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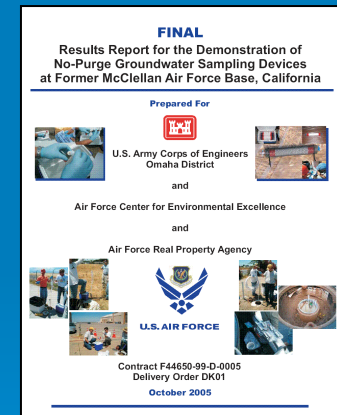
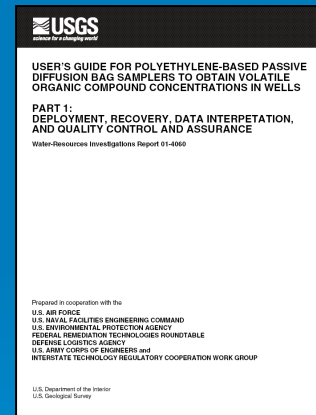
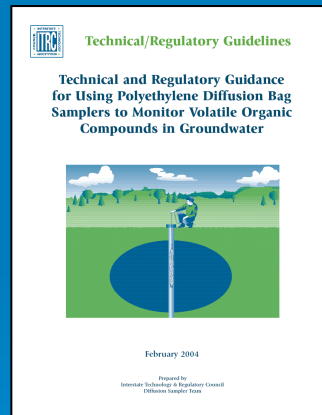
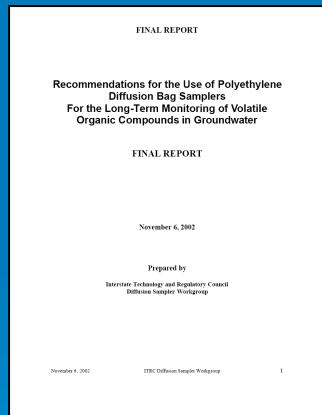
No-Purge Sampling

- Is a method for obtaining representative concentration of groundwater contaminants under natural flow conditions.
 - In-Situ
 - No Induced Flow
 - No Induced Mixing

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Diffusion Reports

➤ Technical Studies & Reports



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Key Benefits

- Reduce Sampling Cost by 50-70%
- Provide Depth Specific Concentrations
- Reduce Chance for Sampling Error
- No Expensive Equipment to Maintain

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Cost Reduction

- Reduce Sampling Cost 50-70%
 - No Well Purging Time
 - No Purge Water Disposal Cost
 - No Pumps or Support Equipment

 - Inexpensive Disposable Samplers
 - Re-Usable Accessories
 - Deploy in Minutes

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NO-Purge Cost Validation

TABLE 5.2
SUMMARY OF COST ANALYSIS RESULTS
NO-PURGE SAMPLER DEMONSTRATION
McCLELLAN AFB, CALIFORNIA

Sampling Method	Per Well, Per Event Cost
3-Volume Purge	\$310
Low-Flow Purge	\$280
Snap Sampler [™]	\$155
RPPS	\$104
PsMS	\$91
RCS	\$80
PDBS	\$68
HydraSleeve [®]	\$63

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Equilibrator Validation

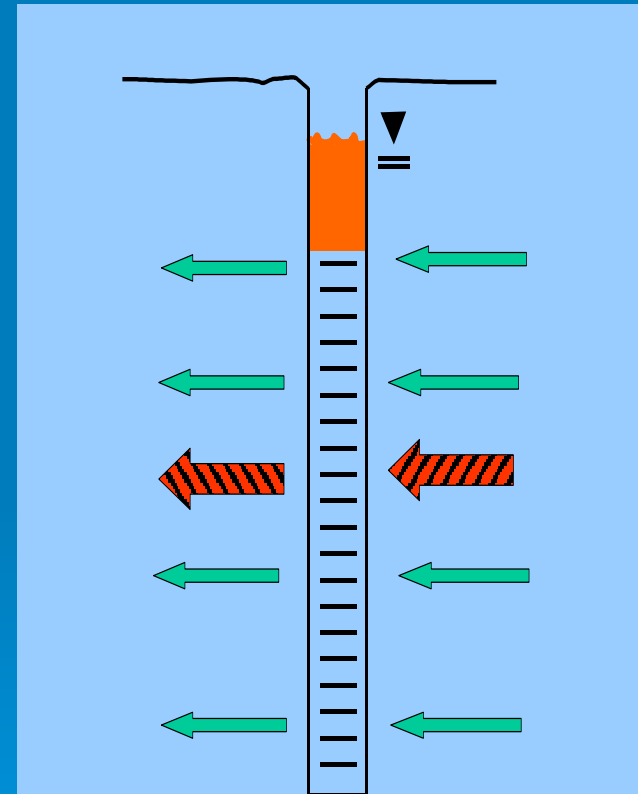
➤ McClellan Excerpt

“The PDBS and HydraSleeve® were the least expensive sampling methods, with the primary cost difference between the two being the time required to refill a new PDBS that is not necessary when using the HydraSleeve®.”

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Technical Basis

- Water in the Screen Zone Represents Water in Adjacent Formation
 - Flow Required
 - Natural Horizontal Flow Refreshes Water in the Screen
 - Requires Flow Greater than the Loss by Partial Pressure

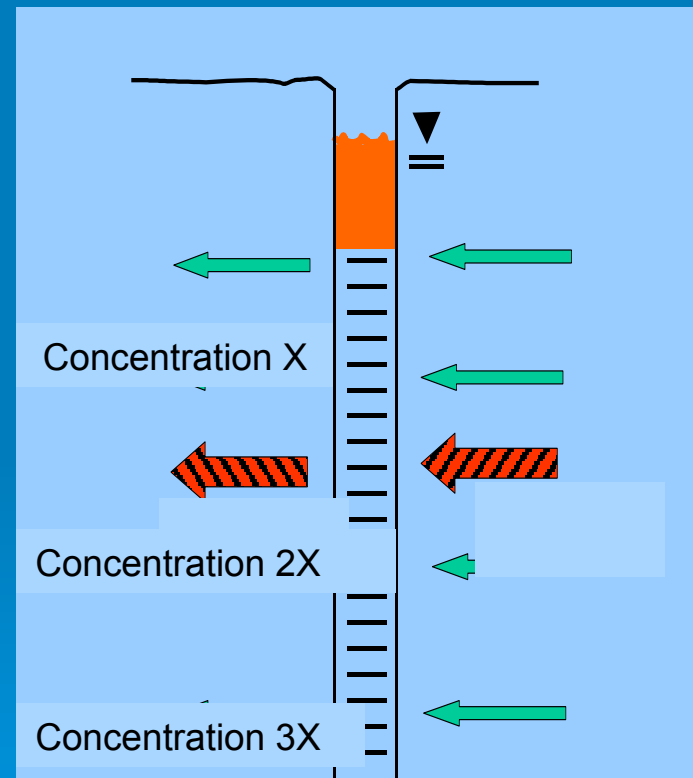




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Concentration Gradient

- Contaminant Concentrations Often Occur in Discrete Intervals
- Contaminant Concentrations Often Change with Depth



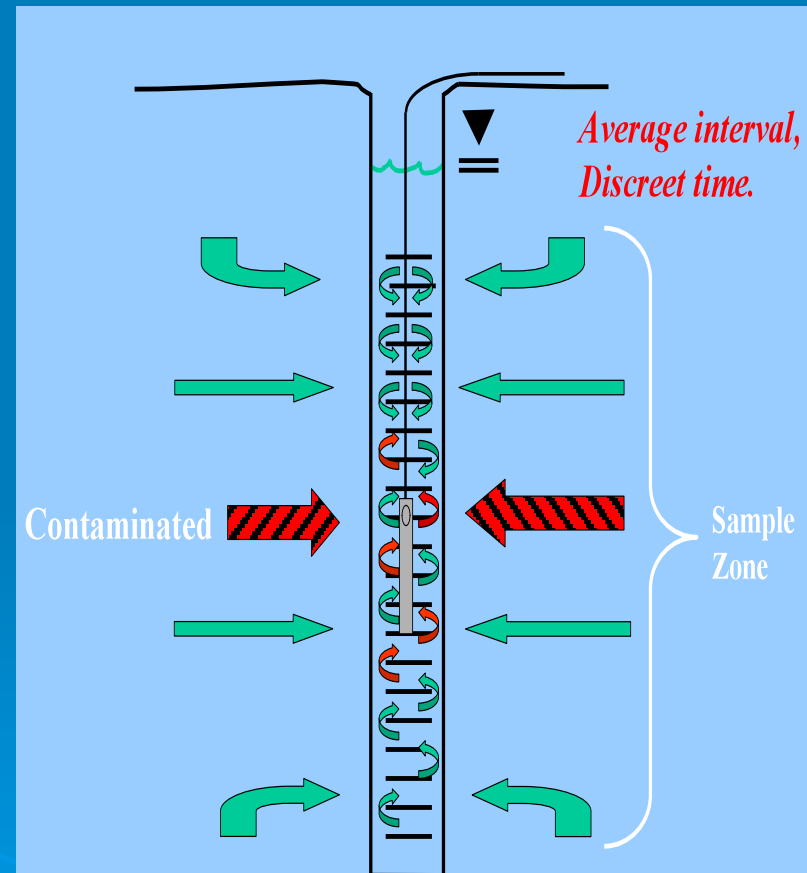
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Purged Wells

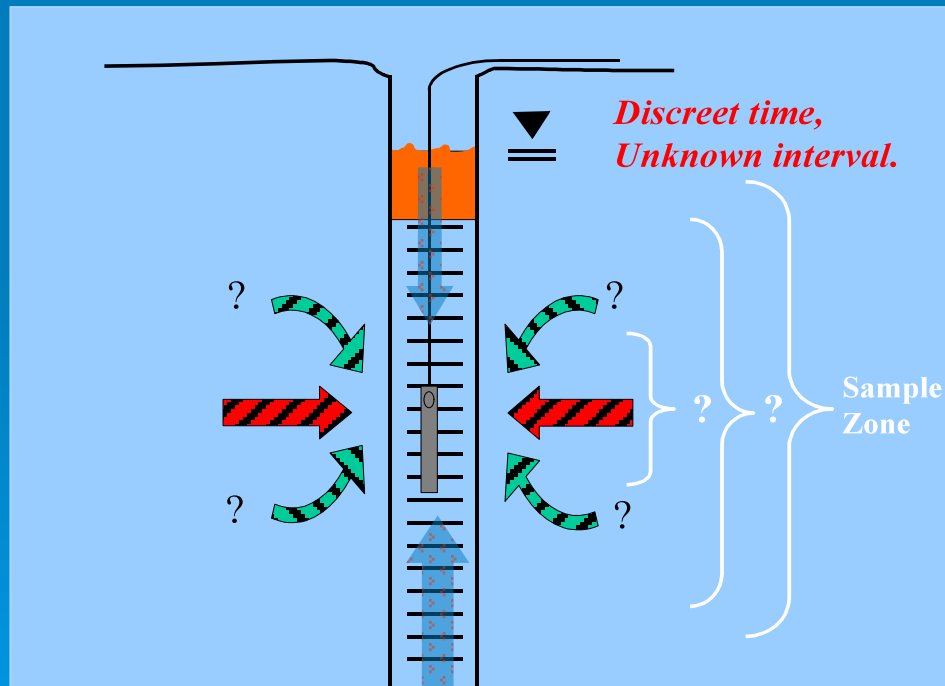
- Flow-Weighted Average Concentrations
- “Blended” Samples



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Low Flow Sampling

- Uncertain Sample Contribution Area
- Can Produce Vertical Flow in Casing



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What is Passive Diffusion Sampling?

- VOCs diffuse from groundwater
- Through a semi-permeable membrane
- Into a DI water-filled, closed sampler
- Until VOC concentrations equilibrate
 - Under Natural Passive Conditions
 - From Discrete Intervals
 - In the Well Screen



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How Does It Work

- Semi-Permeable Membrane Filled with De-Ionized Water
- Installed and Left in Flow Zones
- Concentration Gradient Between Aquifer and De-Ionized Water Drives Diffusion
- Membrane Allows Dynamic Equilibration of Certain VOC Compounds
- Sampler is Recovered with VOCs Intact

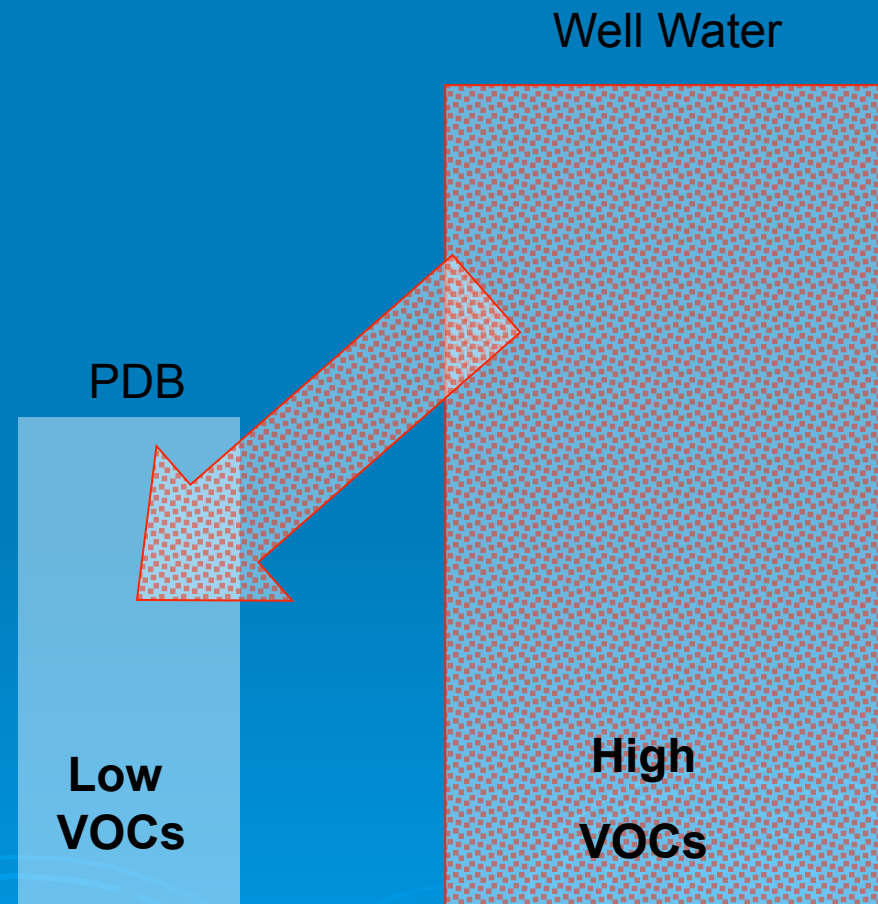
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Diffusion

- Concentration Gradient
- Molecules Migrate



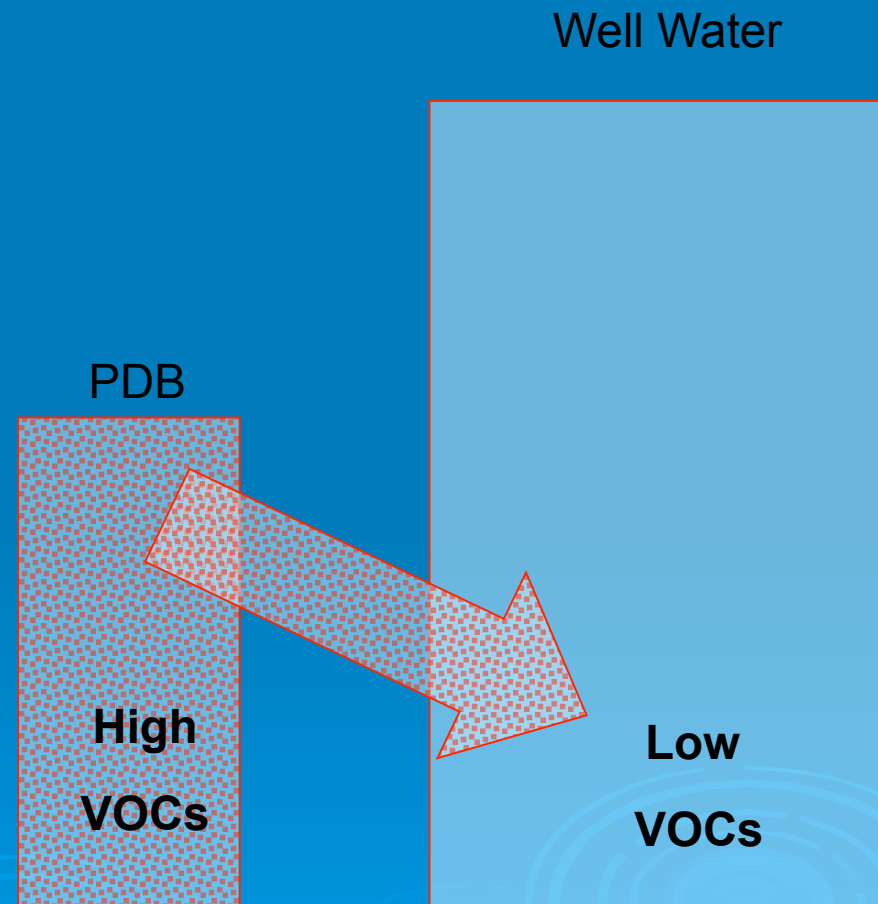
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Diffusion

- Concentration Gradient
- Molecules Migrate



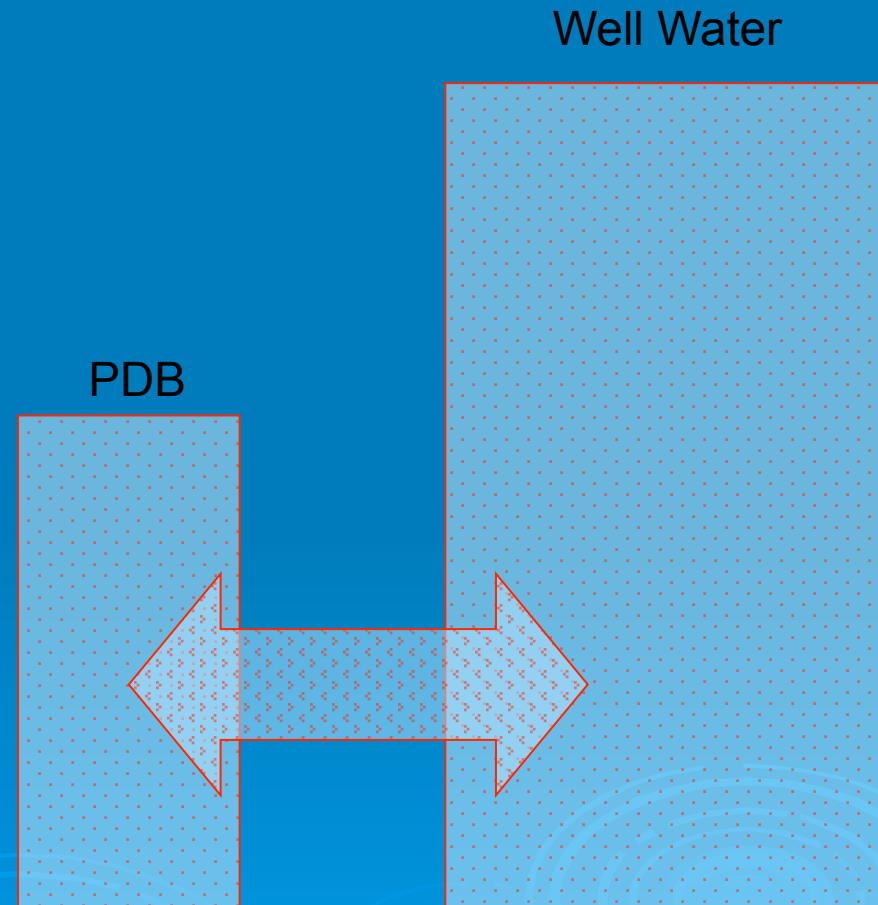
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Equilibration

- Concentration Gradient
- Molecules Migrate



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PDB USE

- Non-Polar VOCs
- Less than 18 Angstroms Diameter

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Partial List of VOCs

Table 1. Compounds tested under laboratory conditions for use with passive diffusion bag samplers [From Vroblesky and Campbell, 2001]

Tested compounds showing good correlation (average differences in concentration of 11 percent or less between diffusion-sampler water and test-vessel water) in laboratory tests			
Benzene	2 Chlorovinyl ether	<i>cis</i> -1,2-Dichloroethene	1,1,1-Trichloroethane
Bromodichloromethane	Dibromochloromethane	<i>trans</i> -1,2-Dichloroethene	1,1,2-Trichloroethane
Bromoform	Dibromomethane	1,2-Dichloropropane	Trichloroethene
Chlorobenzene	1,2-Dichlorobenzene	<i>cis</i> -Dichloropropene	Trichlorofluoromethane
Carbon tetrachloride	1,3-Dichlorobenzene	1,2-Dibromoethane	1,2,3-Trichloropropane
Chloroethane	1,4-Dichlorobenzene	<i>trans</i> -1,3-Dichloropropene	1,1,2,2-Tetrachloroethane
Chloroform	Dichlorodifluoromethane	Ethyl benzene	Tetrachloroethene
Chloromethane	1,2-Dichloroethane	Naphthalene	Vinyl chloride
	1,1-Dichloroethene	Toluene	Total xylenes
Tested compounds showing poor correlation (average differences in concentration greater than 20 percent between diffusion-sampler water and test-vessel water) in laboratory tests			
Acetone*	Methyl- <i>tert</i> -butyl ether	Styrene	

*T.M. Sivavec and S.S. Baghel, General Electric Company, written commun., 2000



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DO NOT Use PDBs

- Acetone, Butanone, MTBE
- Semi-Volatiles
- Metals
- Natural Attenuation Parameters

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PDB Sampling Protocol

- Fill EQUILIBRATOR™
- Install in Screen
- Leave In-Place Until Next Sampling Event
- Remove & Replace
- Repeat

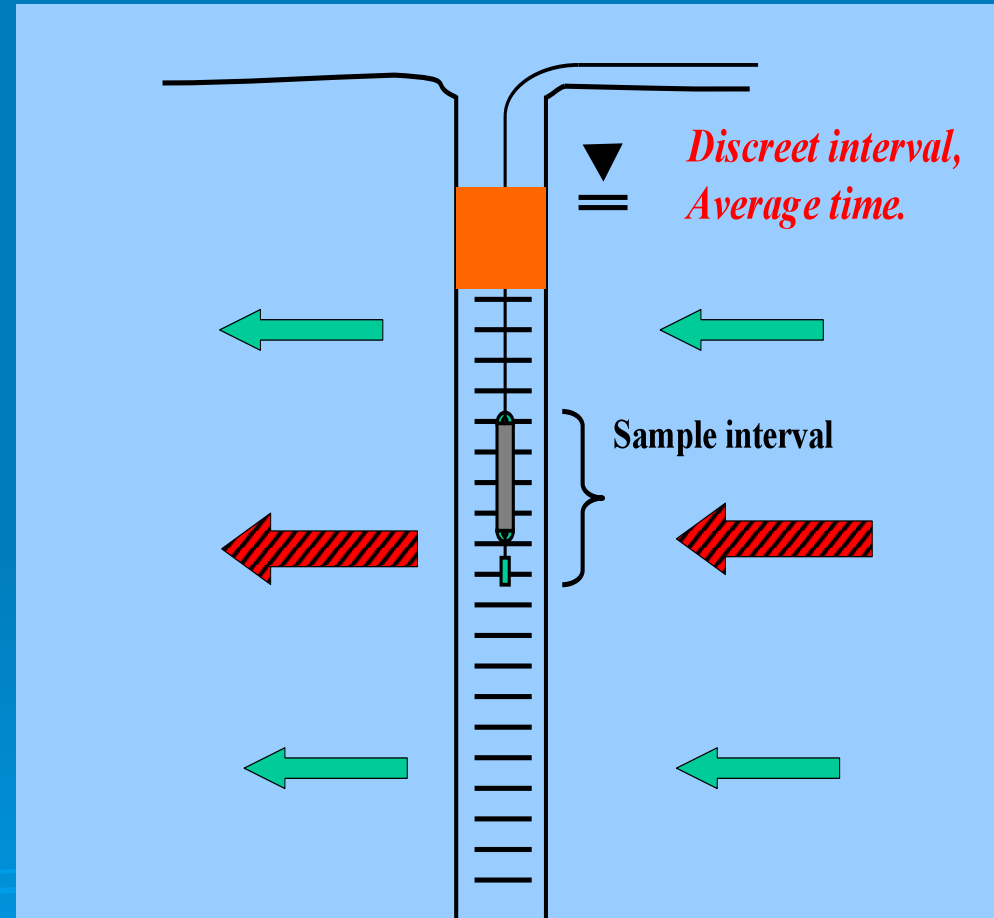


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Diffusion Placement

➤ Sampler is Placed in Well Screen

- Location is Determined by Profile
- Each Sampler Represents No More Than 5ft Interval





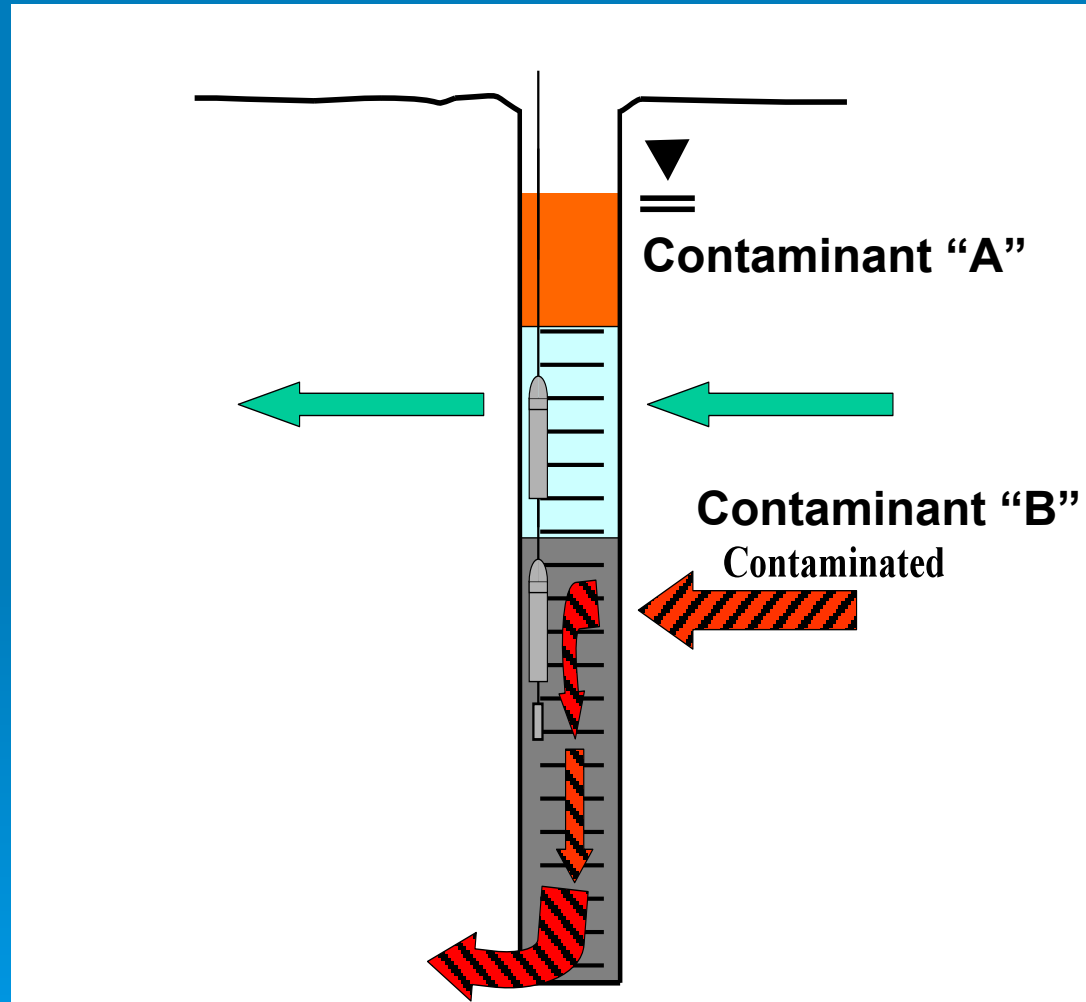
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Concentration Profile

- Use of Multiple Samplers Can Provide a Concentration vs. Depth Profile
- Use of Multiple Samplers Can Provide a Contaminant vs. Depth Profile

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Contaminant Stratification



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Proven Reliable

- Proven Reliable in Thousands of Wells
 - Recovers a Wide Range of Required VOCs
 - Correlation with Historical Data
 - Correlation with Other Techniques
 - Bailing, Pumping, Low-Flow Sampling

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Complete Data Picture

- Depth Discrete Profile
- Less User Interference with Method
 - Fill Sampler
 - Lower to Depth & Leave Site
 - Return to Site, Discharge Contents to VOA

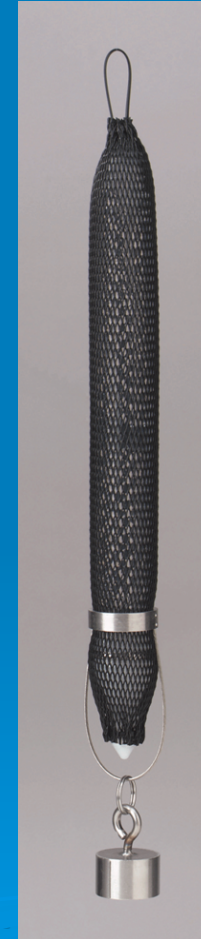
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EQUILIBRATOR™

- **First Commercial PDB**
 - Introduced in 1997
 - Multiple Field Installs
 - Design Refinements
 - Licensed Technology from USGS
 - Design Patent Awarded to **EON**

- **World's #1 Selling PDB**



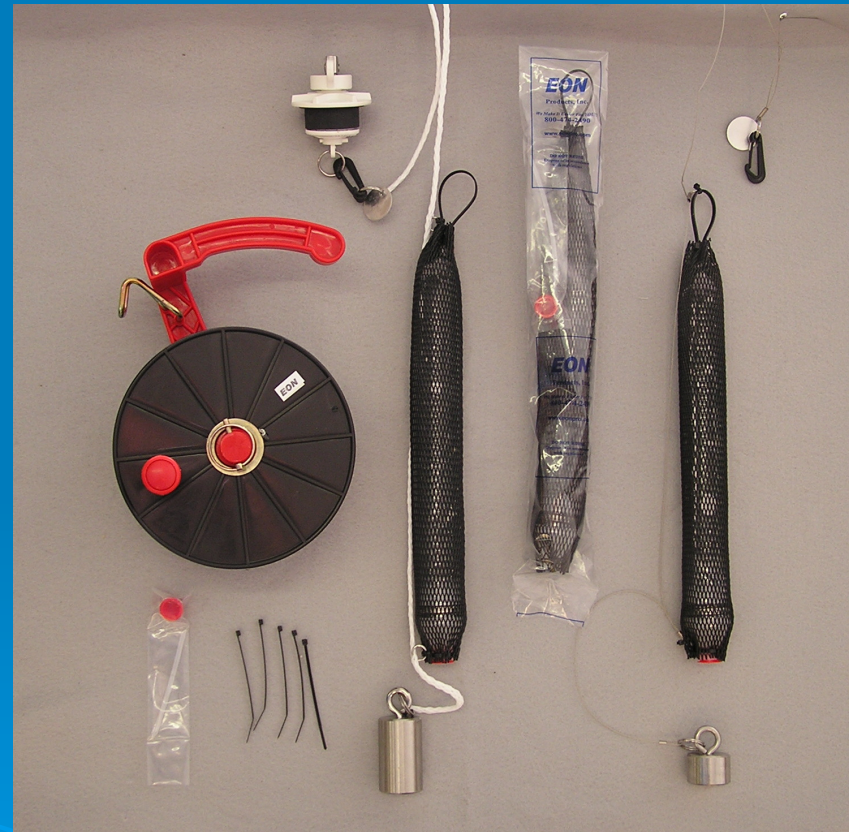
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PDB Accessories

➤ Installation Accessories



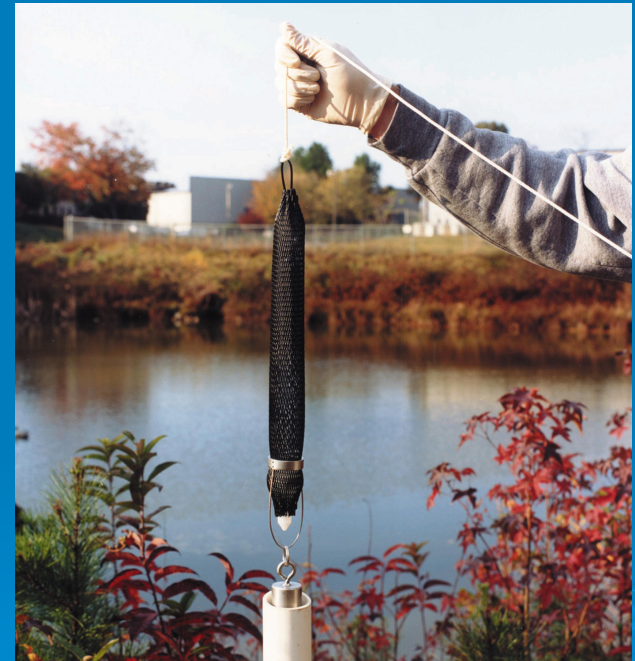
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Key Features

- Fill Port
- Integrated Mesh
- Suspension Handle
- Slide-On Weight Hanger
- Multiple Installation Options
- Multiple Discharge Options



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Fill Port

➤ Versatility

- Factory Pre-Filled
- Lab Filled
- Site Filled

➤ Reliability

- Water Blanks at Time of Installation
- No Volatile Infusion During Transit
- Equipment Rinse Blanks Possible

➤ Lower Cost

- Lower Shipping Cost
- Water & Equipment Blanks Without Sacrificing Sampler



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PDB Preparation

➤ Field Filling PDBs



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Integrated Mesh & Suspension Handle

- Mesh Secured at Top and Bottom to Carry Sampler Weight
- Loop Handle for Rapid & Easy Tether Attachment



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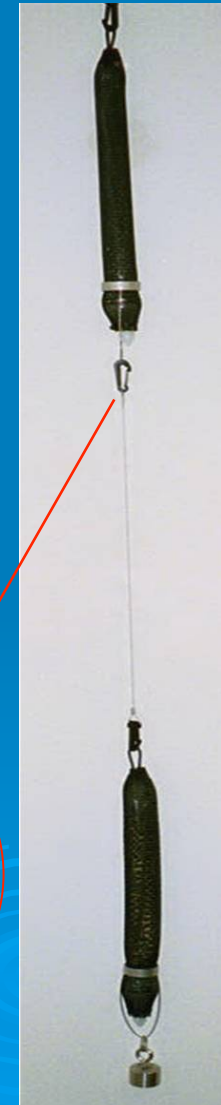
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Installation Methods

➤ “Hanger” Method

- Use for 1 or 2 PDBs
- Use Slip-On Hangers
- Individual Tethers with Snap Hooks
- Weight Suspended from Hanger
- Quickest & Easiest for 1-2 Samplers
- Teflon Coated Stainless or Poly Tether



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“Hanger” Method

- Slide-On Weight Hanger
- Rapid Deployment
- Fixed Tether Position
- Reusable

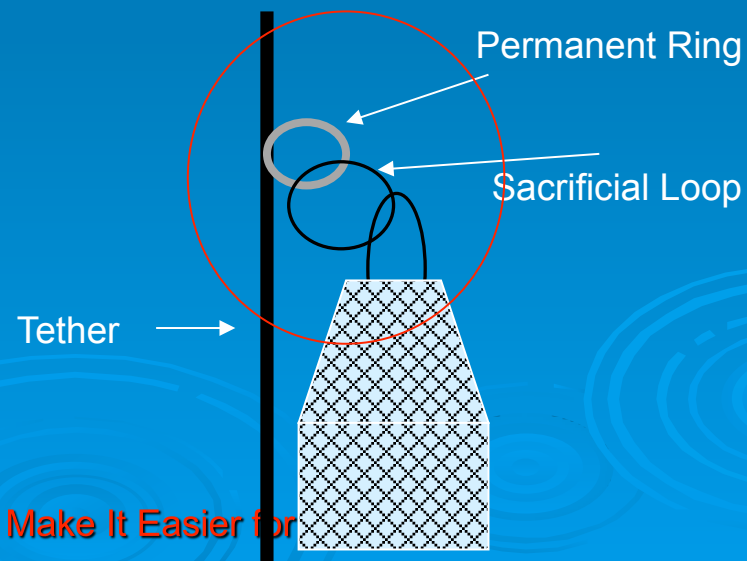


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Installation Method

➤ Single-Tether Method

- Install Multiple PDBs
 - Use 1 Tether & Attachment Rings
 - Attach Sampler at Top & Bottom
 - Weights Attach to Bottom of Tether
 - Easiest for 3 or More Samplers

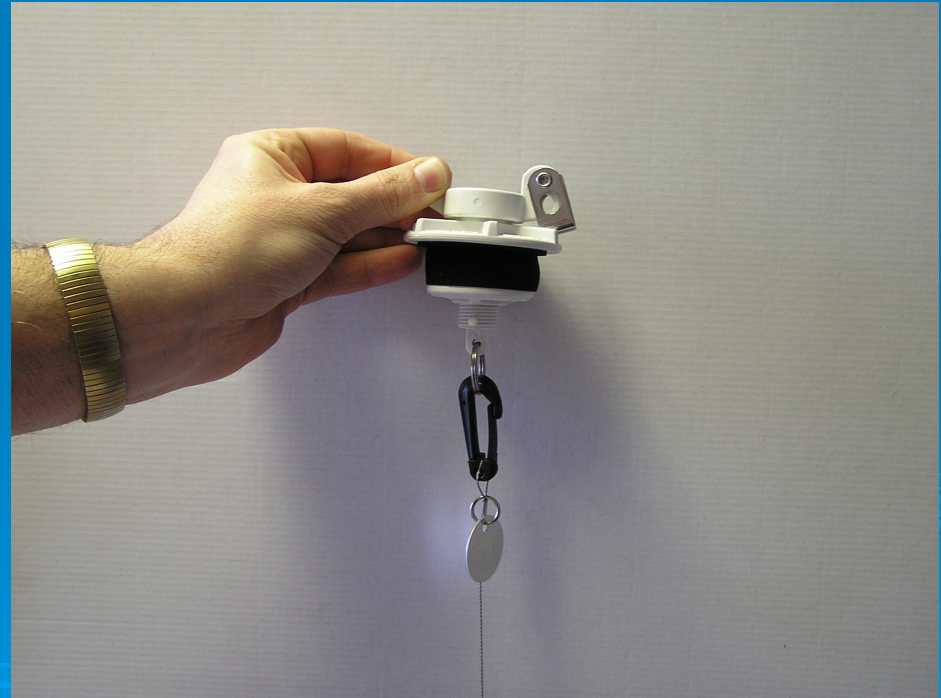


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Suspension Tether

- Well Cap Suspension Assembly
- Snap-Connector
- ID Tag



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Suspension Tether

- Stainless Steel Tether
- Adjustable Connection Point



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Suspension Tether

- Reusable Stainless Steel Weight



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PDB Installation

- Installation Using Single Tether Method



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PDB Installation

➤ Hand Reel Installation



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Discharge Options

- Use “Juice-Box” Straw
 - No Air Contact
 - Laminar Flow
 - Fill VOA Vial from Bottom
 - Very Easy for One Person

- Pour from Fill Port
 - One Person Use

- Use Port Device



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Step-By-Step



Using Fill Kit



Inserting Plug



Attaching Weight



Installing

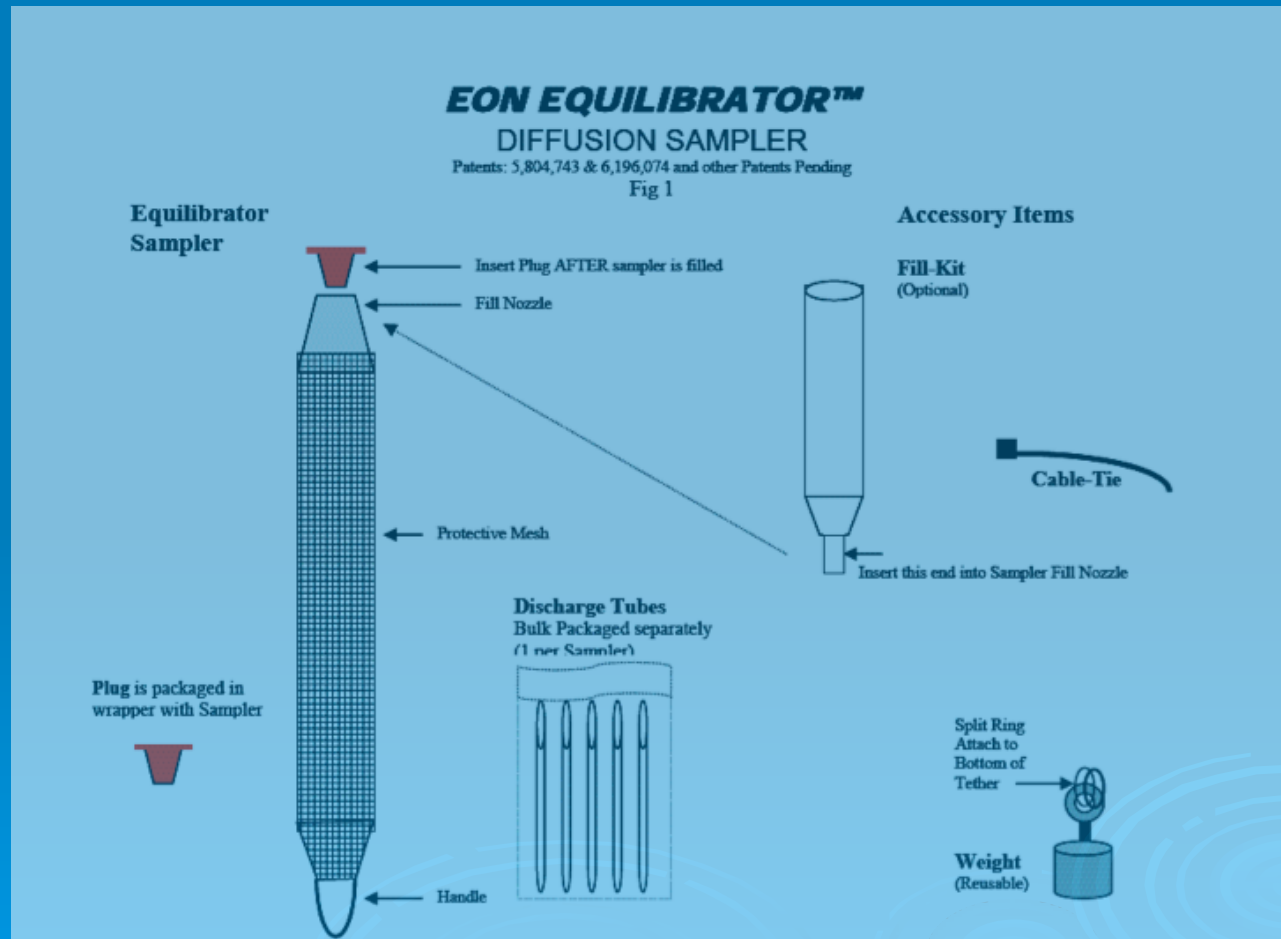


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Dimensions & Capacities

- 4 mil Thick Polyethylene Membrane
- Diameter (when full)
 - Standard ~1.75 inches
 - Mini ~1.00 inches*
 - Micro ~0.69 inches*
 - *Field Testing/Development
- Length
 - Standard; 18 inches, ~350 ml volume
 - Mini & Micro; 24 - 48 inches, ~200+ ml volume
 - Custom Lengths Produced, 12 inches to 5 feet length

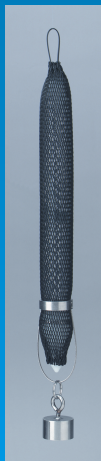
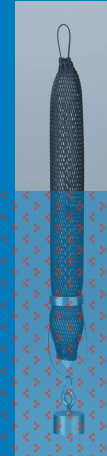
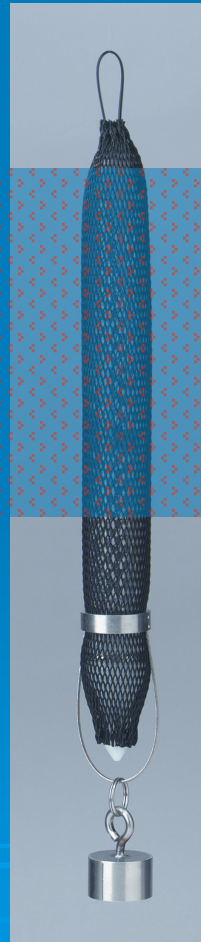
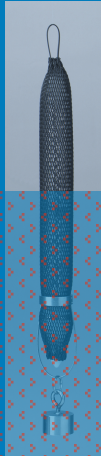


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