Geothermal Drilling Regulations in Connecticut

John F. Sima III

Presented to Northeast Regional Geothermal Workshop
EPA Northeast Regional Laboratory
March 29, 2011
Topics

- Geoexchange Borehole Diameter
- Closed-loop geoexchange fluid
- Closed-loop geoexchange system piping
- Separating distances
- Grouting
Topics (ctd.)

• Borehole Termination
• Abandonment
• Reporting
• Licensing
• Permits
Status of the Regulations

• These regulations have completed their review and public comment period.
• Promulgation is expected this summer.
Geoexchange Borehole Diameter

- Minimum four (4) times the Inside Diameter of largest loop pipe employed in the borehole
  - Allows for proper placement of pipe and grout
1-1/4" Loops

minimum 5" hole

1" Loops

minimum 4" hole

1-1/2" Loops

minimum 6" hole
Closed Loop Geoexchange Fluids

- Refrigerants R-134a, R-407c, R-410a
- Potable Water
- Mixtures of max 20% food grade Propylene Glycol or Potassium Acetate
- Other geoexchange system fluids or additives approved by the Department of Consumer Protection in consultation with Department of Public Health
Closed Loop Geoexchange Fluids

• All chemicals used or added to potable water, circulating through a closed-loop geoexchange system, shall meet NSF/ANSI Standard 60 or 61, or be approved by the DCP in consultation with DPH and DEP
Closed Loop Geoexchange System Piping

• Copper, provided that a cathodic protection system be employed where soil conditions are judged by registered contractor, or local or state authority, to be beneficial to the longevity of the copper.
Closed Loop Geoexchange System Piping

• High Density Polyethylene having cell classification of PE 345434c or PE 355434c . . . . , and listed as a PE 3408

• Materials approved by DCP, in consultation with DPH and DEP
Approved Pipe-Joining Methods

• For Copper – brazed joints
• For Polyethylene – heat fusion according to manufacturer’s specifications, OR by mechanical stab fittings approved by IGSHPA
• For Other – by methods approved by DCP in consultation with DPH and DEP
Connections to Domestic Water Supply

• Must include a reduced pressure backflow preventer
Closed-Loop Geo Wells
Minimum Separating Distances

• 25 feet from:
  – Watertight Septic tanks
  – Watertight Grease traps (tanks)
  – Watertight Pump chambers
  – (In practice, CT DPH does not consider any of these to be watertight)
Closed-Loop Geo Wells
Minimum Separating Distances

- 50 feet from:
  - Subsurface sewage disposal leaching system
  - Septic Tanks
  - Grease Traps
  - Pump Chambers
  - Non-watertight sewer mains
  - Underground fuel tanks
Closed-Loop Geo Wells
Minimum Separating Distances

• 10 feet from:
  – Tight-Joint sewer pipes
  – High water mark of surface water body
  – Drain carrying surface water
  – Foundation drain
  – (Note – geoexchange piping that is not using a well may be placed directly in a body of water)
Connecticut Closed Loop Wells
Safe Separating Distances
Water and Buried Pipes
Closed-Loop Geo Wells
Minimum Separating Distances

• 25 feet from:
  – Private water supply well with withdrawal rate less than 10 gpm
  – Public water supply well with withdrawal rate less than 10 gpm
Closed-Loop Geo Wells
Minimum Separating Distances

• 50 feet from:
  – Private supply well with withdrawal rate greater than 10 gpm
  – Public water supply well with withdrawal rate greater than 10 gpm, but less than 50 gpm
Closed-Loop Geo Wells
Minimum Separating Distances

• 200 feet from:
  – Public water supply well with withdrawal rate greater than 50 gpm
Public or Private well if withdrawal rate is <10 gpm

Private well if withdrawal rate is >10 gpm

200 ft.

Public well if withdrawal rate is >50 gpm

25 ft.

geoexchange well

50 ft.

Public well if withdrawal rate is >10 but <50 gpm

Connecticut Closed Loop wells
Safe Separating Distances
Potable Water Wells
geo well separating dists 3.dwg
Open-Loop Geo Wells
Minimum Separating Distances

• Minimum Separating Distances are the same as for potable supply wells (see Section 19-13-B51d)

• For required withdrawal less than 10 gpm:
  – Septic leaching, etc. - 75’
  – Tight-joint sewer - 25’

• This includes Standing Column wells
Open-Loop Geo Wells
Minimum Separating Distances

• For withdrawal rate greater than 10, but less than 50 gpm:
  – Septic leaching, etc. - 150’
  – Tight-joint sewer - 50’
Open-Loop Geo Wells
Minimum Separating Distances

• For withdrawal rate greater than 50 gpm:
  – Septic leaching, etc. - 200’
  – Tight-joint sewer - 100’
(b) All structures or facilities for the treatment or disposal of sewage or septage shall be located at least 50 from any open water source and 100 feet from any public supply reservoir, unless designed and constr prevent the leakage or overflow of raw or treated sewage to the ground or surface water.

(c) All structures, facilities or locations containing sewage or septage which is exposed to the atmosphere located at least 150 feet from any school, residential building or institution, and shall be fenced or other made inaccessible to the public.

(d) The following minimum separating distances shall be maintained between any discharge or overflow of treated sewage or septage to the ground waters and any drinking water supply well or spring.

<table>
<thead>
<tr>
<th>Required Withdrawal Rate</th>
<th>Minimum Separation Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 10 gallons per minute</td>
<td>75 feet</td>
</tr>
<tr>
<td>10 to 50 gallons per minute</td>
<td>150 feet</td>
</tr>
<tr>
<td>Over 50 gallons per minute</td>
<td>200 feet</td>
</tr>
</tbody>
</table>

(e) The following minimum separating distances shall be maintained between any sewer, structure or facility the conveyance or treatment of sewage or septage and any drinking water supply well or spring.

<table>
<thead>
<tr>
<th>Required Withdrawal Rate</th>
<th>Minimum Separation Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 10 gallons per minute</td>
<td>25 feet</td>
</tr>
<tr>
<td>10 to 50 gallons per minute</td>
<td>75 feet</td>
</tr>
<tr>
<td>Over 50 gallons per minute</td>
<td>100 feet</td>
</tr>
</tbody>
</table>

Statement of Purpose
Underground Piping
Minimum Separating Distances

- Piping (trenches) located between 5 ft. and 25 ft. from subsurface sewage disposal system shall not be backfilled with free-draining material.

- See *Technical Standards for Subsurface Sewage Disposal Systems, Table 1* for distances to utility trenches.
II. LOCATION OF SUBSURFACE SEWAGE DISPOSAL SYSTEMS

A. Minimum separating distance

The minimum separating distances specified in Table No. 1 are required and shall be maintained be any part of a subsurface sewage disposal system, except certain piping, and the cited items. Tables 2, 2-C and 2-D list specific applications whereby specified piping shall have reduced separating distances.

Table No. 1

<table>
<thead>
<tr>
<th>Item</th>
<th>Separating Distance (Feet)</th>
<th>Special Provisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Water supply well (potable, open loop geothermal, irrigation), spring or domestic water suction pipe. Required withdrawal rate:</td>
<td>75</td>
<td>1. Separating distance to the leaching system shall be doubled when the percolation rate is faster than one minute/inch and the leaching shall be at least 8 feet above ledge rock. 2. Separating distance shall be increased as necessary to protect the quality of a public water supply well.</td>
</tr>
<tr>
<td>&lt; 10 gal. per minute</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>10 to 50 gal. per minute</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>&gt; 50 gal. per minute</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>B. Human habitation on adjacent property</td>
<td>15</td>
<td>Building without drains. See items G &amp; H for distance to buildings</td>
</tr>
<tr>
<td>C. Building served</td>
<td>15</td>
<td>Building without drains. See items G &amp; H for distance to buildings. Separating distance to a septic tank, septic tank/pump chamber/gas tank shall be reduced to 10 feet for buildings without drains.</td>
</tr>
<tr>
<td>D. Open watercourse</td>
<td>50</td>
<td>When not located on a public water supply watershed, distance is necessary to not less than 25 feet from in existence prior to the this regulation (8/16/82) and thereafter recorded as required by s</td>
</tr>
<tr>
<td>E. Public water supply reservoir</td>
<td>100</td>
<td>Tight pipe with rubber gasketed joints or accepted equal (see Table) exempted from this requirement as long as the pipe excavation is with free draining material, however no tight pipe shall be less than</td>
</tr>
<tr>
<td>F. Surface or groundwater drain constructed of solid pipe</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>foundation, etc.), storm water infiltration or retention/detention system located up gradient, or on the side of system.</td>
<td>25</td>
<td>1. No such drain shall be constructed down gradient of the leaching system purpose of collecting sewage effluent regardless of the distance. 2. Distance to septic tank/pump chamber/grease interceptor tank shall be 1 to 25 feet if tank is verified to be watertight (Concrete tanks: See Section.)</td>
</tr>
<tr>
<td>H. Groundwater drains (curtain, footing, foundation, etc.), storm water infiltration or retention/detention system located down gradient.</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>I. Top of embankment (Down gradient and on sides)</td>
<td>10</td>
<td>Cuts within 50 feet down gradient of leaching systems shall not be allowed bleed-out conditions are possible. 1. Separating distance between the primary leaching system and a down g property line shall be increased to 25 feet whenever MLSS is applicable. 2. Separating distance to the leaching system shall be increased to 15 feet whenever the top of the leaching system is above natural grade unless gra rights from the affected property owner are secured or retaining walls are (See Section VIII A for retaining wall provisions).</td>
</tr>
<tr>
<td>J. Property line</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>K. Potable water and/or irrigation lines which flow under pressure</td>
<td>10</td>
<td>Excavations between 10 – 25 feet from system shall not be backfilled with draining material.</td>
</tr>
<tr>
<td>L. Below ground swimming pool</td>
<td>25</td>
<td>See item H for down gradient pools with drains.</td>
</tr>
<tr>
<td>M. Above ground swimming pool</td>
<td>10</td>
<td>Includes hot tubs.</td>
</tr>
<tr>
<td>N. Accessory structure</td>
<td>10</td>
<td>Structure shall have no footing drains. See items G &amp; H if drains provided. Structures without full wall, frost protected footings shall be reduced to 5</td>
</tr>
<tr>
<td>O. Utility service trench (Underground electric, gas, phone services, etc.)</td>
<td>5</td>
<td>Excavations between 5 – 25 feet from system shall not be backfilled with draining material.</td>
</tr>
<tr>
<td>P. Water treatment wastewater disposal system</td>
<td>10</td>
<td>See Section X.</td>
</tr>
<tr>
<td>Q. Closed loop geothermal system</td>
<td></td>
<td>Separating distance from borehole to leaching system and watertight tank reduced to 50 feet and 25 feet, respectively, as long as a CT licensed well installs borehole with a permit certifying construction standards per Depa Public Health EHS Circular Letter #2007-12 dated April 27, 2007. Excavation between 10 – 25 feet from system shall not be backfilled with free drainin material.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Borehole (Vertical)</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Horizontal loop/geothermal piping</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>
Non-Vertical Closed Loop
Minimum Separating Distances

• Namely – “DX” closed loop wells
• Measure separating distances from any point along the borehole
Grout Materials

• Grout 111
  – 94 lb Portland Cement
  – 6.19 gallons water
  – 200 lb. Sand (specific gradation and composition)
  – 21 oz. Superplasticizer
  – 1.04 lb. Bentonite (optional)
Grout Materials

• High Grade Bentonite or Thermally Enhanced Bentonite
  – Minimum 20% (by weight) of Bentonite, and coefficient of permeability of $10^{-7}$ cm/sec.

• Other
  – Other materials approved by Dept. Consumer Protection in consultation with DPH
Grout Mixing and Installation

- Follow manufacturer’s specifications
- Use whether formation is consolidated or unconsolidated
- Grout within 7 days of completion of drilling
- Cover borehole with protective layer of bentonite solids 1 ft thick x 3 ft wide
- Install detectable tape over boreholes
Grout Installation Methods

• Use Tremie Method
• Fill the entire borehole, beginning at the bottom
• Minimum diameter for uncased boreholes is 3.5 inches (to ensure room for tremie)
• Minimum diameter for cased boreholes is 4 inches
• Drilling mud and cuttings shall not be mixed into the borehole
Borehole Termination

• Outdoors - Minimum 4 feet below surface
• Indoors – Flush with finished floor
• Cap the casing prior to grouting
• Casing may be removed as borehole is grouted
bury pipes at least 4 feet below surface

Magnetic Marking Tape

Bentonite chips - mounded at the top of the well
3 ft. diameter x 1 ft. high

Steel casing, when required

Grout in accordance with regulations

Termination of Exterior Geoexchange Borehole

ref: geothermal termination exterior.dwg
Geoexchange tubes

provide clearance for loop contraction

Steel casing extends 6 inches above floor

Grout in accordance with regulations

Termination of Interior Geoexchange Borehole

ref: geothermal termination interrior.dwg
Abandonment

• When decommissioning a geoexchange system:
  – Displace fluid with bentonite grout or evacuate it by an approved method
  – Cover borehole with bentonite solids at least 12 inches thick
  – Properly dispose of fluids removed
Completion Report - Filing

• File a report, within 60 days of completion, in a format acceptable to Dept. of Consumer Protection DCP)

• Send copies to Owner, DCP, DEP, and Local Health dept.
Completion Report - Content

- Location – address, GPS coordinates, nearest two cross streets
- Owner – name, address, phone number
- Borehole specifications – date finished, number of boreholes, depths, spacings, depths to bedrock, descriptions of materials encountered, amounts of casing, static water levels
Completion Report - Content

• Loop fields – Installer’s name, registration number, piping material used, number of loops, depths of loops, date last loop installed, date grouting finished, type of grout, bags (and weight) of grout per each borehole, cubic feet of grout per borehole
Completion Report - Content

• Type and volume of geothermal fluid to be used
• Confirm that detectable underground tape was used over boreholes
• Attach a diagram showing major buildings, septic systems, and water supply wells
Registration of Workmen

• Unlimited Drilling Contractor – W1
• Unlimited Well Driller – W2
• Limited Geothermal Contractor – W7
• Limited Geothermal Driller – W8
• Limited DX Geothermal Contractor – W9
• Limited DX Geothermal Driller – W10
• Trainees work under supervision of above
Permits

• Required for geoexchange wells
• Format of permit application must be approved by DCP
• Reviewed / approved by local health dept.
• Include map showing location of each borehole to roads and permanent land features
• Signed by registered contractor