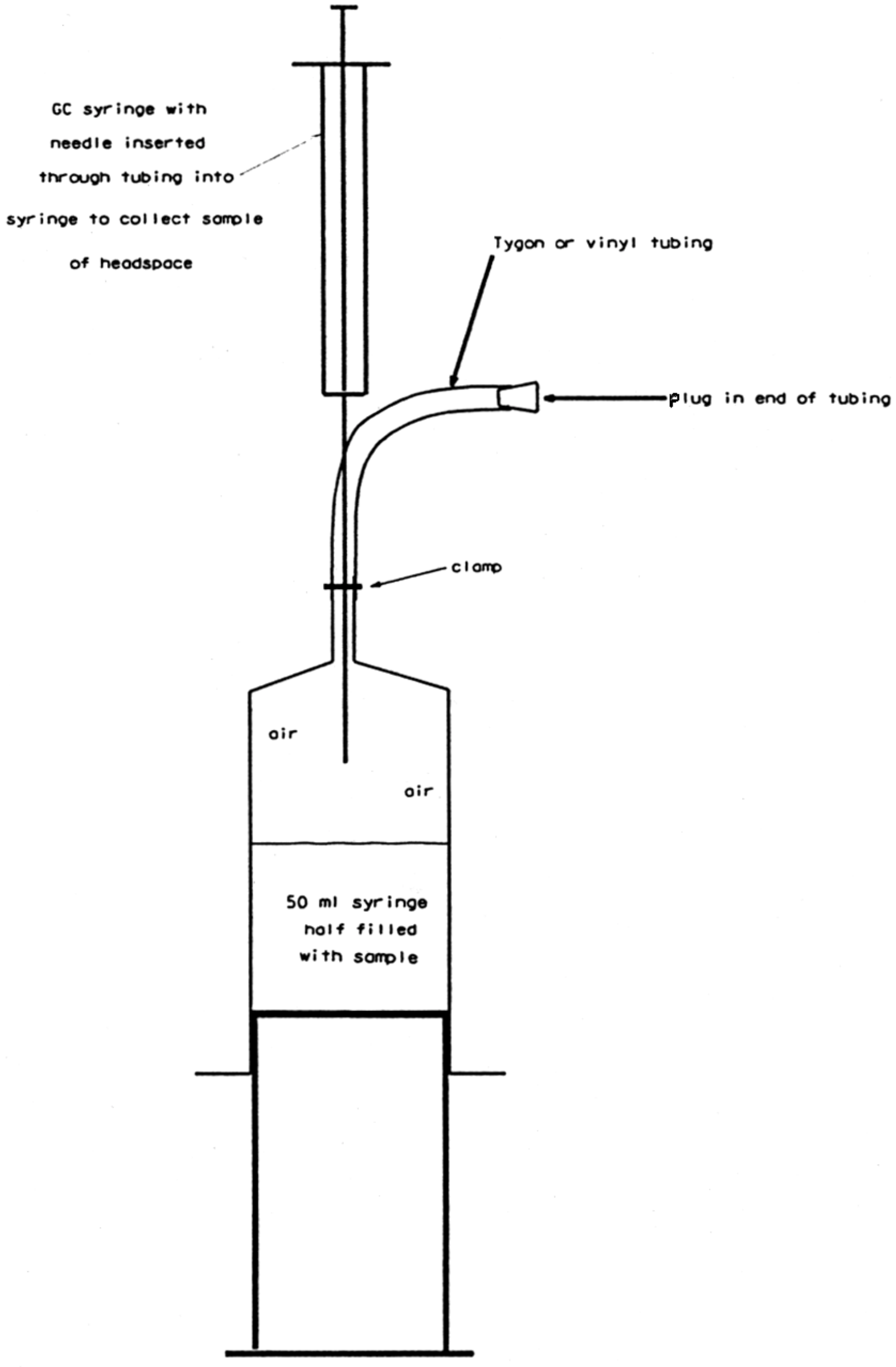

GC syringe with
needle inserted
through tubing into
syringe to collect sample
of headspace
Tygon or vinyl tubing
plug in end of tubing
clamp
air
air
50 ml syringe
half filled
with sample

Figure 8