## Historical Development

In 1992 the first Multi-Level Bundled Nested Wells (MLBNWs) were designed, developed and deployed by J. E. Haas. The wells were deployed to facilitate the cost effective collection of 3-dimensional hydro-geologic data of sufficient volumetric resolution to successfully track plumes of contaminated ground water from contaminated drinking water wells back to their sources. Since 1992 MLBNWs have been utilized to obtain 3D plume characterization data that has helped advance the understanding of dissolved contaminant transport.

## Costs

MLBNW drilling and completion costs vary regionally as do drilling services. However, costs associated with the installation of a full bundle consisting of 12 depth discrete monitoring points typically cost only 10% - 15% more than a 4 inch internal diameter monitoring of comparable depth.

## Following web links for example MLBNW data sets:

www.epa.gov/nerl/mtbe/analysis_spill.pdf
http://www.fueloxrem.com/files/RND%203%20Cross%20Sections.pdf
http://www.globalhydroserv.com/Smithtown%20Case%20Study%20Triad%20Plus%20vs%20CSA.pdf

## Why consider 3D plume characterization?

The US EPA indicates that there are some fairly common situations where we would expect a plume of petroleum hydrocarbons to move vertically into the aquifer—
http://www.epa.gov/nerl/mtbe/plume_diving.pdf

The American Petroleum Institute indicates that detailed plume definition may be necessary at an oxygenate release site that affects a sole-source drinking water aquifer, in order to ensure that corrective actions are effective. A detailed level of assessment would typically include depth-discrete soil samples, and multi-level, short-screened wells for vertical and horizontal dissolved chemical delineation.
http://api-ep.api.org/filelibrary/4699c.pdf#search='API%20MTBE%20Characterization

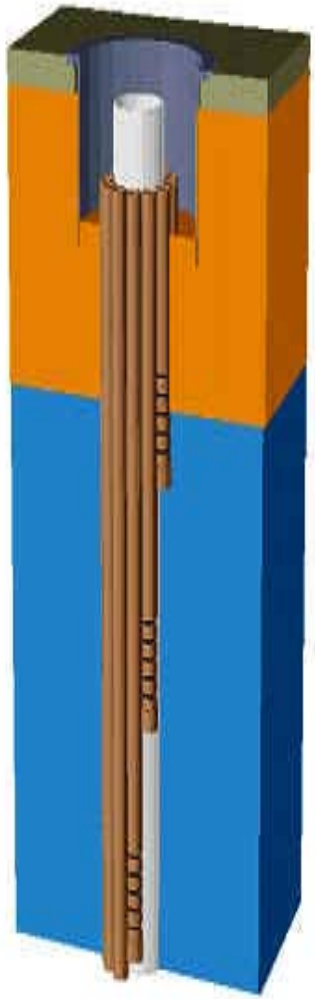
The State of Delaware indicates that MTBE plumes have been discovered that had not been previously identified. Additional characterization of the plumes may be required by the Department, which may include extending monitoring networks farther downgradient, and possibly the installation of multi-level well clusters-
http://www.dnrec.state.de.us/dnrec2000/Divisions/AWM/ust/Thinktank/PDF/pmeweb.pdf

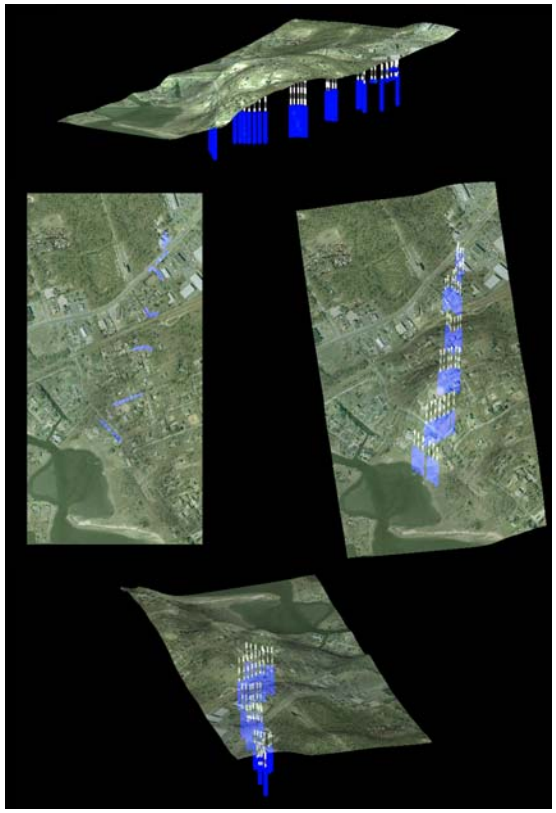
The State of California indicates that if the conceptual site model using regional data implies that persistent downward vertical groundwater gradients may exist, these gradients and the vertical extent of MTBE impacts should be investigated using cluster wells or other methods.
http://www.swrcb.ca.gov/ust/cleanup/docs/mtbe_finaldraft.pdf

## What is Global Hydrologic Services?

Global Hydrologic Services, Inc. is a professional services corporation dedicated to providing, and advancing, industry standards to solve the most vexing technical and regulatory problems facing the hydrologic and environmental communities the world over.

# 3D Plume Characterization Multi-Level Bundled Nested Wells





## Key Benefits

- More cost effective than other alternatives
- Installed via conventional well completion methodologies
- Suited for conventional well development techniques
- Suited for hydraulic measurement and testing
- Suited for gamma logging
- Construction materials are readily available
- Durable for decades

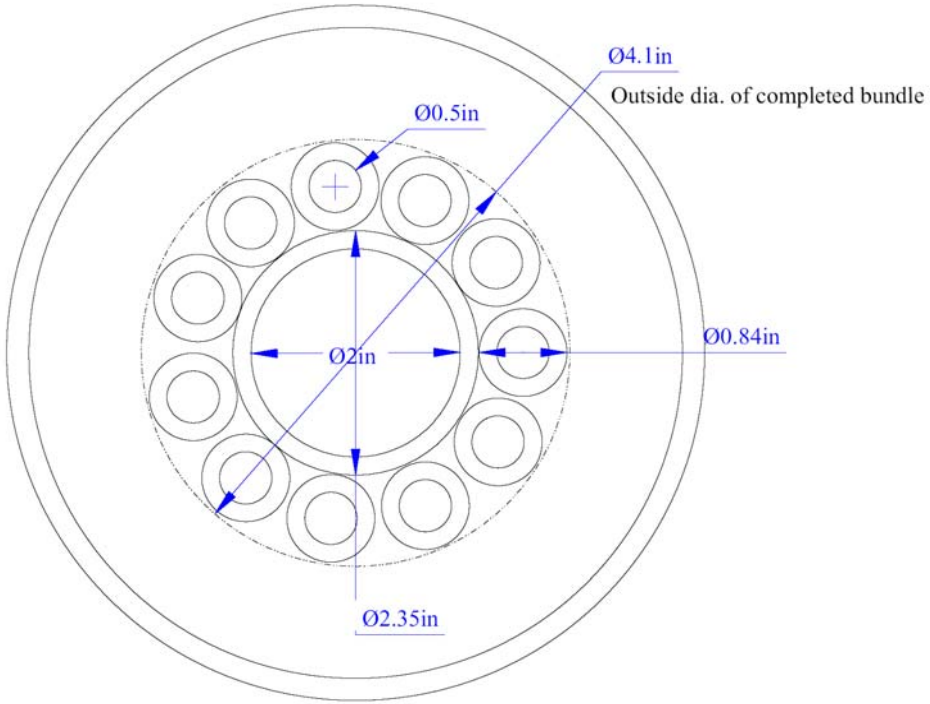
# Specifications

Below are the specifications for construction of a standard Multi-Level Bundle Nested Well (MLBNW) within a 6.25 inch internal diameter (ID) hollow stem auger flight or drill pipe.

• The deepest sampling point is the central structural or "centralizer" pipe around which all other multi-levels wells are bundled. It is to be comprised of 2 inch ID, flush joint, SCH40 PVC riser, and a 1 foot section of 20 slot, 2 inch ID, SCH 40 PVC screen.

• Each successively more shallow sampling point (up to eleven) is to be composed of 0.5 inch diameter, flush joint, SCH40 PVC riser, and a 1 foot section of 20 slot, 0.5 inch ID SCH40 PVC screen. Each 0.5 inch sampling point screen and riser is to be attached to (i.e. bundled around) the 2 inch centralizer pipe and applicable other sampling points (typically with a vertical interval between screens of 5 feet on center)

Multi-Level Nested Well Bundle




Eleven (11) 0.5 inch internal diameter, schedule 40, flush joint, PVC points attached to a central, 2.0 inch internal diameter, schedule 40, flush joint, PVC pipe.