



WHI E-News

Waterloo Hydrogeologic Inc.

WHI E-News Topics

2003 April Edition

Product News

- » [Environmental Software Solutions Bundled to Maximize Your Productivity!](#)

Consulting News

- » [WHI Partner Contributes to a World Bank Publication for Groundwater Protection Strategies](#)
- » [WHI Commences a Niagara Peninsula Groundwater Study](#)

Training News

- » [New Courses This Spring!](#)
 - » [3D Reactive Transport Modeling](#)
 - » [Environmental Risk Assessment](#)
 - » [Bioremediation System Design](#)
- » [Upcoming Professional Courses for April](#)

Tips & Tricks

- » [Modeling Flow and Transport Through an Unsaturated and Saturated Groundwater System - Combining WHI UnSat Suite and Visual MODFLOW Pro](#)

Technical Highlights

- » [From the 3rd World Water Forum - The World's Water Situation: Quantity and Quality](#)
- » [Risk Assessment and Modeling: Plume Status, Modeling, and Points of Compliance](#)

Waterloo Hydrogeologic, Inc. (WHI) is a recognized leader in the development and application of environmental software and services.



Product News

Environmental Software Solutions Bundled to Maximize Your Productivity!

As environmental professionals, you're often faced with deciding which software solution best fits your project requirements. Identifying the best package can be time-consuming and costly. That's why, **for the month of April, WHI is offering BIG savings on specially selected software bundles.**

We've identified software bundles to maximize your productivity - at reduced rates!

For a limited time:

» [purchase any of our pre-selected software bundles below and save](#), OR
» [choose any two products, and receive a 15% discount off the total!](#)

» **Choose from these Software Bundles and Save...**

We're helping you *now* - to *save you money later*. The software bundles listed below are our most requested software combinations. They offer you the ability to transfer similar data types through direct links, or simple file import routines.

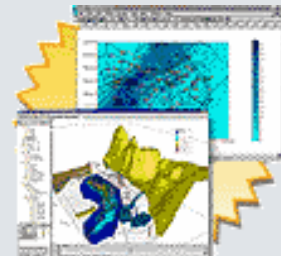


Visual MODFLOW + Surfer

Use Surfer to interpolate field data such as surface elevations; Visual MODFLOW imports Surfer-generated *.grd files, plus ASCII file formats.

NOW US\$1329 (reg. US\$1570)

» [Order Now](#)

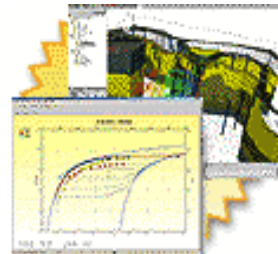


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Use AquiferTest to evaluate pumping tests and estimate aquifer properties (such as hydraulic conductivity); use the estimated aquifer properties as input for your Visual MODFLOW groundwater model.

NOW US\$1349 (reg. US\$1590)

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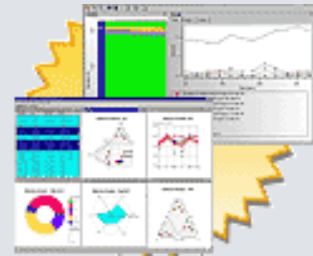


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Predict leachate migration through a landfill with Visual HELP; store, manage, and plot water quality data from landfill monitoring stations with AquaChem.

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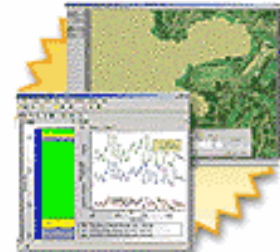


Visual HELP + Visual MODFLOW

Use Visual HELP to predict seasonal infiltration rates through the unsaturated zone, use infiltration rates as groundwater recharge data for your Visual MODFLOW saturated zone model.

NOW US\$1519 (reg. US\$1790)

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FLOWPATH II + RISC WorkBench

Use FLOWPATH II to predict contaminant migration and concentrations; use concentration data to calculate risk using RISC WorkBench.

NOW US\$1139 (reg. US\$1340)

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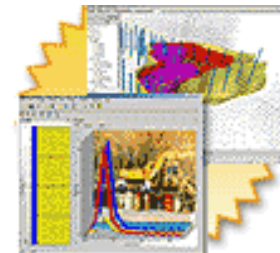


WHI UnSat Suite + Visual MODFLOW

Use the WHI UnSat Suite to estimate contaminant concentrations in the vadose zone; import concentrations at the water table as contaminant loading rates in Visual MODFLOW. [See this months Tips & Tricks for example applications of this!](#)

NOW US\$1429 (reg. US\$1690)

» [Order Now](#)



» **Combine these Products and Save 15%...**

Product	US\$
WinPEST	400
Surfer	575
AquiferTest	595
FLOWPATH II	595
AquaChem	695
WHI UnSat Suite	695
RISC WorkBench	745

Product	US\$
AquiferTest Pro	795
Visual HELP	795
VMOD 3D-Explorer	795
Visual MODFLOW	995
REMEDATION ToolKit	995
WHI UnSat Suite Plus	1095
Visual Groundwater	1695

Please note: Shipping, applicable taxes and duties not included. This special is not available with other discount offers.

For more information about our software bundles, contact us at:

Email: sales@waterloohydrogeologic.com

Phone: (519) 746-1798 and ask for the special!



Consulting News

WHI Partner Contributes to a World Bank Publication for Groundwater Protection Strategies

In 2001, Daniel Gomes, Associate Partner at WHI, was invited to Lima, Peru by the World Bank and the Pan-American Center for Sanitary Engineering and Environmental Sciences (CEPIS) to participate in a discussion group composed of groundwater experts from selected countries. The purpose? To write a publication for groundwater protection strategies, aimed at improving groundwater quality in developing countries.

The project was coordinated by Dr. Stephen Foster, the leading hydrogeologist of the World Bank's [GW-Mate Group \(Groundwater Management Advisory Team\)](#), which promotes strong groundwater management throughout the world.

We are pleased to announce that the publication, entitled "*Groundwater Quality Protection: A Guide for Water Utilities, Municipal Authorities, and Environment Agencies*", by Stephen Foster, Ricardo Hirata, Daniel Gomes, Monica D'Elia and Marta Paris, is now available and being distributed worldwide. We hope that WHI's contribution will positively impact developing countries around the world!



The new publication is dedicated to protecting water sources (i.e. wells) as an initial step towards broader aquifer protection strategies that incorporate not only wellhead protection policies, but also aquifer vulnerability and contaminant sources mapping and hazard ranking in developing countries.

For more information about Groundwater Protection Strategies publication, please contact:

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WHI Commences Niagara Peninsula Groundwater Study

Managed by the Niagara Peninsula Conservation Authority (NPCA), the Niagara Peninsula is located at the southern end of Ontario, Canada, encompassing the section of land between Lake Ontario and Lake Erie, and including the Canadian side of Niagara Falls on the west side of the Niagara River.

Within the Niagara Peninsula watershed, groundwater is a significant source of rural-residential and agricultural water supply. It also augments dry weather river flows and sustains many wetland ecosystems.

The Challenge:

The NPCA has several water management concerns for this area:

- » The increasing demand for groundwater supplies to support crop irrigation, aggregate extraction, and urban development are potentially creating additional stress on the availability of groundwater supplies.
- » A variety of potential groundwater contamination risks have been identified, including, improperly constructed and/or abandoned water wells, septic systems, fertilizers, road salt, landfill sites, and historic oil exploration.

Several specific areas within the watershed are particularly sensitive, due to their geological characteristics, including:

- » The Onondaga Escarpment
- » The Guelph-Lockport Formation
- » St. David's Gorge
- » The Iroquois Sandplain
- » The Fonthill Kame, which has been identified as a critical recharge area supporting Twelve Mile Creek, the only cold water stream in the NPCA watershed.

The Solution:

In recognition of these challenges, the NPCA has contracted a watershed-scale study and awarded the project to WHI's multi-disciplinary team of specialists.

The study will improve understanding of the watershed's hydrogeology and provide the basis for a recommended watershed and source protection management plan that addresses adequate quantity and quality of groundwater in source areas and lower sections of the watershed.

The objectives:

- » Limit or eliminate the risk of groundwater contamination from historical, existing, and future land uses.
- » Manage groundwater quantities to ensure sustainable uses.
- » Promote water conservation and good well management and decommissioning practices.



About the Niagara Peninsula Conservation Authority (NPCA):

- » The watershed area of jurisdiction of the NPCA is 2,424 sq. km., covering the whole of the Region of Niagara and approximately 20% of the City of Hamilton and 25% of the Town of Haldimand.
- » The watershed is drained primarily by the Welland River, Twelve Mile Creek, Twenty Mile Creek and Forty Mile Creek with a number of smaller watercourses draining into Lake Ontario and Lake Erie.
- » The NPCA's jurisdiction also encompasses 117 km. of Great Lakes shoreline, with 67 km. on Lake Erie and 50 km. on Lake Ontario.
- » The total population within the NPCA's area of jurisdiction is approximately 460,000.

As a main partner on this study, the Ontario Ministry of the Environment (MOE) is providing financial and technical assistance. The MOE will also provide a significant amount of data to support the analyses of groundwater resources within the NPCA watershed. Relevant information will also be derived from the on-going Niagara Water Quality Protection Strategy (NWQPS), which includes an extensive list of reports, maps, and papers on file with the MOE and other agencies.

The results of this Watershed Aquifer and Groundwater Study and the NWQPS will also be a key source of information in the evaluation of future improvements to existing infrastructure and the construction of new infrastructure, such as the pending Environmental Assessment of possible routes for the proposed Mid-Peninsula Corridor Highway.

For more information about this technique or other capabilities of WHI's consulting team, visit our website or contact us at:

Website: www.waterloohydrogeologic.com/consulting/consulting_services.htm

Email: consulting@waterloohydrogeologic.com

Phone: (519) 746-1798



Training News

Exciting Spring Courses - Don't Miss These!

3D Reactive Transport Modeling - New to North America!

Waterloo, Canada

May 12-14, 2003

This course is designed for people who require in-depth training on the use of fate and transport models for simulating natural attenuation and groundwater remediation systems. Learn to use Visual MODFLOW with MT3D and RT3D, and 1D transport using PHREEQC.



As a result of its success in the Czech Republic in 2001 and Italy in 2002, we are now offering this course in Waterloo, Ontario.

Check out the full Course Description:

http://www.waterloohydrogeologic.com/training/course_3d_reactive_trans.htm

Environmental Risk Assessment - New to North America!

Chicago, Illinois

June 2-4, 2003

Learn practical approaches to risk-based decision-making related to soil and groundwater clean-up levels. Unlike other courses on risk assessment, this course recognizes the interdependence of contaminant-transport modeling and risk assessment, and provides an integrated approach on both topics.

Covering the topic of risk assessment, co-instructor [Troy Schultz](#) has extensive experience in conducting risk assessments and delivering training courses.



After a successful debut of this innovative course last year in Spain, we are now offering Environmental Risk Assessment in Chicago, Illinois.

Check out the full Course Description:

http://www.waterloohydrogeologic.com/training/course_environmental_risk.htm

Bioremediation System Design using Visual MODFLOW and RT3D - Special Conference Course!

Orlando, Florida

June 6, 2003

Join WHI, along with Chris Johnson of Battelle Pacific Northwest Laboratory and Prabhakar Clement of Auburn University, at the upcoming Seventh International Symposium on "In Situ and On-site Bioremediation". This special one-day course will introduce you to using RT3D for designing bioremediation systems through a combination of lectures and hands-on exercises.



Check out the full Course Description:

http://www.waterloohydrogeologic.com/training/course_bioremediation.htm






Register Online:

<https://www.battelle.org/secure/biosymp/short-reg.stm>

Get the Battelle Conference Details:

<http://www.battelle.org/environment/er/conferences/biosymp/default.stm>

Upcoming Professional Courses

	Dates/Locations
<p>Groundwater Modeling </p> <p>3D Groundwater Flow and Solute Transport Modeling Using Visual MODFLOW Pro.</p> <p>Simple to complex applications of groundwater flow and contaminant transport models are covered in this hands-on course. Ideally suited for people with beginner or intermediate level modeling experience who wish to advance their modeling knowledge and who's responsibilities include model review, planning, and project management.</p>	<p>Waterloo, Canada May 6-8, 2003</p> <p>Vancouver, Canada May 25-27, 2003</p> <p>Lyon, France June 17-20, 2003</p> <p>Rome, Italy June 17-20, 2003</p> <p>Japan June 25-27, 2003</p> <p>Register Now</p>
<p>Model Calibration Using PEST </p> <p>Applied to MODFLOW and Other Numeric Models.</p> <p>This course teaches strategies for calibrating groundwater models, the most time-consuming, challenging and critical phase of a modeling study. You will learn about model calibration issues in general and also how to use the parameter estimation software package PEST, which has been developed to enhance our ability to calibrate models and to understand the limits of that calibration.</p>	<p>Waterloo, Canada May 9, 2003</p> <p>Vancouver, Canada May 28, 2003</p> <p>Lyon, France June 20, 2003</p> <p>Rome, Italy June 20, 2003</p> <p>Register Now</p>
<p>Advanced Groundwater Modeling </p> <p>Applying Innovative Techniques and Avoiding Common Pitfalls using MODFLOW-2000, MODPATH, & MT3D.</p> <p>The advanced course builds on the topics covered in “Groundwater Modeling” and develops a higher level of skill in building and troubleshooting groundwater flow models. Ideal for “Groundwater Modeling” graduates or experienced modeling professionals.</p>	<p>Vancouver, Canada May 29-31, 2003</p> <p>Rome, Italy June 24-27, 2003</p> <p>Register Now</p>
<p> Click here for our full 2003 training schedule!</p>	
<p> Click here to request your free 2003 Training Course Schedule Catalog!</p>	

For more information about our course offerings, visit our website or contact us at:

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Tips & Tricks

Modeling Flow and Transport Through an Unsaturated and Saturated Groundwater System by Combining WHI UnSat Suite and Visual MODFLOW Pro

The Challenge - Modeling the Complete System, Including the Unsaturated Zone:

One of the major limitations of MODFLOW and its associated transport codes (e.g. MODPATH, MT3DMS, RT3D) is they are only capable of simulating the flow and transport processes in a fully saturated system. But, in many situations, the contamination source originates at, or near, the ground surface and well above the water table (saturated zone).

In these cases, professionals often use a conservative approach to modeling by assuming the concentrations entering the saturated groundwater system are the same as the concentrations at the source. This approach tends to over-estimate the concentrations entering the groundwater system, and hence, over-estimates the potential impact and risk of the contamination on downstream receptors.

In today's strict regulatory environment, a concentration uncertainty of as little as 5 ug/L could drive the decision between relying on natural attenuation processes to degrade the plume, or installing an expensive groundwater remediation system to capture it. With potentially millions of dollars at stake, a conservative estimate is not always the best approach - a more accurate approach is required.

The Solution - Combine the simulation capabilities of the WHI UnSat Suite together with Visual MODFLOW Pro:

» Use WHI UnSat Suite's Weather Generator to predict site-specific climatic data (precipitation, temperature and solar radiation), and then use the HELP model to simulate evapotranspiration, runoff, infiltration data for your vadose zone profile. Then export the infiltration rates to be used as recharge rates for the Visual MODFLOW groundwater flow model.

» Use one of the WHI UnSat Suite transport models to determine concentrations at the bottom of a vadose zone soil profile, and export the results as a concentration source for the Visual MODFLOW

[Visual MODFLOW Pro](#) is 3D groundwater flow and contaminant transport modeling software. It includes MODFLOW, MODPATH, MT3DMS, RT3D, automatic model calibration using WinPEST, and built-in 3D visualization and animation using the Visual MODFLOW 3D-Explorer.

[WHI UnSat Suite Plus](#) is a 1D unsaturated zone flow and transport modeling software package that integrates SESOIL, VS2DT, VLEACH, PESTAN and Visual HELP.

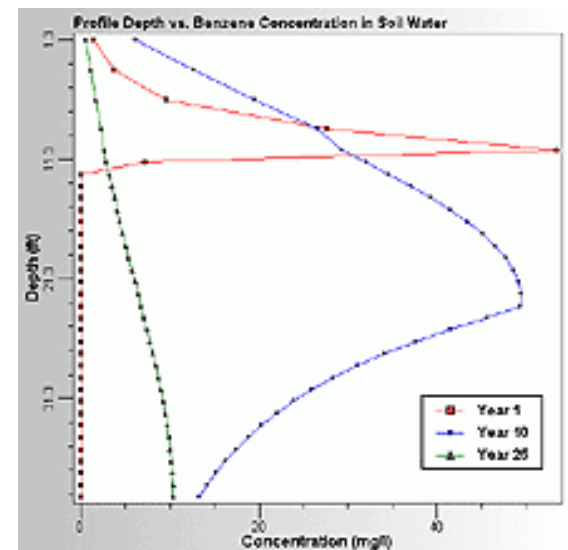


Figure 1A.

contaminant transport model.

Example 1:

Challenge: A VOC spill on the ground surface has resulted in contaminant migration through the vadose zone, and is threatening a municipal water supply aquifer.

Solution: Use SESOIL to model the transport and volatilization of the VOC as it leaches down through the vadose zone.

Figure 1A and Figure 1B: At the capillary fringe zone, SESOIL calculates the time-varying concentrations of the VOC in the pore water. These concentrations can be used as initial concentrations or as recharge concentrations in a Visual MODFLOW model.

Figure 1C: To import the concentration data from the SESOIL model into the Visual MODFLOW model, use the Import option in the Assign Recharge Concentration dialogue. Then, you can run a mass transport simulation using data that is truly representative of your site conditions!

Example 2 - Using the HELP Model to Generate Recharge Values:

Challenge: The lack of reliable or justifiable recharge values when designing and calibrating a groundwater flow model.

Solution: Use the Weather Generator to predict the climatological data for a 100 year simulation time, then use the HELP model to predict the rate of water infiltrating through the bottom of your vadose zone profile. Use these infiltration rates as recharge values for the Visual MODFLOW saturated zone model.

Figure 2A: Example of a two-layer soil profile representing the unsaturated soil zone above the water table.

Figure 2B: Use site-specific weather data with the HELP model to predict seasonal recharge rates (infiltration) through the bottom of the soil profile.

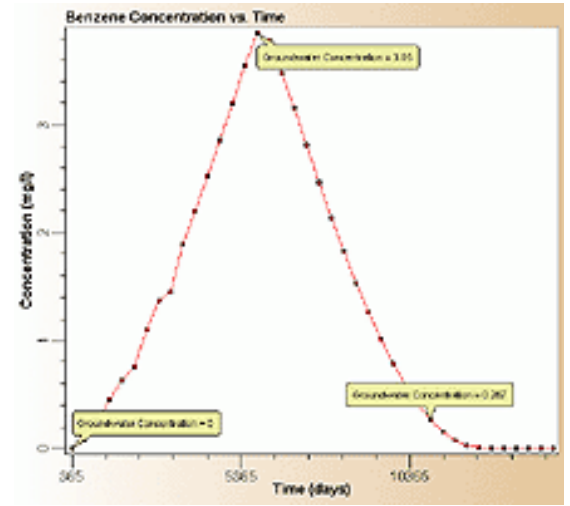


Figure 1B.

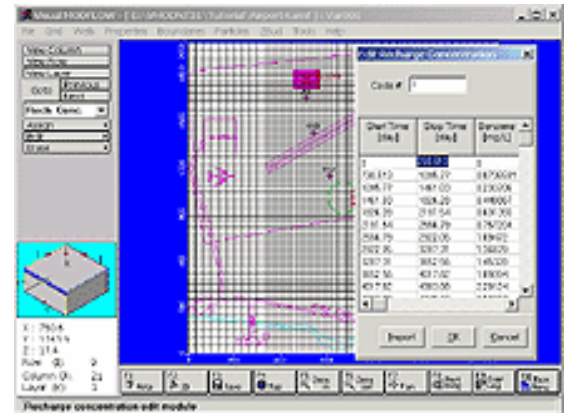


Figure 1C.

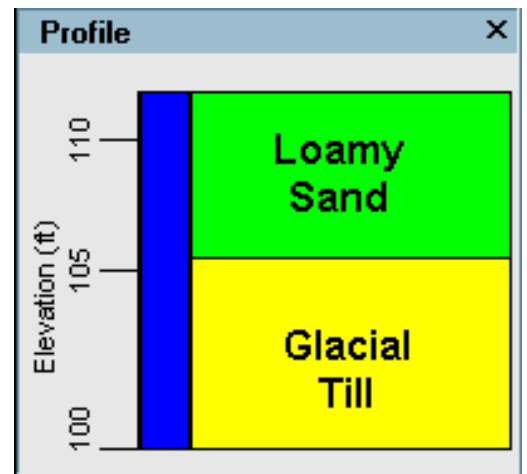


Figure 2A.

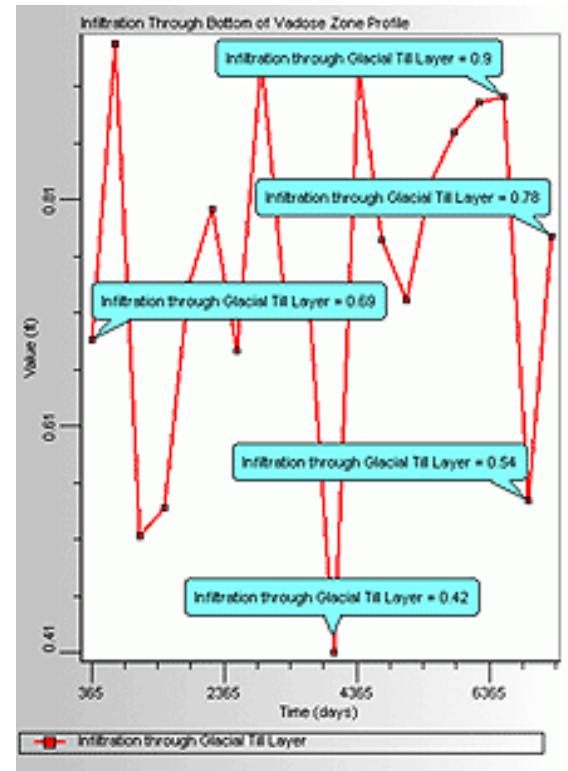


Figure 2B.

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Technical Highlights

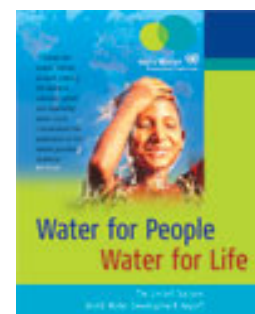
The World's Water Situation: Quantity and Quality

At the recently held 3rd World Water Forum, the United Nation's World Water Assessment Program released the "[*World Water Development Report*](#)" containing a ranking of 180 countries according to the annual quantity of surface and ground water available per capita and the quality of that water. Here are some interesting stats...

Water Quantity:

Canada is in the 9th position, with 48.314 m³ per person/year and the United States is in the 24th position. Kuwait is the country with the least sustainable freshwater per person, with 10m³ per capita, while 100m³/capita/yr is considered normal consumption.

Rather than a simple average, the calculation used to attain these rankings takes into account seasonality and different regions within a country.



The [3rd World Water Forum](#) was held in Kyoto, Japan from March 16th-23rd, at which WHI was represented through its business partners, Raax and Terra Corporations. More than 12,000

participants from 145 countries debated issues related to water resource management-including economic and social impacts-demonstrating the importance of this vital resource.

Most Water Per Capita	m ³
French Guiana	812,121
Iceland	609,319
Guiana	316,689
Suriname	292,566
Congo	275,679
Papua New Guinea	166,563
Gabon	133,333
Salomon Islands	100,000
Canada	94,353
New Zealand	86,554
Source: WWAP/Unesco	

Least Water Per Capita	m ³
Kuwait	10
United Arab Emirates	58
Bahamas	66
Qatar	94
Maldives	103
Libya	113
Saudi Arabia	118
Malta	129
Singapore	149
Jordan	179
Source: WWAP/Unesco	

Water Quality:

The report also ranked 122 countries according to their water quality, as well as the country's pollution control measures. The ranking was based on factors such as water quantity and quality, existent water treatment facilities and legal framework.

In this ranking, Finland leads, followed by Canada, New Zealand, the United Kingdom, etc. Surprisingly, Belgium presents the worst situation, mainly due poor quality groundwater resources, combined with high contamination rates and an insufficient number of treatment facilities.

Best Water Quality:	Worst Water Quality:
Finland	Belgium
Canada	Morocco
New Zealand	India
United Kingdom	Jordan
Japan	Sudan
Norway	Niger
Russia	Burkina Faso
South Korea	Burundi
Sweden	Central-African Republic
France	Rwanda

Unesco considers 2003 "International Freshwater Year".

With the exception of Belgium, developing countries are the most affected by poor water quality. According to the report, 50% of populations in developing countries are exposed to contaminated water.

Source: WWAP/Unesco

For the full "World Water Development Report", visit:
http://www.unesco.org/water/wwap/wwdr/ex_summary/

For more information about the "United Nation's World Water Assessment Program", visit:
<http://www.unesco.org/water/>

For details regarding the 3rd World Water Forum, go to:
<http://www.world.water-forum3.com/>

Plume Status, Modeling, and Points of Compliance

Feature "Risk Assessment" Guest Column by Troy L. Schultz, CPG

Greetings to all the subscribers of WHI's E-News. Over the next few months, I will present a series of short articles relating risk assessment and modeling. This first topic relates the plume status (i.e., expanding, shrinking, or stable), and modeling to site-specific Points of Compliance (POC).

A Point of Compliance (POC) is a specific location between the source and a potentially exposed receptor (e.g., a residential drinking water well) where you must meet certain human health or ecological standards. These standards can be either site-specific clean-up goals derived through risk assessment or some pre-determined standards such as Maximum Contaminant Levels (MCLs). (POCs vary broadly depending on what region or state you are working in so be sure to check requirements with your local site coordinator.) In some cases, they may be actual receptor exposure points; in others, they may be arbitrary locations such as property lines where land use restrictions can be applied.

Common issues to consider when modeling your plume:

The Expanding Plume:

Most often, we model to a POC to determine if the standards will ever be exceeded and, if so, by how much the contamination will rise at the POC. If remediation is deemed necessary to protect the receptor, one can develop remediation goals by simulating reduced site source concentrations in an iterative manner until the applicable standards at the POC are met. This assumes that the contaminant plume is indeed expanding. Given a lack of plume status information, it is always better to assume an expanding plume condition to protect human and ecological receptors.



Troy Schultz is President of [BJAAM Environmental, Inc. \(BJAAM\)](#). Mr. Schultz specializes in the development of site-specific standards and has given numerous lectures to various governments regarding the use and implementation of risk-based approaches to corrective actions (e.g., OhioEPA, Argentina, Brazil, etc.). He has also provided expert witness reports and testimony regarding risk assessment on behalf of companies such as Shell and BP.

The Shrinking Plume:

If significant field information is available to demonstrate a shrinking plume status, then that field data itself should become the primary line of evidence to show compliance at the POC (see USEPA, 1999). In this case, you could use a model as secondary evidence to demonstrate that changing conditions will not impact the plume's status.

For example: The removal of a cement or asphalt pad causing more than the historically observed recharge and leaching to occur might warrant the modeling of what was a steady state plume.

The Shrinking Plume Area in which Standards are Currently Exceeded:

It is also possible that your POC is within a shrinking plume area, yet the applicable standards are currently exceeded. In this case, modeling can determine if, and when, the standards will be met - perhaps by natural attenuation. One could also simulate the effects of enhanced attenuation or remediation by iterative simulation and modified transport conditions. When modeling a shrinking contaminant plume for these objectives, calibrate your wells on the decreasing part of the contaminant level trend through time.

The Stable Plume:

If field data suggests that your plume is stable or oscillating, you might use modeling to determine limiting factors that could change this condition to either shrinking or expanding. If you intend to demonstrate to a regulator that the POC will not be impacted and that no additional remedial efforts are needed, modeling could play a crucial role. Also, simulation of a stable plume could require certain concentration release assumptions that reveal insights into what is occurring in the field (e.g., continued source leaching). One could also simulate several remedial options and evaluate their effects on the status of the stable plume.

For lines of evidence to document the plume status see ASTM E1943-98 or USEPA, 1999.

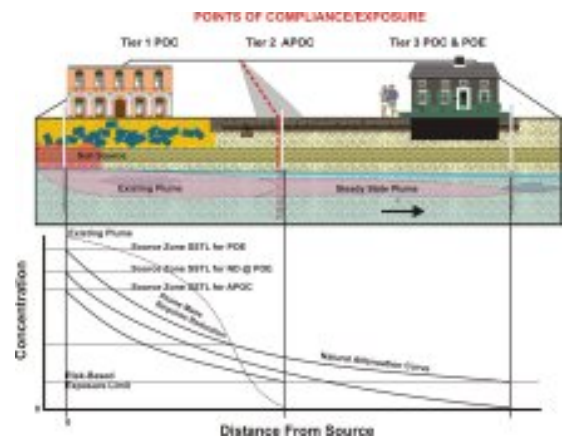
Thus, the modeling of all plume status conditions have their place depending on the POC and the standards being applied.

References:

ASTM, Method E1943-98. Standard Guide for Remediation of Ground Water by Natural Attenuation at Petroleum Release Sites. Annual Book of American Society of Testing and Materials Standards. Philadelphia, Pennsylvania.

USEPA, 1999. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites. Office of Solid Waste and Emergency Response.

NEXT MONTH'S TOPIC: Heterogeneities, Modeling Selection, and Pathway Completeness



Join Troy Schultz at our "[Environmental Risk Assessment](#)" course in Chicago, Illinois, June 2-4, 2003; find out more in the [Training Section!](#)



WHI is pleased to consider contributions to our upcoming Feature Guest Columns; if you are interested in writing one of our upcoming features, please contact:
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