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Cambridge, Massachusetts 02139
tel: 617 452-6000
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November 16, 2006

Mr. Michael Willis, Chairperson
Water Resources Committee
Town Hall
29 Middle Road
Boxborough, Massachusetts 01719-1402

Subject: Summary of Final Bedrock Test Well Installations at Wolf Swamp
Groundwater Exploration Program
Town of Boxborough, Massachusetts

Dear Mr. Willis:

This letter report summarizes the results of the recent bedrock test well installations at the Wolf Swamp site. The work has been performed jointly by Camp Dresser & McKee Inc. (CDM) and Boart Longyear DL Maher Division (Maher) for the Town of Boxborough, as part of the ongoing Groundwater Exploration Program.

Project Background

In 2001, the Town undertook a Water Resources Analysis Study to identify and prioritize potential sites for municipal groundwater supply testing in both unconsolidated deposits (i.e., sand and gravel) and bedrock. In order to identify potentially favorable sites for bedrock well testing, a bedrock fracture-trace analysis was performed by Maher. The results were presented in the *Final Report Water Resources Analysis Study* prepared by the CDM/Maher Team (December 2002).

The bedrock fracture-trace analysis identified fourteen sites for bedrock well exploration (Sites A through N), prioritized in order of geological preference. The report recommended that the Town re-prioritize these sites in consideration of such factors as legal/physical access conditions, ownership, and proximity to a future water service area. Subsequently, the Town selected Wolf Swamp (Site C) as the first location for bedrock test well exploration, as the parcel is owned by the town. Furthermore, Wolf Swamp is located in the southwest corner of Boxborough near a potential water service area based on groundwater quality concerns along I-495.

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Bedrock Test Well Program

Two bedrock test wells were installed by Maher at Wolf Swamp. Each installation proceeded following receipt of Conservation Commission approval and site access preparation by the Town's Highway Department. The location of the test wells are as shown on Figure 1. Well logs are provided in Attachment A. The following summarizes the selection and results of each test well site.

Bedrock Well #1

To select the sites for bedrock test well drilling, field staking was conducted by Maher. Sites were staked in the field based on the presence of converging bedrock fractures, as identified by review of aerial photography and satellite images. Sites were then correlated in the field by inspection. The Town provided input on each staked location based upon such institutional concerns as land ownership, surrounding land uses, and wetland proximity. Specifically, town criteria included:

- Preference for a site in which the town already owns/controls the surrounding 400 foot protective radius (i.e., Zone I) to meet MassDEP permit requirements should future water supply development proceed, thereby, eliminating the cost of land purchase.
- Substantial setback distances from any surrounding land uses incompatible with groundwater supply development such as roadways and the gas station on Route 111.
- Selection of drilling sites beyond the limits of wetland resource areas so as to minimize permit requirements and associated costs, both for the test well program and future municipal supply development.

Based on this criteria, the Town identified its preferred location within Wolf Swamp. Drilling at the site proceeded on March 22-27, 2006. The well was drilled to 603 feet. Although bedrock fractures were encountered, the yield at Well #1 was insufficient for water supply development.

Bedrock Well #2

Although the first bedrock test well did not provide sufficient yield for water supply development, CDM/Maher recommended that a second bedrock test well be conducted in Wolf Swamp. Reasons included:

- There were other technically preferred locations within Wolf Swamp, as evidenced by the sites staked and the local fracture traces *Did town put constraints on #2?*

*~340' Fern Bonney Rd.
~300' 1300 Mass Ave*

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- The presence of bedrock wells yielding 300 gpm at the former N.E.C. facility just to the north of Wolf Swamp, suggested the potential for favorable results.
- A significant bedrock feature crossing the Cisco parking lot, trending in a northwest to southeast direction, which might yield water.

Based on these technical considerations, Maher recommended a second test well at the location shown on Figure 1. Well #2 was installed on September 26-28, 2006, to a depth of 603 feet. Although fractures were encountered at three intervals below ground, the yield was again insufficient for water supply development.

Recommendations

Based upon the results of the bedrock test well drilling in Wolf Swamp, no further groundwater exploration is recommended at this site. The two test wells have been left in place and are available to serve as observation wells during any future groundwater supply testing in the area.

The Town may wish to consider installation of bedrock test wells at other sites identified in the bedrock fracture-trace analysis. CDM and Maher are available to assist the Town in evaluating any of these sites further.

As always, please feel free to call me at (617) 452-6532 if you have any questions or require additional information.

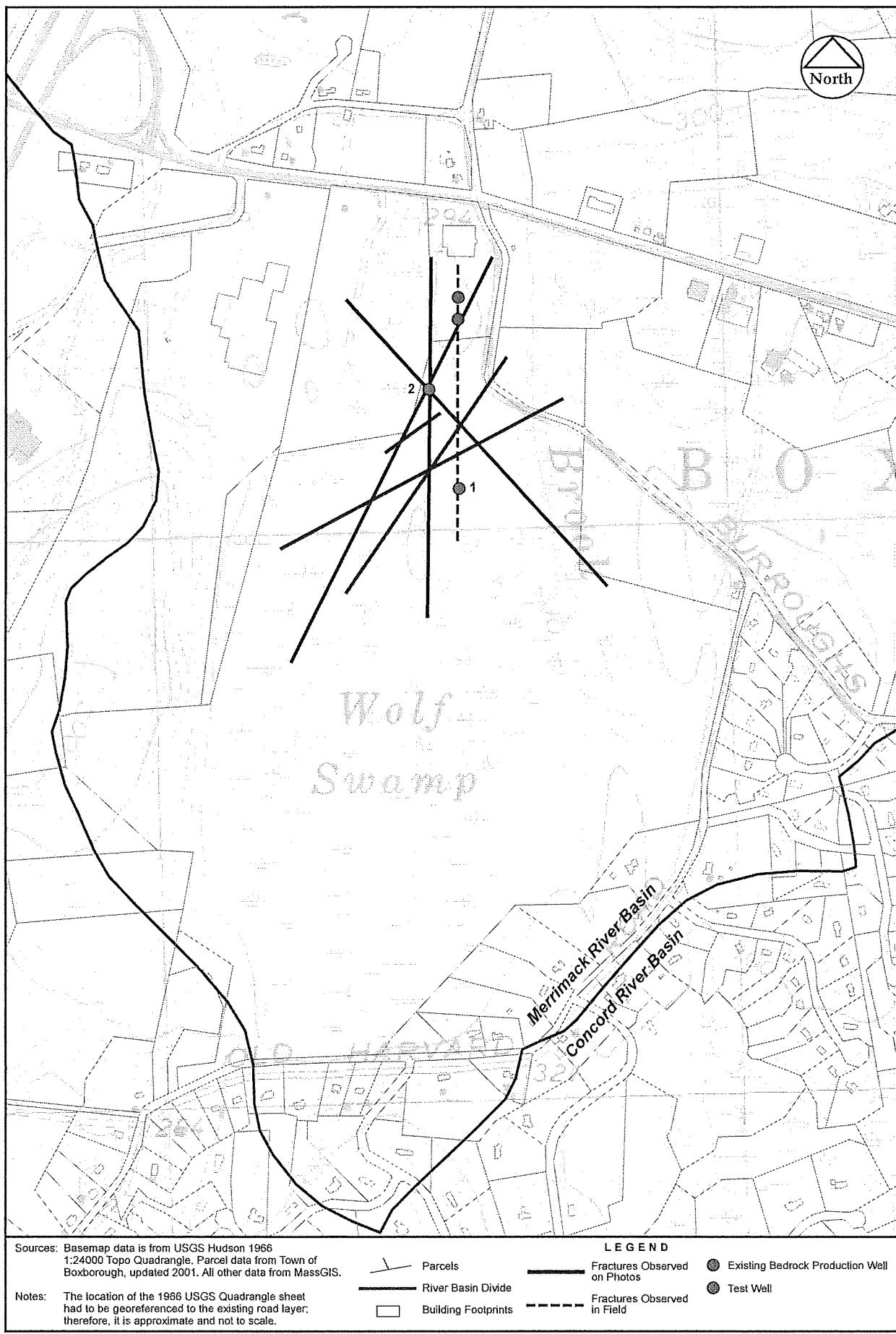
Very truly yours,



Andrew B. Miller, P.E.
Principal Engineer
Camp Dresser & McKee Inc.

Attachments

cc: Selina Shaw, Boxborough Acting Town Administrator
Ted Morine, Boart Longyear DL Maher Division
William Pauk, CDM



Town of Boxborough, Massachusetts
Bedrock Well Exploration Program - Wolf Swamp

Figure 1
Project Location Map

Attachment A
Bedrock Test Well Logs
Wolf Swamp

Wolf Swamp
Well #1

See 11/16/2006
for well #2



of Board L...
Reading, MA
664-3299

Wolf Swamp

Wells #1 & #2

See better figure



G

BEDROCK TEST WELL #1

JOB INFORMATION

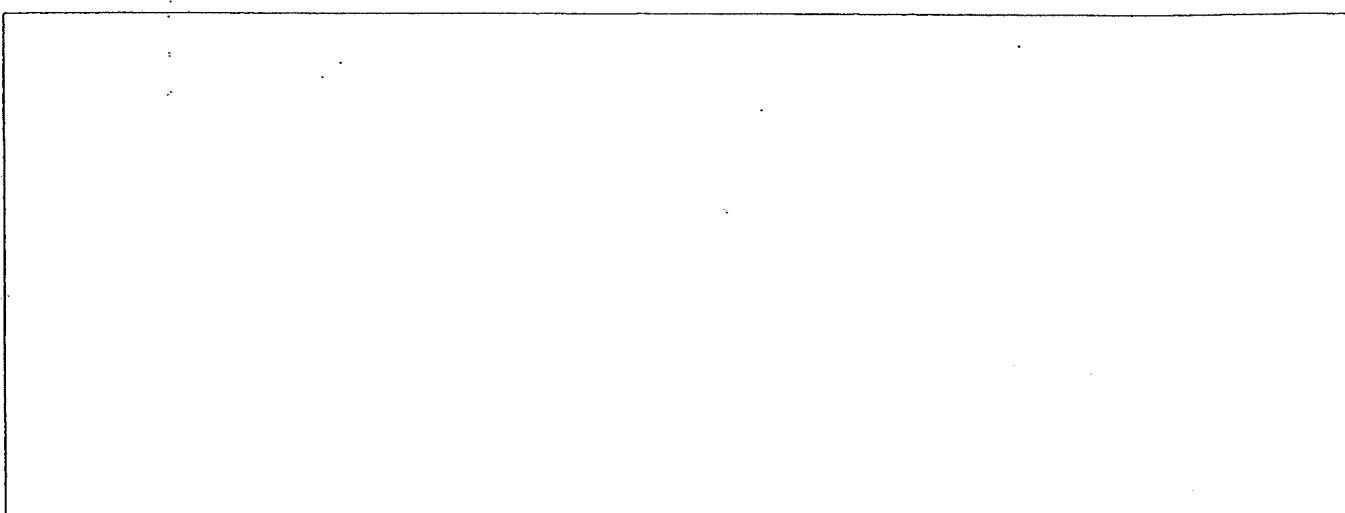
Job Name: <i>Wolf Swamp</i>	Job Number: <i>3YS03282RW</i>
Driller: <i>Tom Reid</i>	Rig Number: <i>01-1 T690</i>
Customer: <i>C DM</i>	
Contact: <i>Andy Miller</i>	Phone: <i>617-452-6532</i>

WELL INFORMATION

Well Location: <i>Boxboro, Mass.</i>	
Longitude:	Latitude:
Date Started: <i>3/22/06</i>	Date Completed: <i>3/27/06</i>
Depth of Well: <i>603'</i>	Depth to Ledge: <i>8'</i>
Feet of Pipe: <i>50' x 8"</i>	Grouted: <i>YES 10 BAGS</i>
Static Water Level: <i>4' B/L</i>	Est. Gallons per Minute: <i>6-7 gpm</i>

MAP

Location of job by street names or route number and show location of well on property.



WOLF Swamp

BEDROCK TEST WELL #1

Drilling Log

Location:

3/28/06

Bit Drilled	Total Feet Drilled	Total Drilling Time	Eng. RPM	Drilling Pressure	Drillability Soft/Med/Hard	Water Injection GPM	Hole Making Water GPM	Formation	Remarks
1.5	63	8	1800	500	MED	3			
2.0	83	7			SOFT				
	103	7							
	123	7							
	143	8							
	163	7							
	183	8							
	203	8							
	223	7							
	243	8							
	263	9							
	283	10							
	303	7							
	323	8							
	343	10							
	363	10							
	383	10							
	403	11							
	423	11							
	443	9							
	463	11							
	483	10							
	503	14							

Bit SN: _____ Bit Size: 6.1"

Wolf Slams

Drilling Log

Location:

BEDrock Test Case #1
(cont'd)
3/27/06

Bit SN:

Bit Size:

DRILLING LOG

BEDROCK TEST WELL #2

JOB INFORMATION	
Job Name: <i>Wolf Swamp Rutt#2</i>	Job Number: <i>34503282</i>
Driller: <i>TOM REID, MAHER</i>	Rig Number: <i>01-1 7680</i>
Customer: <i>TOWN OF BOXBORO</i>	
Contact:	Phone:

WELL INFORMATION	
Well Location: <i>Boxboro, MASS</i>	
Longitude: <i>021.48279</i>	Latitude: <i>071.53670</i>
Date Started: <i>9-26-06</i>	Date Completed: <i>9-28-06</i>
Depth of Well: <i>603'</i>	Depth to Ledge: <i>8'</i>
Feet of Pipe: <i>360 ft of 8" CASING</i>	Grouted: <i>yes 6 BBLs</i>
Static Water Level: <i>ft</i>	Est. Gallons per Minute: <i>1 GPM</i>

MAP

Location of job by street names or route number and show location of well on property.



One Cambridge Place, 50 Hampshire Street
Cambridge, Massachusetts 02139
tel: 617 452-6000
fax: 617 452-8000

April 14, 2006

Mr. Michael Willis, Chairperson
Water Resources Committee
Town Hall
29 Middle Road
Boxborough, Massachusetts 01719-1402

Subject: Project Status Report – Bedrock Test Well
Groundwater Exploration Program
Town of Boxborough, Massachusetts

Dear Mr. Willis:

At your request and in preparation for the Water Resources Committee meeting scheduled for Tuesday evening April 18, we have prepared this project status report relative to the bedrock test well program conducted at Wolf Swamp.

Bedrock Test Well Program

As you are aware, DL Maher a division of Boart Longyear (Maher) recently installed a bedrock test well within the Wolf Swamp conservation area. Attached correspondence from Ted Morine of Maher summarizes the work and presents the final drilling log. The well was drilled to 603 feet. Although bedrock fractures were encountered, the yield was insufficient for water supply development.

The site selected for drilling was one of seven field staked by Ted Morine. Sites were staked in the field based on the presence of converging bedrock fractures, as identified by review of aerial photography and satellite images. Sites were then correlated in the field by inspection.

The Town provided input on each staked location based upon such institutional concerns as land ownership, surrounding land uses, and wetland proximity. Specifically, town criteria included:

- Preference for a site in which the town already owns/controls the surrounding 400 foot radius (i.e., Zone I) to meet MassDEP permit requirements should future water supply development proceed, thereby, eliminating the cost of land purchase.

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- Substantial setback distances from any surrounding land uses incompatible with groundwater supply development such as roadways and the gas station on Route 111.
- Beyond the limits of wetland resource areas to minimize permit requirements and associated costs, both for the test well program and future municipal supply development.

Based on the criteria identified, the Town identified its preferred location within Wolf Swamp. Drilling at the site proceeded on March 22-27, 2006.

Although the first bedrock test well did not provide sufficient yield for water supply development, it is CDM/Maher's recommendation that further bedrock well exploration within Wolf Swamp should be considered. Reasons include:

- There remain many other technically preferred locations within Wolf Swamp, as evidenced by the sites staked by Maher. Several of these sites have three or more converging bedrock fractures, which increases the potential for a high yielding well.
- Maher previously sited the 300 gpm bedrock wells at the former N.E.C. facility just to the north of Wolf Swamp. If the same trending bedrock fractures are encountered, it increases the supply potential of the area.
- A significant bedrock feature has been identified by Maher crossing the Cisco parking lot in a northwest to southeast direction. Testing of a field staked site within the Wolf Swamp conservation area, further southeast may prove favorable.

Although these locations may not satisfy the Town's preferred criteria, we recommend testing to assess site viability. Costs associated with institutional issues such as land acquisition and permitting can then be estimated, and the value assessed relative to potential yield. It should also be realized that there will be a future capital cost savings for any site developed further north within Wolf Swamp, as less infrastructure (i.e., pipes, roadways, etc.) would be needed.

CDM/Maher will have available for the April 18 meeting a USGS map showing bedrock fractures and preferred drilling locations relative to site features such as property lines, roadways and wetlands. If desired, this can be a topic for discussion that evening.



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Financial Status

The following summarizes the financial status of the project to date.

	CDM	Maher	Total
CDM/Maher Budget	\$18,600	\$29,900	\$48,500
Expended to Date	\$ 9,400	\$12,000	\$21,400
Amount Remaining	\$ 9,200	\$17,900	\$27,100

The budget remaining is sufficient for conducting the 2.5-inch test well program. In fact, the anticipated Maher portion of that program is about \$15,600 with contingency, which is less than the dollars remaining.

It should also be noted that the original Town Appropriation was \$60,000, thus, there may be sufficient funds available for execution of an additional bedrock test well at Wolf Swamp if so desired by the Town. It is our recommendation that the Town consider this option based upon available funds remaining, once the 2.5-inch test well program is complete.

We look forward to discussing these options with you at next Tuesday's meeting. In the meantime, please feel free to call me at (617) 452-6532 if you have any questions or require additional information.

Very truly yours,

A handwritten signature in black ink, appearing to read "Andrew B. Miller".

Andrew B. Miller, P.E.
Principal Engineer
Camp Dresser & McKee Inc.

Enclosures

cc: Selina Shaw, Boxborough Assistant Town Administrator
Ted Morine, DL Maher a Division of Boart Longyear
William Pauk, CDM



Boart Longyear Company

Drilling Services

DL Maher Division

71 Concord Street, North Reading, MA 01864

Tel: 781-933-3210 / Fax: 978-664-3299

www.boartlongyear.com

April 5, 2006

Mr. Andrew B. Miller, P.E.
Camp, Dresser & McKee, Inc.
One Cambridge Place
50 Hampshire Street
Cambridge, MA 02139

RE: Rock Drilling in the Wolf Swamp Conservation area in Boxborough MA

Dear Sir:

As requested, I have summarized the results of the recently completed rock well drilling in Boxborough, Massachusetts within the Wolf Swamp Conservation area west of Burroughs Road. My notes indicate that potential well site locations were field staked during year 2005 on October 27th, November 16th and December 29th with a total of seven sites identified. Field staking was based on a composite of aerial photos upon which fracture traces and lineaments were mapped. The length, strength and number of these linear features which converge at a single location delineates favorable drilling sites much like the hub of a wheel being the convergence of the spokes.

The Town provided input on each staked location based on institutional criteria such as distance from wetland resource areas, ownership considerations relative to the D.E.P. required 400 foot radius (Zone I) of ownership should a well be established, and distance from Burroughs Road and the Exxon Station.

When the drilling spot was finally agreed upon, the Boxborough D.P.W. had to prepare access for a 35 ton drilling machine. Some trees were removed or trimmed and fill was placed along the existing cart path to firm up soft areas. In accordance with

the Boxborough Conservation Commission's Orders of Condition, hay bales were placed within the staked designated work area.

Drilling commenced on March 22, 2006(drilling log attached). A 12 inch diameter socket hole was drilled through the overburden (till). The underlying bedrock was logged at a depth of eight feet below the surface. However, the upper 35 of ledge was broken up (fractured) necessitating drilling to a depth of 49 feet. Eight inch diameter steel casing was centered in the socket hole and grouted. This procedure is mandated for public water supply wells to prevent surface drainage from migrating downward into the production well. A six inch diameter button bit drilled a pilot hole from 49 to 603 feet below grade. The only fracture encountered was at 360 feet which produced 6 to 7 GPM. As no change in the color of the bedrock nor were zones of fractures penetrated, drilling was stopped at 603 feet. It would appear that the linear features observed on the aerial photography lie near the surface. This well should not be abandoned as it will be useful for determining ground water elevation and potential water chemistry for any future pumping test associated with other rock well drilling sites.

It is my opinion that based upon the existing drilled rock well yielding 300 GPM at the former N.E.C. facility another drilling site should be selected and drilled prior to abandoning the Wolf Swamp area for further consideration.

Very truly yours,

Boart Longyear Company
D.L. Maher Division

J. Theodore Morine
Senior Hydrogeologist

D.L. Maher, a division of Boart Longyear Company
71 Concord Street, North Reading, MA 01864
781-932-3210 Fax 978-664-3299



DRILLING LOG

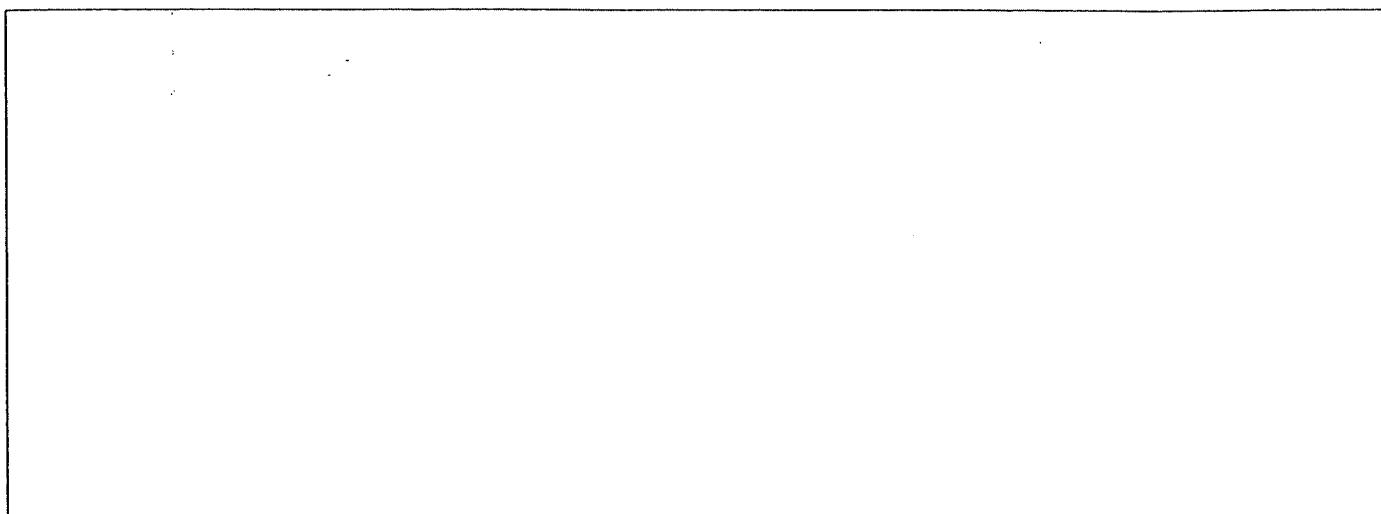
BEDROCK TEST WELL #1

JOB INFORMATION	
Job Name: <i>wolf swamp</i>	Job Number: <i>3YS03282RW</i>
Driller: <i>Tom Reid</i>	Rig Number: <i>01-1 T690</i>
Customer: <i>C DM</i>	
Contact: <i>Andy Miller</i>	Phone: <i>617-452-6532</i>

WELL INFORMATION	
Well Location: <i>Boxboro, mass.</i>	
Longitude:	Latitude:
Date Started: <i>3/22/06</i>	Date Completed: <i>3/27/06</i>
Depth of Well: <i>603'</i>	Depth to Ledge: <i>8'</i>
Feet of Pipe: <i>50' x 8"</i>	Grouted: <i>yes 10 bags</i>
Static Water Level: <i>4' 13/16</i>	Est. Gallons per Minute: <i>6-7 gpm</i>

MAP

Location of job by street names or route number and show location of well on property.



Bedrock Test Well #1 (cont'd)

3ED rock TEST WELL #1
(cont'd)
3/27/96

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Drilling Log
Box 300a
Location: Wolf Springs

Location:

Total Feet Drilled	Total Drilling Time	Eng. RPM	Drilling Pressure	Drillability Soft/Med/ Hard	Water Injection GPM	Hole Making Water GPM	Formation	Remarks
								at drilled
20	523	12	1800	500	160	3		Dark grey
	543	13						
	563	13						
	583	13						
	603	13						

Bit SN: _____

Bit Size:

Bedrock Test Well #1

Bedrock Test Well #1
3/28/06
Date:

WOLF Swamp Location: Drilling Log Box 304

Location:

Drilling Log
Box 2000, Mass.

111

Bit SN: _____ Bit Size: _____