

Draft for Stakeholder Discussion

*Note: This draft is a modification of the version dated May 6, 2009.
Added language is in **bold** type and deleted language has a ~~strike through~~.*

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY

FINAL DETERMINATION AND NOTICE REGARDING GEOTHERMAL HEAT PUMP CLOSED-LOOPS

In accordance with the authority vested in me pursuant to Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA), Section 3112, MCL 324.3112, I determine the following:

1. “**Vertical** geothermal heat pump closed-loop” (VCL) means a loop of piping installed in the earth in ~~trenches or boreholes~~, in a vertical, angled, or diagonal configuration, for the purpose of transferring heat between a building space and the earth.
2. Faulty installation or damage of a VCL may result in a direct or indirect discharge to waters of the state, as defined in Part 31 of the NREPA, and pose a threat to water resources and public health.
3. Failure to adequately and promptly seal (or grout) the annular space between the loop piping and borehole wall of a ~~vertical, angle-drilled or directionally-drilled~~ VCL, or failure to sufficiently plug a VCL that is ~~abandoned and no longer in service~~, may result in the following conditions:
 - a. Aquifer contamination that can adversely impact drinking water supplies. ~~(Pollutants such as sewage, animal wastes, agricultural runoff, surface runoff, fuels, pesticides, or fertilizers can move downward in an unsealed or improperly abandoned VCL and reach an aquifer used by nearby wells.)~~
 - b. Loss of natural artesian pressure in an aquifer.
 - c. Mixing of groundwater from different aquifers and change in water quality in an aquifer.
4. Local (county or district) health departments (LHDs) issue permits for the installation of on-site water systems and sewage disposal systems. Consequently, LHDs need to be aware of the proposed and permanent location of **VCLs and horizontal closed-loops** so that proper separation distances from sources of groundwater contamination, water supplies, sewage systems, and other on-site features can be attained.
5. Indirect or direct discharges to the waters of the state are prohibited, except as authorized by a Part 31 discharge permit.

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6. A discharge that causes or contributes to a violation of R 323.1041 through R 323.1117 of the Part 4 Rules, Water Quality Standards, promulgated pursuant to Part 31 of the NREPA, is a violation of Part 31. A person who violates Part 31 as a result of not adhering to the practices set forth in this ~~FDN~~ **Final Determination and Notice (FDN)** is subject to the penalties and actions set forth in Sections 3112, 3114 and 3115 of Part 31.

NOTICE

1. To abate discharges to waters of the state, it is hereby ordered that beginning on ~~August 1, 2009~~, **November 1, 2009**, any **VCL or horizontal closed-loop** that extends more than 15 feet below ground surface shall be constructed using nationally-recognized industry standards and other provisions as prescribed below.
2. If construction practices other than those described in this ~~Final Determination and Notice (FDN)~~ **FDN** are proposed to be used, a **VCL** installer or owner must apply for and receive a discharge permit pursuant to Part 31 of the NREPA before beginning the installation. Whether a person proposing an alternative practice must apply for an individual discharge permit or qualifies for a general discharge permit will be determined on a case-by-case basis by the Department of Environmental Quality (DEQ).
3. **VCL** boreholes shall be drilled and grouted by a water well drilling contractor who is registered pursuant to MCL 333.12704 of Part 127, Water Supply and Sewer Systems, of the Public Health Code, 1978 PA 368, as amended (Public Health Code) **and who has attained accreditation by the International Ground Source Heat Pump Association (IGSHPA) as a geothermal heat pump installer or vertical loop installer**, or by an individual performing under the direct supervision of a **an IGSHPA accredited** Michigan registered water well driller.
4. A person who by ~~September 30, 2009~~, **December 31, 2009**, provides evidence to the DEQ that ~~all~~ **both** of the following conditions have been met, may continue to engage in **VCL** installation **in Michigan** without having obtained a certificate of registration as a water well drilling contractor pursuant to Part 127 of the Public Health Code:
 - (a) For a period of not less than two years, the person has engaged in the installation of **VCLs** using practices that do not pose a risk to the environment or public health.
 - (b) ~~Possession of a valid license pursuant to the Forbes Mechanical Contractors Act (FMCA), 1974 PA 192, being MCL 338.971 et seq.~~
 - (c) ~~Certification~~ **Accreditation** as a geothermal installer **or vertical loop installer** by the International Ground Source Heat Pump Association (IGSHPA).

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5. **A Michigan Registered Water Well Drilling Contractor who is IGSHPA accredited as a geothermal installer or vertical loop installer, or a person meeting the provisions of Section 4 of this FDN, may install VCL vertical piping but shall not install horizontal header or manifold piping unless that person also possesses a valid license pursuant to the Forbes Mechanical Contractor's Act, 1974 PA 192, being MCL 338.971 et seq.**
6. **A person who is IGSHPA-certified accredited as a geothermal installer or vertical loop installer, who is employed by a licensed mechanical contractor or a registered water well driller, shall be on-site to supervise the installation of a VCL system and assure compliance with these standards.**
6. 7. **Not less than seven (7) business days 72 hours before installing a VCL system or a horizontal closed-loop system, the mechanical contractor or VCL installer shall provide the LHD and the DEQ, Water Bureau, with details of the proposed installation, as required on the attached Geothermal Closed Loop Construction Notice form. This submittal will provide state and local regulatory agencies with a permanent record of the location and construction features of each closed-loop system. If the LHD or the DEQ identify potential concerns with the proposed installation, the installer shall be notified within four (4) business days 48 hours of the date of the submitted plan with a written explanation of the concerns. If the installer is not notified within five (5) business days 48 hours after the submittal of the plan, the installer installation may proceed with the installation.**
7. 8. **The reporting provisions of Section 6 7. above may be modified at the discretion of the health officer of a LHD that is authorized to regulate regulates VCLs through a locally-adopted permitting ordinance at least as stringent as these standards, provided the installation records for CLs are forwarded to the DEQ by the local health department. A LHD that permits and inspects VCLs shall forward a copy of the Geothermal Closed Loop Construction Report to the DEQ within 30 days of receipt.**
8. 9. **The DEQ copy of the VCL installation notice shall be sent to: Department of Environmental Quality, Water Bureau, Drinking Water and Environmental Health Section, Well Construction Unit, P.O. Box 30273, Lansing, MI 48909-7773, or faxed to 517-241-1328.**
9. 10. **If a VCL was installed in a manner that differs substantially from the method described in the notification to the LHD and the DEQ, the installer shall file an amended record of installation within 30 days following completion of the installation.**
10. 11. **The following provisions shall apply to the grouting (sealing) of the annular space between the piping and borehole of VCLs vertical, angle-drilled, or directionally-drilled-CLs:**
 - (a) **Grouting shall be completed in a manner that prevents the introduction of surface or near surface contaminants into an aquifer, the interchange of**

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water from different aquifers, or the loss of natural artesian pressure from an aquifer.

- (b) The maximum allowable permeability value of the set grout shall be 1×10^{-7} centimeters per second, as determined in accordance with ASTM D5084-03, Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
- (c) Grouts such as neat cement, concrete grout, bentonite grout, and thermally-conductive **bentonite, and cementitious** grout, ~~that meet~~ **meeting** the provisions of the Michigan Water Well Construction and Pump Installation Code (Well Code), Groundwater Quality Control Rules, R 325.1601 *et seq.*, **or as specified below**, are acceptable for VCLs **under the conditions set forth in this FDN.**

Geothermal Vertical Closed Loop Grouting Materials

Hydrogeological Condition	Authorized Grouting Material
i. Saturated unconsolidated sand, gravel, clay, or combinations	Bentonite grout ¹ , thermally-conductive bentonite ² , neat cement ³ concrete grout ⁴ , or cementitious grout designed for geothermal applications ⁵ .
ii. Unsaturated, unconsolidated sand, gravel, clay, or combinations (vadose zone)	Thermally-conductive bentonite grout, or any grout listed in Section iii.
iii. Consolidated (bedrock) (e.g., sandstone, shale, limestone dolomite, granite, schist, conglomerates)	Neat cement, concrete grout, or cementitious grout
iv. Fractured, creviced, jointed, or cavernous limestone (Karst)	See grouts listed in Section iii. If lost circulation zones are encountered, grouting in those zones may be conducted using a mixture of cementitious grout and clean peastone aggregate or layered with a combination of cementitious grout and short intervals of bentonite chips.
v. Flowing artesian conditions encountered or expected	See grouts listed in Section iii.
vi. Methane or other gas encountered or expected	See grouts listed in Section iii.
vii. Groundwater with total hardness over 500 ppm or chlorides over 1,500 ppm encountered or expected	See grouts in listed in Section iii.

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1. ***“Bentonite grout” means a slurry which consists of sodium montmorillonite bentonite and water and which has a solids concentration of not less than 20 percent. A slurry of drilling fluid bentonite and water or drilled cuttings, either singularly or in combination, is not bentonite grout.***
 2. ***“Thermally-conductive bentonite grout” means a bentonite grout into which silica sand or other materials approved by the DEQ have been added to improve the thermal characteristics for geothermal applications, with a minimum solids content of 60 percent.***
 3. ***“Neat cement” means a mixture of one (1) bag of Portland cement (94 pounds) and not more than six (6) gallons of fresh water. Drilling fluid bentonite that is not more than five (5) percent by weight of cement and additional water that is not more than 0.6 gallons for each one (1) percent of bentonite may be added to neat cement.***
 4. ***“Concrete grout” means a mixture of cement, sand, and water in the proportion of one (1) bag of cement, and equal volume (1 cubic foot) of dry sand or gravel aggregate, and not more than six (6) gallons of fresh water.***
 5. ***“Cementitious grout” means a mixture of the following, or other cement-based admixtures designed for geothermal applications as authorized by the DEQ prior to use:***
 - a. ***6.2 gallons of fresh water.***
 - b. ***200 pounds of silica sand with not less than 80 percent of the sand having a diameter smaller than 0.0117 inches and passing through a U.S. Sieve #50.***
 - c. ***1 pound of 200-mesh sodium montmorillonite bentonite.***
 - d. ***94 pounds of Type I Portland cement conforming to ASTM International Standard C150 – 07, Standard Specification for Portland Cement.***
 - e. ***21 fluid ounces of a Type F water reducing admixture (or plasticizer) conforming to ASTM Standard C494/C494M – 08a, Standard Specification for Chemical Admixtures for Concrete.***

d. ~~Grouts used for the portion of a CL installed in bedrock or in a location where flowing artesian conditions are encountered or known to occur shall be either neat cement as defined in R 325.1603(a), concrete grout as defined in R 325.1602, or a fluid mixture comprised of all of the following:~~

 - i. ~~Not more than 6.5 gallons of fresh water.~~
 - ii. ~~Not more than 200 pounds of silica sand with not less than 80 percent of the sand having a diameter smaller than 0.0117 inches and passing through a U.S. Sieve #50.~~
 - iii. ~~Not more than 1.00 pound of 200-mesh sodium montmorillonite bentonite.~~
 - iv. ~~Not more than 94 pounds of Type I Portland cement conforming to ASTM International Standard C150 – 07, Standard Specification for Portland Cement.~~
 - v. ~~A Type F water reducing admixture conforming to ASTM C494/C494M – 08a, Standard Specification for Chemical Admixtures for Concrete.~~

A grout proposed to be used for the bedrock portion of a VCL which is not listed in Section 11c, shall not be used unless written authorization has been given by the LHD health officer or the DEQ before use.

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- e. **Copper VCL piping for direct exchange geothermal systems shall not be used unless the grout/piping combination has been shown by a third party testing laboratory to not result in pipe corrosion.**
- e. f. All grouts, drilling fluids, and additives **to grouts and drilling fluids, including sand added to grout as a thermal-enhancer**, shall meet NSF/ANSI Standard 60 – 2005, Drinking Water Treatment Chemicals – Health Effects.
- ~~f. Grouts which do not meet the provisions of Sections 10.c. or 10.d. shall not be used without prior written authorization from the department.~~
- ~~g.~~ g. The annular space between the VCL piping and the borehole shall be grouted **in one continuous operation from bottom to top** using procedures set forth in the Well Code or the IGSHPA Grouting for Vertical Heat Pump Systems, Engineering Design and Field Manual, 2000. **Grout shall be mixed and placed in accordance with the grout manufacturers' specifications.**
- ~~h.~~ h. Spacing devices intended to place VCL piping in direct contact with the borehole wall shall not be used.
- ~~i.~~ i. A tremie pipe (or grout pipe) of sufficient size **not less than 1.25 inches nominal diameter** shall be placed to the bottom of the borehole **prior to** grouting. **The tremie pipe** may be retracted as grouting proceeds, and shall be removed from the borehole after grouting.
- ~~j.~~ j. Grout shall be pumped from the bottom of the borehole until the density of the grout flowing from the annular space at the ground surface, **as measured with a mud scale**, is equal to the density of the grout being pumped in.
- ~~k.~~ k. During borehole construction, drilling fluid consisting of a bentonite clay viscosifier and water mixture shall be circulated to form a filter cake on the borehole wall to minimize borehole collapse. The borehole shall be kept full of bentonite drilling fluid until the loop piping is installed. ~~The drilling fluid shall be flushed before grouting.~~ **Before grouting the drilling fluid in the borehole shall be thinned until the drilling fluid density is lower than the grout density.**
- ~~l.~~ l. Boreholes shall be grouted within 24 hours after the CL piping is installed. **A Each VCL borehole shall be grouted upon completion. The contractor shall monitor each borehole for settling for a period of not less than 12 hours. Additional grout shall be added and the monitoring period shall be extended until settling of grout stops.**

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- m. **VCL boreholes drilled using horizontal directional drilling technologies shall be grouted by pumping grout as the grout pipe is retracted through the borehole.**
- 12. The Standard Dimension Ratio (SDR) and working pressure rating of VCL piping shall be sufficient to accommodate system pre-pressurization and the total dynamic head. The total system pressure shall remain below the working pressure of the pipe.**
- ~~1113.~~ Closed loop piping materials, joining methods, and pressure testing before backfilling or grouting shall adhere to the provisions of the Michigan Residential Code (MRC), 2006, Sections M2104.2.1 and M2105.1.
- ~~1214.~~ **All polyethylene pipe and tubing used in a VCL borehole shall be factory assembled and pre-tested prior to insertion into the borehole.**
- ~~1215.~~ **A closed-loop that is leaking shall be immediately excavated and repaired or the loop shall be permanently decommissioned in accordance with the procedures described herein in Section 19 of this FDN.**
- ~~1316.~~ **Heat transfer fluids shall be food-grade propylene glycol-water solution up to twenty (20) percent propylene glycol by volume, (20 percent), methanol-water solution up to twenty (20) percent methanol by volume, ethanol-water solution up to twenty (20) percent ethanol by volume, or other nontoxic compounds that meet IGSHPA Closed-Loop/Geothermal Heat Pump (GHP) Systems, Design and Installation Standards, 2007 2008 Edition, Section 3B and 3C, and are compatible with GHP manufacturers' specifications. Flammable liquids shall not be used. Final heat transfer fluid solutions shall not be flammable.**
- 17. VCLs for direct exchange geothermal systems shall use only a non-ozone depleting refrigerant such as R-410A , R 407C, R-22, or an equally safe refrigerant as specified by the heat pump manufacturer, as a heat transfer fluid.**
- ~~14-18.~~ **A VCL or horizontal closed-loop shall be installed in a location meeting the following minimum horizontal separation distances:**

Minimum Distance
to GHP Closed-Loop

Household drinking water well	50 feet
Type IIb* or III* public water well	75 feet
Type I* or IIa* public water well	200 feet
Residential on-site sewage system	25 feet
Buried water service line or sewer line	10 feet
Property line	10 feet

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* *As defined in 1976, PA 399, as amended, Rule 502, R 325.10502.*

Water lines and sewer lines that are crossed by geothermal ~~CL~~ **closed-loop** piping or header piping shall be protected by insulation and not less than 3 feet of separation **shall be maintained**.

Deviations to the above separation distances may be authorized by the LHD, in writing on a case-by-case basis or by a local ordinance, if public health, safety, and welfare are assured.

19. **Sites of groundwater contamination, as identified at the DEQ Environmental Mapper website (<http://mcgi.state.mi.us/environmentalmapper/>) or the occurrence of groundwater contamination as identified by a reliable source(s), that are closer than 800 feet to the VCL or VCL field, shall be evaluated to determine if site conditions exist that may prevent the installation of VCLs or if special grouting provisions are needed.**
- ~~15.~~**20.** A water make-up line to a ~~CL~~ closed-loop shall be protected with a backflow prevention device as specified in Section P2902 of the MRC, 2006, or Section 608.1 of the Michigan Plumbing Code, 2006, as applicable.
- ~~16.~~**21.** A VCL or VCL loop field that is no longer used shall be decommissioned by flushing the heat exchange fluid **with air** and completely filling the loop or loop field and header piping with grout as specified in the Well Code or IGSHPA standards. Filling the loop piping with grout shall be completed by a Michigan registered water well drilling contractor, ~~or by an individual who is an IGSHPA accredited geothermal installer or vertical loop installer, or by an individual performing under the direct supervision of a Michigan registered water well drilling contractor~~ **or an IGSHPA accredited geothermal installer or vertical loop installer**. A record of the abandonment shall be provided to the property owner, LHD, and the DEQ, Water Bureau, not later than 30 days after the VCL is plugged.
- ~~17.~~**22.** Surface water shall not be used as a source of water used during the drilling of a VCL borehole unless it is obtained from a municipal water supply system.
- ~~18.~~**23.** Water that is used for drilling purposes shall be potable water that contains a free chlorine residual of not less than 10 parts per million ~~at the time of use~~.
- ~~19.~~**24.** A VCL installed using angle drilling or directional drilling methods shall not extend closer than 10 feet from the vertical plane perpendicular to the ground surface at the property boundary. **A closed-loop shall not encroach upon adjacent property** unless the property owner has obtained a written and recorded easement or similar legal instrument **has been obtained** from the adjacent property owner.

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25. A property owner shall obtain permission from easement holders to install a geothermal closed-loop within or which crosses an existing or non-constructed easement location.

~~20-26.~~ This FDN, or the filing of a permit application in accordance with this FDN, does not authorize a discharge from a closed-loop.

~~24-27.~~ Adhering to the provisions of this FDN does not relieve an individual of his or her responsibility to obtain construction permits and approvals pursuant to other applicable state and local laws, regulations, and codes.

~~22-28.~~ In addition to the requirements set forth in this FDN, an individual who installs a closed-loop shall also comply with applicable state laws pertaining to utility notification before excavating or drilling and set-backs from road right-of-ways.

~~23-29.~~ This FDN does not supersede, rescind, or otherwise alter any other existing rule or statute pertaining to the pollution of the waters of the state, nor does it relieve any person from any reporting requirement imposed under federal, state, or local law or regulation.

Issued this _____ day of _____, 2009.

By: _____
Steven E. Chester, Director
Department of Environmental Quality

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Referenced Standards

1. International Ground Source Heat Pump Association, Closed-Loop/Geothermal Heat Pump Systems: Design and Installation Standards, ~~2007~~ **2008** Edition, International Ground Source Heat Pump Association (IGSHPA), 374 Cordell South, Oklahoma State University, Stillwater, OK 74078-8018. The IGSHPA standards are available for inspection at the office of the Department of Environmental Quality, Water Bureau, 525 West Allegan Street, Lansing, MI 48909 or online at www.igshpa.org.
2. Grouting for Vertical Geothermal Heat Pump Systems, Engineering Design and Field Manual, 2000, IGSHPA.
3. Michigan Water Well Construction and Pump Installation Code, Groundwater Quality Control Rules, R 325.1601 *et seq.*, adopted under authority of Part 127, Water Supply and Sewer Systems, 1978 PA 368, as amended, Public Health Code, MCL 333.12701 *et seq.* These regulations are available **online** at www.michigan.gov/deqwaterwellconstruction. www.michigan.gov/deq, through the following links: Water, Drinking Water, Water Well Construction. Under "Laws & Rules," select: "Well Construction Code Administrative Rules."
4. NSF/ANSI Standard 60 - 2005 – Drinking Water Treatment Chemicals – Health Effects. The NSF/ANSI standard is available for inspection at the office of the Department of Environmental Quality, Water Bureau, 525 West Allegan Street, Lansing, MI 48909, or available for purchase from NSF International, World Headquarters, 789 North Dixboro Road, Ann Arbor, MI 48105, www.nsf.org.
5. Forbes Mechanical Contractors Act, Michigan Mechanical Code, and Michigan Residential Code, available from the Department of Energy, Labor & Economic Growth, Bureau of Construction Codes, Mechanical Division at www.michigan.gov/dleg/0,1607,7-154-10575_17394_17566---,00.html.
6. ASTM D5084-03, Standard Test Methods for Measurement of Hydraulic Conductivity of Saturate Porous Materials Using a Flexible Wall Permeameter, ASTM C494/C494M – 08a, Standard Specification for Chemical Admixtures for Concrete, and ASTM C150 – 07, Standard Specification for Portland Cement. The ASTM standards are available for purchase from ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA, www.astm.org.

WCU 9/17/09