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ARCADIS
Infrastructure, environment, facilities

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ARCADIS U.S., Inc.
430 First Avenue North
Suite 720
Minneapolis
Minnesota 55401
Tel 612.339.9434
Fax 612.336.4538
www.arcadis-us.com

Mr. Doug Hildre
BAE Systems Land & Armaments L.P
4800 East River Road
Fridley, MN 55421-1498

Mr. Lonnie Norman
FMC Corporation
1735 Market Street
Philadelphia, PA 19103

Subject:
Results of the Dye Tracer Study
Former FMC Site, 4800 East River Road, Fridley, MN

Environment

Date:
August 22, 2007

Contact:
Denice Nelson

Phone:
612.373.0249

Email:
dnelson@arcadis-us.com

Our ref:
MN000553.0003

Dear Messrs. Hildre and Norman:

On behalf of BAE Systems Land & Armaments L.P. (BAE Systems) and FMC Corporation (FMC), ARCADIS has attached the results of the dye tracer study conducted at the former FMC site located in Fridley, Minnesota (the South Site). This letter report summarizes the activities of the dry tracer study performed at the Site. A description of the study, results, discussion, and recommendations regarding future activities surrounding the seep are presented below.

Background

The South Site is located next to the Mississippi River at an elevation of 830 feet mean sea level (msl), approximately 30 feet above the Mississippi River elevation (800 feet msl). The South Site is comprised of two parcels of property consisting of: 1) the northerly parcel (13 acres) owned by BAE Systems Land & Armaments and 2) the southerly parcel (5 acres) sold by FMC Corporation to Burlington Northern/Santa Fe Railroad (BNR) in 1969. The South Site was formerly used for disposal of industrial wastes from the BAE Systems Land & Armaments L.P. (BAE Systems; formerly FMC Corporation) Armament Systems facility. A Response Action Plan (RAP) approved by the MPCA called for the construction and operation of a groundwater extraction, collection, and discharge system to prevent the groundwater containing high concentrations of trichloroethylene (TCE) from migrating beyond the Site property boundary. The groundwater extraction system was constructed in 1987 and was placed into operation on December 7, 1987. The system has been operated and maintained by BAE Systems since its startup.

On behalf of BAE Systems and FMC Corporation, ARCADIS performed a vertical aquifer profiling (VAP) in the vicinity of a suspected seep area located downgradient of the South Site and seep monitoring activities in 2005. The analytical results of the seep, the groundwater monitoring wells and VAP in the vicinity of the seep show

detectable concentrations of TCE and tetrachloroethylene (PCE). ARCADIS proposed a tracer study to determine whether the seep is hydraulically connected with the South Site impacted groundwater.

Tracer Study Description

The purpose of the tracer study was to investigate whether the detected concentrations of TCE and PCE at the seep are originating from the vicinity of Monitoring Well FMC-14 which appeared to be hydraulically upgradient of the seep. Accordingly, ARCADIS proposed injecting a dye tracer solution into Monitoring Well FMC-14 with subsequent monitoring for dye in downgradient monitoring points the seep and locations along the river. Dye, samplers, dye selection, and laboratory analysis of dye were provided by Ozark Underground Laboratory, Protem, Missouri.

The dye dosage for the tracer test was recommended by Mr. Tom Aley of Ozark Underground Laboratory and was verified using the tracer model Efficient Hydrologic Tracer-Test Design (EHTD) program developed by the United Stated Environmental Protection Agency (EPA). A request for well code variances was submitted to the Minnesota Department of Health (MDH) detailing the dye dosage including the EHTD program output, site hydrogeology, and activities of the tracer study. An approval of the variance request was received on October 13, 2006. The approval letter is included as Appendix A. In addition, the Minneapolis Water Works was notified prior to tracer introduction in the circumstances that a visual amount of dye is discharged to the river upgradient of the water intake.

Dye Tracer Study Activities

Two rounds of background samples for fluorescein dye were collected from five locations: Monitoring Wells FMC-71 and USGS-6, the seep, and two locations in the Mississippi River near the seep in October 2006. The purpose of the background sampling was to determine potential fluorescence interferences from sources such as the storm water runoff from the street (a typical dye used in tracing is fluorescein, which is also used as a colorant for antifreeze). No dye was detected in the background samples and introduction of the tracer solution was initiated on November 2, 2006. Five pounds of fluorescein dye (provided by Ozark Underground Laboratory) was injected into Monitoring Well FMC-14. Following the injection, routine dye sampling using charcoal samplers was performed on a weekly to biweekly basis in Monitoring Wells FMC-14, FMC-20, FMC-21B, FMC-70, FMC-71, USGS-6, USGS-5, and the seep location. In addition, grab water samples were

collected periodically from Recovery Well RW-4 and the above wells to confirm presence or absence of dye. The locations of the wells monitored during the tracer study are presented on Figure 1. The distance of the monitoring locations from Monitoring Well FMC-14 along with the sampling results are presented in Table 1.

Supplemental sampling events were conducted in May and June 2007. An additional eight monitoring wells downgradient of FMC-14 were included in this event. Seven monitoring wells (FMC-11, FMC-12, FMC-13, FMC-53, FMC-54A, NIROP MS-52S and MS-52I) were sampled on May 25, 2007, and one monitoring well (USGS-4) was sampled on June 28, 2007. Grab samples were collected from the wells and the results are presented in Table 2.

On June 18, 2007, five soil borings were installed with a Geoprobe and advanced near Monitoring Well FMC-14 (Figure 2). Discrete water samples were collected from the soil borings and analyzed for dye. The analytical results are included on Figure 2.

The last round of routine dye sampling was conducted on July 9, 2007. The duration of the tracer study was 36 weeks after introduction of the dye.

Results and Discussion

As shown on the results tables, no dye has been detected in water samples from Recovery Well RW-4. Samples from Week 4 indicated 260,000 ppb of dye was detected in Monitoring Well FMC-14 whereas no dye was detected in Recovery Well RW-4. Dilution calculations show that a 26-million times dilution is required to dilute the concentration at Monitoring Well FMC-14 to below the instrumental detection limit (0.01 ppb). If Monitoring Well FMC-14 was located within the capture zone of Recovery Well RW-4, it is unlikely that dilution caused the non-detect results in RW-4.

In addition, no dye was detected in any of the monitoring points with the exception of a slight detection in Monitoring Well FMC-13 during the supplemental sampling events, and two slight detections in FMC-20, located between East River Road and the Mississippi River (Figure 1). Monitoring Well FMC-13 is located five feet north of Monitoring Well FMC-14 but is screened ten feet deeper. The results suggest that vertical transport of dye occurred during the duration of the tracer study, however the detections were slight, less than 1 part per billion (ppb). Detections of dye in Monitoring Well FMC-20 at the beginning of the tracer study (weeks 5 and 8) were also less than 1 ppb. It is possible that interference from storm water run off traveling

towards the Mississippi River impacted this well, therefore were not a reflection of the dye introduction to Monitoring Well FMC-14. In addition, the detections were intermittent and did not occur after Week 8, further supporting the detections did not stem from the Monitoring Well FMC-14 injection.

The absence of dye in both downgradient wells and the nearby recovery well was further analyzed by (1) performing a capture zone analysis on Recovery Well RW-4, and (2) installation of five Geoprobe soil borings near Monitoring Well FMC-14 to evaluate the lateral distribution of dye. These are discussed in further detail below.

Capture Zone Analysis

An analysis on the capture zone of Recovery Well RW-4 was performed to determine whether Monitoring Well FMC-14 is potentially located within a stagnation point. A stagnation point is a region downgradient of an extraction well where the pull of water toward the well through pumping is countered by the flow away from the well due to the natural groundwater gradient (Todd, 1980; Keely and Tsang, 1983).

Parameters used within the analysis include groundwater velocity, saturated thickness, effective porosity, and the extraction rate. Previous groundwater velocity estimates provide a range of two to five feet per day using hydraulic gradient and hydraulic conductivity values, therefore this same range was used for this calculation. The saturated thickness was assumed to be the aquifer unit where Recovery Well RW-4 is located (approximately 70-ft). An effective porosity range of 0.15 to 0.3 was used within the calculations. As shown on Table 3, the point of stagnation ranges from 10 to 51 feet from Recovery Well RW-4. This analysis indicates that it is feasible that Monitoring Well FMC-14 is located within a point of stagnation. This would indicate it is not located within the immediate capture zone; therefore, water from this vicinity is not being extracted by Recovery Well RW-4. This is supported by the absence of dye in Recovery Well RW-4 during the tracer study. This also indicates that water is effectively contained on site, further supported by the absence of dye within the downgradient points. Water near a stagnation point will have low to no movement, therefore groundwater velocity, if present, will have a much lower velocity relative to groundwater influenced by a natural gradient. Accordingly, if the water near Monitoring Well FMC-14 is present within a stagnation point, it will travel slower than expected, resulting in longer travel time to the downgradient monitoring points. A slower travel velocity may explain why there was no detection of dye in the monitoring wells located at a radial distance of between 300 and 600 feet downgradient of Monitoring Well FMC-14 or in the seep.

An additional explanation for the absence of dye in Recovery Well RW-4 is impediment of dye movement to the recovery and downgradient wells by an obstruction, such as a clay layer. Previously constructed cross-section B-B' (Figure 3) indicates that Monitoring Well FMC-14 is screened just below a low permeability unit. The thickness and bottom depth of the unit varies which may result in dye transport being confined to the Monitoring Well FMC-14 location and subsequently not being recovered by the extraction well. However, if this well is separated from Recovery Well RW-4 by the low permeability unit, it would be expected that it is not in hydraulic communication with RW-4. This would indicate that changes in the Recovery Well RW-4 pumping rate should not have an effect on the groundwater elevation in Monitoring Well FMC-14. This relationship was examined in 2004 where the pump placement and pumping rate of Recovery Well RW-4 were modified and water levels were evaluated in Monitoring Well FMC-14. As shown on Table 4, water levels were affected by the pumping rate after the modifications were completed; therefore this well appears to be in hydraulic connection to Recovery Well RW-4. Accordingly, this scenario is ruled out as an explanation of absence of dye in Recovery Well RW-4.

Geoprobe Installation

Given the above, two main questions remained regarding the behavior of injected dye: (1) Is the dye traveling at a slower rate toward the river, therefore present between Monitoring Well FMC-14 and the nearest downgradient point (Monitoring Well USGS-5, ~300 feet away)? (2) Is the dye only present in the immediate vicinity of Monitoring Well FMC-14, therefore supporting this location is either truly in a stagnation point or localized stratigraphy is confining the groundwater to this location? To answer the above two questions, five geoprobe points were installed on June 18, 2007 in the vicinity of Monitoring Well FMC-14 to verify lateral distribution of the dye in this location. Groundwater was sampled from each borehole and sent in for laboratory analysis of dye.

The results of the geoprobe investigation are shown on Figure 2. These data suggest that the dye has been lingering in close proximity to Monitoring Well FMC-14. The absence of dye in Soil Boring GP-5E, located five feet east of Monitoring Well FMC-14, suggests that FMC-14 is located outside the influence of Recovery Well RW-4. This coupled with the absence of dye to the west (Soil Boring GP-24W), suggests Monitoring Well FMC-14 is located within a point of stagnation as dye had not yet traveled the 24 foot distance to Soil Boring GP-5E in 228 days. Given these

data, the velocity is, at a minimum, less than 0.1 ft/d, and essentially indicates groundwater is at stagnation within this portion of the aquifer.

Recommendations

Results of the tracer study demonstrate that Monitoring Well FMC-14 is likely located within a point of stagnation, indicating the groundwater within this vicinity is not being extracted by Recovery Well RW-4, but is effectively contained on site.

The chemical signature and associated concentrations of the groundwater discharging from the seep is most similar to FMC-14, when compared to wells located on the former FMC property. This resemblance prompted the tracer study. However, based on the results above, the area surrounding FMC-14 has been clearly shown to not be in hydraulic connection with the seep. Previous VAP investigations on the South Site have revealed two observations (1) the low permeability unit normally present at the Site separating the upper and lower aquifers is absent in the vicinity of the seep, and (2) elevated concentrations of TCE and PCE are present above and below the low permeability unit and quickly decrease with distance away from the low permeability unit. In the instance of the first observation, the absence of the low permeability unit near the seep promotes upwelling from all areas of the Site towards this point due to pressure differential. Accordingly, water emerging from the seep may have originated from any number of locations ranging from near the seep to locations further away. In the instance of the second observation, the low permeability unit appears to contain elevated concentrations of TCE and PCE. This unit is mostly comprised of clay and silt which tend to contain higher organic carbon content than sands. Sorption of chlorinated compounds will have occurred over time to these materials, therefore this unit may be a source of TCE and PCE discharge to the groundwater due to dissolution of sorbed mass and equilibrium mechanisms.

Given the complexity of the site geology, further refining the source of the seep (as defined as activities in addition to the previous VAP investigations and the tracer study) will be costly, and may not be effective. Rather than defining the source of the seep direction, it may be necessary to install a treatment barrier directly upgradient of the seep to capture contaminated groundwater prior to discharging to the river.

ARCADIS recommends an engineering evaluation as the next step in defining a remedial strategy for the impacted groundwater discharging from the seep. This evaluation will review the technical issues regarding installing a remedial system to

address seep impacts, and will also include the costs associated with a variety of treatment options. The best option for the site would take into consideration technical feasibility, implementability at the site as well as cost effectiveness.

Sincerely,

ARCADIS U.S., Inc.

Denice Nelson, PE
Senior Engineer

Bryan Zinda, PE
Project Manager

References

Keely, J.F. and Tsang, C.F., 1983. Velocity Plots and Capture Zones of Pumping Centers for Groundwater Investigations. Ground Water. Vol. 21, No. 6.

Todd, D.K., 1980. Groundwater Hydrology. 2nd Edition. John Wiley and Sons, New York, New York

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Table 1. Routine Tracer Dye Sampling Results
Former FMC Site, Fridley, Minnesota

Injection Well: FMC-14
Dye Injection Date: 02-Nov-06

Sampling Date	Sampling Point	FMC-14	RW-4	FMC-20	FMC-21B	FMC-70	FMC-71	USGS-6	USGS-5	SEEP	Upstream of Seep	Downstream of Seep
	Distance from FMC-14 (feet)	0	42	510	631	586	492	541	308	602	580	664
	Elapsed Time (Week)											
11-Oct-06	-3	ND	--	ND	ND	ND	ND	ND	ND	ND	ND	ND
20-Oct-06	-2	ND	--	ND	ND	ND	ND	ND	ND	ND	ND	ND
09-Nov-06	1	941,000 [a]	ND [a]	ND	ND	ND	ND [c]	ND [c]	ND	ND [c]	--	--
15-Nov-06	2	--	--	ND	ND	ND	ND	ND	ND	ND	--	--
22-Nov-06	3	--	--	ND	ND	ND	ND	ND	ND	ND	--	--
29-Nov-06	4	261,000 [a]	ND [a]	ND	ND	ND	ND [c]	ND [c]	ND	ND [c]	--	--
08-Dec-06	5	--	--	0.677	ND	ND	ND	ND	ND	ND	--	--
15-Dec-06	6	--	--	ND	ND	ND	ND	ND	ND	ND	--	--
22-Dec-06	7	--	--	ND	ND	ND	ND	ND	ND	ND	--	--
28-Dec-06	8	230,000 [a]	ND [a]	0.406	ND	ND	ND [c]	ND [c]	ND	ND [c]	--	--
05-Jan-07	9	--	--	ND	ND	ND	ND	ND	ND	ND	--	--
17-Jan-07	11	--	--	ND	ND	ND	ND	ND	ND	ND	--	--
26-Jan-07	12	101,000 [a]	ND [a]	ND	ND	ND	ND [c]	ND [c]	ND	ND [c]	--	--
31-Jan-07	13	--	--	ND	ND	ND	ND	ND	ND	ND	--	--
15-Feb-07	15	--	--	ND	ND	ND	ND	ND	ND	ND	--	--
21-Feb-07	16	33,800 [a]	ND [a]	ND	ND	ND	ND [c]	ND [c]	ND	ND [c]	--	--
28-Feb-07	17	--	--	ND	ND	ND	ND	ND	ND	ND	--	--
14-Mar-07	19	--	--	ND	ND	ND	ND	ND	ND	ND	--	--
23-Mar-07	20	8,830 [a]	ND [a]	ND	ND	ND	ND [c]	ND [c]	ND	ND [c]	--	--
29-Mar-07	21	--	--	ND	ND	ND	ND	ND	ND	--[b]	--	--
04-Apr-07	22	--	--	ND	ND	ND	ND	ND	ND	--[b]	--	--
20-Apr-07	24	1,780 [a]	ND [a]	ND	ND	ND	ND [c]	ND [c]	ND	ND [c]	--	--
02-May-07	26	--	--	ND	ND	ND	ND	ND	ND	--[b]	--	--
10-May-07	27	--	--	ND	ND	ND	ND	ND	ND	ND [a]	--	--
17-May-07	28	--	--	ND	ND	ND	ND	ND	ND	--[b]	--	--
25-May-07	29	1,250 [a]	--	ND	ND	ND	ND [c]	ND [c]	ND	--[b]	--	--
08-Jun-07	31	--	--	ND	ND	ND	ND	ND	ND	--[b]	--	--
15-Jun-07	32	725 [a]	--	ND	ND	ND	ND [c]	ND [c]	ND	ND	--	--

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Table 1. Routine Tracer Dye Sampling Results
Former FMC Site, Fridley, Minnesota

Injection Well FMC-14
Dye Injection Date 02-Nov-06

	Sampling Point	FMC-14	RW-4	FMC-20	FMC-21B	FMC-70	FMC-71	USGS-6	USGS-5	SEEP	Upstream of Seep	Downstream of Seep
	Distance from FMC-14 (feet)	0	42	510	631	586	492	541	308	602	580	664
Sampling Date	Elapsed Time (Week)											
28-Jun-07	34	--	--	ND	ND	ND	ND	ND	ND	ND	--	--
09-Jul-07	36	503 [a]	--	ND	ND	ND	ND [c]	ND [c]	ND	ND	--	--

Notes:
Charcoal samplers were used for dye sampling unless otherwise noted.
Dye concentrations are in parts per billion (ppb).

a	Dye analyzed using water sample.
b	Sampler installed at the seep cannot be retrieved due to high river levels.
c	Dye analyzed using both charcoal sampler and water sample.
--	not sampled
ND	not detected

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Table 2. Supplemental Tracer Dye Sampling Results
Former FMC Site, Fridley, Minnesota

Injection Well FMC-14
Dye Injection Date 02-Nov-06

	Sampling Point Direction / distance from FMC-14 (feet)	FMC-11 NW / 30	FMC-12 NW / 20	FMC-13 NW / 10	FMC-54A W / 300	FMC-53 SW / 336	MS-52I W / 360	MS-52S W / 360	USGS-4 W / 306
Sampling Date	Elapsed Time (Week)								
25-May-07	29	ND	ND	0.062	ND	ND	ND	ND	---
28-Jun-07	34	---	---	---	---	---	---	---	ND

Notes:
Grab water samples were collected from all wells for dye analysis.
Dye concentrations are in parts per billion (ppb).
-- not sampled
ND not detected

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Table 3. Stagnation Point Calculations
Former FMC Site, Saint Paul, Minnesota

Distance between RW-4 and FMC-14: 42 ft

Scenario	RW-4 pumping rate (gpm)	Saturated aquifer thickness (ft)	Effective porosity	Natural ground water velocity (ft/day)	Distance from RW-4 to downgradient stagnation point
1	35	70	0.3	2	**26**
2	35	70	0.15	2	**51**
3	35	70	0.3	5	**10**
4	35	70	0.15	5	**20**

Eqn's Used:

$$r = \frac{Q}{2 \times \pi \times h \times \phi_e \times V_{natural}}$$

where
r = distance from a pumping well to a downgradient stagnation point
Q = extraction rate
h = saturated zone thickness
ϕ_e = effective porosity
$V_{natural}$ = natural groundwater velocity

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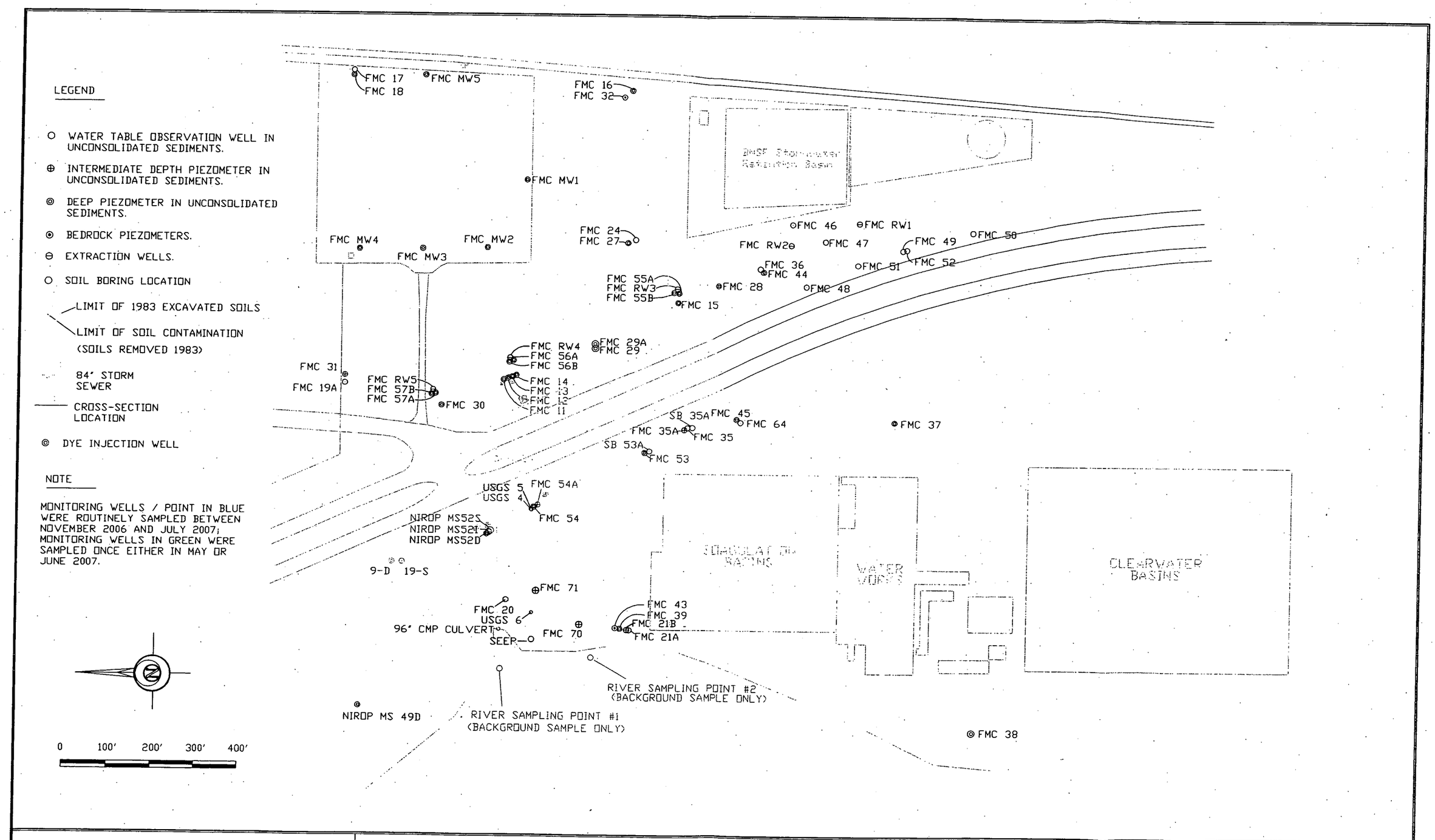
Table 4. Groundwater Elevations During RW-4 Modifications
Former FMC Site, Fridley, Minnesota

Date	RW-4 (ft msl)	Pump Location ft msl	Flow Rate (gpm)	FMC-14 (ft msl)	Comment
7/16/2004	804.55	787	49	811.05	prior to well modification
8/12/2004	811.05	---	---	810.8	well not operating
9/28/2004	803.34	799	41	810.55	post modification
9/28/2004	802.45	799	55	810.44	

Notes:
msl mean sea level
gpm gallons per minute
--- not applicable



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DYE TRACER STUDY
INJECTION AND MONITORING WELL LOCATIONS

FORMER FMC SITE
FRIDLEY, MINNESOTA

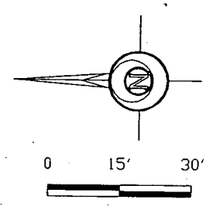
DRAWN	DATE	PROJECT MANAGER	DRAWING NAME
		LEAD DESIGN PROF.	CHECKED
		PROJECT NUMBER	FIGURE NUMBER
		MN000553.0003	1

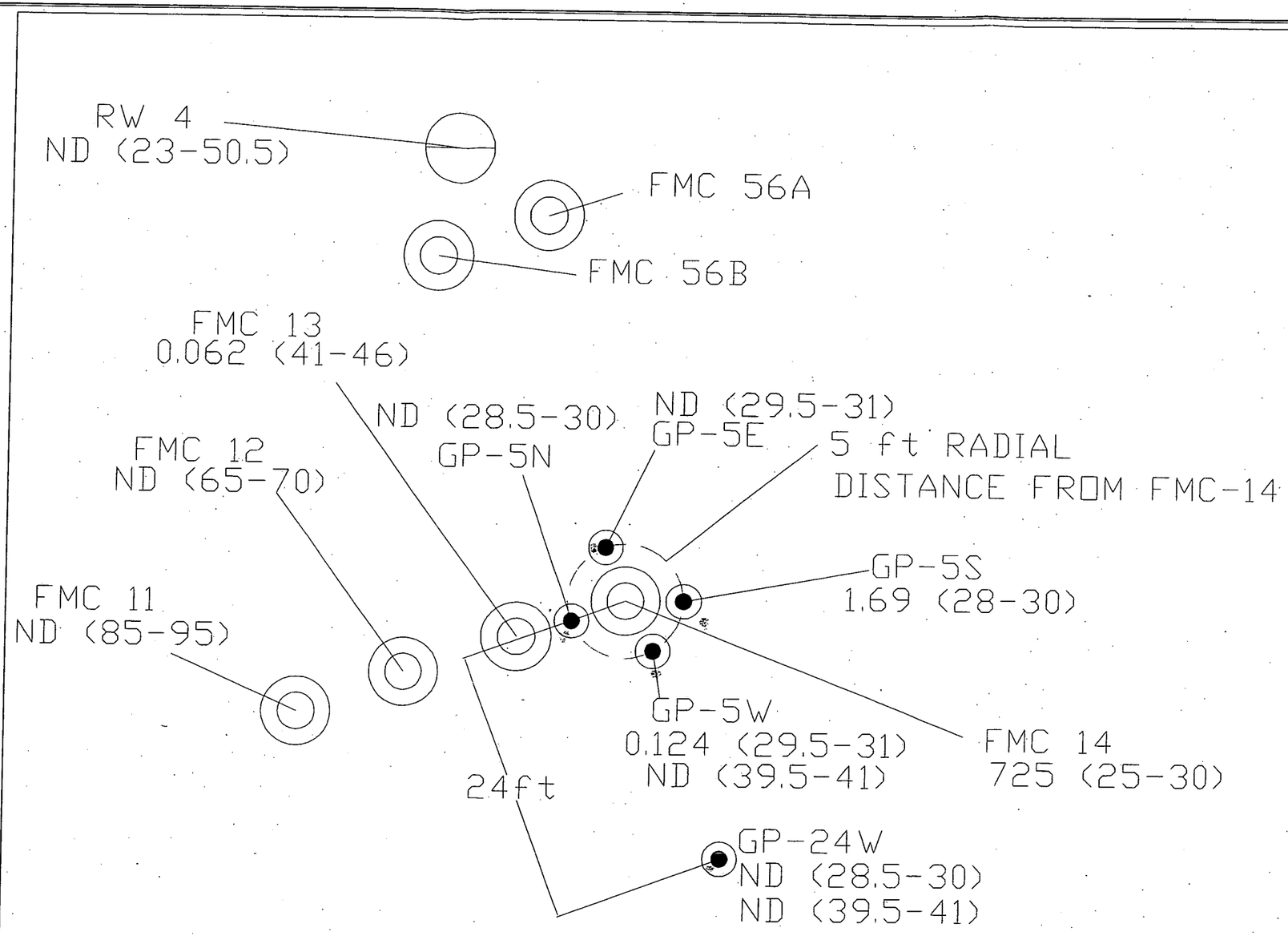
LEGEND

- WATER TABLE OBSERVATION WELL IN UNCONSOLIDATED SEDIMENTS
- EXTRACTION WELL
- SOIL BORING LOCATION
- 729 DYE CONCENTRATION (parts per billion)
- ND DYE NOT DETECTED
- (41-46) SCREEN INTERVAL OF WELLS OR SOIL BORINGS WHERE WATER SAMPLES WERE COLLECTED

NOTES

SAMPLES FROM FMC-11 THROUGH 13 WERE COLLECTED ON 5-25-2007; SAMPLES FROM RW-4 AND FMC-14 WERE COLLECTED ON 6-15-2007; SAMPLES FROM SOIL BORINGS WERE COLLECTED ON 6-18-2007.





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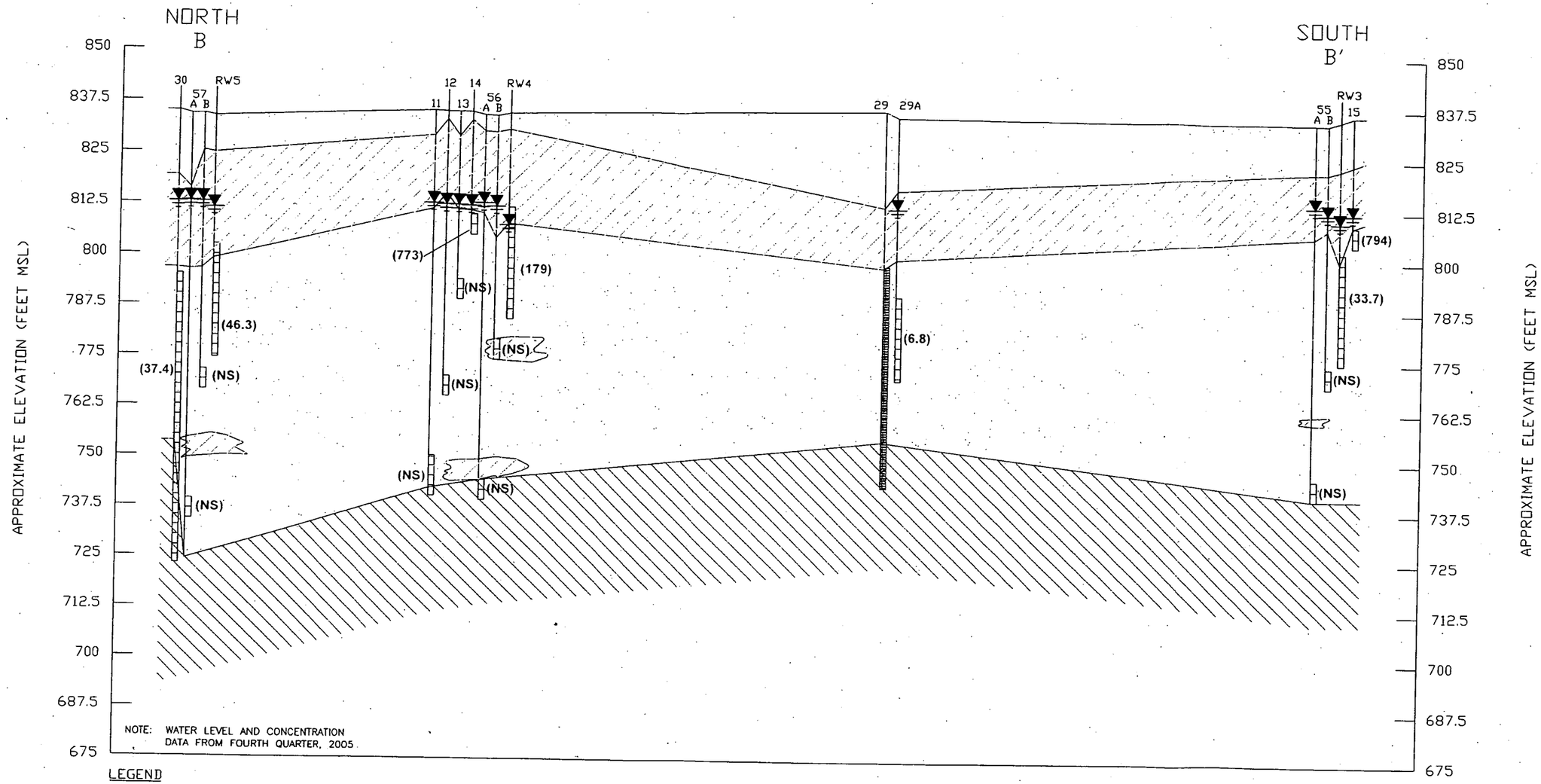
DYE TRACER STUDY
GEOPROBE BORING LOCATIONS
AND DYE ANALYTICAL RESULTS
FORMER FMC SITE
FRIDLEY, MINNESOTA

DRAWN	DATE	PROJECT MANAGER	DRAWING NAME
		LEAD DESIGN PROF.	CHECKED
		PROJECT NUMBER	FIGURE NUMBER
		MN000553.0003	2



LEGEND

0 — 25: VERTICAL SCALE APPROXIMATE SCALE IN FEET

SAND

CLAY / SILTY CLAY

ST. PETER SANDSTONE

(37.4) TCE CONCENTRATION, ug/l

SCREENED INTERVAL

(NS) NOT SAMPLED

ABANDONED WELL

GROUNDWATER TABLE

0 — 50: HORIZONTAL SCALE APPROXIMATE SCALE IN FEET

VERTICAL EXAGGERATION = 2X

ARCADIS

Cross Section B-B'
2005 Trichloroethene Concentrations
Former FMC Site
Fridley, Minnesota

DRAWN	DATE	PROJECT MANAGER	DRAWING NAME
		LEAD DESIGN PROF.	CHECKED
		PROJECT NUMBER	FIGURE NUMBER
		MN00553.002	3

MINNESOTA MDH DEPARTMENT OF HEALTH

Protecting, maintaining and improving the health of all Minnesotans

Environmental Health Division

P.O. Box 64975
St. Paul, Minnesota 55164-0975

WELL MANAGEMENT SECTION

Facsimile Cover Sheet

Fax Number: (651) 201-4599

DATE: Oct. 13, 2006

TO: Denise Nelson

ADDRESS:

FAX NO: 612-336-4538

FROM: Ed Schneider PHONE: (651) 201-4595

Number of pages, including cover sheet: 4

REMARKS: Variance TN 3898 for dye Trace study at BAR

If transmission is incomplete or illegible, please call sender (shown at "FROM" above).

origs\faxcover 9/26/05R

MINNESOTA MDH DEPARTMENT OF HEALTH

Protecting, maintaining and improving the health of all Minnesotans

October 13, 2006

Refer to: TN 3898

Ms. Denice Nelson, P.E.
ARCADIS G & M, Inc.
Suite 720
430 First Avenue North
Minneapolis, Minnesota 55401

Mr. Doug Hildre
BAE System Land & Armaments, L.P.
4800 East River Road
Fridley, Minnesota 55421

Dear Ms. Nelson and Mr. Hildre:

Subject: Request for a Variance from Minnesota Rules, Chapter 4725, to Inject Eosine, Fluorescein, or Rhodamine WT Dye into a Monitoring Well, Minnesota Unique Well Number 196704, at 4800 East River Road, Fridley, Located in the SW ¼ of the SE ¼ of Section 27, Township 30 North, Range 24 West, Anoka County, Minnesota

This letter is in response to your request for a variance from Minnesota Rules, Chapter 4725, to inject eosine, fluorescein, or rhodamine WT into Monitoring Well FMC-14 (Minnesota Unique Well Number 196704) at the former FMC Corporation site in Fridley.

Minnesota Rules, part 4725.2050 requires that a well or a boring must not be used for disposal of surface water, groundwater, or any other liquid, gas, or chemical. This rule part prohibits the injection of dye tracing chemicals, nutrients, organisms, or other remediation materials in a well or boring. Minnesota Rules, part 4725.0475, subpart 1 requires that a person must be licensed or registered as a well contractor in Minnesota in order to modify or materially affect the water quality of a well.

The stated purpose of the dye trace study is to determine if trichloroethylene (TCE) and tetrachloroethylene (PCE) detected in a seep on the bank of the Mississippi River are originating from the vicinity of FMC-14. Monitoring well FMC-14 is 4 inches in diameter, 30 feet deep, and screened from 25 to 30 feet in a Quaternary buried artesian aquifer.

The variance request proposes to inject 5 pounds of a 75 percene fluorescein mixture, 8 pounds of a 75 percent eosine mixture, or 15 pounds of a 20 percent rhodamine WT mixture. The eosine and fluorescein are powders, and would be thoroughly mixed with approximately one gallon of water per pound of dye before injecting into the well through a funnel. The rhodamine WT is a liquid, and would be injected directly into the well without mixing with water. After injection of the tracer solution, sampling would be conducted once a week for 38 weeks at the following monitoring points: the seep and two other river locations near the seep; and monitoring wells FMC-20, FMC-21B, FMC-70, FMC-71, USGS-5, and USGS-6.

The proposed dye doses were determined by Mr. Tom Aley of Ozark Underground Laboratory and were intended to provide a dye concentration of 1 part per million (ppm) or less at the points of groundwater discharge (the seep and nearby river locations). At the request of the Minnesota Department of Health (MDH), additional dye dose calculations based on the Efficient Hydrologic Tracer-Test Design program developed by the U.S. Environmental Protection Agency (EPA) were submitted by ARCADIS. The predicted doses that would be necessary to obtain the targeted concentration of 1 ppm at the discharge were slightly higher than the original estimates (e.g. 7 pounds of fluorescein), so the lower original doses will be used.

The procedure and materials, as outlined in the variance application and in subsequent information provided by Ms. Denice Nelson of ARCADIS, do not appear to pose a significant threat to public health or groundwater. Based on the information provided, and in accordance with Minnesota Rules, Chapter 4725, your request for a variance is granted for the one time injection eosine, fluorescein, or rhodamine WT into monitoring well FMC-14 (Minnesota Unique Well Number 196704) at the former FMC Corporation site in Fridley.

The variance is approved with the following conditions:

1. The variance is granted for a single injection event into Minnesota Unique Well Number 196704, using a total of approximately 5 pounds of a 75 percent fluorescein mixture, 8 pounds of a 75 percent eosine mixture, or 15 pounds of a 20 percent rhodamine WT mixture. Water used for preparing the dye solution must be only clean water taken from a potable water supply. No other injection may take place unless and until a variance request for that injection has been submitted to and approved by the MDH.

2. Minneapolis Water Works must be notified prior to the introduction of the dye, and made aware that there is a possibility that there will be a visible dye discharge into the Mississippi River above the municipal water intake.

3. Mr. Steven Bennett at 651/643-2113 or Mr. Ronald Thompson at 651/643-2108 must be contacted at least 24 hours prior to beginning introduction of the dye, so that an inspector may be present. Mr. Bennett, Mr. Thompson, or Mr. Ed Schneider at 651/201-4595 must also be contacted within 24 hours of any visible dye discharge into the Mississippi River.

4. All other requirements of Minnesota Rules, Chapter 4725, are in effect.

Alternative measures or conditions attached to a variance have the force of law and effect of applicable rule. If the party violates the alternative measures or conditions attached to the variance, the party is subject to enforcement actions and penalties provided in the applicable law or rule.

This variance is conditioned upon the applicable acceptance of and compliance with the conditions of the variance. Failure by the applicant to comply with the conditions prescribed in the variance will result in the immediate expiration of the variance.

If you have any questions regarding this matter, please contact Mr. Schneider at 651/201-4595.

Sincerely,

Daniel A. Wilson

Daniel A. Wilson, Manager
Well Management Section
Environmental Health Division
P.O. Box 64975
St. Paul, Minnesota 55164-0975

DAW:ECS:dg
cc: John Betcher, MPCA Superfund & Emergency Response Section