

# **WELL INSTALLATION AND GROUNDWATER MONITORING REPORT FEBRUARY 2009**

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## **STRONG 21-15JI**

LT Environmental, Inc. (LTE) was retained by Noble Energy, Inc. (Noble) to install post-remediation monitoring wells and to conduct sampling activities at the Strong 21-15JI Tank Battery (Site). Monitoring well installation activities and groundwater sampling occurred on January 30, 2009 and February 6, 2009, respectively. Site history and remediation activities were described in the preceding *Remediation Summary Report*, dated February 2009. This well installation and groundwater monitoring event constitutes the first post remediation performance groundwater monitoring event.

LTE personnel were onsite January 30, 2009 to install three monitoring wells (MW01 through MW03) to determine if impacted groundwater exists at the Site. The monitoring wells were installed using a direct-push drill rig owned and operated by Alpine Field Services of Golden, Colorado, and were advanced to 15 feet below ground surface (bgs). The monitoring wells were completed as two-foot stickups with 1-inch diameter, 0.010-inch slotted, schedule 40, poly-vinyl chloride (PVC) screen from 7 feet bgs to 12 feet bgs. Boreholes were filled with 10-20 silica sand from total depth to 5 feet bgs. Bentonite chips were then placed from the top of the sand pack to ground surface and hydrated. Monitoring well (MW01) was installed to the west of the excavation, as an upgradient well. The remaining two monitoring wells (MW02 and MW03) were installed east of the excavation footprint (downgradient). The locations of the three monitoring wells relative to the excavation are presented as Figure 1. Borehole lithologic logs are included as Appendix A.

Groundwater level measurements were collected from the monitoring wells and are summarized in Table 1. Depth to groundwater, which ranged from 9.39 feet below top of casing (btoc) in MW03 to 9.84 feet btoc in MW01, was used to calculate well-specific purge volumes. Following purging, groundwater samples were collected and preserved on ice. Samples were then submitted under strict chain of custody protocol to Origins Laboratory, Inc. of Denver, Colorado for analysis of benzene, toluene, ethylbenzene, and total xylenes (BTEX) by United States Environmental Protection Agency Method 8260B.

Analytical results from the monitoring wells, presented in Table 1, indicate BTEX concentrations in all three wells are in compliance with Colorado Groundwater Quality Standards (CGWQS) and are below laboratory method detection limits. The laboratory analytical report is included as Appendix B.

LTE will continue to conduct quarterly groundwater monitoring events with the goal of observing four consecutive quarters with analytical results in compliance with the CGWQS. The next quarterly groundwater sampling event is scheduled for May 2009.



**TABLE**



**TABLE 1**

**GROUNDWATER ANALYTICAL DATA  
STRONG 21-15JI TANK BATTERY  
WELD COUNTY, COLORADO  
NOBLE ENERGY, INC.**

<b>MONITORING</b>		<b>DEPTH TO</b>				
<b>WELL</b>	<b>DATE</b>	<b>WATER</b>	<b>BENZENE</b>	<b>TOLUENE</b>	<b>ETHYLBENZENE</b>	<b>XYLENES</b>
		<b>(feet btoc)</b>	<b>(ug/L)</b>	<b>(ug/L)</b>	<b>(ug/L)</b>	<b>(ug/L)</b>
MW01	2/6/2009	9.84	<1.0	<1.0	<1.0	<3.0
MW02	2/6/2009	9.40	<1.0	<1.0	<1.0	<3.0
MW03	2/6/2009	9.39	<1.0	<1.0	<1.0	<3.0
<b>CGWQS</b>			<b>5.0</b>	<b>1,000</b>	<b>700</b>	<b>1,400</b>

**NOTES:**

btoc - below top of casing

Benzene, toluene, ethylbenzene, and xylenes analyzed by EPA Method 8260B

ug/L - micrograms per liter

&lt; indicates result is less than the stated laboratory method detection limit

CGWQS - Colorado Groundwater Quality Standards

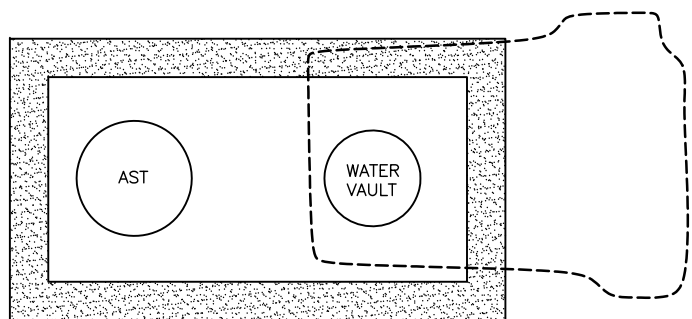


**FIGURE**





MW01



MW03

M  
M

SEPARATOR

MW02



FLARE

### LEGEND

MW01



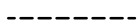
MONITORING WELL LOCATION



METER HOUSE



BERM



EXTENT OF EXCAVATION



ESTIMATED GROUNDWATER FLOW DIRECTION

AST

ABOVEGROUND STORAGE TANK

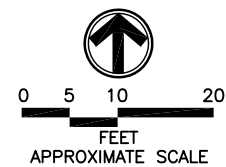


FIGURE 1  
SITE MAP  
STRONG 21-15 JI  
WELD COUNTY, CO  
NOBLE ENERGY, INC.



NEP083302

**APPENDIX A**  
**BOREHOLE LITHOLOGIC LOGS**



Well Location Sketch:



Compliance - Engineering - Remediation

LT Environmental, Inc.

4600 W. 60th Avenue

Arvada, Colorado 80003

## BORING LOG/MONITORING WELL COMPLETION DIAGRAM

Boring/Well Number: <b>MW01</b>	Project: <b>Strong 21-15JI</b>
Date: <b>1/29/2009</b>	Project Number: <b>NEP0833</b>
Logged By: <b>BDD</b>	Drilled By: <b>Alpine Field Services</b>
Drilling Method: <b>Direct Push</b>	Sampling Method: <b>Continuous</b>
Gravel Pack: <b>CSSI 10x20</b>	Seal: <b>Bentonite Chips</b>
Casing Type: <b>Sch 40 PVC</b>	Diameter: <b>1"</b>
Screen Type: <b>Sch 40 PVC</b>	Length: <b>5'</b>
Slot: <b>0.01</b>	Hole Diameter: <b>2"</b>
	Depth to Liquid: <b>~8'</b>
	Total Depth: <b>~8'</b>
	Depth to Water: <b>~8'</b>

Penetration Resistance	Moisture Content	Vapor (ppm)	Staining	Sample #	Depth (ft. bgs.)	Sample Run	Recovery	Soil/Rock Type	Lithology/Remarks	Well Completion Diagram
					0					
	Dry	0.7	N		2			SM	Sand, fine grained, silty, dk brown, no odor	
	Dry	0.6			4					
	Moist	1.4			6			SW	Sand, fine to coarse grained, w/ abundant gravel, brown, nodular	
	Moist	1.9			8					
	Wet	1.6			10					
		1.6			12					
		1.6			14					
					16					
					18					
					20					
					22					
					24					
					26					
					28					
					30					
					32					
					34					
					36					
					38					
					40					

TD-15'

Well Location Sketch:



Compliance - Engineering - Remediation

LT Environmental, Inc.

4600 W. 60th Avenue

Arvada, Colorado 80003

## BORING LOG/MONITORING WELL COMPLETION DIAGRAM

Boring/Well Number: <b>MW02</b>	Project: <b>Strong 21-15JI</b>
Date: <b>1/29/2009</b>	Project Number: <b>NEP0833</b>
Logged By: <b>BDD</b>	Drilled By: <b>Alpine Field Services</b>

Elevation:	Detector: <b>MiniRAE 2000</b>	Drilling Method: <b>Direct Push</b>	Sampling Method: <b>Continuous</b>
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Gravel Pack: <b>CSSI 10x20 (15'-5')</b>	Seal: <b>Bentonite Chips (5'-0')</b>	Grout: <b>NA</b>
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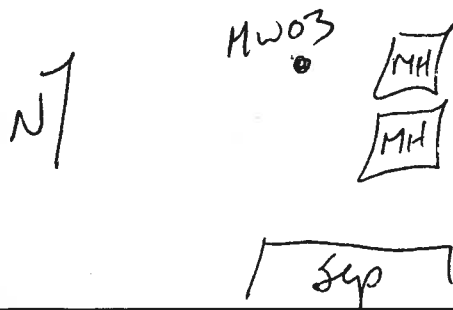
Casing Type: <b>Sch 40 PVC</b>	Diameter: <b>1"</b>	Length: <b>9' 10"</b>	Hole Diameter: <b>2"</b>	Depth to Liquid:
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Screen Type: <b>Sch 40 PVC</b>	Slot: <b>0.01</b>	Diameter: <b>1"</b>	Length: <b>5'</b>	Total Depth: <b>15'</b>	Depth to Water: <b>28</b>
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Penetration Resistance	Moisture Content	Vapor (ppm)	Staining	Sample #	Depth (ft. bgs.)	Sample Run	Recovery	Soil/Rock Type	Lithology/Remarks	Well Completion Diagram
					0					
Dry	0.4				2			SM	Sand, fine to coarse grained, silty, brown no odor	
Dry	0.3				4					
Moist	7.2				6			SW	Sand, fine to coarse grained, w/ abundant gravel, brown, no odor	
Moist	7.4				8					
Wet					10					
	1.0				12					
	1.2				14				Sand, fine to medium grained, w/ abundant gravel, brown, no odor	
					16				TD-15'	
					18					
					20					
					22					
					24					
					26					
					28					
					30					
					32					
					34					
					36					
					38					
					40					



Well Location Sketch:



Compliance - Engineering - Remediation

LT Environmental, Inc.

4600 W. 60th Avenue

Arvada, Colorado 80003

## BORING LOG/MONITORING WELL COMPLETION DIAGRAM

Boring/Well Number:

MW03

Project:

Strong 21-15JI

Date:

1/29/2009

Project Number:

NEP0833

Logged By:

BDD

Drilled By:

Alpine Field Services

Drilling Method:

Direct Push

Sampling Method:

Continuous

Elevation:

Detector:

MiniRAE 2000

Gravel Pack:

CSSI 10x20

(15'-5')

Seal:

Bentonite Chips

(5'-8')

Grout:

NA

Casing Type:

Sch 40 PVC

Diameter:

1"

Length:

Hole Diameter:

2"

Depth to Liquid:

Screen Type:

Sch 40 PVC

Slot:

0.01

Diameter:

1"

Length:

5'

Total Depth:

Depth to Water:

~8'

Penetration Resistance	Moisture Content	Vapor (ppm)	Staining	Sample #	Depth (ft. bgs.)	Sample Run	Recovery	Soil/Rock Type	Lithology/Remarks	Well Completion Diagram
					0					
	Dry		N		2	X		SC	Sand, fine to medium grained, clayey, dk brown, no odor	
	Dry				4	X				
	Moist				6	X		SW	Sand, fine to coarse grained, w/ abundant gravel, brown, no odor, non staining	
	Moist				8	X				
	Wet				10	X				
					12	X				
					14	X				
					16				TD - 15'	
					18					
					20					
					22					
					24					
					26					
					28					
					30					
					32					
					34					
					36					
					38					
					40					

**APPENDIX B**  
**ANALYTICAL REPORT**





4640 Pecos Street | Unit C | Denver, Colorado 80211  
303.433.1322 Phone 303.265.9645 Fax

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February 10, 2009

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LT Environmental, Inc.  
4600 West 60th Avenue  
Arvada CO 80003

Brian Dodek  
Project Number: NEP0833  
Project: Noble - Strong 21-15Jl,23

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Attached are the analytical results for Noble - Strong 21-15Jl,23 received by Origins Laboratory, Inc. 2/6/2009 3:20:00PM. Please let us know if you have any questions, or if we can help with anything at all.

Laboratory Manager  
Noelle E Doyle

The analytical results in the following report were analyzed under the guidelines of EPA Methods specified in SW-846. The analytical results apply specifically to the samples and analyses specified per the attached Chain of Custody. This laboratory report is intended solely for the above addressee and it is only to be used and or reproduced in its entirety.

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LT Environmental, Inc.  
4600 West 60th Avenue  
Arvada CO 80003

Brian Dodek  
Project Number: NEP0833  
Project: Noble – Strong 21–15Jl,23

#### CROSS REFERENCE REPORT

Sample ID	Laboratory ID	Matrix	Sampled	Date Received
MW-01	X902021-01	Water	2/6/2009 1:39:00PM	02/06/2009 15:20
MW-02	X902021-02	Water	2/6/2009 1:36:00PM	02/06/2009 15:20
MW-03	X902021-03	Water	2/6/2009 1:33:00PM	02/06/2009 15:20

Origins Laboratory, Inc.

Noelle E Doyle, Laboratory Manager

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LT Environmental, Inc.  
4600 West 60th Avenue  
Arvada CO 80003

Brian Dodek  
Project Number: NEP0833  
Project: Noble – Strong 21–15JL,23

1202021

page of

originslaboratory.com



Client: LT  
Address: 4600 W 60th  
Telephone Number: Arvada 80003  
E-Mail Address: ON FILE

Project Manager: BDD  
Project Name: Strong 21-15JL 23  
Project Number: NEP 0833 TED  
Samples Collected by: TED

Sample ID - Description	Date Sampled	Time Sampled	Number of Containers	Preservative				Matrix			Analysis	Sample Instructions	
				Unpreserved	HCl	HNO <sub>3</sub>	Other - ICE	Groundwater	Soil	Air - Summa Canister #			
MW01	2/6/09	1339	3	X									1 Please
MW02	2/6/09	1334	3	X									2 Filter
MW03	2/6/09	1333	3	X									3 before
													4 testing
													5
													6
													7
													8
													9
													10
Relinquished by: <u>SSD</u>	Date: <u>2/6/09</u>	Time: <u>1520</u>	Received by: <u>[Signature]</u>	Date: <u>2/6/09</u>	Time: <u>15:20</u>	Turn Around Time: <u>24-hr</u>	Temperature Upon Receipt: <u>28°C</u>						
Relinquished by: <u>[Signature]</u>	Date: <u>2/6/09</u>	Time: <u>15:20</u>	Received by: <u>[Signature]</u>	Date: <u>2/6/09</u>	Time: <u>15:20</u>	Turn Around Time: <u>24-hr</u>	Temperature Upon Receipt: <u>28°C</u>						

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Origins Laboratory, Inc.

*Noelle E Doyle*

Noelle E Doyle, Laboratory Manager

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Brian Dodek  
Project Number: NEP0833  
Project: Noble – Strong 21–15Jl,23

**MW-01**

**X902021-01 (Water)**

Analyte	Result	Reporting		Units	Dilution	Batch	Prepared	Analyzed	Notes
		Limit							

**Origins Laboratory, Inc.**

**BTEX by EPA 8260B**

Benzene	ND	0.00100	mg/L	1	9B09001	02/09/2009	02/09/2009
Toluene	ND	0.00100	"	"	"	"	"
Ethylbenzene	ND	0.00100	"	"	"	"	"
o-Xylene	ND	0.00100	"	"	"	"	"
m,p-Xylene	ND	0.00200	"	"	"	"	"

Surrogate: 1,2-Dichloroethane-d4	106 %	70.3-123	"	"	"
Surrogate: Toluene-d8	86.0 %	75.9-123	"	"	"
Surrogate: 4-Bromofluorobenzene	105 %	83-123	"	"	"

Origins Laboratory, Inc.

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Noelle E Doyle, Laboratory Manager

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Arvada CO 80003

Brian Dodek  
Project Number: NEP0833  
Project: Noble – Strong 21–15Jl,23

**MW-02**

**X902021-02 (Water)**

Analyte	Result	Reporting		Units	Dilution	Batch	Prepared	Analyzed	Notes
		Limit							

**Origins Laboratory, Inc.**

**BTEX by EPA 8260B**

Benzene	ND	0.00100	mg/L	1	9B09001	02/09/2009	02/09/2009
Toluene	ND	0.00100	"	"	"	"	"
Ethylbenzene	ND	0.00100	"	"	"	"	"
o-Xylene	ND	0.00100	"	"	"	"	"
m,p-Xylene	ND	0.00200	"	"	"	"	"

Surrogate: 1,2-Dichloroethane-d4	107 %	70.3-123	"	"	"
Surrogate: Toluene-d8	86.5 %	75.9-123	"	"	"
Surrogate: 4-Bromofluorobenzene	104 %	83-123	"	"	"

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Project: Noble – Strong 21–15Jl,23

**MW-03**

**X902021-03 (Water)**

Analyte	Result	Reporting		Units	Dilution	Batch	Prepared	Analyzed	Notes
		Limit							

**Origins Laboratory, Inc.**

**BTEX by EPA 8260B**

Benzene	ND	0.00100	mg/L	1	9B09001	02/09/2009	02/09/2009
Toluene	ND	0.00100	"	"	"	"	"
Ethylbenzene	ND	0.00100	"	"	"	"	"
o-Xylene	ND	0.00100	"	"	"	"	"
m,p-Xylene	ND	0.00200	"	"	"	"	"

Surrogate: 1,2-Dichloroethane-d4	106 %	70.3-123	"	"	"
Surrogate: Toluene-d8	86.4 %	75.9-123	"	"	"
Surrogate: 4-Bromofluorobenzene	105 %	83-123	"	"	"

Origins Laboratory, Inc.

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Arvada CO 80003

Brian Dodek  
Project Number: NEP0833  
Project: Noble – Strong 21–15JL23

**Volatile Organic Compounds by EPA Method 8260B – Quality Control**  
**Origins Laboratory, Inc.**

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
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**Batch 9B09001 – EPA 5030B**

**Blank (9B09001–BLK1)**

Prepared: 02/09/2009 Analyzed: 02/09/2009

Benzene	ND	0.001	mg/L
Toluene	ND	0.001	"
Ethylbenzene	ND	0.001	"
o-Xylene	ND	0.001	"
m,p-Xylene	ND	0.002	"

Surrogate: 1,2-Dichloroethane-d4	67.4	ug/L	62.5	108	70.3–123
Surrogate: Toluene-d8	54.6	"	62.5	87.4	75.9–123
Surrogate: 4-Bromofluorobenzene	64.7	"	62.5	104	83–123

**LCS (9B09001–BS1)**

Prepared: 02/09/2009 Analyzed: 02/09/2009

Benzene	0.05	0.001	mg/L	0.0500	109	64.2–124
Toluene	0.05	0.001	"	0.0500	96.3	63.9–119
Surrogate: 1,2-Dichloroethane-d4	65.3		ug/L	62.5	104	70.3–123
Surrogate: Toluene-d8	54.8		"	62.5	87.7	75.9–123
Surrogate: 4-Bromofluorobenzene	66.4		"	62.5	106	83–123

**Matrix Spike (9B09001–MS1)**

Source: X902021–02

Prepared: 02/09/2009 Analyzed: 02/09/2009

Benzene	0.06	0.001	mg/L	0.0500	ND	115	64.2–124
Toluene	0.05	0.001	"	0.0500	ND	103	63.9–119
Surrogate: 1,2-Dichloroethane-d4	65.6		ug/L	62.5		105	70.3–123
Surrogate: Toluene-d8	55.1		"	62.5		88.2	75.9–123
Surrogate: 4-Bromofluorobenzene	64.6		"	62.5		103	83–123

**Matrix Spike Dup (9B09001–MSD1)**

Source: X902021–02

Prepared: 02/09/2009 Analyzed: 02/09/2009

Benzene	0.06	0.001	mg/L	0.0500	ND	113	64.2-124	2.44	25
Toluene	0.05	0.001	"	0.0500	ND	95.4	63.9-119	7.53	25
Surrogate: 1,2-Dichloroethane-d4	65.8		ug/L	62.5		105	70.3-123		
Surrogate: Toluene-d8	53.6		"	62.5		85.8	75.9-123		
Surrogate: 4-Bromofluorobenzene	63.9		"	62.5		102	83-123		

Origins Laboratory, Inc.

Noelle E Doyle, Laboratory Manager

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Brian Dodek  
Project Number: NEP0833  
Project: Noble – Strong 21–15Jl,23

### Notes and Definitions

ND Analyte NOT DETECTED at or above the reporting limit  
RPD Relative Percent Difference

Origins Laboratory, Inc.

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Noelle E Doyle, Laboratory Manager