Comprehensive Evaluation of Environmental & Health Effects Related to Natural Gas Extraction: A cumulative approach

Michel C. Boufadel,Ph.D., PE, P.Hydro.

Professor and Chair
Department of Civil and Environmental Engineering
Professor of Earth and Environmental Science
Temple University
Philadelphia, Pennsylvania
www.temple.edu/environment
boufadel@temple.edu

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December 10, 2009. Public meeting.

Environmental groups: Damascus Citizens, Delaware River Keepers, Catskill Mountain Keepers, EarthJustice .org.

March 18, 2010. Marcellus Shale Summit

Environmental groups, Industry, Academia, DEP, DCNR.

A panel moderated by Rep. Greg Vitali.

April 16, 2010. The case for Air Quality.

(Co-sponsored by the Clean Air Council)

Mayor Calvin Tillman of DISH Texas.

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The Precautionary Principle

"When human activities may lead to morally unacceptable harm that is scientifically plausible but uncertain, actions shall be taken to avoid or diminish that harm“

United Nations Educational, Scientific and Cultural Organization (UNESCO) and World Commission on the Ethics of Scientific Knowledge and Technology (COMEST).

Natural Resources NRDP Development and Protection

The Precautionary Principle

- The grounds for concern that can trigger the precautionary principle needs to be plausible or tenable and that the scientific uncertainty should be considerable.

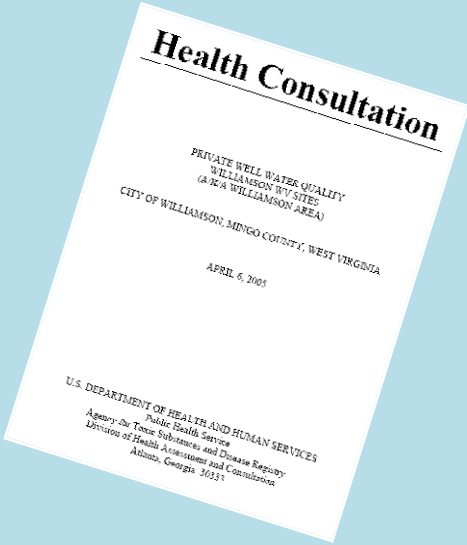
- The precautionary principle is not based on *zero risks* but aims to achieve lower or more acceptable risks or hazards

The Precautionary Principle in the Context of Natural Gas Extraction

Does the precautionary principle apply in the context of natural gas extraction?

Environmental & Health Risk Assessment

- Based on **ATSDR** (Agency for Toxic Substance and Disease Registry) **Public Health Assessment**
- Systematic process investigating the risk of an environmental concern for public health
- Leads to identification of contaminants of concerns and **public health implications** and **children's health implications**


Health Consultation

PRIVATE WELL WATER QUALITY
WILLIAMSON WV SITES
(A/K/A WILLIAMSON AREA)
CITY OF WILLIAMSON, MINGO COUNTY, WEST VIRGINIA

APRIL 6, 2005

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

ATSDR Public Health Assessment

1. Selection of contaminants of concerns
2. **Determination of pathways (air, ground, streams)**
3. Exposure (inhalation, ingestion, skin contact)
4. Toxicology review (compare to database).
5. Implications for Public Health and Children's Health
6. Recommendations for reducing risk.

Toxicity Testing

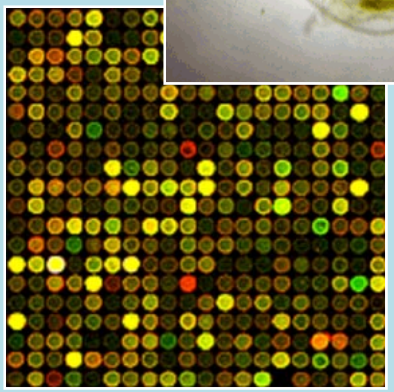
Previous approach does not apply to poorly **characterized** mixture of chemicals.

What we propose:

Alternative approach: (Eco)toxicology testing

- Microbiotests: *Daphna magna*, earthworms, bioluminescent bacteria (Microtox®)

- *In vitro* toxicity testing: Cytotoxicity, genotoxicity, cellular responses



Problem Statement

- Literature review reveals the existence of gap in data regarding environmental/health impacts of natural gas extraction

- Most information consists in anecdotes, which cannot be used for objective risk assessment

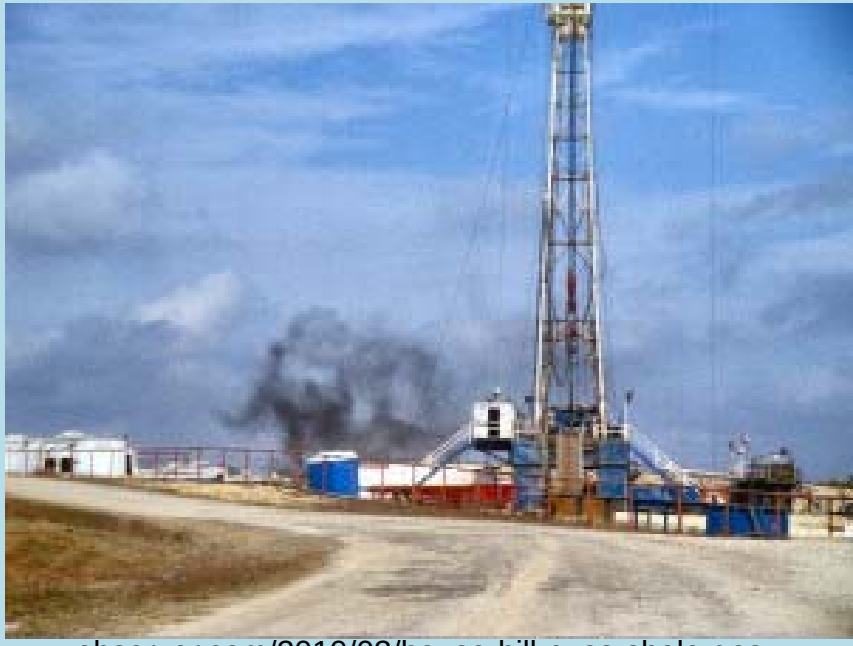
Pathways of Exposure

- Air
- Groundwater
- Stream

Air Quality at Shale Sites

- Drilling operations have been reported to adversely affect local and regional air quality
- Operations involve heavy equipment, compressors, diesel trucks and tank venting
  - Emissions include NOx, PM, VOCs, and CH_4
- Armendariaz (Southern Methodist University) inventoried oil and gas operations in the Dallas-Fort Worth area.

	NOx +VOC Emissions (tpd)
All mobile sources in D-FW (Summer)	273
Oil and gas operations in D-FW	306



http://www.wvobserver.com/2010/03/house-bill-eyes-shale-gas-drilling/

Impacts of Emissions: Local

Near-source Impacts

- Exposure to local residents and potentially high-risk communities (senior citizens and children)
- Immediate hazards:
  - Chronic exposure to NOx leads to respiratory ailments
  - Hazardous Air Pollutants are listed due to carcinogenic and mutagenic effects
  - Elevated levels of particulate matter are linked to asthma, respiratory distress and developmental disorders.

Impacts of Emissions: Regional

Although gas wells may be rurally located, emissions can be transported very rapidly to populated areas.

- During transport, the emissions soup will stew, yielding smog and aerosols.
- Overarching effect is air quality impacts throughout the region

Cumulative Risk Assessment

Evaluate the pathways through:
Groundwater

Brine Leakage

Courtesy of J. Henry Fair

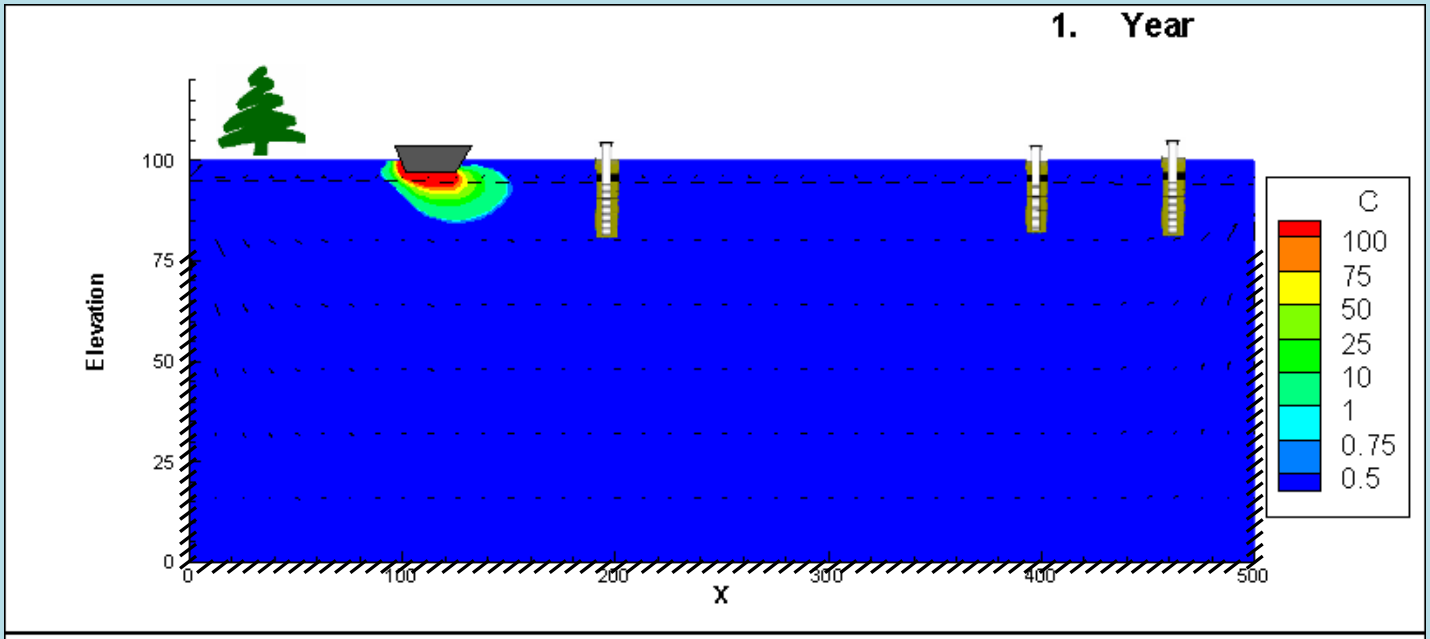
Brine Leakage

Courtesy of J. Henry Fair

Brine Leakage

Brine Properties

- Injected water contains hazardous chemicals.
- The flow-back water (the brine) picks up additional hazardous chemicals and NORM. It also picks up a lot of salts.
- The brine is 6 times more concentrated than seawater.
- The brine is much heavier than freshwater.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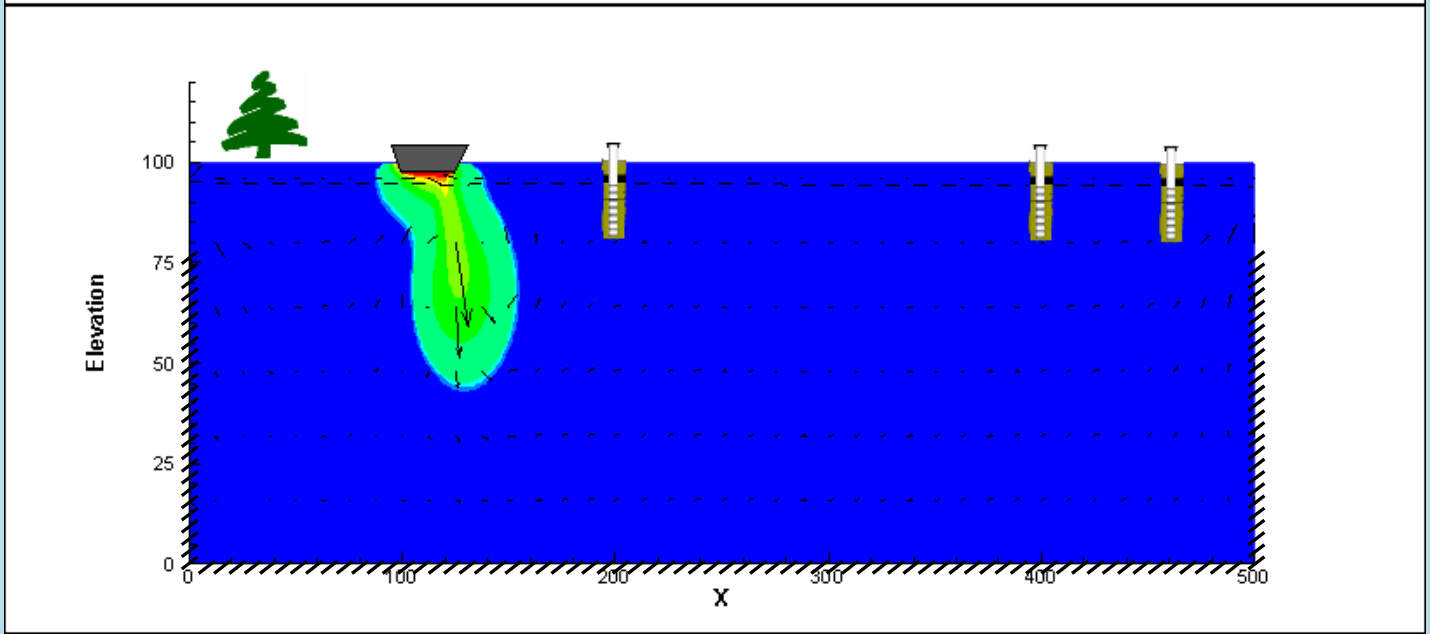
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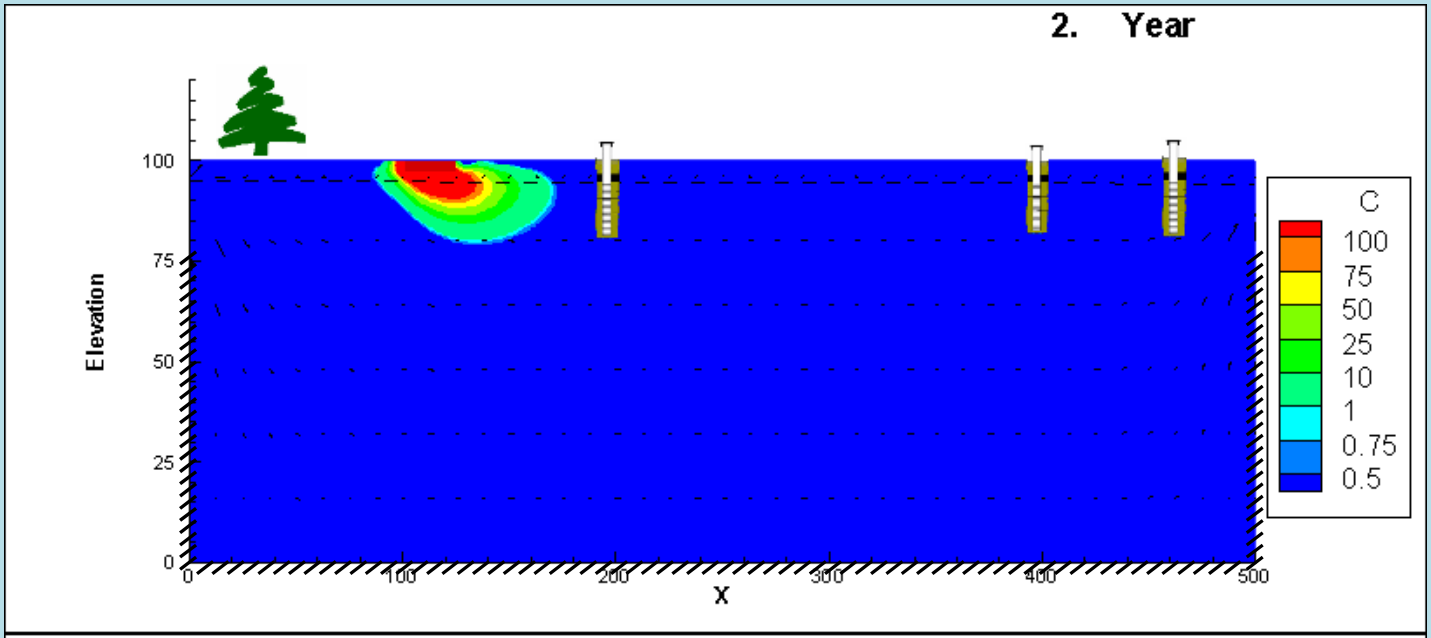
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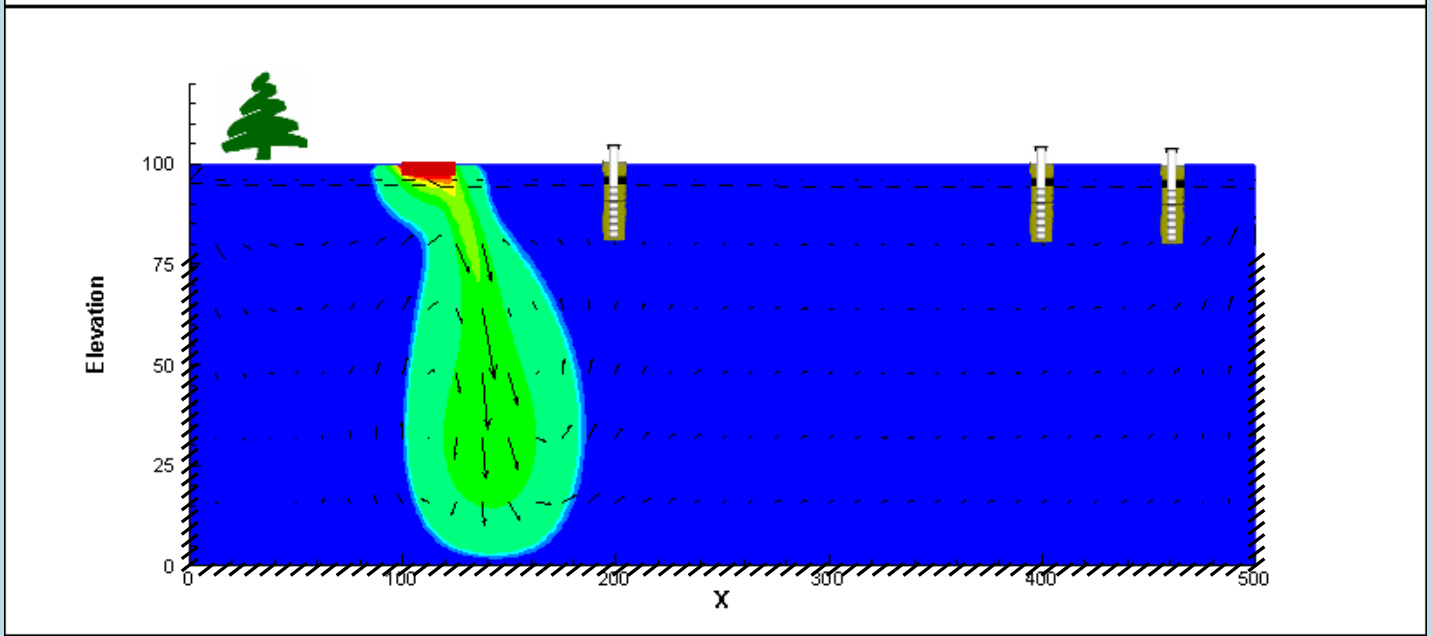
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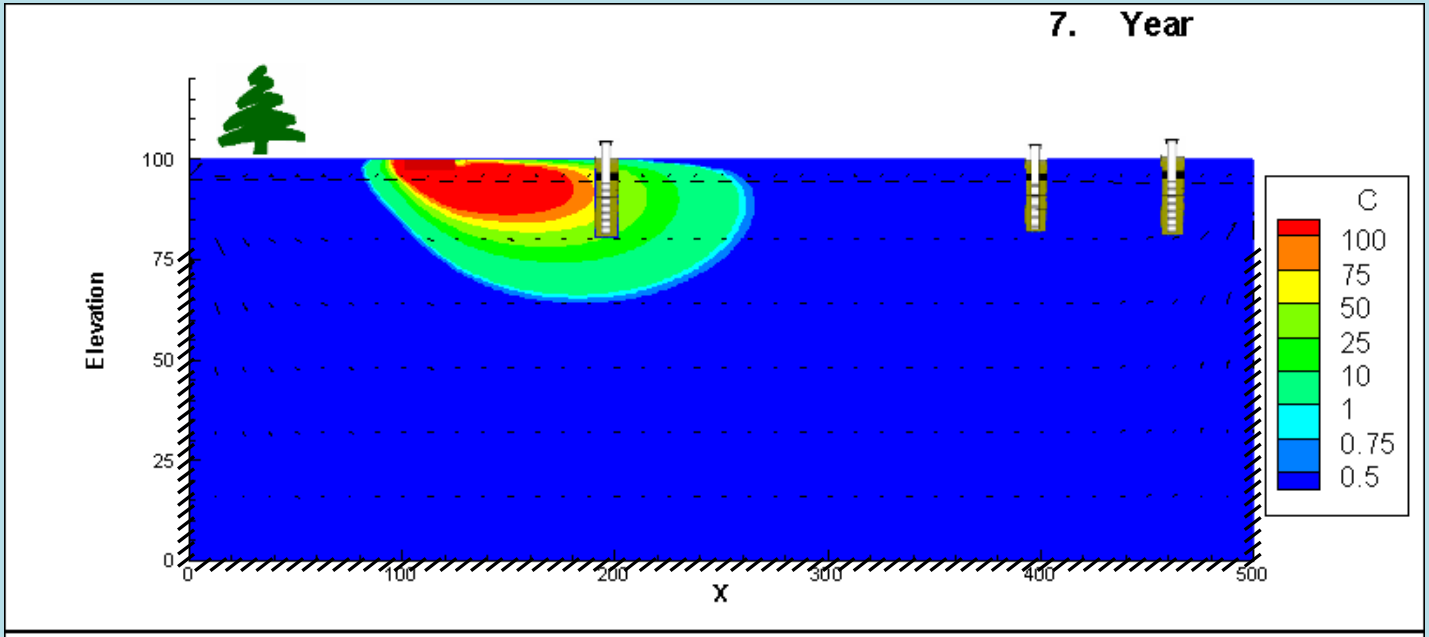
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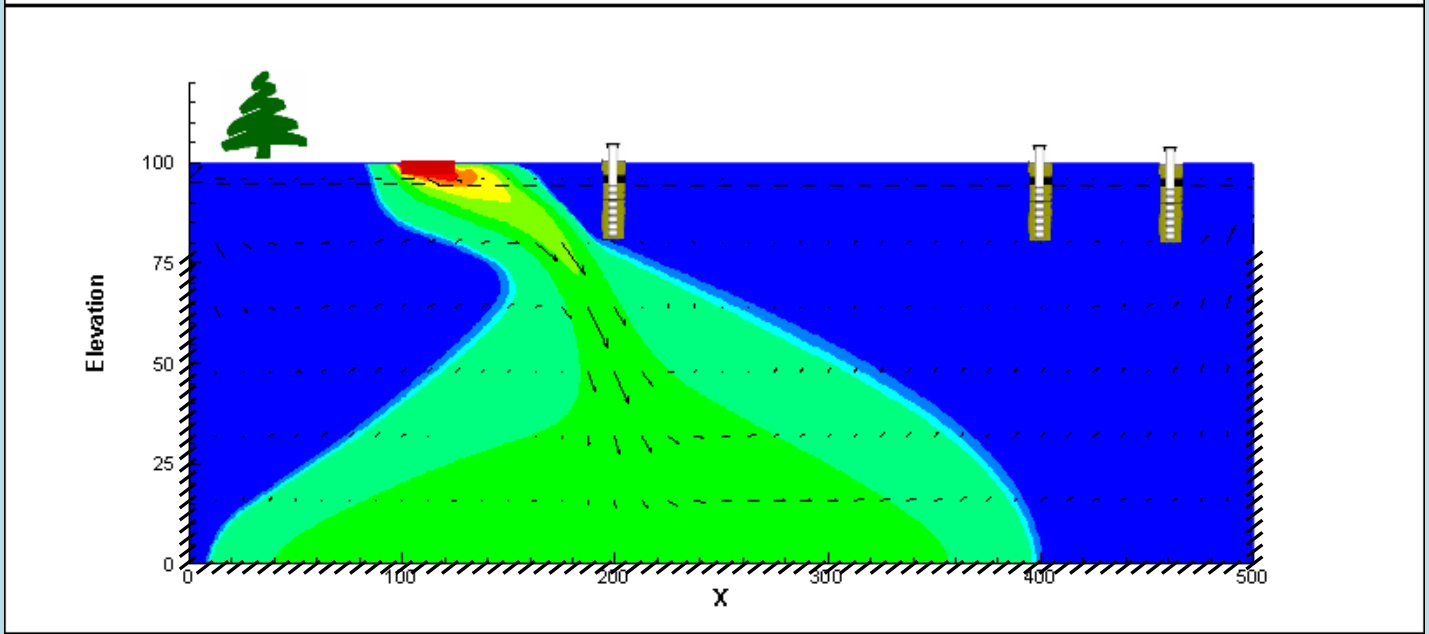
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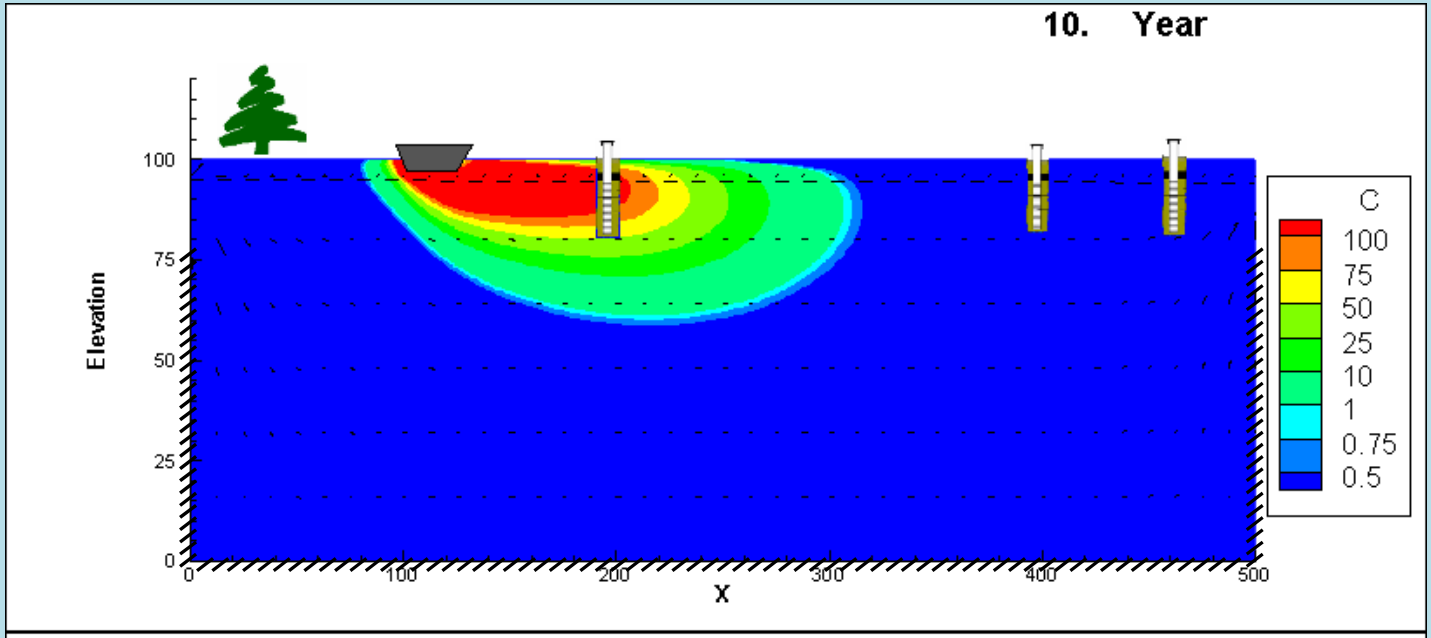
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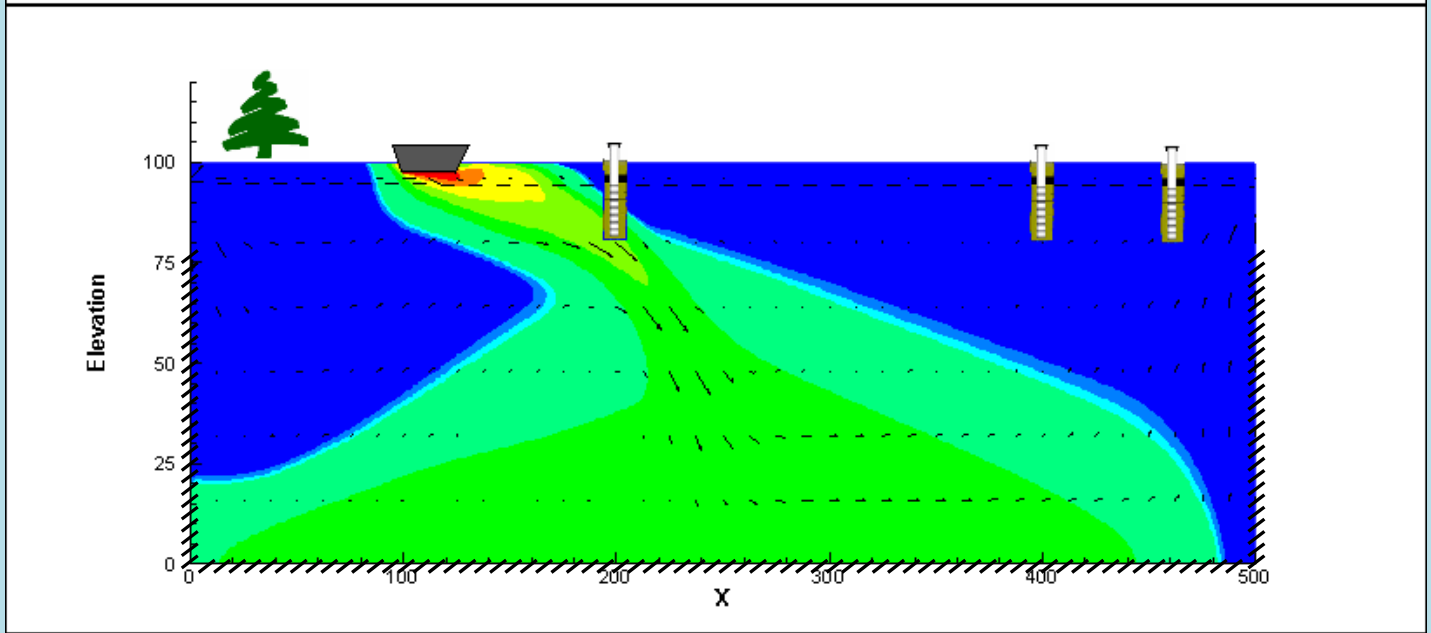
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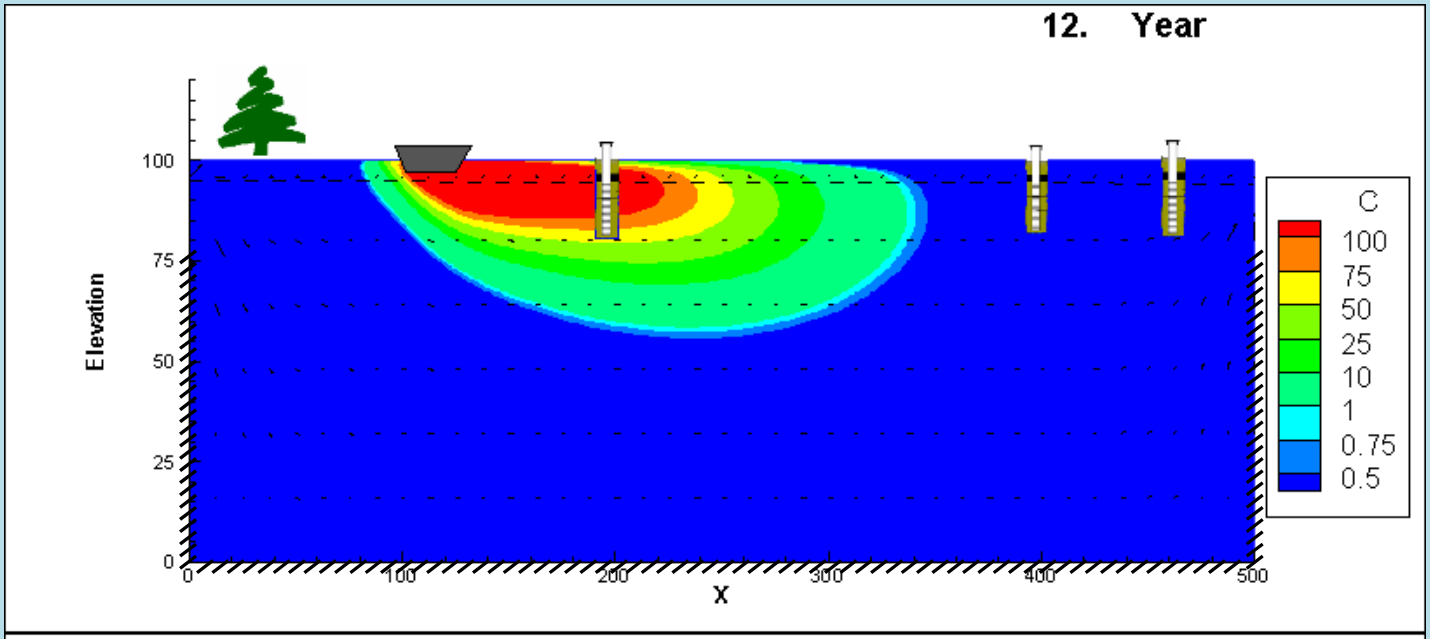
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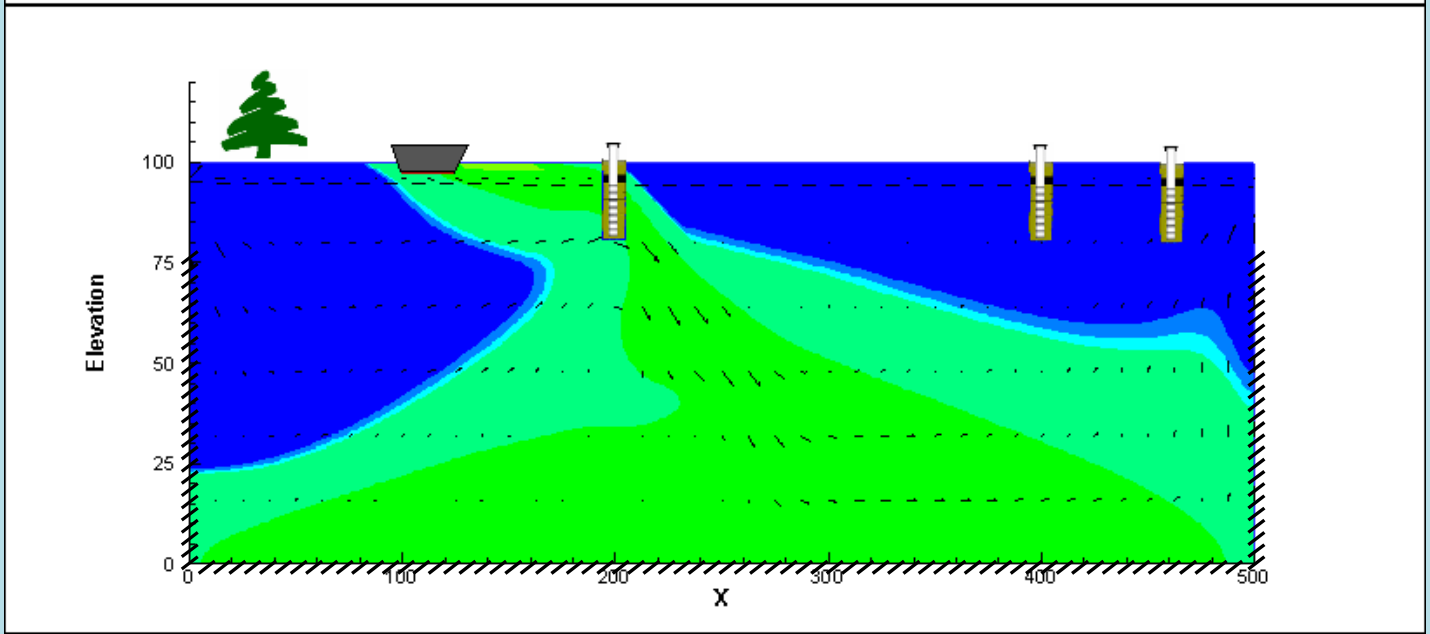
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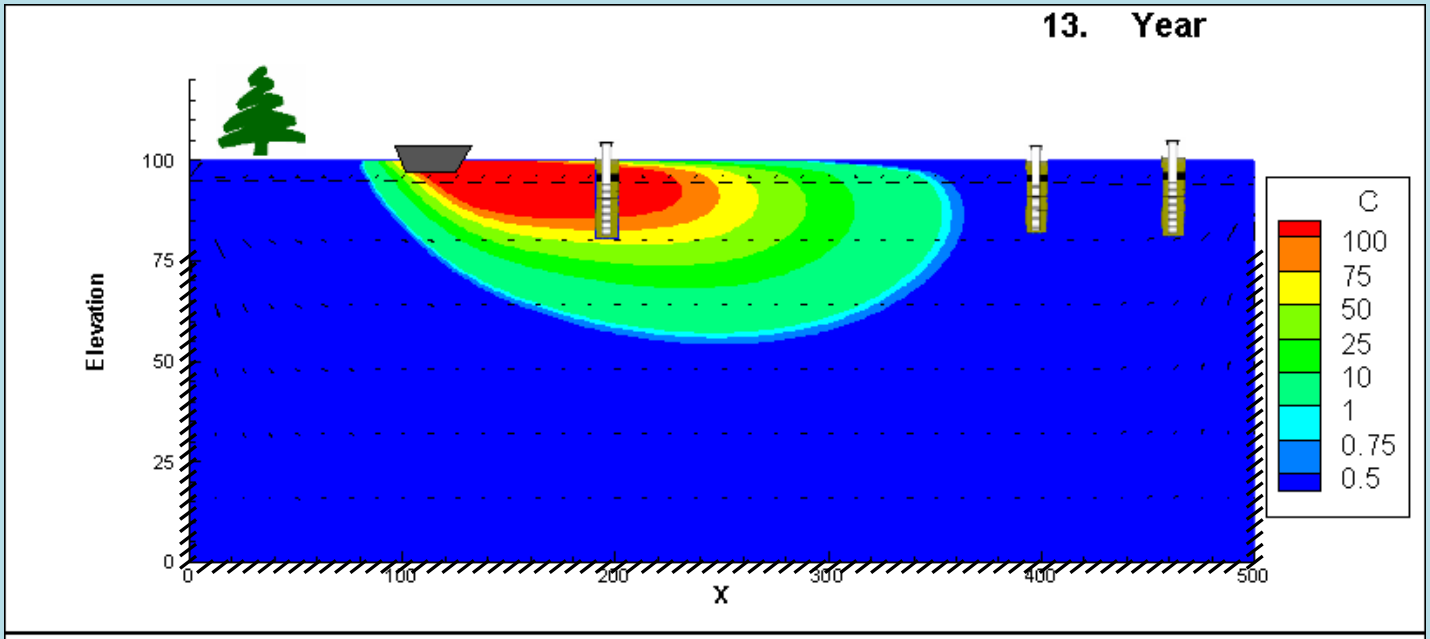
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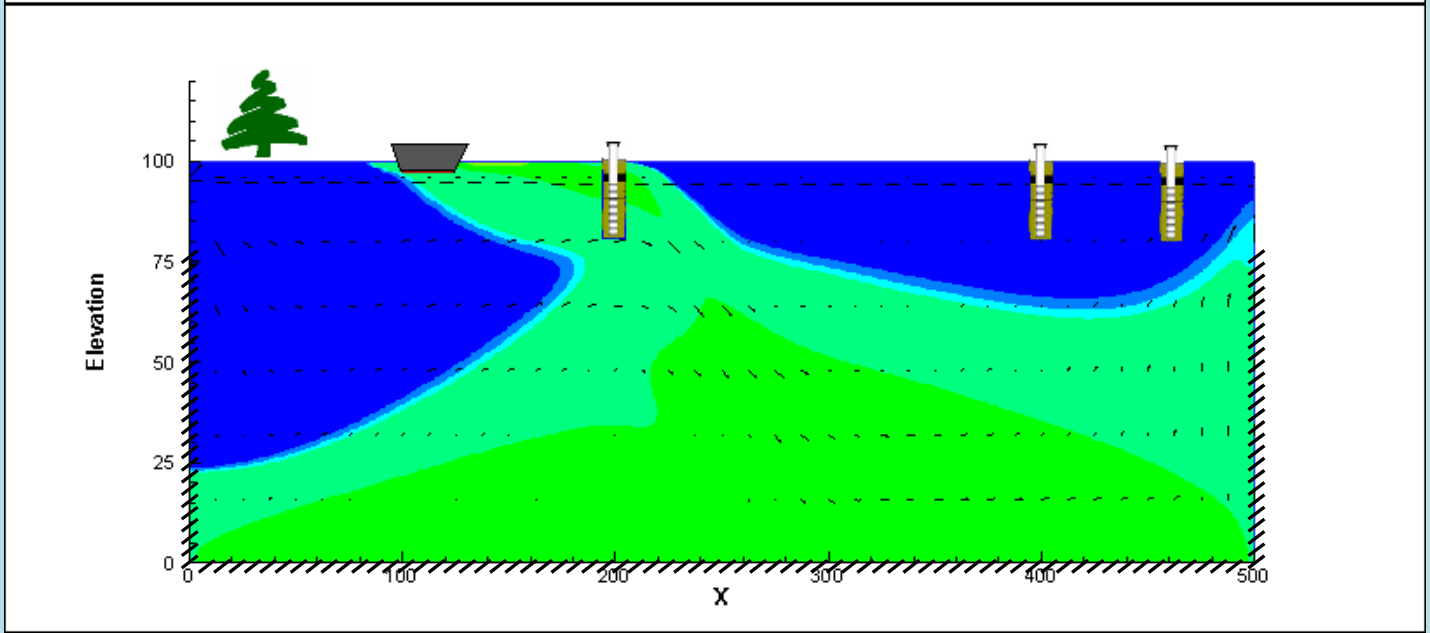
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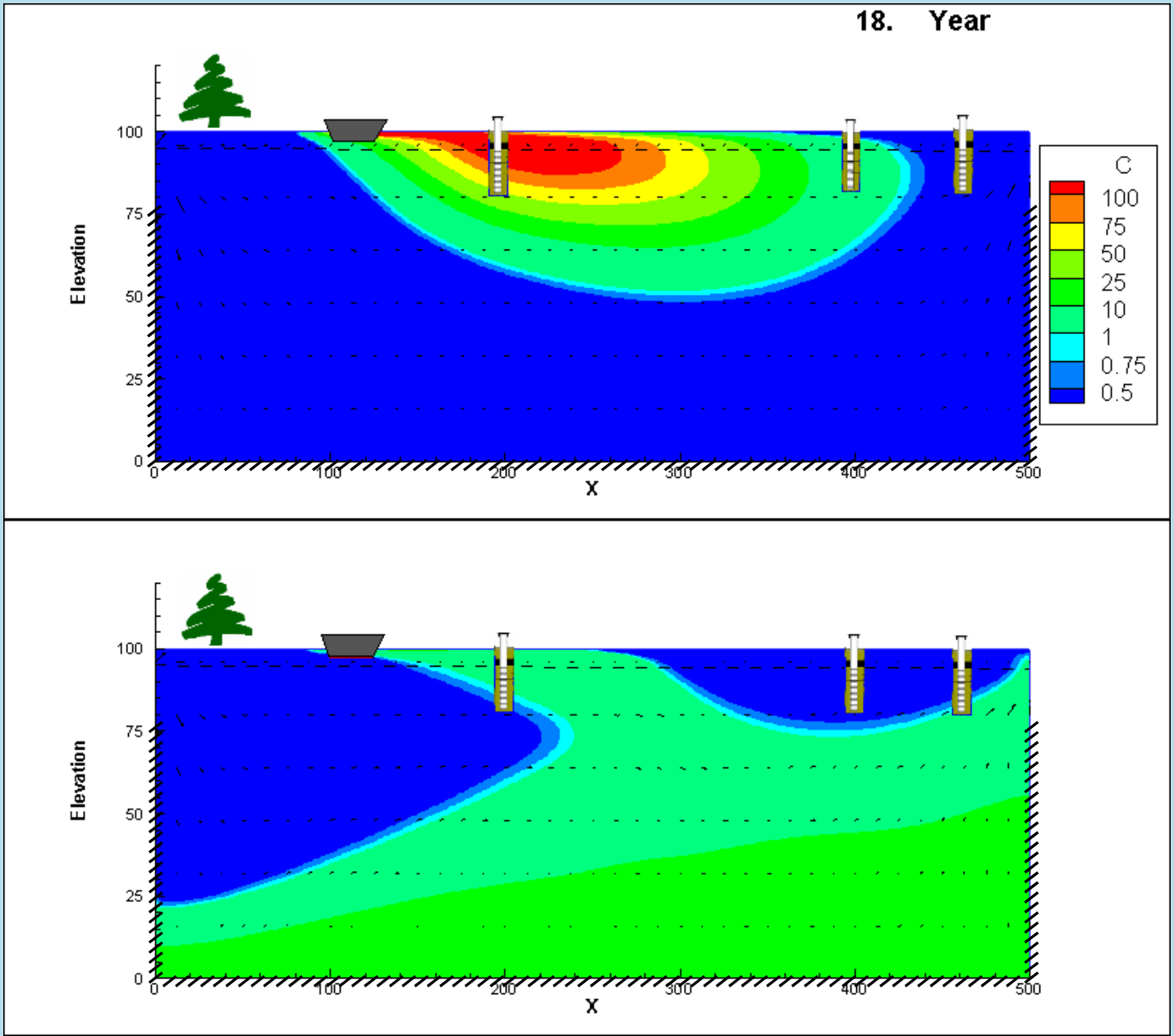
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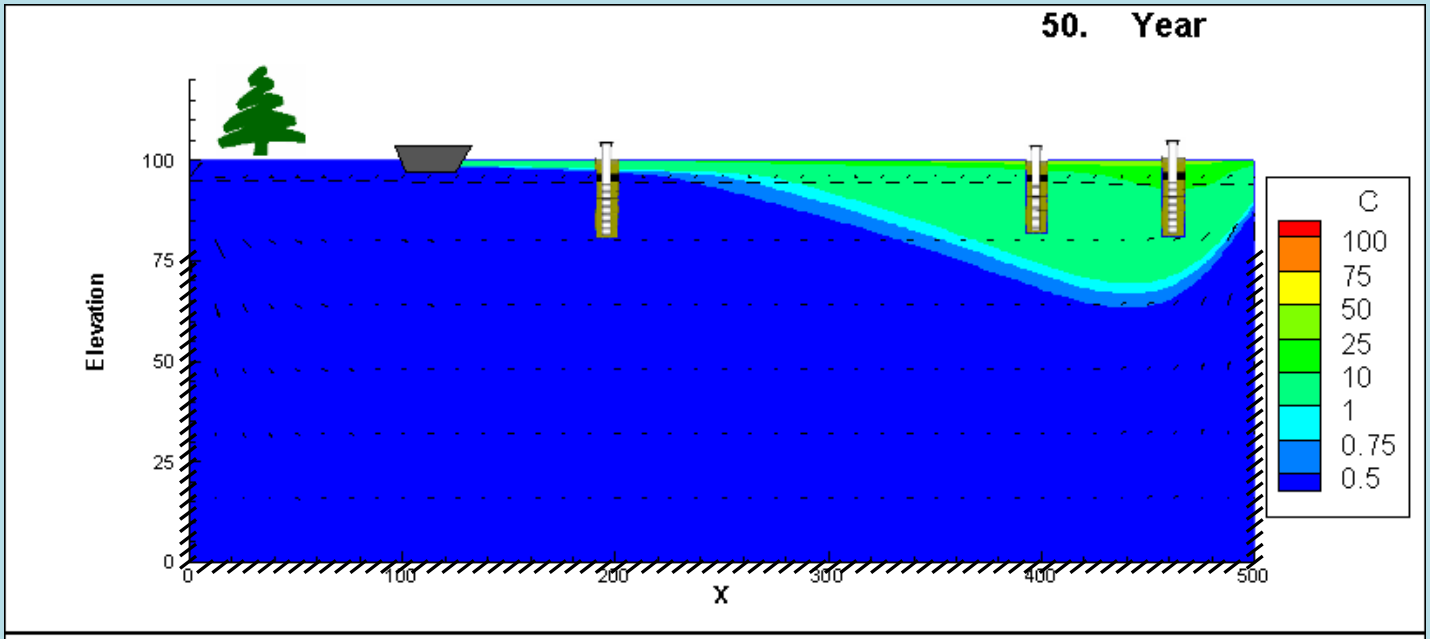
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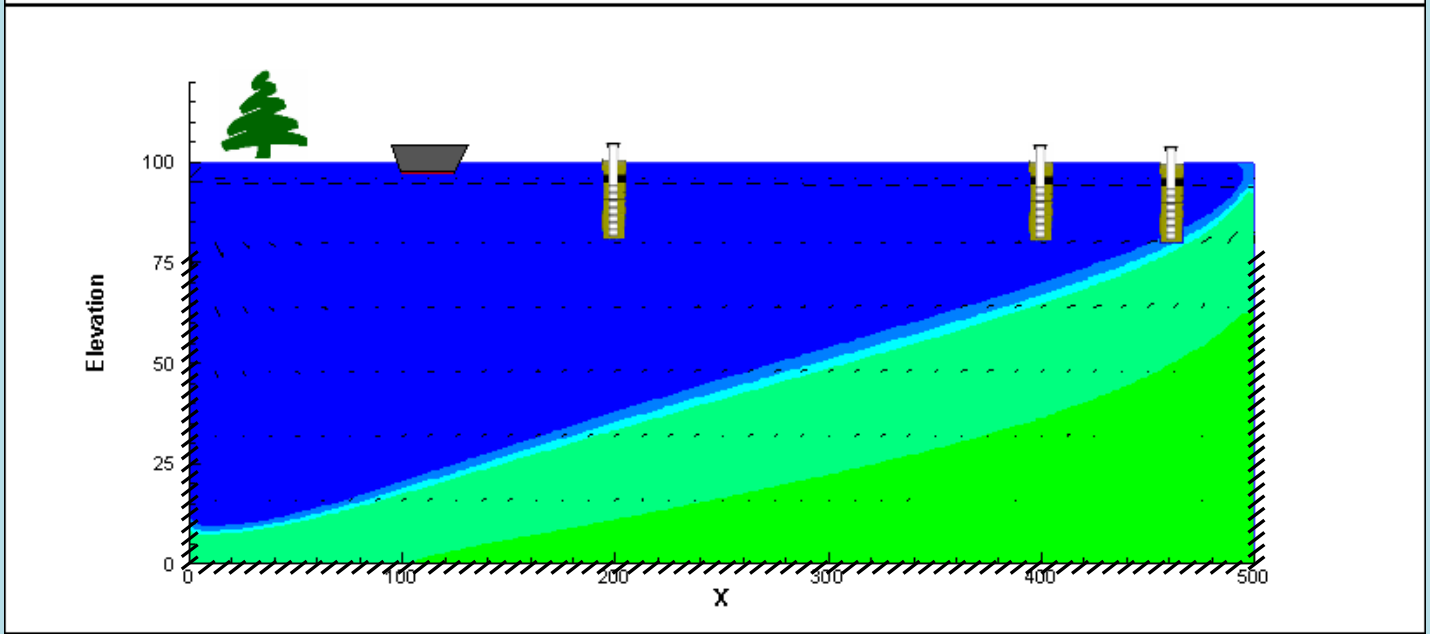
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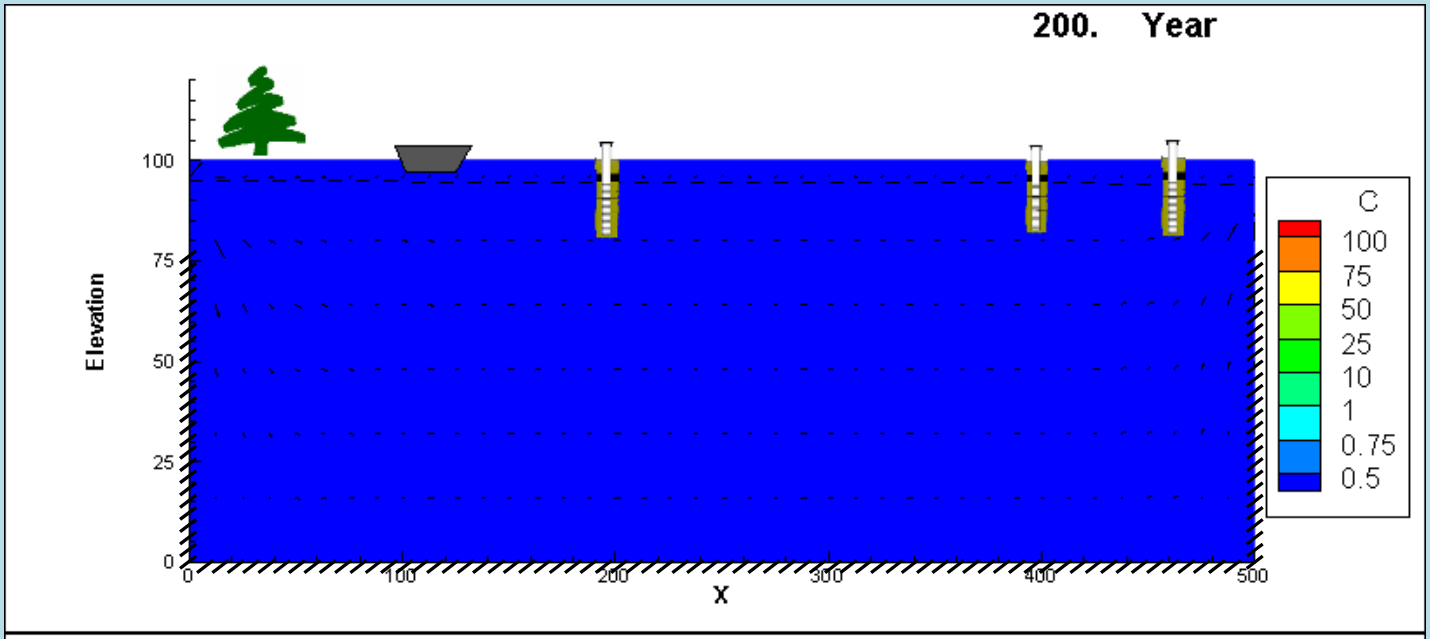
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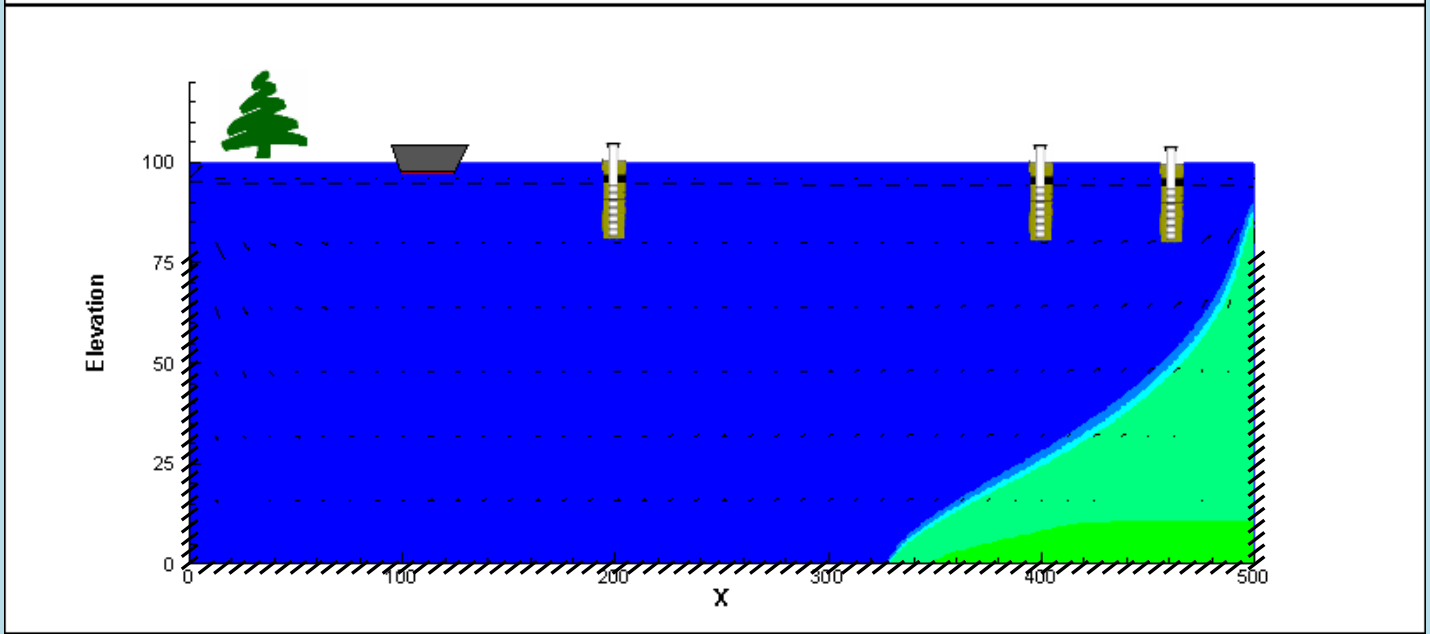
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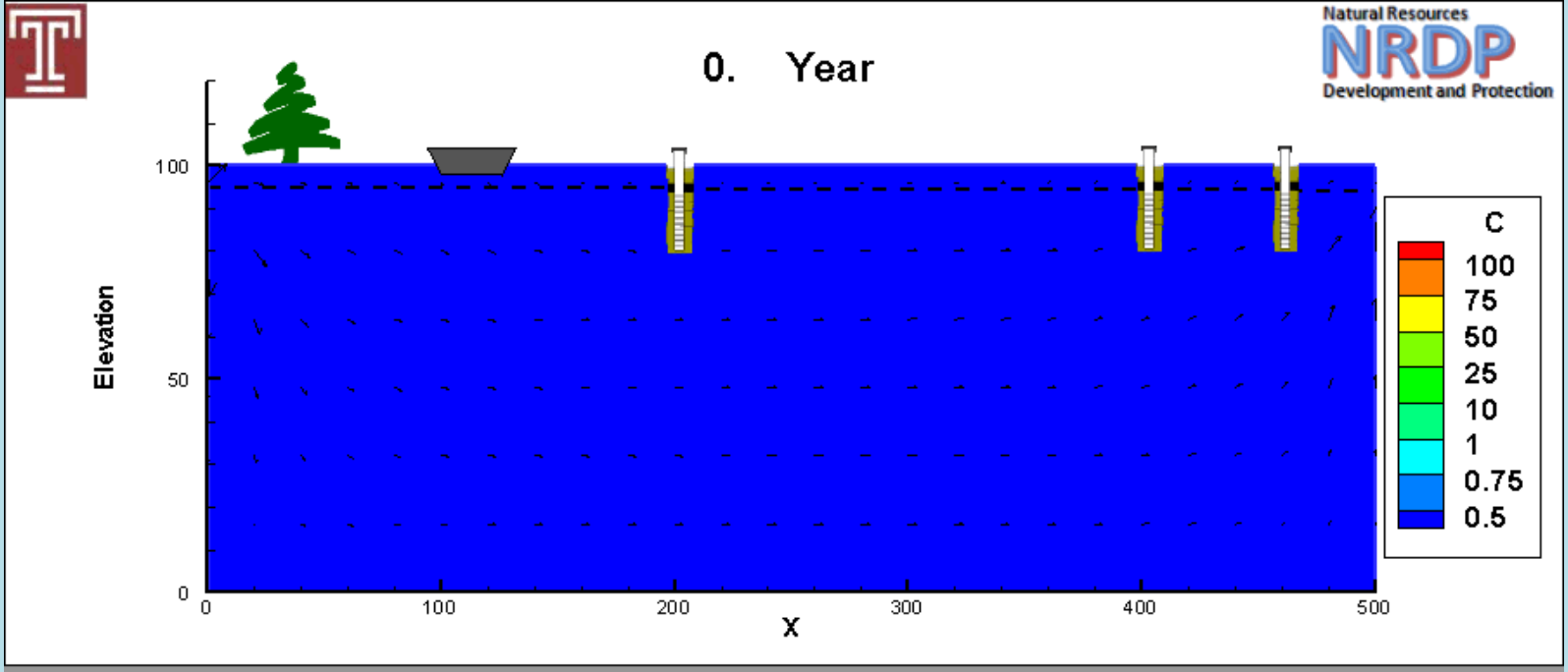
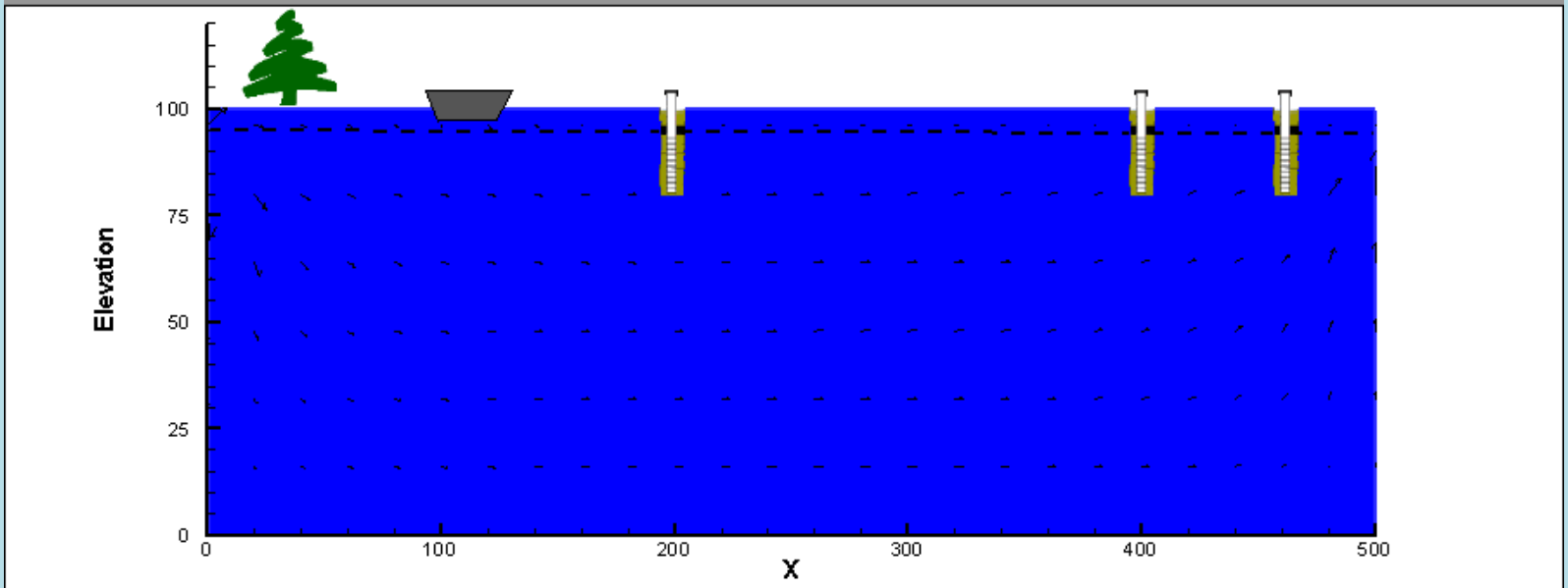
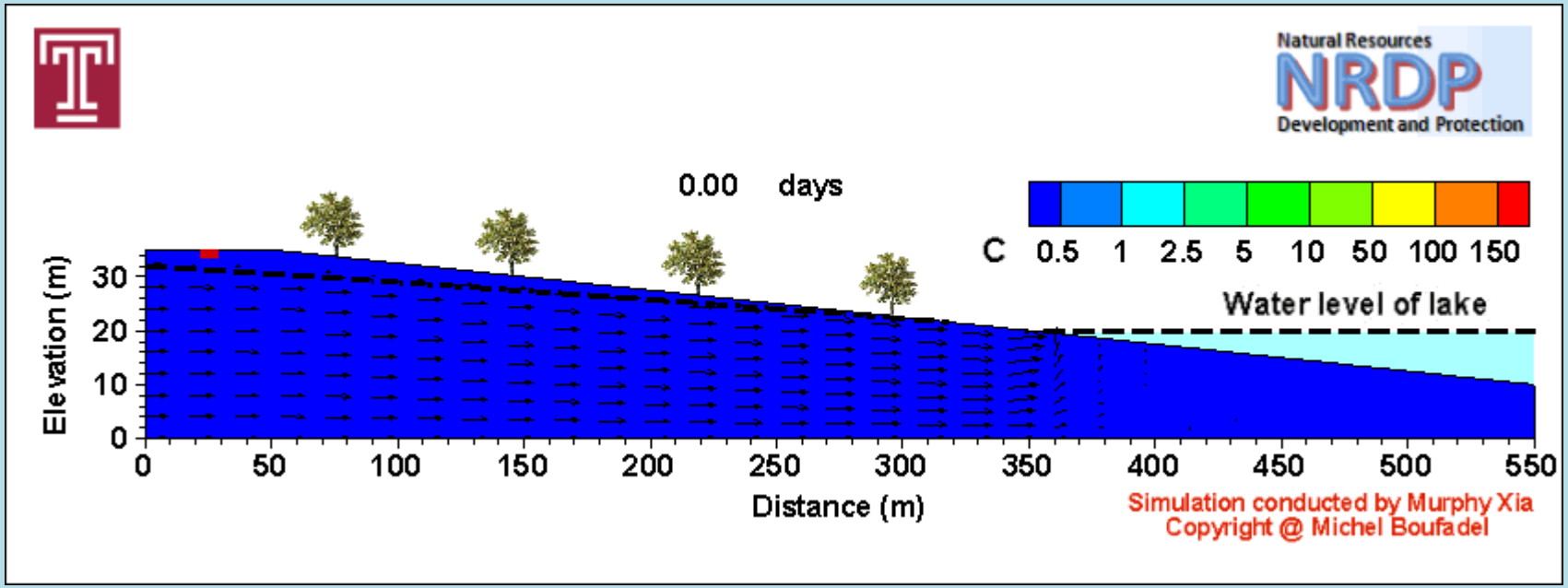
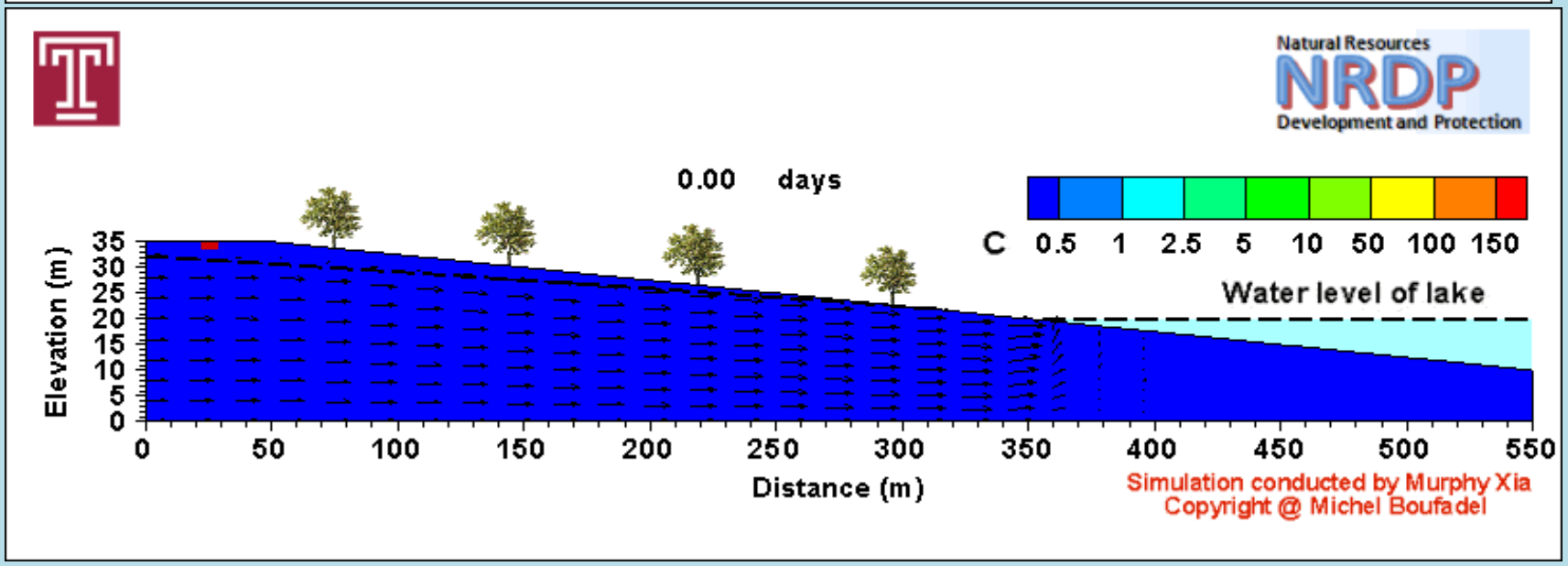




Clearfield County Well Blowout?

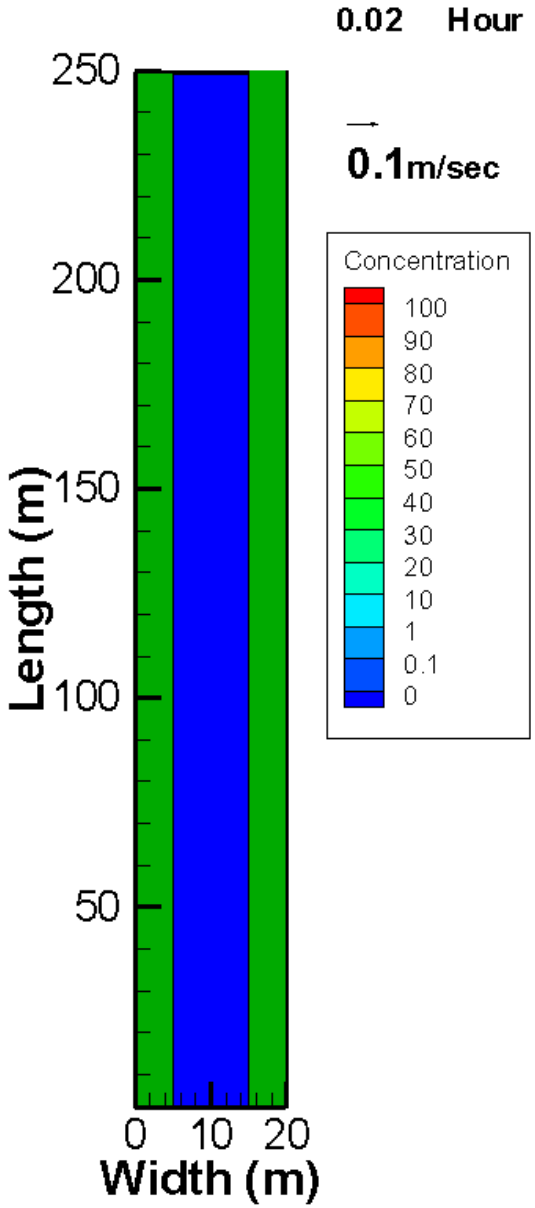




Rivers

Stream

Stagnant Zones



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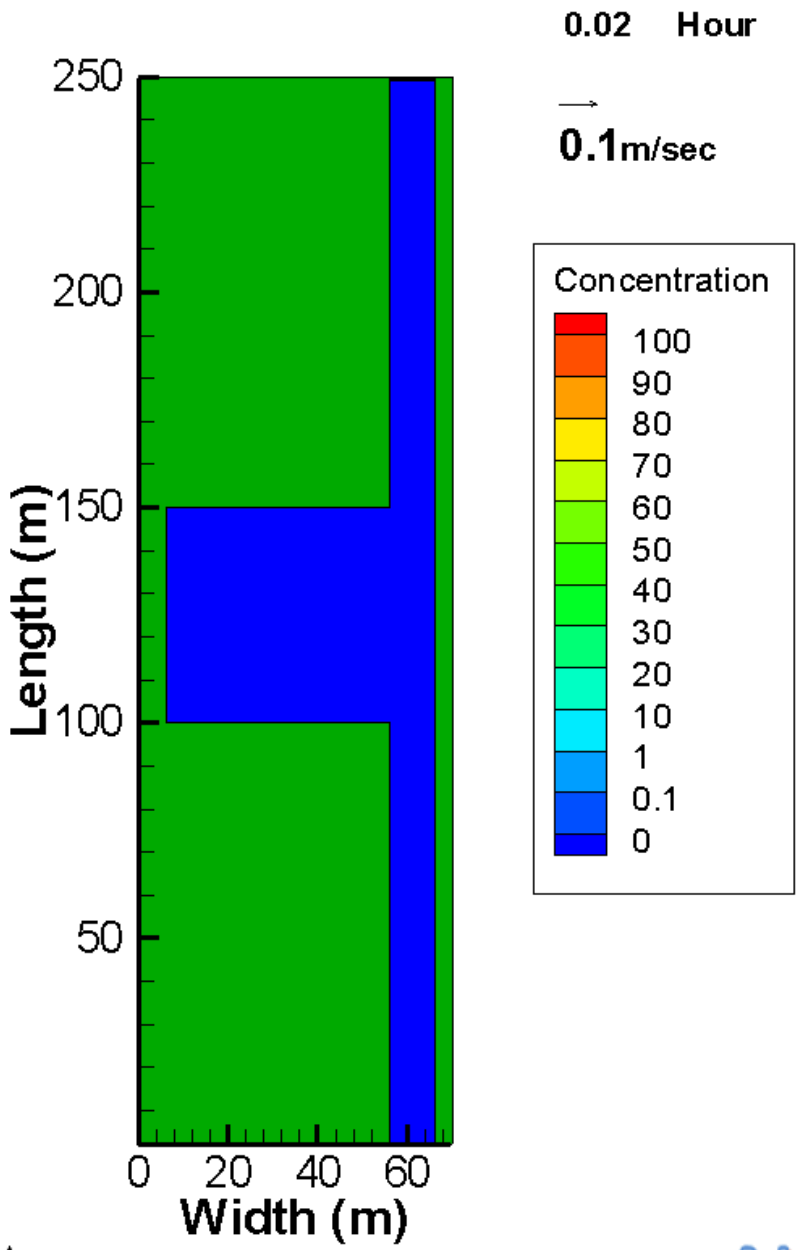

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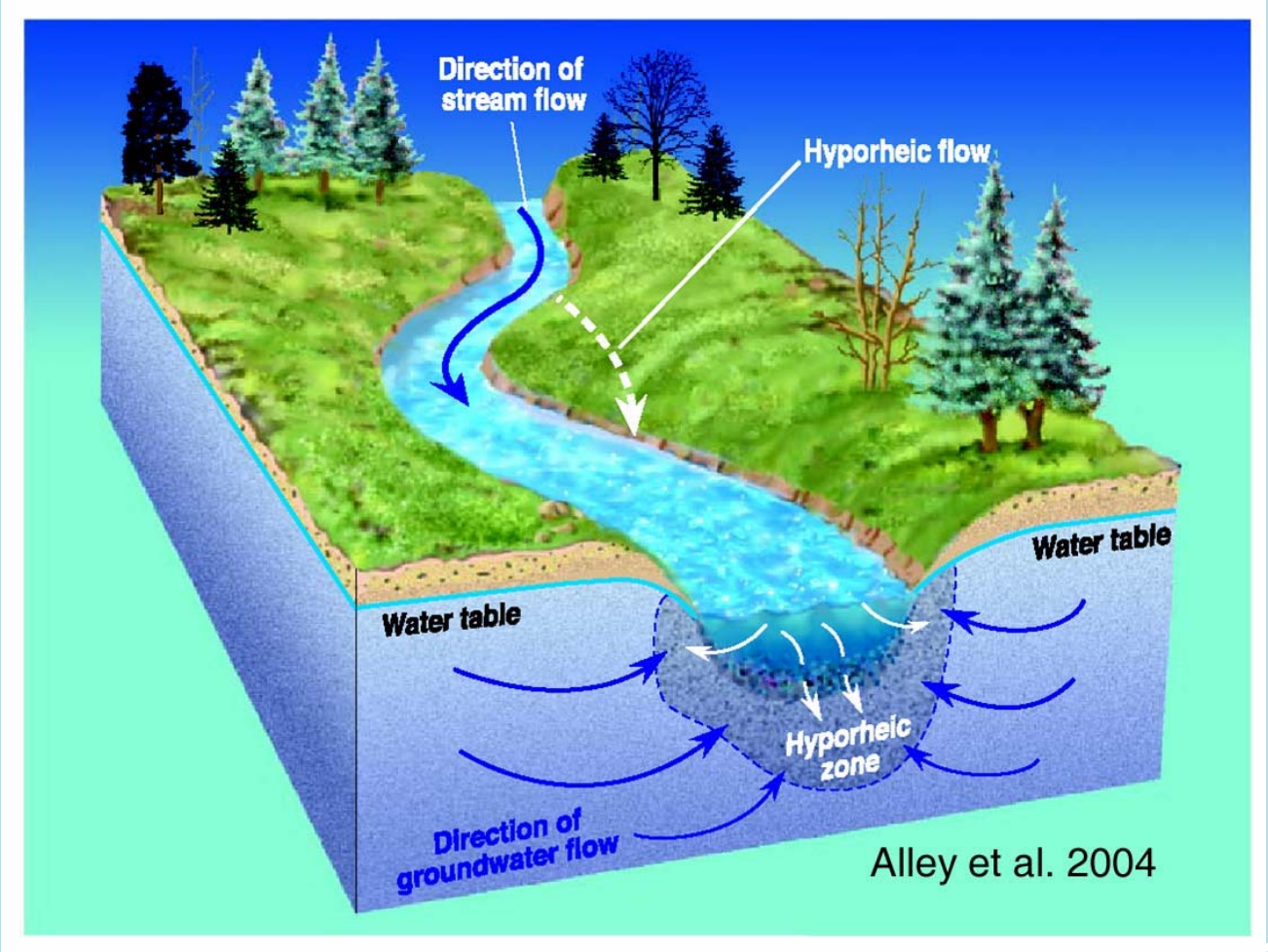
Hyporheic Exchange

- Exchange flow varies along the stream



Risk Maps

Similar to Floodplain Maps

Summary and Recommendations

- Monitoring is not sufficient.
- Inspectors are not sufficient.
- Risk assessment studies should be conducted.
  - Models that account for migration through multiple pathways: Air, runoff, streams, and groundwater while allowing for biochemical reactions should be used.
  - Long term effects.
- Risk results could be presented as maps to better communicate with the lay person and provide concise information to decision makers.

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Bilal Khan, Youness Sharifi, Adane Bobo

www.temple.edu/environment
boufadel@temple.edu