1,4-DIOXANE
Case Study, Eastham Landfill
Eastham, Massachusetts

Northeast Waste Management Officials
Association Seminar
September 2015

Paul Locke, MassDEP
Gerard Martin, MassDEP
Angela Gallagher, MassDEP

MassDEP 1,4-Dioxane Case Study
Occurrence of 1,4-D in Groundwater in Massachusetts

LEGEND

Cities/Towns with Detections of 1,4-Dioxane Below GW-1/0RS-0
Cities/Towns with Detections of 1,4-Dioxane Above GW-1/0RS-0

Source: UCRM Data, MassDEP Site File Viewer, MassDEP Solid Waste Files

THIS DATA IS FOR REFERENCE ONLY; THIS DATA IS NOT INTENDED TO BE USED FOR DECISION MAKING.
MassDEP 1,4-Dioxane Case Study

**Site Location**

- Cape Cod Bay
- Atlantic Ocean
- Route 6
- Eastham Landfill

**Background Information**

- Eastham Landfill
- Moll's Pond
- Minister's Pond
MassDEP 1,4-Dioxane Case Study
Geology/Contaminant Profile

• Site Hydrogeology
  – Depth to groundwater at 45 feet
  – Outwash aquifer consisting of stratified sand and gravel to 60 feet
  – Sandy till with silt and clay to 150
  – Sand and blue at depths greater than 150

• Shallower groundwater high iron and nitrates
• Groundwater at greater depths found to contain VOCs in past
  – Vinyl chloride in the groundwater migrating from the landfill travelled in the deeper portion of the outwash aquifer and at greater distances than landfill leachate indicator parameters

MassDEP 1,4-Dioxane Case Study
Immediate Response Action (IRA)

• November 2012 through January 2013
  – Landfill Sampling event indicated groundwater from MW-3D contained 1,4-D >3.0 µg/L near a private water supply well
  – Sampled residential private wells immediately downgradient of Landfill
    • 1.7 µg/L 1,4-D in sample from private well
  – Provided bottled water
  – Expanded private water supply well sampling
  – Three properties provided bottled water
  – MassDEP issues Conditional Approval of written IRA Plan with requirement to submit quarterly Status reports and continue private water supply wells sampling
    • Town of Eastham has samples analyzed with a < 0.3 µg/L detection limit to meet ORS-Guideline
MassDEP 1,4-Dioxane Case Study
Approximate Study Area

MassDEP 1,4-Dioxane Case Study
Preliminary Analytical Results

Range of 1,4-Dioxane Concentrations in Landfill Monitoring Wells
And Downgradient Private Water Supply Wells with Well Depths
Late 2012 to early 2013

- MW-SS, SD:
  - 1.2 ug/L (74)
  - ≤0.2 ug/L (116)

- MW-4S, SD:
  - 0.2 ug/L (71)
  - ≤0.2 ug/L (91)

- MW-2S, SD:
  - 0.47 ug/L (88)
  - 0.14 ug/L (66)

- MW-2S, MW-3L:
  - ≤0.2 ug/L (92)
  - ≤0.2 ug/L (62)

- 11 Edie Way:
  - 3.1 ug/L (17)

- 325 Scholes Road:
  - 6.7 ug/L (219)

- 30 Knories Street:
  - 3.1 ug/L (212)

- 30 Knories Street:
  - 2.1 ug/L (22)

- 30 Knories Street:
  - 1.0 ug/L (98)

- 20 Alston Avenue:
  - 3.1 ug/L (57)

- 100 Meetinghouse Road:
  - 3.1 ug/L (57)

- 20 Alston Avenue:
  - 3.1 ug/L (57)

- 325 Scholes Road:
  - 6.7 ug/L (219)

- 30 Knories Street:
  - 3.1 ug/L (212)

- 30 Knories Street:
  - 2.1 ug/L (22)

- 30 Knories Street:
  - 1.0 ug/L (98)
MassDEP 1,4-Dioxane Case Study  
MassDEP, EPA and BU Partnering

• EPA Personnel
  – Provided four personnel from Chelmsford lab to conduct sampling of private water supply wells (analyses paid for by Town) in April/May 2013

• MassDEP personnel assisted
  – Provided risk communication assistance
  – Door to door visits to gain access
  – Provided information to owners regarding “what to expect”, “next steps”, “how to read analytical data”

• BU Superfund Research Project Personnel
  – Provided additional risk communication

MassDEP 1,4-Dioxane Case Study  
Large-Scale Sampling Program

• March 2013 (1st IRA Status report)
  – 8 properties (6 residential private wells) with 1,4-dioxane > 0.3 µg/L
  – Approximately 20 additional private wells with detections of 1,4-dioxane < 0.3 µg/L

• June 2015 (10th and latest IRA Status report)
  – A total of 293 private wells tested in the landfill study area
  – 42 properties (38 private wells) with 1,4-Dioxane > 0.3 µg/L
  – 108 additional private wells with detections of 1,4-dioxane < 0.3 µg/L
  – 143 private wells with 1,4-dioxane not detected
  – Selected private wells were sampled outside of the study area for background purposes
    • 1,4-dioxane detected in samples from some of those wells, but below 0.3 µg/L
MassDEP 1,4-Dioxane Case Study
Granulated Activated Carbon (GAC) Pilot Test

• GAC point-of-entry treatment system installed at one residence
  — 110 pounds of acid washed, coconut based, 12x40 virgin GAC in two vessels
  — Sample valves to collect influent, midpoint, and effluent water samples
  — Flow meter to determine volume treated

• Samples were collected weekly to evaluate breakthrough at first carbon vessel
  — Influent concentration ranged between 1.3 to 2.2 µg/L

• Carbon change-out at 90 days
  — Secondary GAC unit is moved to the primary location
  — Removed primary and replaced with virgin carbon
  — Total volume of water before breakthrough appears to be approximately 10,000 gallons
  — Carbon treatment system adsorbed approximately 73 mg of 1,4-dioxane
MassDEP 1,4-Dioxane Case Study
Advanced Oxidation Pilot Test

• Zuvo point-of-entry filtration system
  – Five step process:
    • disinfect water and remove lead via ozone
    • Apply UV light
    • Photo oxidation
    • Filtration, and
    • Post filtration UV light
  – UV and ozone reportedly successful in destroying 1,4-dioxane
  – Bench test using water sample from Eastham
    • Results were promising

MassDEP 1,4-Dioxane Case Study
Advanced Oxidation Pilot Test

• Installed at a residential property
  – Influent and effluent samples collected after 92 minutes of operation
    • Influent: 2.0 µg/L; Effluent 1.8 µg/L
    • 10% removal efficiency
  – Influent/Effluent samples after 158 minutes:
    • Influent 2.0 µg/L; Effluent 1.6 µg/L
    • 20% removal efficiency

  NOT EFFECTIVE AT TREATING 1,4-dioxane
MassDEP 1,4-Dioxane Case Study

Conceptual Site Model

• Does 1,4-dioxane migrate in groundwater the same as vinyl chloride?
  – Observed 1,4-dioxane in groundwater from deeper overburden aquifer and downgradient of groundwater with measurable leachate parameters
  – However, also observed 1,4-dioxane at concentrations above 0.3 µg/L in groundwater cross-gradient groundwater flow lines extending from the landfill of leachate plume contain 1,4-dioxane

• Confounding Sources
  – Cosmetic and personal care products (such as laundry detergent) from septic systems

• Sample Septic Systems

---

MassDEP 1,4-Dioxane Case Study

Private Septic System Sampling

Analytical Results – Residential Properties
Private wells versus Septic Grey Water

<table>
<thead>
<tr>
<th></th>
<th>Residence 1</th>
<th>Residence 2</th>
<th>Residence 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2/19/2013</td>
<td>4/14/2014</td>
<td>6/19/2014</td>
</tr>
<tr>
<td>Private well</td>
<td>0.26</td>
<td>&lt;0.144</td>
<td>.0910J</td>
</tr>
<tr>
<td>Gray water</td>
<td>0.887</td>
<td>3.7</td>
<td>0.596</td>
</tr>
<tr>
<td>7/23/2013</td>
<td>.11J</td>
<td>5.03</td>
<td>0.217</td>
</tr>
<tr>
<td>3/27/2014</td>
<td></td>
<td></td>
<td>.075J</td>
</tr>
<tr>
<td>6/16/2014</td>
<td></td>
<td></td>
<td>&lt;0.144</td>
</tr>
<tr>
<td>4/30/2013</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5/8/2014</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6/17/2014</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

• Consultant concluded that these residences using products containing 1,4-D, and the Landfill is not a source
• Other issue – private water supply wells re-circulating groundwater impacted with 1,4-dioxane water through septic system

---
MassDEP 1,4-Dioxane Case Study

Municipal Water Issue

- No municipal water in the Town of Eastham
  - Trying to vote in municipal water since the 1970s
  - Several attempts by proponents and Selectmen to vote in municipal water
  - 1,4-dioxane was not the only issue
    - High nitrates
    - High fire insurance rates (no fire hydrants)
    - Higher costs for business owners maintaining community water supplies
  - In May 2015 the Town voted to build an municipal water system
    - Currently being installed

MassDEP 1,4-Dioxane Case Study

Status of IRA

- IRA status reports are required until the impacted residences are connected to municipal water without a cross-connection
- Site is “adequately regulated” under MCP, and will revert back to Solid Waste once IRA is completed
- Continued activities under Solid Waste Landfill Monitoring Program to define extent of 1,4-dioxane
MassDEP 1,4-Dioxane Case Study

THANK YOU

Contact Information

Paul Locke: Paul.Locke@state.ma.us
Gerard Martin: Gerard.Martin@state.ma.us
Angela Gallagher: Angela.Gallagher@state.ma.us