

March 2011

Geothermal Issues in NH



Geothermal System Issues in New Hampshire

Stephen Roy – Groundwater Permitting
Mitch Locker – UIC Program Manager

**NHDES Drinking Water and Groundwater Bureau
Hydrology and Conservation Section**

Overview of Presentation

- Process by which NH assessed up-and-coming Geothermal Issues
- Current state of regulatory drivers and upcoming rules
- Current regulatory framework
- Summary of some system tracking/use statistics
- Lingering concerns/issues pertaining to certain Geothermal Systems with examples

Geothermal Issues Review

- 2006/2007

Bureau staff compiles White Paper on Geothermal Issues brought about by stakeholder interest and inquiry;

- Summary of technology;
- Review other states rules;
- Review existing NHDES administrative rules that apply to geothermal systems;
- Review the state of compliance with existing rules;
- Identify Issues of concern and develop recommendations:
 - Construction Standards; Statutory Definition Issues:
 - Increased tracking; Need to streamline UIC registration process
 - More outreach to encourage registration

Geothermal Issues Review

- 2007/2008

Bureau Staff present recommendations to NH Water Well Board

- **In 2008, NH WWB re-adopts new well rules to include:**

- Modify well driller's construction form with 'geothermal' checkbox [better tracking];
- Establish Open Loop well construction standard;
 - Min. Setbacks, min. casing, return flow requirements (no pump-and-dump);
- Establish Closed Loop vertical well construction standard;
 - Requires Licensed contractor, new grouting standard, min. setbacks;

**** Since this time WWB has issue two 'limited' driller's licenses (via waiver) and has recently decided to develop stand-alone license specific to geothermal installations.**

Regulatory Drivers

- 2008/2009

Bureau Staff track reports, get input from consumers, designers, installers – hold stakeholder meeting to identify issues, concerns and problems. Work with legislature to pass SB48 in July 2009.

1. Change definition of well in state statutes (added... “or to transfer heat to or from the Earth”);
2. Gives NHDES rule-making authority to establish list of approved closed loop geothermal fluids and some practices that would prohibit a release of fluids;
3. Prohibits the use of open loop geothermal systems in areas impacted by seawater intrusion to avoid impacts to shallow (fresh) groundwater; and
4. Exempts open loop systems from state large groundwater withdrawal permit requirements provided ‘bleed’ water estimate doesn’t exceed permit threshold of 57,600 gallons per day. - This only applies to the larger open loop systems and additionally exempts them from water conservation rules.

Regulatory Drivers Closed Loops Heat Transfer Fluids

TABLE 1: FLUIDS ACCEPTABLE TO THE STATES
(of the sixteen states who specify fluids)

FLUID	NUMBER WHICH ACCEPT THE FLUID
Potable Water	All
Aqueous propylene glycol	13
Aqueous potassium acetate	10
Aqueous calcium chloride	6
Aqueous sodium chloride	3
Aqueous ethanol	3
HCFC-22	2
Glycerin (Pharmaceutical grade)	2
Dipotassium phosphate	2
Aqueous methanol	2
Calcium carbonate	1
Aqueous ethylene glycol	1
Salt water	1
"Others on approval"	1

(from DeBraven, 1999)

Table 8. Composite Results.

Category	Methanol	Ethanol	Propylene Glycol	Potassium Acetate	CMA	Urea
Life Cycle Cost	☆☆☆	☆☆☆	☆☆ ¹	☆☆ ¹	☆☆ ¹	☆☆☆
Corrosion	☆☆ ²	☆☆ ³	☆☆☆	☆☆	☆☆ ⁴	☆ ⁵
Leakage	☆☆☆	☆☆ ⁶	☆☆ ⁵	☆ ⁷	☆ ⁸	☆ ⁹
Health Hazard Risk	☆ ^{10,11}	☆☆ ^{10,12}	☆☆☆ ¹⁰	☆☆☆ ¹⁰	☆☆☆ ¹⁰	☆☆☆ ¹⁰
Fire Risk	☆ ¹³	☆ ¹³	☆☆☆ ¹⁴	☆☆☆	☆☆☆	☆☆☆
Environmental Risk	☆☆ ¹⁵	☆☆ ¹⁵	☆☆☆	☆☆ ¹⁵	☆☆ ¹⁵	☆☆☆
Risk of Future Use	☆ ¹⁶	☆☆ ¹⁷	☆☆☆	☆☆ ¹⁸	☆☆ ¹⁹	☆☆ ¹⁹

Key:
 ☆ Potential problems, caution in use required
 ☆☆ Minor potential for problems
 ☆☆☆ Little or no potential for problems

(from Heinonen, 1996)

- Some heat transfer fluids available for use by the industry have enforceable ambient groundwater quality standards in New Hampshire and are regulated substances.
- Others, if released, may biodegrade to the point of impacting surface water.

Upcoming Rules

- 2010 Draft Geothermal Rules

Bureau Staff complete draft rules relative to SB48 statutory requirements.

- Establishes approved list of heat transfer fluids for closed loop systems. - See JC's upcoming presentation.
- Establishes registration requirement and some construction standards for horizontal trench loops, lake loops and DX systems.
- Requires open loop systems proposed in Seacoast Communities only to test TDS of well water – if brackish or saline, must be a closed loop system, no open loop allowed.

Coming Soon – Hold initial stakeholder meetings and start formal rule adoption process.

Current Regulatory Framework

- Cover most Geothermal-related issues through our UIC/Groundwater Discharge program and WW rules. (New rules will be administered by the groundwater discharge program). Other programs apply on a case-by-case basis, e.g. NPDES, Water Use reporting, Water withdrawal permitting.
- UIC program coordinator currently using coupled database to track and encourage more compliance for all-things geothermal.
- Program divides systems into two primary classes by size (residential [single structure use] and industrial, commercial and institutional [ICI]).

Current Regulatory Framework – Forms: Residential and ICI

Geothermal Issues in NH



STATE OF NEW HAMPSHIRE
DEPARTMENT OF ENVIRONMENTAL SERVICES
29 HAZEN DRIVE, P.O. BOX 95
CONCORD, NH 03302-0095
(603) 271-2858

REGISTRATION FORM FOR SINGLE FAMILY RESIDENTIAL GEOTHERMAL AND GROUND SOURCE HEAT EXCHANGE SYSTEMS

Location of the Geothermal Well

Address: _____

- One Pager
- Who, What, Where
- Type, Where does Bleed go (if OLS)?
- If SCW 'Does it also provide Drinking Water?'



STATE OF NEW HAMPSHIRE
DEPARTMENT OF ENVIRONMENTAL SERVICES
WATER DIVISION
29 HAZEN DRIVE, PO BOX 95
CONCORD, NEW HAMPSHIRE 03302-0095
(603) 271-2858

REGISTRATION FORM FOR INDUSTRIAL, COMMERCIAL, INSTITUTIONAL, OR MULTI UNIT GEOTHERMAL/GROUND SOURCE HEAT EXCHANGE SYSTEMS USING UNDERGROUND INJECTION CONTROL (UIC) WELLS

- Facility Plan
 - System Type
 - Well Locations
- If OLS
 - Meters, sampling tap locations
 - Operational water balance estimate

Type of Geothermal Well or Well Field

Standing Column

Closed Loop

Open Loop

Facility Information

ICI Registrations require annual sampling and reporting for operational and naturally occurring inorganics, rads and VOCs

System Tracking and Use Statistics

Geothermal Issues in NH

** UIC database codes all UIC with appropriate 'class' and an additional indexing scheme to allow for further stratification of the geothermal system type.

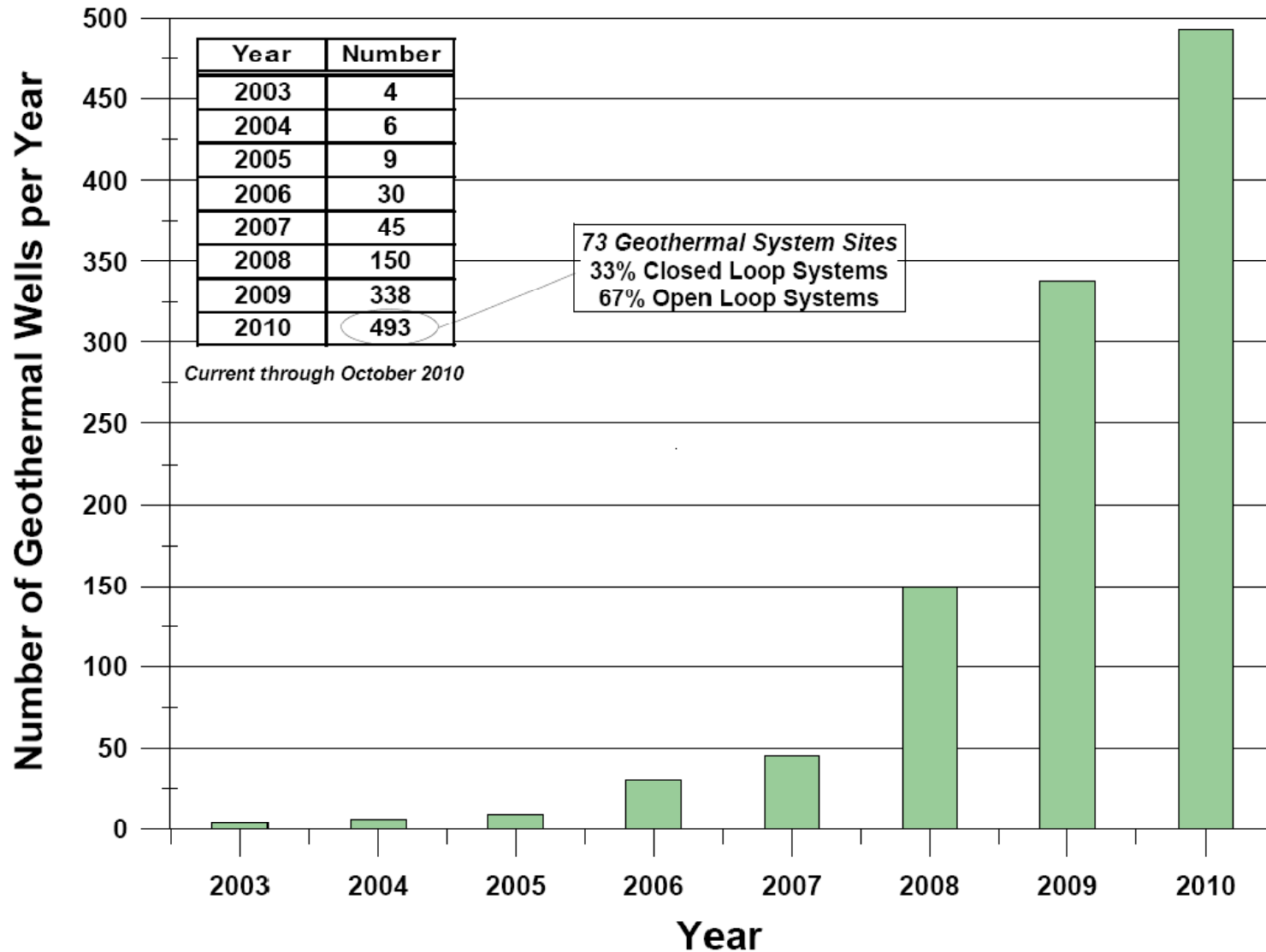
All Data Records

Total Number of Geothermal Sites in UIC Database:	411
Number of Open Loop systems :	338
Number of Closed Loop systems :	73
Number of Residential systems :	383
Number of ICI systems:	28

Open Loop System Data only

Number of ICI systems :	23
Number of Residential Systems:	315
*Confirmed Dual Use SCWs :	37
*Suspected Dual Use SCWs :	43
Unknown Dual Use or known non-dual use :	235

Figure 1. Geothermal Well Installations (2003 - 2010)*



System Tracking and Use Statistics

Most locations from GPS recording requirements of well driller's record

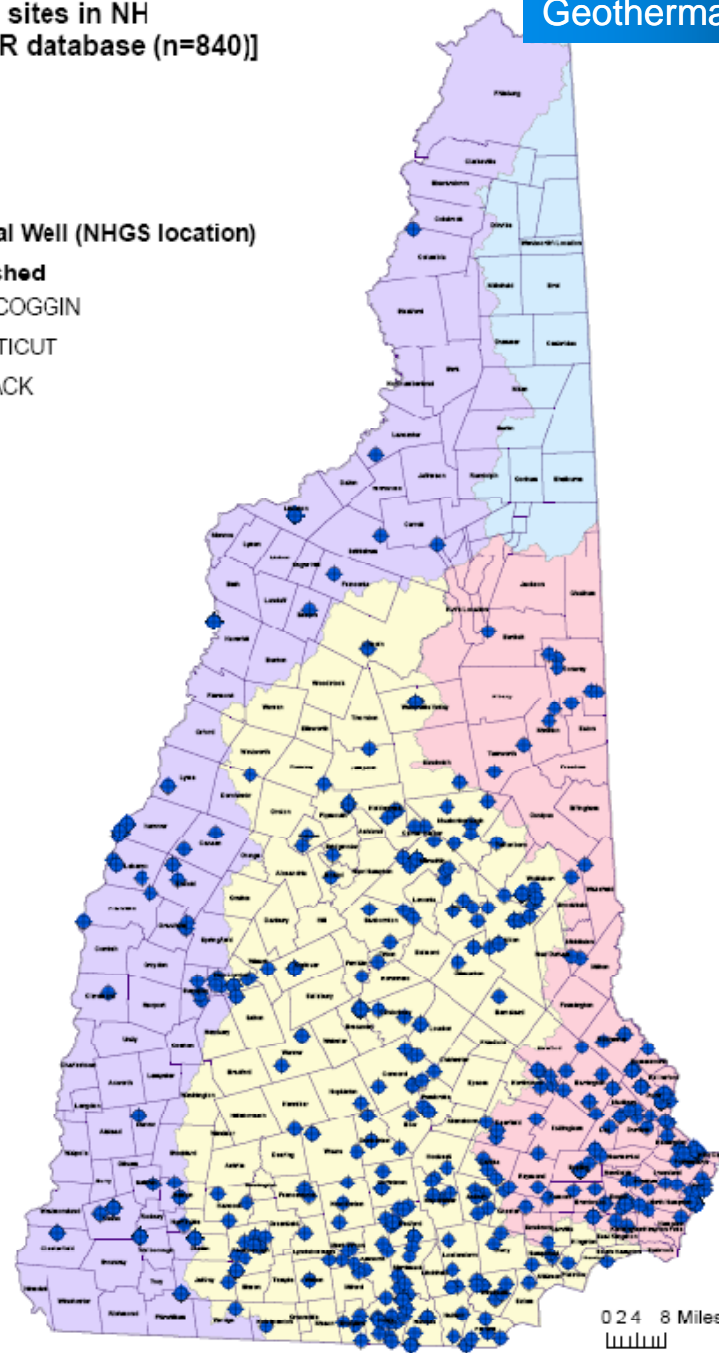
Geothermal well sites in NH
[from NHGS WCR database (n=840)]

Legend

◆ Geothermal Well (NHGS location)

Primary Watershed

- ANDROSCOGGIN
- CONNECTICUT
- MERRIMACK
- SACO



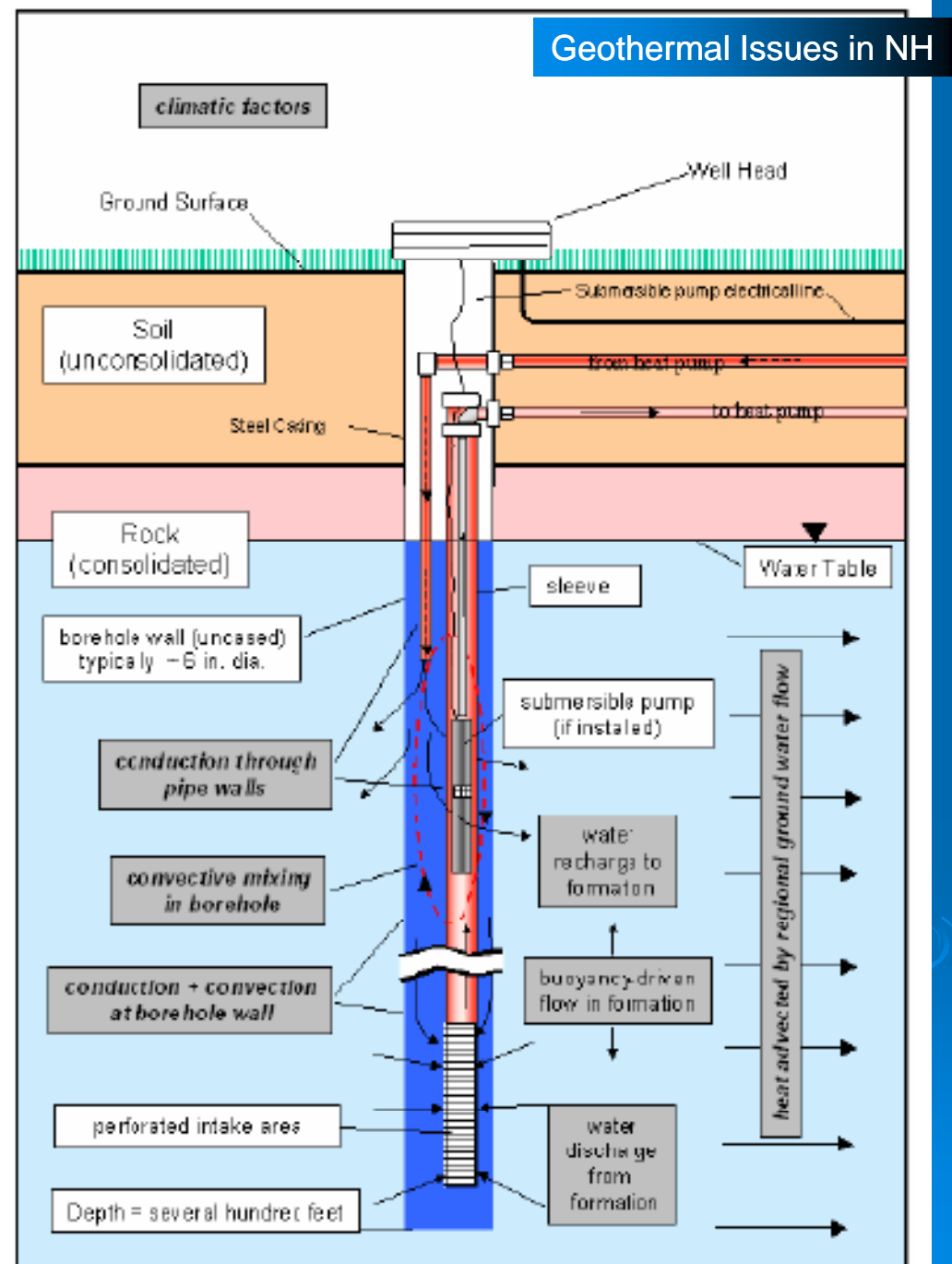
NHDES – Lingering Issues and concerns

-Based on NHDES UIC program tracking, a common Open Loop well configuration in NH for single residences is a single, standing column well [SCW].

-At the residential scale, due to the cost effectiveness of installing one well at a residence as opposed to multiple wells, many SCWs serve the dual purpose of the heat exchange *and* the water supply well for the home.

-This dual use of a well to act as the heat exchanger / return well is cause for concern for :

leaching of 'operational inorganics', mobilizing nat. occurring compounds, bacteria growth issues in GSHP and borehole.



NHDES – Lingering Issues and concerns

All Data Records

Total Number of Geothermal Sites in UIC Database:	411
Number of Open Loop systems :	338
Number of Closed Loop systems :	73
Number of Residential systems :	383
Number of ICI systems:	28

Open Loop System Data only

Number of ICI systems :	23
Number of Residential Systems:	315
*Confirmed Dual Use SCWs :	37
*Suspected Dual Use SCWs :	43
Unknown Dual Use or known non-dual use :	235

** Problem is, there is really very little water quality data related to small-scale residential use of any geothermal well, regardless of type.

NHDES – Lingering Issues and Concerns

Geothermal Issues in NH

ICI Facility water quality results – Four SCWs (1,500 feet deep each)

System purge
July 2010

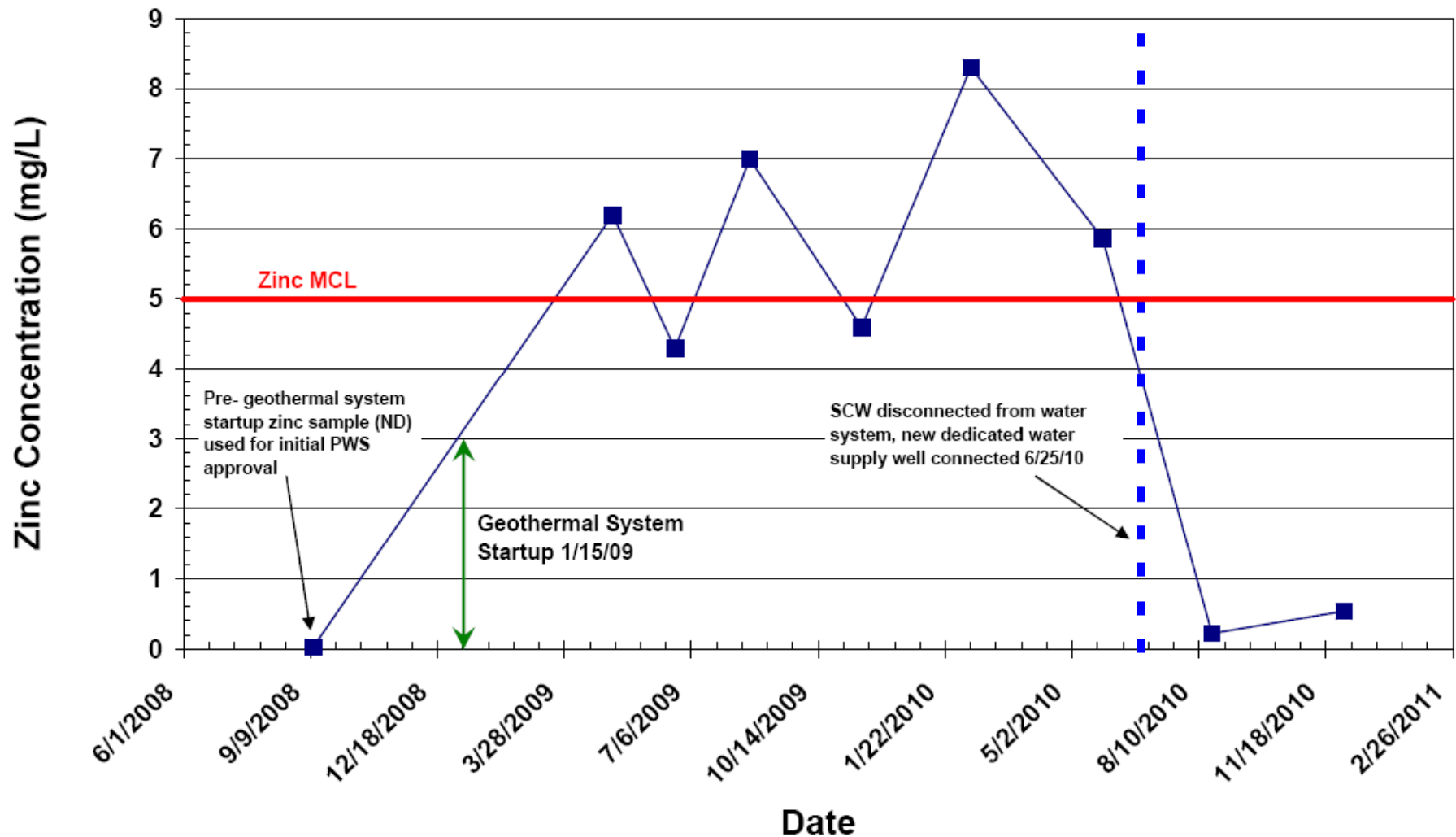
Parameter	Pre – start 7/07	Supply 9/08 Unfil	Return 11/08 Unfil	Supply 6/09 UnFil/Fil	Return 6/09 UnFil/Fil	Supply 8/09 UnFil/Fil	Return 8/09 UnFil/Fil	Supply 8/10 UnFil	Return 8/10 UnFil
Temp (C)	NS	25.6	27.2	27.7	32	29.5	33.6	22.4	23.5
Lead	<50	<5	8.1	2.6 / 1.6	15.3 / 5.4	<5 / <5	<5 / <5	1.4	2
Copper	13	340	484	8.2 / 5.3	26.6 / 6.2	<10 / <10	<10 / <10	6.2	7.5
Zinc	310	631	782	87 / 68	96 / 66	62 / 42	58 / 47	93	92
Arsenic	<100	38	301	150 / 144	145 / 144	166 / 157	160 / 158	132	132
Uranium	140	330	1,800	450 / 477	450 / 476	620 / 590	610 / 590	411	406
Iron	140 - 1000	593	22,700	76 / <50	95 / <50	130 / <50	138 / <50	56	165

All Concentrations in PPB.

System plagued by operational problems, questionable well yields, and pump co

ICI Facility water quality results – One SCW (~1,200 feet deep)

**Figure 2. SCW Geothermal System at Day School
Water Quality Results - Compliance Zinc Sampling Results**



NHDES – Lingering Issues and Concerns

Geothermal Issues in NH

ICI Facility water quality results – 18 Individual withdrawal/return wells (not an SCW System). Well configured in two operational zones (1,500 feet deep each).

No pre-start monitoring data, start date mid-2008

Parameter	6/09 In	6/09 Out	8/09 In	8/09 Out	6/10 In	6/10 Out
	Z-1 Z-2	Z-1 Z-2	Z-1 Z-2	Z-1 Z-2	Z-1 Z-2	Z-1 Z-2
Temp (C)	17	22	20	24	19	22
	18	18	20	22	22	23
Lead	<0.001	<0.001	<0.001	0.001	0.003	0.005
	<0.001	<0.001	<0.001	<0.001	0.001	0.002
Copper	0.019	0.034	0.019	0.040	0.031	0.043
	0.022	0.025	0.033	0.024	0.039	0.040
Zinc	0.23	0.32	0.21	0.29	0.15	0.21
	0.21	0.21	0.20	0.19	0.23	0.21
Arsenic	0.003	0.003	0.003	0.002	0.002	0.002
	0.002	0.002	0.002	0.002	<0.001	<0.001
Uranium	0.0024	0.0024	0.0028	0.0028	0.0022	0.0023
	0.0027	0.0028	0.0031	0.0030	0.0022	0.0024

All Concentrations in PPM.

- Primarily Concern focus around the dual use of SCWs, particularly since majority use is at a non-observed, non state regulated residential water supply scale.
- Concerns related to presence of:
 - Leaching of Operational inorganics;
 - Enhanced mobilization, solubilization of naturally occurring contaminants; or
 - Bacteria -- ??
 - VOCs -- ? Tetrahydrofuran pretty common in return water
- At the ICI scale, there appears to be potential for these issues to crop up for SCWs.
- Definitely a case to support more education and outreach to private water supply well owners of dual-use SCWs.



Contacts:

- Stephen Roy : Stephen.Roy@des.nh.gov
(603) 271 – 3918
- Mitch Locker : Mitchell.Locker@des.nh.gov
(603) 271 – 2858