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Technical Memorandum

To	Nadine Marion, Arnold Magnetic Technologies
CC	Julie Johnson, AECOM Pat Dunne, AECOM
Subject	Marengo Wastewater Permit Assistance 2016
From	Dan McHale, AECOM
Date	March 17, 2016

AECOM Technical Services, Inc. (AECOM) prepared this Technical Memorandum to summarize our review of available groundwater data relative to Arnold Magnetic Technologies' (AMT) Marengo, Illinois facility's wastewater pond system. The purpose of the data review was to provide information supporting the Marengo facility's wastewater permit renewal.

Background

The facility operates a non-contact cooling water system utilizing a deep (800 foot) groundwater well as the source of system make up water. Spent cooling water, process wastewater, and treated sanitary wastewater are discharged into four (4) onsite lined treatment ponds connected in series. Water from Pond 4 is either reused and cycled through the process cooling system, or discharged to a percolation field. Groundwater from the deep groundwater well is used to provide the additional make up water to maintain system water balance. Groundwater quality from the deep well is likely geochemically different than shallow site groundwater, and there is little likelihood that the shallow aquifer is in hydraulic communication with the deep aquifer because of a regionally extensive aquitard (Maquoketa Shale Group) separating the two groundwater systems.

AECOM understands that the Illinois Environmental Protection Agency (Illinois EPA) recently denied renewal of AMT's wastewater permit. Illinois EPA has indicated that the denial was based on the agency's concern that the wastewater treatment ponds potentially could be a source of chlorinated organic compound and metal exceedances in the shallow aquifer at and to the northwest of the AMT site as depicted in the provided site monitoring report figures. We also understand there are ongoing efforts to characterize groundwater contamination in the vicinity of the site, but that the on-site source of the contamination is presently ill-defined. The reported Constituents of Concern in shallow groundwater include chlorinated organic compounds (tetrachloroethene, trichloroethene, 1,1,1-trichloroethane, 1,1-dichloroethene) and 1,4-dioxane. Remaining groundwater constituents of concern include the metal species: aluminum, lead, iron, nickel, chromium, beryllium and manganese.

Materials Reviewed

All reviewed material was provided to AECOM by AMT; a list of reviewed materials can be provided upon request. Salient laboratory or other data used to support the conclusions of this memorandum are provided in Attachment 1.

Summary of Data Review

AECOM reviewed reports and laboratory data describing groundwater contamination that has been documented since at least 2001. AECOM also reviewed historical laboratory data for the pond system, including data that supported previously- approved wastewater permits issued by Illinois EPA (Attachment 1). These same data were used to demonstrate that the pond discharge to the percolation field did not require further monitoring, and supported Illinois EPA's May 2011 revision of the prior wastewater permit. The May 2011 permit revision reduced the number of routinely-monitored parameters based on the demonstrated historical absence of elevated constituent concentrations, and presumably, the fact that no changes had been made in the design or nature of the pond system.

AECOM compared the historical laboratory results for the pond system with groundwater sampling results. Water from the Pond 4 outfall appears to have been consistently free (*i.e.,* not detected) of chlorinated compounds throughout the provided monitoring period (2001 to 2010). Furthermore, water samples from the 2010 data submitted to Illinois EPA in support of the May 2011 permit show non-detect to low concentrations of the metals that are currently present at concentrations above Illinois Class I groundwater standards in site shallow groundwater. The concentrations associated with the pond water are not consistent with the relatively higher concentrations of chlorinated compounds and metals observed in groundwater samples.

We note that AMT's operations associated with the cooling and process water discharges have not changed since the last wastewater permit renewal. Therefore it is unlikely that the chemistry of the pond water has changed significantly since previous testing in 2010.

Conclusions

In our opinion, the information AECOM reviewed indicates the wastewater pond system does not contribute chlorinated solvents or elevated metals to shallow groundwater; therefore, the water treatment system is not expected to have any impact on the concentrations of the Constituent of Concern in the groundwater. The historical laboratory data used as the basis for previous permitting (Attachment 1) show either non-detections or low concentrations for the specific Constituents of Concern in the vicinity of the site. Review of the groundwater data from previous reports indicates the presence of contaminants in shallow groundwater that have not been observed in water samples taken from the pond system.

Although pond system water samples have not been analyzed for the specific Constituents of Concern over the previous five years (in accordance with the revised wastewater permit approved by Illinois EPA), the use of the industrial process water has not changed, and it is therefore unlikely that the pond water chemistry has significantly changed.

Although the historical data described above appear to provide a reasonable means to demonstrate that the pond system is not a source of groundwater contamination, there are additional lines-of-evidence that could be pursued to further support the conclusions of this memorandum. These arguments include:

- AECOM understands that the ponds are lined. An existing potentiometric surface map of the shallow groundwater system at the site, though not available at the time of this review, combined with system water balance calculations of the cooling system, could be used to support the argument that the ponds are not a significant source of water to the underlying shallow groundwater system. If additional water quality evidence is required, deep groundwater (*i.e.*, cooling system water) geochemistry (major cation/anion composition) should be sufficiently different from the groundwater in the shallow aquifer system to identify if mixing is occurring immediately downgradient of the wastewater ponds.
- As indicated in several site reports, the source of shallow groundwater impacts at the site appears to be ill-defined and/or from multiple unspecified sources. Based on a very preliminary review, It would seem far more logical to presume that the likely sources of groundwater contamination at the site would be the former USTs (*e.g.,* two 6,000-gallon USTs containing 1,1,1-TCA closed circa 1990), a reported LUST incident (two 8,000-gallon tanks, contents unknown, removed in 2008) and other existing/former site manufacturing buildings, rather than the routinely monitored wastewater system.
- Analytical results from monitoring wells in the vicinity of the percolation field area do not suggest a source of chlorinated solvent or metal contamination. Reported shallow groundwater exceedances in the percolation field areas consist of manganese. Unlike aluminum, cobalt, iron, or nickel, manganese is not believed to be a common constituent of the alloys used at the facility. Further, manganese was not detected above ambient levels in the discharge to the percolation field. Conversely, nickel was detected at concentrations near or at the Class I groundwater standard in the 2010 discharge, but was not detected above the Class I standard in percolation field area groundwater. These inconsistencies show that the elevated manganese results in shallow groundwater, as indicated in previous site reports, are more likely indicative of ambient area background concentrations or sampling methodology (suspended solids presence and subsequent digestion).

Recommendations

AECOM recommends that available records be searched for historical laboratory data associated with the pond system, including groundwater sampling data from the deep groundwater supply well, and if found, these data be evaluated to help support the conclusions stated above. Other data to help support the conclusions of this memorandum include groundwater contour maps and pond construction as-builts.

AECOM also recommends that consideration be given to performing additional pond water sampling to further demonstrate permit compliance and characterize the current quality of the wastewater. At the minimum, verification sampling of the Pond 4 outfall could be performed in support of the current permit re-application.

We recommend that AMT contact the laboratory that provided pond water analyses from 2001 through 2010 to determine if additional metal analyses were performed, but not reported; this is a possibility since nickel has been consistently analyzed during this time period.

Attachments

Attachment 1 – Supporting Historical Data

ATTACHMENT 1

This Agency is authorized to require this information under Illinois Revised Statutes, 1979, Chapter 111 1/2, Section 1039. Disclosure of this information is required under that section. Failure to do so may prevent this form from being processed and could result in your application being denied.

For IEPA Use:
Log #
Date Received:

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
DIVISION OF WATER POLLUTION CONTROL
PERMIT SECTION
Springfield, Illinois 62794-9276

SCHEDULE N WASTE CHARACTERISTICS

1 Name of Project: Arnold Magnetic Technologies - Arnold Engineering

2 FLOW DATA

	EXISTING	PROPOSED-DESIGN
2.1 Average Flow (gpd)	163,030 gpd	NA
2.2 Maximum Daily Flow (gpd)	217,333 gpd	NA
2.3 TEMPERATURE		

Time of Year	Avg. Intake Temp. F	Avg. Effluent Temp.F	Max Effluent Temp. F.	Max. Temp Outside Mixing Zone F
SUMMER	NA	NA	NA	NA
WINTER	NA	NA	NA	NA

2.4 Minimum 7-day, 10-year flow NA cfs NA MGD

2.5 Dilution Ratio: NA : NA

2.6 Stream flow rate at time of sampling NA cfs NA MGD

3 CHEMICAL CONSTITUENT Existing Permitted Conditions X ; Existing Conditions ☐ ; Proposed Permitted Conditions ☐

Type of Sample: X grab (time of collection) 10/18/2010, 10/19/2010, 11/18/2010, 12/21/2010

☐ composite (number of samples per day) See below

Historical metals and VOC data

Single 24-hr composite (10/18/2010) for all reported values except total phenols, VOCs, TRC, oil & grease, total cyanide, pH and mercury

(see instructions for analyses required)

CONSTITUENT	RAW WASTE (mg/l)	TREATED EFFLUENT Avg. (mg/l) Max.	UPSTREAM (mg/l)	DOWNSTREAM SAMPLES (mg/l)
Ammonia Nitrogen (as N)	< 0.2†	<0.2†	NA	NA
Arsenic (total)	<0.045	0.046‡	NA	NA
Barium	0.12	0.064	NA	NA
Boron	0.17†	0.16‡	NA	NA
BOD_5	<2.0**	<2.0**	NA	NA
Cadmium	<0.0050	<0.0050	NA	NA
Carbon Chloroform Extract	see TOC Dup	see TOC Dup	NA	NA
Chloride	160	160	NA	NA
Chromium (total)	<0.01	<0.01	NA	NA
Chromium (total trivalent)	NA	NA	NA	NA
Copper	<0.018	<0.018	NA	NA
Cyanide (total)	<0.0054	<0.0054	NA	NA
Dissolved Oxygen	NA	NA	NA	NA
Fecal Coliform	NA	NA	NA	NA
Fluoride	<0.2	<0.2	NA	NA
Hardness (as Ca CO_3)	280	180	NA	NA
Iron (total)	0.50	0.54	NA	NA
Lead	<0.016	<0.016	NA	NA
Manganese	0.0045	0.005	NA	NA
MBAS	<0.12	<0.12	NA	NA
Mercury	<0.000065	<0.000065	NA	NA
Nickel	0.088	0.1	NA	NA
Nitrates (as N)	0.17‡	<.024	NA	NA
Oil & Grease (hexane solubles or equivalent)	0.9‡	<0.87	NA	NA
Organic Nitrogen (as N)	<0.25	<0.25	NA	NA
pH	6.6	8.54	NA	NA
Phenols	0.0075	0.00845 (avg), 0.014 (max)	NA	NA
Phosphorous (as P)	120	150	NA	NA
Radioactivity	NA	NA	NA	NA
Selenium	<0.044	<0.044	NA	NA
Silver	<0.0037	<0.0037	NA	NA
Sulfate	12	12	NA	NA
Total Suspended Solids	4	3‡	NA	NA
Total Dissolved Solids	730	700	NA	NA
Zinc	<0.002†	<0.002†	NA	NA
Others	see attached	see attached	NA	NA

† Analyte detected in method blank
‡ Result between MDL and LOQ and is therefore less certain.
* Result less than RL but greater than MDL. Value is estimated.
** Oxygen depletion less than 2 mg/l. Result is estimated.
Note: All metals are reported as "Total"

Table of Other Inorganic Compounds and Remaining Conventional Parameters

CONSTITUENT	RAW WASTE (mg/l)	TREATED EFFLUENT Avg. (mg/l) Max.	UPSTREAM (mg/l)	DOWNSTREAM SAMPLES (mg/l)
TOC Dup	6.5	1.9	NA	NA
COD	17‡	<11	NA	NA
TKN	<0.25	<0.25	NA	NA
TRC	<0.016	0.1	NA	NA
Aluminum	<0.15	<0.15	NA	NA
Antimony	0.088	<0.042	NA	NA
Beryllium	<0.005	<0.005	NA	NA
Cobalt	0.034	0.04	NA	NA
Magnesium	36	36	NA	NA
Molybdenum	0.0068	0.0069	NA	NA
Thallium	<0.017	<0.017	NA	NA
Tin	<0.00061	<0.00061	NA	NA
Titanium	<0.002	<0.002	NA	NA
Bromide	<1.0	<1.0	NA	NA
Sulfide	<0.2	<0.2	NA	NA

† Analyte detected in method blank
‡ Result between MDL and LOQ and is therefore less certain.
* Result less than RL but greater than MDL. Value is estimated.
** Oxygen depletion less than 2 mg/l. Result is estimated.
Note: All metals are reported as "Total"

Table of SVOCs

CONSTITUENT	RAW WASTE (ug/l)	TREATED EFFLUENT Avg. (ug/l) Max.	UPSTREAM (ug/l)	DOWNSTREAM SAMPLES (ug/l)
1,2,4-Trichlorobenzene	<1.4	<1.4	NA	NA
1,2-Dichlorobenzene	<1.2	<1.2	NA	NA
1,2-Diphenylhydrazine	<1.4	<1.4	NA	NA
1,3-Dichlorobenzene	<1.3	<1.3	NA	NA
1,4-Dichlorobenzene	<1.3	<1.3	NA	NA
2,4,6-Trichlorophenol	<1.1	<1.1	NA	NA
2,4-Dichlorophenol	<1.3	<1.3	NA	NA
2,4-Dimethylphenol	<1.6	<1.6	NA	NA
2,4-Dinitrophenol	<8.1	<8.1	NA	NA
2,4-Dinitrotoluene	<1.5	<1.5	NA	NA
2,6-Dinitrotoluene	<1.3	<1.3	NA	NA
2-Chloronaphthalene	<1.4	<1.4	NA	NA
2-Chlorophenol	<1.1	<1.1	NA	NA
2-Nitrophenol	<1.2	<1.2	NA	NA
3,3'-Dichlorobenzidine	<1.3	<1.3	NA	NA
4,6-Dinitro-o-cresol	<5.0	<5.0	NA	NA
4-Bromophenyl phenyl ether	<1.4	<1.4	NA	NA
4-Chlorophenyl phenyl ether	<1.3	<1.3	NA	NA
4-Nitrophenol	<3.6	<3.6	NA	NA
Acenaphthene	<1.5	<1.5	NA	NA
Acenaphthylene	<1.5	<1.5	NA	NA
Anthracene	<1.4	<1.4	NA	NA
Benzidine	<10	<10	NA	NA
Benzo[a]anthracene	<1.1	<1.1	NA	NA
Benzo[a]pyrene	<1.2	<1.2	NA	NA
Benzo[b]fluoranthene	<1.1	<1.1	NA	NA
Benzo[g,h,i]perylene	<1.4	<1.4	NA	NA
Benzo[k]fluoranthene	<1.4	<1.4	NA	NA
bis (2-chloroisopropyl) ether	<1.4	<1.4	NA	NA
Bis(2-chloroethoxy)methane	<1.4	<1.4	NA	NA
Bis(2-ethylhexyl) phthalate	6.1*	<1.1	NA	NA
Butyl benzyl phthalate	<1.3	<1.3	NA	NA
Chrysene	<1.3	<1.3	NA	NA
Dibenz(a,h)anthracene	<1.4	<1.4	NA	NA
Diethyl phthalate	<1.3	<1.3	NA	NA
Dimethyl phthalate	<1.2	<1.2	NA	NA
Di-n-butyl phthalate	<1.2	<1.2	NA	NA
Di-n-octyl phthalate	<1.6	<1.6	NA	NA
Fluoranthene	<1.4	<1.4	NA	NA
Fluorene	<1.6	<1.6	NA	NA
Hexachlorobenzene	<1.3	<1.3	NA	NA
Hexachlorobutadiene	<1.5	<1.5	NA	NA
Hexachlorocyclopentadiene	<1.3	<1.3	NA	NA
Hexachloroethane	<1.2	<1.2	NA	NA
Indeno[1,2,3-cd]pyrene	<1.3	<1.3	NA	NA
Isophorone	<1.4	<1.4	NA	NA
Naphthalene	<1.4	<1.4	NA	NA
Nitrobenzene	<1.3	<1.3	NA	NA
N-Nitrosodimethylamine	<5.2	<5.2	NA	NA
N-Nitrosodi-n-propylamine	<1.6	<1.6	NA	NA
N-Nitrosodiphenylamine	<1.8	<1.8	NA	NA
p-Chloro-m-cresol	<1.4	<1.4	NA	NA
Pentachlorophenol	<7.5	<7.5	NA	NA
Phenanthrene	<1.4	<1.4	NA	NA
Pyrene	<1.4	<1.4	NA	NA

† Analyte detected in method blank
‡ Result between MDL and LOQ and is therefore less certain.
* Result less than RL but greater than MDL. Value is estimated.
** Oxygen depletion less than 2 mg/l. Result is estimated.
Note: All metals are reported as "Total"

Table of VOCs

CONSTITUENT	RAW WASTE (ug/l)	TREATED EFFLUENT Avg. (ug/l) Max.	UPSTREAM (ug/l)	DOWNSTREAM SAMPLES (ug/l)
Benzene	<0.2	<0.2	NA	NA
Bromodichloromethane	<0.2	<0.2	NA	NA
Bromoform	<0.2	<0.2	NA	NA
Bromomethane	<0.5	<0.5	NA	NA
Carbon Tetrachloride	<0.8	<0.8	NA	NA
Chlorobenzene	<0.2	<0.2	NA	NA
Chloroethane	<1.0	<1.0	NA	NA
Chloroform	4.0	4.2	NA	NA
Chloromethane	<0.3	<0.3	NA	NA
Chlorodibromomethane	<0.2	<0.2	NA	NA
1,1-Dichloroethane	<0.5	<0.5	NA	NA
1,2-Dichloroethane	<0.5	<0.5	NA	NA
1,1-Dichloroethene	<0.5	<0.5	NA	NA
cis-1,2-Dichloroethene	<0.5	<0.5	NA	NA
trans-1,2-Dichloroethene	<0.5	<0.5	NA	NA
1,2-Dichloropropane	<0.5	<0.5	NA	NA
Ethylbenzene	<0.5	<0.5	NA	NA
Methylene Chloride	<1.0	<1.0	NA	NA
Styrene	<0.5	<0.5	NA	NA
1,1,2,2-Tetrachloroethane	<0.2	<0.2	NA	NA
Tetrachloroethene	<0.5	<0.5	NA	NA
Toluene	<0.5	<0.5	NA	NA
1,1,1-Trichloroethane	<0.5	<0.5	NA	NA
1,1,2-Trichloroethane	<0.25	<0.25	NA	NA
Trichloroethene	<0.2	<0.2	NA	NA
Trichlorofluoromethane	<0.5	<0.5	NA	NA
Vinyl Chloride	<0.2	<0.2	NA	NA
Total Xylenes	<0.5	<0.5	NA	NA

† Analyte detected in method blank
‡ Result between MDL and LOQ and is therefore less certain.
* Result less than RL but greater than MDL. Value is estimated.
** Oxygen depletion less than 2 mg/l. Result is estimated.
Note: All metals are reported as "Total"

MONTHLY SUMMARY OF GROUNDWATER SAMPLING RESULTS

THE ARNOLD ENGINEERING CO.
MARENGO, IL

Historical VOC data

	Monitoring Well #1						Monitoring Well #2					
	111 TRICHLOROETHANE	TETRACHLOROETHENE	TRICHLOROETHENE	DISSOLVED SOLIDS	NICKEL	pH	111 TRICHLOROETHANE	TETRACHLOROETHENE	TRICHLOROETHENE	DISSOLVED SOLIDS	NICKEL	pH
LIMITS	200	5	5	1200	0.1	6.5-9	200	5	5	1200	0.1	6.5-9
Date	ug/l	ug/l	ug/l	mg/l	mg/l		ug/l	ug/l	ug/l	mg/l	mg/l	
a 1/10/01	<1.0	<1.0	<1.0	240	<0.050		<1.0	<1.0	<1.0	270	0.059	
2/2/2001	<1.0	<1.0	<1.0	368	<0.050		<1.0	<1.0	<1.0	366	<0.050	
3/7/2001	<1.0	<1.0	<1.0	340	<0.050		<1.0	<1.0	<1.0	412	<0.050	
4/2/2001	<1.0	<1.0	<1.0	336	<0.050		<1.0	<1.0	<1.0	414	<0.050	
5/2/2001	<1.0	<1.0	<1.0	336	<0.050		<1.0	<1.0	<1.0	454	<0.050	
6/11/2001	<1.0	<1.0	<1.0	348	<0.050		<1.0	<1.0	<1.0	484	<0.050	
7/10/2001	<1.0	<1.0	<1.0	324	<0.050		<1.0	<1.0	<1.0	464	0.063	
8/16/2001	<1.0	<1.0	<1.0	352	<0.050		<1.0	<1.0	<1.0	378	0.059	
9/7/2001	<1.0	<1.0	<1.0	376	<0.050		<1.0	<1.0	<1.0	448	<0.050	
10/2/2001	<1.0	<1.0	<1.0	400	<0.050		<1.0	<1.0	<1.0	454	0.051	
11/16/2001	<1.0	<1.0	<1.0	350	<0.050		<1.0	<1.0	<1.0	428	0.055	
12/11/2001	<2.0	<2.0	<2.0	385	<0.010		<2.0	<2.0	<2.0	428	0.071	
1/11/2002	<2.0	<2.0	<2.0	380	0.013		<2.0	<2.0	<2.0	390	0.059	
2/11/2002	<1.0	<1.0	<1.0	396	0.021		<1.0	<1.0	<1.0	426	0.062	
3/7/2002	<2.0	<2.0	<2.0	375	0.018		<2.0	<2.0	<2.0	414	0.055	
4/22/2002	<2.0	<2.0	<2.0	346	0.019		<2.0	<2.0	<2.0	457	0.099	
5/21/2002	<2.0	<2.0	<2.0	356	<0.010		<2.0	<2.0	<2.0	540	0.111	
6/7/2002	<2.0	<2.0	<2.0	340	<0.010		<2.0	<2.0	<2.0	281	0.026	
7/12/2002	<2.0	<2.0	<2.0	321	<0.010		<2.0	<2.0	<2.0	487	0.111	
8/2/2002	<1.0	<1.0	<1.0	335	0.072		<1.0	<1.0	<1.0	551	0.063	
9/6/2002	<1.0	<1.0	<1.0	345	<0.010		<1.0	<1.0	<1.0	400	0.037	
10/11/2002	<1.0	<1.0	<1.0	354	0.029		<1.0	<1.0	<1.0	566	0.198	
11/12/2002	<1.0	<1.0	<1.0	347	0.011		<1.0	<1.0	<1.0	613	0.14	
12/16/2002	<1.0	<1.0	<1.0	357	<0.010		<1.0	<1.0	<1.0	696	0.169	
1/10/2003	<1.0	<1.0	<1.0	360	0.015		<1.0	<1.0	<1.0	744	0.101	
2/7/2003	<1.0	<1.0	<1.0	288	0.013		<1.0	<1.0	<1.0	704	0.047	
3/21/2003	<1.0	<1.0	<1.0	370	0.023		<1.0	<1.0	<1.0	675	0.055	
4/11/2003	<1.0	<1.0	<1.0	384	0.019		<1.0	<1.0	<1.0	688	0.056	
5/9/2003	<1.0	<1.0	<1.0	396	0.01		<1.0	<1.0	<1.0	699	0.102	
6/7/2003	<1.0	<1.0	<1.0	364	0.033		<1.0	<1.0	<1.0	518	0.081	

	Monitoring Well #3						Outfall Pond 4					
	111 TRICHLOROETHANE	TETRACHLOROETHENE	TRICHLOROETHENE	DISSOLVED SOLIDS	NICKEL	pH	111 TRICHLOROETHANE	TETRACHLOROETHENE	TRICHLOROETHENE	DISSOLVED SOLIDS	NICKEL	pH
LIMITS	200	5	5	1200	0.1000	6.5-9	NO LIMIT - 2'NDARY WATER CLASS					
Date	ug/l	ug/l	ug/l	mg/l	mg/l		ug/l	ug/l	ug/l	mg/l	mg/l	
a 1/10/01	2100	1.3	4.7	610	<0.050		<1.0	2.2	<1.0	476	0.405	
2/2/2001	1600	<20	<20	672	<0.050		<1.0	1.2	<1.0	527	1.02	
3/7/2001	1700	<10	<10	542	<0.050		<1.0	<1.0	<1.0	504	1.2	
4/2/2001	1200	1.4	3.8	684	<0.050		<1.0	<1.0	<1.0	534	2.14	
5/2/2001	1200	1.2	3.7	658	<0.050		<1.0	<1.0	<1.0	532	1	
6/11/2001	1800	<10	<10	664	<0.050		<1.0	<1.0	<1.0	508	0.47	
7/10/2001	2800	<10	<10	662	<0.050		<1.0	<1.0	<1.0	518	0.38	
8/16/2001	3000	<10	<10	663	<0.050		<1.0	<1.0	<1.0	916	0.25	
9/7/2001	2200	1.3	4.6	703	<0.050		<1.0	<1.0	<1.0	462	0.333	
10/2/2001	2200	<20	<20	656	<0.050		<1.0	<1.0	<1.0	542	0.645	
11/16/2001	1900	1.1	4.8	646	<0.050		<1.0	<1.0	<1.0	638	0.352	
12/11/2001	1750	<2.0	4.8	662	0.0250		<2.0	<2.0	<2.0	670	0.298	
1/11/2002	1250	<2.0	2.8	655	0.0500		<2.0	<2.0	<2.0	634	0.431	
2/11/2002	789	1.3	3.6	708	0.0290		<1.0	<1.0	<1.0	646	0.325	
3/7/2002	505	<2.0	2.8	635	0.0290		<2.0	<2.0	<2.0	691	0.466	
4/22/2002	271	<2.0	<2.0	605	0.0320		<2.0	<2.0	<2.0	698	0.431	
5/21/2002	203	<2.0	<2.0	593	0.0130		<2.0	<2.0	<2.0	851	0.776	
6/7/2002	170	<2.0	<2.0	560	0.0430		<2.0	<2.0	<2.0	630	0.6	
7/12/2002	140	<2.0	<2.0	523	0.0350		<2.0	<2.0	<2.0	608	0.336	
8/2/2002	87	<1.0	<1.0	536	0.0220		<1.0	<1.0	<1.0	20600	0.386	
9/6/2002	76	<1.0	<1.0	592	0.0190		<1.0	<1.0	<1.0	886	0.701	
10/11/2002	192	<1.0	<1.0	630	0.0400		<1.0	<1.0	<1.0	738	0.306	
11/12/2002	188	<1.0	<1.0	602	0.0130		<1.0	<1.0	<1.0	964	0.298	
12/16/2002	617	<1.0	<1.0	637	0.0230		<1.0	<1.0	<1.0	703	0.273	
1/10/2003	636	1.1	1.1	676	0.0290		<1.0	<1.0	<1.0	520	0.22	
2/7/2003	310	1.2	<1.0	576	<0.010		<1.0	<1.0	<1.0	564	0.218	
3/21/2003	62	2.3	<1.0	48	0.1280		<1.0	<1.0	<1.0	611	0.247	
4/11/2003	42	2.2	<1.0	650	0.1160		<1.0	<1.0	<1.0	792	0.227	
5/9/2003	83	<1.0	<1.0	564	0.0790		<1.0	<1.0	<1.0	682	0.262	
6/7/2003	87	2.7	<1.0	583	0.0760		<1.0	<1.0	<1.0	750	0.243	

MONTHLY SUMMARY OF GROUNDWATER SAMPLING RESULTS

THE ARNOLD ENGINEERING CO.
MARENGO, IL

	Monitoring Well #1						Monitoring Well #2						Monitoring Well #3						Outfall Pond 4					
	111 TRICHLOROETHANE	TETRACHLOROETHENE	TRICHLOROETHENE	DISSOLVED SOLIDS	NICKEL	pH	111 TRICHLOROETHANE	TETRACHLOROETHENE	TRICHLOROETHENE	DISSOLVED SOLIDS	NICKEL	pH	111 TRICHLOROETHANE	TETRACHLOROETHENE	TRICHLOROETHENE	DISSOLVED SOLIDS	NICKEL	pH	111 TRICHLOROETHANE	TETRACHLOROETHENE	TRICHLOROETHENE	DISSOLVED SOLIDS	NICKEL	pH
LIMITS	200	5	5	1200	0.1	6.5-9	200	5	5	1200	0.1	6.5-9	200	5	5	1200	0.1000	6.5-9	NO LIMIT - 2'NDARY WATER CLASS					
Date	ug/l	ug/l	ug/l	mg/l	mg/l		ug/l	ug/l	ug/l	mg/l	mg/l		ug/l	ug/l	ug/l	mg/l	mg/l		ug/l	ug/l	ug/l	mg/l	mg/l	
7/15/2003	<1.0	<1.0	<1.0	379	0.028		<1.0	<1.0	<1.0	585	0.05		29	1.2	<1.0	514	0.0180		<1.0	<1.0	<1.0	778	0.701	
8/15/2003	<1.0	<1.0	<1.0	402	<0.010		<1.0	<1.0	<1.0	622	0.142		47	3	<1.0	857	0.0180		<1.0	<1.0	<1.0	499	0.45	
9/10/2003	<1.0	<1.0	<1.0	742	0.024		<1.0	<1.0	<1.0	751	0.059		48	3.4	<1.0	500	0.0320		<1.0	<1.0	<1.0	1090	0.409	
10/13/2003	<1.0	<1.0	<1.0	490	0.115		<1.0	<1.0	<1.0	790	0.139		33	3.7	<1.0	509	0.0270		<1.0	<1.0	<1.0	948	0.325	
11/10/2003	<1.0	<1.0	<1.0	410	0.026		<1.0	<1.0	<1.0	770	0.062		24	3.3	<1.0	486	0.0280		<1.0	<1.0	<1.0	831	0.271	
12/12/2003	<1.0	<1.0	<1.0	454	0.092		<1.0	<1.0	<1.0	862	0.046		18	5.7	<1.0	500	0.0400		<1.0	<1.0	<1.0	700	0.162	
1/15/2004	<1.0	<1.0	<1.0	480	0.052		<1.0	<1.0	<1.0	840	0.044		23	6.5	<1.0	480	0.0270		<1.0	<1.0	<1.0	800	0.149	
2/9/2004	<1.0	<1.0	<1.0	424	0.088		<1.0	<1.0	<1.0	740	0.059		23	5.1	<1.0	468	0.0250		<1.0	<1.0	<1.0	844	0.142	
3/5/2004	<1.0	<1.0	<1.0	1580	0.071		<1.0	<1.0	<1.0	261	0.028		20	6.7	<1.0	63	0.0180		<1.0	<1.0	<1.0	25	0.166	
4/2/2004	<1.0	<1.0	<1.0	405	0.016		<1.0	<1.0	<1.0	584	0.041		17	6.3	<1.0	472	0.0250		<1.0	<1.0	<1.0	908	0.266	
5/7/2004	<1.0	<1.0	<1.0	356	0.013		<1.0	<1.0	<1.0	670	0.064		24	6.7	<1.0	480	0.0630		<1.0	<1.0	<1.0	1070	0.368	
6/11/2004	<1.0	<1.0	<1.0	290	<0.010		<1.0	<1.0	<1.0	428	0.039		15	4.8	<1.0	544	0.0130		<1.0	<1.0	<1.0	748	0.219	
7/13/2004	2.5	<1.0	<1.0	611	0.07		<1.0	<1.0	<1.0	634	0.08		18	5.1	<1.0	522	0.1100		<1.0	<1.0	<1.0	656	0.201	
8/25/2004	<1.0	<1.0	<1.0	372	0.045		<1.0	<1.0	<1.0	734	0.155		21	6	<1.0	522	0.0850		<1.0	<1.0	<1.0	1030	0.424	
9/3/2004	<1.0	<1.0	<1.0	332	0.087		<1.0	<1.0	<1.0	704	0.184		18.7	6.5	<1.0	464	0.0800		<1.0	<1.0	<1.0	852	0.44	
10/18/2004	<1.0	<1.0	<1.0	280	<1.0	7.47	<1.0	<1.0	<1.0	736	0.083	6.80	18.9	6.9	<1.0	524	0.0260	7.11	<1.0	<1.0	<1.0	924	0.262	6.68
11/26/2004	<1.0	<1.0	<1.0	340	0.0074	7.40	<1.0	<1.0	<1.0	780	0.065	6.70	17	9.2	<1.0	470	0.0200	7.10	---	---	---	---	---	---
12/20/2004	<1.0	<1.0	<1.0	340	0.0094	7.30	<1.0	<1.0	<1.0	790	0.038	6.80	16	8.7	<1.0	510	0.0160	7.00	<1.0	<1.0	<1.0	750	0.14	6.60
1/25/2005	<1.0	<1.0	<1.0	400	0.093	ND	<1.0	<1.0	<1.0	790	0.038	ND	14	9	<1.0	500	0.0190	ND	<1.0	<1.0	<1.0	660	0.15	ND
2/28/2005	<5.0	<5.0	<5.0	352	<0.139	7.30	<5.0	<5.0	<5.0	710	<0.139	6.80	14.4	7.83	<5.0	458	<0.139	7.00	<5.0	<5.0	<5.0	745	0.235	5.90
3/29/2005	<5.0	<5.0	<5.0	346	<0.046	7.30	<5.0	<5.0	<5.0	696	0.074	6.80	16.1	10.7	<5.0	491	<0.046	7.20	<5.0	<5.0	<5.0	815	0.175	6.20
4/25/2005	6.68	<2.0	<2.0	325	<0.0125	7.15	3.41	<2.0	<2.0	681	0.0781	6.85	20	10.4	<2.0	490	<0.0125	7.54	<2.0	<2.0	<2.0	873	0.235	5.29
5/12/2005	<2.0	<2.0	<7.0	335	<0.0125	7.28	3.37	<2.0	<7.0	666	.0916	7.58	26.6	12.6	<8.0	484	0.0197	7.33	<2.0	<2.0	<2.0	869	0.23	ND
6/9/2005	<2.0	<2.0	<2.0	369	<0.0125	7.51	<2.0	<2.0	<2.0	669	0.0849	6.87	14.1	10.4	<2.0	489	0.0223	7.06	<2.0	<2.0	<2.0	992	0.265	5.56
7/7/2005	<5.0	<5.0	<5.0	350	0.029	7.30	<5.0	<5.0	<5.0	760	0.034	6.80	12	10	<5.0	440	0.0260	7.00	<5.0	<5.0	<5.0	1000	0.32	6.40
8/26/2005	<2.0	<5.0	<5.0	236	0.0424	7.13	<2.0	<5.0	<5.0	792	0.0218	6.55	7.8	9.5	<5.0	418	0.0208	6.80	<2.0	<5.0	<5.0	824	0.22	6.07
9/16/2005	<2.0	<5.0	<5.0	328	0.0258	7.09	<2.0	<5.0	<5.0	816	0.0352	6.52	8.3	10.4	<5.0	422	0.0362	6.92	<2.0	<5.0	<5.0	924	0.285	6.18
10/14/2005	<2.0	<5.0	<5.0	324	0.0113	7.24	<2.0	<5.0	<5.0	814	0.0264	6.57	6.6	8.8	<5.0	390	0.0322	6.95	<2.0	<5.0	<5.0	800	0.191	6.66
11/14/2005	<2.0	<5.0	<5.0	292	<.0050	7.19	<2.0	<5.0	<5.0	780	0.0322	6.54	7.4	11.9	<5.0	378	0.0266	7.02	<2.0	<5.0	<5.0	928	0.156	5.95
12/19/2005	<2.0	<5.0	<5.0	340	0.0359	7.15	<2.0	<5.0	<5.0	782	0.029	6.63	7.1	10.2	<5.0	418	0.0378	6.96	<2.0	<5.0	<5.0	972	0.124	4.65

MONTHLY SUMMARY OF GROUNDWATER SAMPLING RESULTS

THE ARNOLD ENGINEERING CO.
MARENGO, IL

	Monitoring Well #1						Monitoring Well #2						Monitoring Well #3						Outfall Pond 4					
	111 TRICHLOROETHANE	TETRACHLOROETHENE	TRICHLOROETHENE	DISSOLVED SOLIDS	NICKEL	pH	111 TRICHLOROETHANE	TETRACHLOROETHENE	TRICHLOROETHENE	DISSOLVED SOLIDS	NICKEL	pH	111 TRICHLOROETHANE	TETRACHLOROETHENE	TRICHLOROETHENE	DISSOLVED SOLIDS	NICKEL	pH	111 TRICHLOROETHANE	TETRACHLOROETHENE	TRICHLOROETHENE	DISSOLVED SOLIDS	NICKEL	pH
LIMITS	200	5	5	1200	0.1	6.5-9	200	5	5	1200	0.1	6.5-9	200	5	5	1200	0.1000	6.5-9	NO LIMIT - 2'NDARY WATER CLASS					
Date	ug/l	ug/l	ug/l	mg/l	mg/l		ug/l	ug/l	ug/l	mg/l	mg/l		ug/l	ug/l	ug/l	mg/l	mg/l		ug/l	ug/l	ug/l	mg/l	mg/l	
1/17/2006	<2.0	<5.0	<5.0	348	0.0102	6.97	<2.0	<5.0	<5.0	786	0.0162	6.44	8.2	12.8	<5.0	394	0.0405	6.90	<2.0	<5.0	<5.0	746	0.132	6.07
2/10/2006	<2.0	<5.0	<5.0	372	0.0182	7.00	<2.0	<5.0	<5.0	748	0.0362	6.25	8	12.1	<5.0	394	0.0293	6.62	<2.0	<5.0	<5.0	912	0.137	3.75
3/10/2006	<2.0	<5.0	<5.0	316	0.0144	6.58	<2.0	<5.0	<5.0	752	0.0344	6.31	8.5	12.6	<5.0	398	0.0537	6.63	<2.0	<5.0	<5.0	726	0.144	4.88
4/10/2006	<2.0	<5.0	<5.0	404	<0.0050	6.64	<2.0	<5.0	<5.0	696	0.026	6.29	7.9	11.8	<5.0	378	0.0253	6.54	<2.0	<5.0	<5.0	722	0.0997	6.18
5/15/2006	<2.0	<5.0	<5.0	326	0.0087	6.62	<2.0	<5.0	<5.0	700	0.0338	6.04	8	9.7	<5.0	446	0.0268	6.36	<2.0	<5.0	<5.0	648	0.0493	6.15
6/12/2006	<2.0	<5.0	<5.0	376	0.0268	6.60	<2.0	<5.0	<5.0	680	0.0424	6.08	9.6	11.5	<5.0	498	0.0936	6.42	<2.0	<5.0	<5.0	672	0.0991	6.52
7/14/2006	<2.0	<5.0	<5.0	408	<.0050	6.46	<2.0	<5.0	<5.0	700	0.0304	5.76	8.7	14.6	<5.0	462	0.0207	6.33	<2.0	<5.0	<5.0	708	0.0624	6.11
8/22/2006	<2.0	<5.0	<5.0	290	0.0172	7.26	<2.0	<5.0	<5.0	456	0.0526	6.82	9	13.4	<5.0	458	0.0357	7.05	<2.0	<5.0	<5.0	668	0.0805	7.01
9/15/2006	<2.0	<5.0	<5.0	318	0.0077	7.28	<2.0	<5.0	<5.0	602	0.0259	6.78	6.9	12.0	<5.0	474	0.0355	6.90	<2.0	<5.0	<5.0	610	0.0507	6.88
10/13/2006	<2.0	<5.0	<5.0	364	0.0175	7.53	<2.0	<5.0	<5.0	640	0.0219	6.56	8.7	13.9	<5.0	490	0.0183	7.23	<2.0	<5.0	<5.0	662	0.0579	6.17
11/13/2006	<2.0	<5.0	<5.0	358	0.0188	6.85	<2.0	<5.0	<5.0	624	0.022	6.21	9.31	13.9	<5.0	452	0.0329	6.78	<2.0	<5.0	<5.0	672	0.0464	6.38
12/15/2006	<2.0	<5.0	<5.0	374	0.0183	6.79	<2.0	<5.0	<5.0	550	0.0319	6.89	11.3	<5.0	<5.0	424	0.0211	6.91	<2.0	<5.0	<5.0	552	0.0401	6.75
1/12/2007	<2.0	<5.0	<5.0	394	0.019	7.17	<2.0	<5.0	<5.0	600	0.0765	6.71	10.8	15.5	<5.0	420	0.0305	7.33	<2.0	<5.0	<5.0	556	0.0506	7.01
2/19/2007	<2.0	<5.0	<5.0	462	0.0412	7.30	<2.0	<5.0	<5.0	538	0.0304	6.72	12.1	18.0	<5.0	428	<0.005	6.54	<2.0	<5.0	<5.0	500	0.0393	7.18
3/16/2007	<2.0	<5.0	<5.0	404	0.024	7.24	2.2	<5.0	<5.0	580	0.0544	6.85	18.8	18.3	<5.0	520	0.0557	6.74	<2.0	<5.0	<5.0	532	0.0497	7.27
3/22/2007	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
4/23/2007	<2.0	<5.0	<5.0	378	0.0322	7.07	<2.0	<5.0	<5.0	626	0.0642	6.82	<2.0	12.2	<5.0	532	0.0416	6.89	<2.0	<5.0	<5.0	604	0.0426	7.55
5/11/2007	<2.0	<5.0	<5.0	364	0.016	7.48	<2.0	<5.0	<5.0	658	0.0975	7.15	13.6	16.0	<5.0	498	0.0589	7.12	<2.0	<5.0	<5.0	592	0.0274	7.54
6/25/2007	<2.0	<5.0	<5.0	346	0.0142	7.43	<2.0	<5.0	<5.0	494	0.082	7.14	12.0	10.3	<5.0	462	0.0380	7.02	<2.0	<5.0	<5.0	614	0.0696	7.5
7/13/2007	<2.0	<5.0	<5.0	296	<0.0050	7.38	<2.0	<5.0	<5.0	492	0.0651	7.12	10.8	16.1	<5.0	466	0.0233	7.03	<2.0	<5.0	<5.0	630	0.0474	6.97
8/10/2007	<2.0	<5.0	<5.0	344	0.0129	7.32	<2.0	<5.0	<5.0	180	0.0072	7.68	12.3	16.1	<5.0	548	0.0238	7.17	<2.0	<5.0	<5.0	620	0.0427	6.78
9/7/2007	<2.0	<5.0	<5.0	318	0.0155	7.23	<2.0	<5.0	<5.0	348	0.0206	7.19	11.2	12.1	<5.0	436	0.0393	7.22	<2.0	<5.0	<5.0	594	0.0707	6.72
10/19/2007	<2.0	<5.0	<5.0	342	0.0139	7.39	<2.0	<5.0	<5.0	546	0.0402	7.23	10.5	14.4	<5.0	540	0.0260	7.12	<2.0	<5.0	<5.0	758	0.060	6.78
11/16/2007	<2.0	<5.0	<5.0	340	0.0059	7.04	4.9	<5.0	<5.0	508	0.0599	6.98	11.7	13.8	<5.0	472	0.0162	7.07	<2.0	<5.0	<5.0	722	0.050	6.08
12/17/2007	<2.0	<5.0	<5.0	446	0.0075	7.04	<2.0	<5.0	<5.0	644	0.0765	6.93	7.9	13.1	<5.0	530	0.0125	6.90	<2.0	<5.0	<5.0	784	0.088	6.18
1/18/2008	<2.0	<5.0	<5.0	386	0.0063	6.57	<2.0	<5.0	<5.0	592	0.0596	7.15	12.4	12.0	<5.0	536	0.0170	6.74	<2.0	<5.0	<5.0	820	0.0794	6.1
2/18/2008	<2.0	<5.0	<5.0	340	0.016	7.14	<2.0	<5.0	<5.0	582	0.0501	7.12	11.4	13	<5.0	510	0.0306	7.24	<2.0	<5.0	<5.0	630	0.0479	6.46
3/24/2008	<2.0	<5.0	<5.0	334	0.0222	6.87	<2.0	<5.0	<5.0	492	0.0314	7	<2.0	12.8	<5.0	552	0.0134	6.86	<2.0	<5.0	<5.0	768	0.0454	5.89
4/18/2008	<2.0	<5.0	<5.0	336	0.012	6.75	<2.0	<5.0	<5.0	520	0.0204	7.16	<2.0	10.5	<5.0	520	0.0211	6.78	<2.0	<5.0	<5.0	652	0.0588	6.38
5/16/2008	<2.0	<5.0	<5.0	292	0.0166	7.11	<2.0	<5.0	<5.0	508	0.0266	7.18	8.3	8.6	<5.0	514	0.0167	6.82	<2.0	<5.0	<5.0	664	0.052	6.48

MONTHLY SUMMARY OF GROUNDWATER SAMPLING RESULTS

THE ARNOLD ENGINEERING CO.
MARENGO, IL

	Monitoring Well #1					
	111 TRICHLOROETHANE	TETRACHLOROETHENE	TRICHLOROETHENE	DISSOLVED SOLIDS	NICKEL	pH
LIMITS	200	5	5	1200	0.1	6.5-9
Date	ug/l	ug/l	ug/l	mg/l	mg/l	
6/19/2008	<2.0	<5.0	<5.0	300	0.00727	7.71
7/29/2008	<2.0	<5.0	<5.0	306	<0.0050	7.37
8/25/2008	<2.0	<5.0	<5.0	350	0.0094	7.52
9/22/2008	<2.0	<5.0	<5.0	382	<0.0050	7.29
10/17/2008	<2.0	<5.0	<5.0	354	<0.0050	7.77
11/24/2008	<2.0	<5.0	<5.0	452	0.00505	7.42
12/30/2008	<2.0	<5.0	<5.0	358	<0.0050	7.55
1/21/2009	<2.0	<5.0	<5.0	374	<0.0050	7.88
2/23/2009	<2.0	<5.0	<5.0	364	0.0103	7.72
3/20/2008	<2.0	<5.0	<5.0	364	<0.0050	8.02
4/27/2009	<2.0	<5.0	<5.0	322	0.00677	7.62

	Monitoring Well #2					
	111 TRICHLOROETHANE	TETRACHLOROETHENE	TRICHLOROETHENE	DISSOLVED SOLIDS	NICKEL	pH
LIMITS	200	5	5	1200	0.1	6.5-9
Date	ug/l	ug/l	ug/l	mg/l	mg/l	
6/19/2008	<2.0	<5.0	<5.0	352	0.0165	7.72
7/29/2008	<2.0	<5.0	<5.0	496	0.0259	7.2
8/25/2008	<2.0	<5.0	<5.0	610	0.0418	7.04
9/22/2008	<2.0	<5.0	<5.0	558	0.0562	7.03
10/17/2008	<2.0	<5.0	<5.0	514	0.0425	7.26
11/24/2008	<2.0	<5.0	<5.0	530	0.0511	7.21
12/30/2008	<2.0	<5.0	<5.0	554	0.053	7.18
1/21/2009	<2.0	<5.0	<5.0	552	0.0522	7.66
2/23/2009	7.5	<5.0	<5.0	520	0.0455	7.3
3/20/2008	<2.0	<5.0	<5.0	284	0.0132	7.3
4/27/2009	<2.0	<5.0	<5.0	500	0.0274	7.4

	Monitoring Well #3					
	111 TRICHLOROETHANE	TETRACHLOROETHENE	TRICHLOROETHENE	DISSOLVED SOLIDS	NICKEL	pH
LIMITS	200	5	5	1200	0.1000	6.5-9
Date	ug/l	ug/l	ug/l	mg/l	mg/l	
6/19/2008	9.1	7.5	<5.0	480	0.0128	7.57
7/29/2008	9.7	11.5	<5.0	442	0.0296	7.17
8/25/2008	<2.0	9.5	<5.0	522	0.0422	7.18
9/22/2008	8	7.4	<5.0	484	0.0176	7.14
10/17/2008	10.2	9.1	<5.0	512	0.0556	7.26
11/24/2008	18.4	10.8	<5.0	460	0.0234	7.3
12/30/2008	16.8	10.6	<5.0	358	0.0281	7.34
1/21/2009	16.7	12.8	<5.0	474	0.0266	7.53
2/23/2009	13.9	12.2	<5.0	470	0.0304	7.48
3/20/2008	14.6	11.2	<5.0	446	0.0429	7.68
4/27/2009	15.7	11	<5.0	414	0.0335	7.26

	Outfall Pond 4					
	111 TRICHLOROETHANE	TETRACHLOROETHENE	TRICHLOROETHENE	DISSOLVED SOLIDS	NICKEL	pH
LIMITS	NO LIMIT - 2'NDARY WATER CLASS					
Date	ug/l	ug/l	ug/l	mg/l	mg/l	
6/19/2008	<2.0	<5.0	<5.0	698	0.101	7.08
7/29/2008	<2.0	<5.0	<5.0	580	0.0851	6.65
8/25/2008	<2.0	<5.0	<5.0	720	0.0796	6.38
9/22/2008	<2.0	<5.0	<5.0	654	0.0508	6.67
10/17/2008	<2.0	<5.0	<5.0	660	0.0432	6.96
11/24/2008	<2.0	<5.0	<5.0	600	0.342	7.09
12/30/2008	<2.0	<5.0	<5.0	524	0.0362	7.16
1/21/2009	<2.0	<5.0	<5.0	568	0.0287	7.56
2/23/2009	<2.0	<5.0	<5.0	524	0.0216	7.2
3/20/2008	<2.0	<5.0	<5.0	464	0.0312	7.37
4/27/2009	<2.0	<5.0	<5.0	520	0.0312	7.1

SEMI-ANNUAL MONITORING REPORT OF THE MONTHLY GROUNDWATER SAMPLING RESULTS

ARNOLD MAGNETIC TECHNOLOGIES
MARENGO, IL
PERMIT NO.: 2006-EO-0690

Monitoring Well #1

Permit Parameters	1,1,1- TRICHLOROETHANE	TETRACHLOROETHENE	TRICHLOROETHYLENE	DISSOLVED SOLIDS	NICKEL	pH
Permit Parameter Limits	0.2 mg/l	0.005 mg/l	0.005 mg/l	1,200 mg/l	0.1 mg/l	6.5 - 9.0 SU
Sample Date	Sample Results Units of Measure					
	mg/l	mg/l	mg/l	mg/l	mg/l	SU
5/15/2009	<0.005	<0.005	<0.005	318	<0.005	7.56
6/15/2009	<0.005	<0.005	<0.005	350	<0.0050	7.51
7/10/2009	<0.005	<0.005	<0.005	278	<0.0050	7.38
8/14/2009	<0.005	<0.005	<0.005	352	<0.0050	7.43
9/11/2009	<0.005	<0.005	<0.005	380	<0.0050	7.40
10/16/2009	<0.005	<0.005	<0.005	368	<0.0050	7.50
11/13/2009	<0.005	<0.005	<0.005	2130	<0.0050	7.35
12/18/2009	<0.005	<0.005	<0.005	398	<0.0050	7.28
1/15/2010	<0.005	<0.005	<0.005	412	<0.0050	7.41
2/12/2010	<0.005	<0.005	<0.005	236	<0.0050	6.97
3/15/2010	<0.005	<0.005	<0.005	302	<0.0050	7.29
4/16/2010	<0.005	<0.005	<0.005	376	<0.0050	7.05
5/14/2010	<0.005	<0.005	<0.005	378	<0.0050	6.55

Monitoring Well #2

Permit Parameters	1,1,1- TRICHLOROETHANE	TETRACHLOROETHENE	TRICHLOROETHYLENE	DISSOLVED SOLIDS	NICKEL	pH
Permit Parameter Limits	0.2 mg/l	0.005 mg/l	0.005 mg/l	1,200 mg/l	0.1 mg/l	6.5 - 9.0 SU
Sample Date	Sample Results Units of Measure					
	mg/l	mg/l	mg/l	mg/l	mg/l	SU
5/15/2009	<0.005	<0.005	<0.005	360	0.013	7.47
6/15/2009	<0.005	<0.005	<0.005	354	0.0133	7.45
7/10/2009	<0.005	<0.005	<0.005	448	0.0278	7.26
8/14/2009	<0.005	<0.005	<0.005	412	0.0375	7.13
9/11/2009	<0.005	<0.005	<0.005	478	0.0431	7.15
10/16/2009	<0.005	<0.005	<0.005	554	0.068	7.14
11/13/2009	<0.005	<0.005	<0.005	3300	0.0499	7.1
12/18/2009	<0.005	<0.005	<0.005	500	0.0682	7.05
1/15/2010	<0.005	<0.005	<0.005	520	0.0555	7.12
2/12/2010	<0.005	<0.005	<0.005	394	0.0438	7
3/15/2010	<0.005	<0.005	<0.005	482	0.0687	7.09
4/16/2010	<0.005	<0.005	<0.005	472	0.0646	7.07
5/14/2010	<0.005	<0.005	<0.005	206	0.0124	7.04

Monitoring Well #3

Permit Parameters	1,1,1- TRICHLOROETHANE	TETRACHLOROETHENE	TRICHLOROETHYLENE	DISSOLVED SOLIDS	NICKEL	pH
Permit Parameter Limits	0.2 mg/l	0.005 mg/l	0.005 mg/l	1,200 mg/l	0.1 mg/l	6.5 - 9.0 SU
Sample Date	Sample Results Units of Measure					
	mg/l	mg/l	mg/l	mg/l	mg/l	SU
5/15/2009	0.0267	0.0111	<0.005	416	0.0241	7.3
6/15/2009	0.0274	0.0091	<0.005	474	0.0279	7.18
7/10/2009	<0.005	<0.005	<0.005	284	0.0198	7.18
8/14/2009	0.102	0.0086	<0.005	294	0.0237	7.29
9/11/2009	0.0874	0.0104	<0.005	432	0.0152	7.2
10/16/2009	0.0479	0.0094	<0.005	348	0.0090	7.56
11/13/2009	0.125	0.0111	<0.005	460	0.0360	7.16
12/18/2009	0.102	0.0093	<0.005	444	0.0122	7.19
1/15/2010	0.0469	0.0097	<0.005	432	0.0164	7.26
2/12/2010	0.767	0.0128	<0.005	412	0.0087	7.01
3/15/2010	0.591	0.0132	<0.005	426	0.0192	7.63
4/16/2010	0.483	0.0116	<0.005	468	0.0314	7.01
5/14/2010	0.482	0.0112	<0.005	464	0.0406	7.09

Outfall Pond 4

Permit Parameters	1,1,1- TRICHLOROETHANE	TETRACHLOROETHENE	TRICHLOROETHYLENE	DISSOLVED SOLIDS	NICKEL	pH
Permit Parameter Limits	NO LIMIT - SECONDARY WATER CLASS					
Sample Date	Sample Results Units of Measure					
	mg/l	mg/l	mg/l	mg/l	mg/l	SU
5/15/2009	<0.005	<0.005	<0.005	652	0.0441	6.05
6/15/2009	<0.005	<0.005	<0.005	522	0.0332	7.71
7/10/2009	<0.005	<0.005	<0.005	474	0.0221	7.8
8/14/2009	<0.005	<0.005	<0.005	496	0.0164	7.74
9/11/2009	<0.005	<0.005	<0.005	600	0.0339	7.2
10/16/2009	<0.005	<0.005	<0.005	718	0.0557	6.49
11/13/2009	<0.005	<0.005	<0.005	2550	0.0482	6.65
12/18/2009	<0.005	<0.005	<0.005	703	0.0664	6.25
1/15/2010	<0.005	<0.005	<0.005	482	0.0428	6.56
2/12/2010	<0.005	<0.005	<0.005	560	0.0546	6.11
3/15/2010	<0.005	<0.005	<0.005	674	0.0521	6.43
4/16/2010	<0.005	<0.005	<0.005	698	0.246	6.52
5/14/2010	<0.005	<0.005	<0.005	612	0.114	6.75

SEMI-ANNUAL MONITORING REPORT OF THE MONTHLY GROUNDWATER SAMPLING RESULTS

ARNOLD MAGNETIC TECHNOLOGIES
MARENGO, IL
PERMIT NO.: 2006-EO-0690

Monitoring Well #1

Permit Parameters	1,1,1- TRICHLOROETHANE	TETRACHLOROETHENE	TRICHLOROETHYLENE	DISSOLVED SOLIDS	NICKEL	pH
Permit Parameter Limits	0.2 mg/l	0.005 mg/l	0.005 mg/l	1,200 mg/l	0.1 mg/l	6.5 - 9.0 SU
Sample Date	Sample Results Units of Measure					
	mg/l	mg/l	mg/l	mg/l	mg/l	SU
4/16/2010	<0.005	<0.005	<0.005	376	<0.0050	7.05
5/14/2010	<0.005	<0.005	<0.005	378	<0.0050	6.55
6/14/2010	<0.005	<0.005	<0.005	358	<0.0050	6.74
7/16/2010	<0.005	<0.005	<0.005	432	<0.0050	7.27
8/13/2010	<0.005	<0.005	<0.005	400	<0.0050	7.07
9/17/2010	<0.005	<0.005	<0.005	434	<0.0050	7
10/15/2010	<0.005	<0.005	<0.005	334	<0.0050	6.65
11/12/2010	<0.005	<0.005	<0.005	354	<0.0050	6.93
12/10/2010	<0.005	<0.005	<0.005	328	<0.0050	7.09
1/14/2011	<0.005	<0.005	<0.005	426	<0.0050	7.5
2/18/2011	<0.005	<0.005	<0.005	350	<0.0050	7.26
3/11/2011	<0.005	<0.005	<0.005	342	<0.0050	6.92

Monitoring Well #2

Permit Parameters	1,1,1- TRICHLOROETHANE	TETRACHLOROETHENE	TRICHLOROETHYLENE	DISSOLVED SOLIDS	NICKEL	pH
Permit Parameter Limits	0.2 mg/l	0.005 mg/l	0.005 mg/l	1,200 mg/l	0.1 mg/l	6.5 - 9.0 SU
Sample Date	Sample Results Units of Measure					
	mg/l	mg/l	mg/l	mg/l	mg/l	SU
4/16/2010	<0.005	<0.005	<0.005	472	0.0646	7.07
5/14/2010	<0.005	<0.005	<0.005	206	0.0124	7.04
6/14/2010	<0.005	<0.005	<0.005	388	0.0761	6.81
7/16/2010	<0.005	<0.005	<0.005	634	0.0977	6.99
8/13/2010	<0.005	<0.005	<0.005	504	0.103	6.63
9/17/2010	<0.005	<0.005	<0.005	608	[redacted]	6.78
10/15/2010	<0.005	<0.005	<0.005	414	[redacted]	6.75
11/12/2010	<0.005	<0.005	<0.005	512	[redacted]	6.75
12/10/2010	<0.005	<0.005	<0.005	440	0.0984	6.95
1/14/2011	<0.005	<0.005	<0.005	586	0.0528	7.26
2/18/2011	<0.005	<0.005	<0.005	514	0.0334	6.82
3/11/2011	<0.005	<0.005	<0.005	518	0.0892	6.85

Monitoring Well #3

Permit Parameters	1,1,1- TRICHLOROETHANE	TETRACHLOROETHENE	TRICHLOROETHYLENE	DISSOLVED SOLIDS	NICKEL	pH
Permit Parameter Limits	0.2 mg/l	0.005 mg/l	0.005 mg/l	1,200 mg/l	0.1 mg/l	6.5 - 9.0 SU
Sample Date	Sample Results Units of Measure					
	mg/l	mg/l	mg/l	mg/l	mg/l	SU
4/16/2010	[redacted]	[redacted]	<0.005	468	0.0314	7.01
5/14/2010	[redacted]	[redacted]	<0.005	464	0.0406	7.09
6/14/2010	[redacted]	[redacted]	<0.005	410	0.0202	6.99
7/16/2010	[redacted]	[redacted]	<0.005	552	0.0302	7.07
8/13/2010	[redacted]	[redacted]	<0.005	576	0.0292	6.8
9/17/2010	0.167	[redacted]	<0.005	422	0.0141	7.03
10/15/2010	[redacted]	[redacted]	<0.005	360	0.0155	6.86
11/12/2010	0.0106	<0.005	<0.005	634	0.0249	7.11
12/10/2010	0.0709	<0.005	<0.005	358	0.0356	7.17
1/14/2011	0.0756	[redacted]	<0.005	462	0.0298	7.33
2/18/2011	0.107	[redacted]	<0.005	522	0.0180	7.04
3/11/2011	0.0916	0.0050	<0.005	506	0.0228	6.89

4/18/2011 – 10/20/2011: New WPCP issued (2011-EO-1001) which no longer requires the sampling of any monitoring wells

Outfall Pond 4

Permit Parameters	1,1,1- TRICHLOROETHANE	TETRACHLOROETHENE	TRICHLOROETHYLENE	DISSOLVED SOLIDS	NICKEL	pH	Total Residual Chlorine
Permit Parameter Limits	NO LIMIT - SECONDARY WATER CLASS						
Sample Date	Sample Results Units of Measure						
	mg/l	mg/l	mg/l	mg/l	mg/l	SU	mg/l
4/16/2010	<0.005	<0.005	<0.005	698	0.246	6.52	
5/14/2010	<0.005	<0.005	<0.005	612	0.114	6.75	
6/14/2010	<0.005	<0.005	<0.005	474	0.0415	6.98	
7/16/2010	<0.005	<0.005	<0.005	570	0.0443	7.46	
8/13/2010	<0.005	<0.005	<0.005	568	0.0579	6.81	
9/17/2010	<0.005	<0.005	<0.005	638	0.0856	6.64	
10/15/2010	<0.005	<0.005	<0.005	616	0.115	6.51	
11/12/2010	<0.005	<0.005	<0.005	625	0.0725	6.95	
12/10/2010	<0.005	<0.005	<0.005	466	0.0526	6.88	
1/14/2011	<0.005	<0.005	<0.005	510	0.0474	7.75	
2/18/2011	<0.005	<0.005	<0.005	340	0.044	7.29	
3/11/2011	<0.005	<0.005	<0.005	330	0.0434	6.86	
New WPCP Parameter Limits	None				0.1 mg/l	6.5-9.0 SU	No Standard
4/18/2011	New WCPC does not require the sampling of these analites				0.0548	6.18 6.33 resampled on 4/27	<0.05
5/16/2011					0.0522	6.9	<0.05
6/23/2011					0.0422	7.11	<0.05
7/11/2011					0.0284	7.23	<0.05
8/23/2011					0.0267	6.97	0.13
9/19/2011					0.0283	7.05	0.42
10/20/2011					0.0325	7.98	0.07

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Technical Memorandum

To	Nadine Marion, Arnold Magnetic Technologies
CC	Julie Johnson, AECOM Pat Dunne, AECOM
Subject	Marengo Wastewater Permit Assistance 2016 Groundwater Mounding Analysis
From	Dan McHale, AECOM
Date	April 25, 2016

AECOM Technical Services, Inc. (AECOM) evaluated potential effects of percolating water from Arnold Magnetic Technologies' (AMT) wastewater pond system on groundwater contaminant transport in the vicinity of the Marengo, Illinois facility. As detailed below, AECOM's analysis indicates that potential leakage from the surface water ponds, as well as infiltration from the associated percolation field, has no significant impact on shallow groundwater flow gradients, and would therefore not significantly impact hydraulic contaminant transport at the site.

Approach

Water percolating at ground surface (a recharge area) generally has the potential to alter groundwater flow, and could consequently affect the movement of existing groundwater contamination by locally altering groundwater flow gradients. The mechanism by which this could occur includes:

- Water continuously discharged at ground surface percolates vertically through the unsaturated zone under influence of gravity to the shallow groundwater table;
- Over time, the groundwater table builds up (mounds) locally beneath the percolation area due to concentrated recharge;
- The mounded groundwater increases the local hydraulic gradient, thereby increasing groundwater contaminant velocity; and,
- Mounded groundwater possibly alters groundwater flow direction, thereby altering groundwater contaminant transport direction, relative to natural/background groundwater flow direction, typically by creating a radially-outward groundwater flow pattern emanating from the groundwater mound.

AECOM evaluated the potential for groundwater mounding impacts due to percolating water associated with AMT's pond system discharge. The pond system discharges water to a 16-acre percolation field located in the southwestern portion of the site. AECOM recognizes that leakage may also occur beneath the four-pond system itself, as well as beneath associated drainage ditches. We focused on evaluating the mounding associated with the percolation field, where the majority of the water likely percolates, as the worst-case scenario. AECOM evaluated mounding using groundwater contour maps presented in the March 2016 Weaver CSI Report, and by performing a groundwater mounding analysis using analytical techniques developed by Hantush (1967).

Groundwater Contour Map Interpretation

AECOM evaluated groundwater contour maps developed by Weaver which represent the shallow groundwater system at the site during April 2015, October 2015 and February 2016 field activities. The Weaver maps are provided as Attachment 1.

Localized groundwater recharge areas typically are characterized by groundwater contours with higher elevations than the surrounding aquifer, often with high elevation contour lines wrapping around the recharge area and associated groundwater flow lines diverging radially. These signature contours and flow lines are not apparent in the vicinity of the ponds or the percolation field. The groundwater contours are relatively smooth, and do not diverge or wrap around the percolation field. Divergence would be expected if the volume of percolating groundwater were sufficient to cause sustained groundwater mounding beneath the area. Groundwater flow directions (shown as red arrows in Attachment 1) generally indicate relatively straight downgradient flow directions with little radial deviation.

Based on review of the Weaver contour maps, AECOM concluded that percolating groundwater has a relatively minor impact on groundwater levels at the AMT site. The minor nature of any impact is likely due to the relatively high hydraulic conductivity of site soils, which has the effect of dampening and dissipating mounding buildup relatively quickly, as well as a limited volume of water percolating over a large area.

Mounding Analysis

AECOM performed a groundwater mounding analysis to confirm the accuracy of the groundwater contour maps. The mounding analysis is based on analytical techniques developed by Hantush (Hantush, 1967), and incorporated into a spreadsheet format by the United States Geological Survey (USGS, 2010). Inputs for AECOM's mounding analysis are provided below and in Attachment 2:

- Recharge (percolation) rate = 0.027 feet per day. This value is based on information in AMT's wastewater permit application: 140,000 gallons per day are pumped from the onsite deep well and added to the water recycling system.
- Specific yield of aquifer (S_y) = 0.2 (literature value).
- Hydraulic conductivity (K) = 136 feet per day (March 2016 Weaver CSI Report).
- Basin size = 16 acres or 696,960 square feet (March 2016 Weaver CSI Report).
- Aquifer thickness = 70 feet (March 2016 Weaver CSI Report).

The mounding analysis indicates a maximum groundwater mound of approximately one (1) foot after 1,000 days of continuous, uninterrupted groundwater percolation. Based on the Weaver groundwater contour maps, this value is less than natural variations observed in the groundwater level over the course of a calendar year.

AECOM's mounding analysis is likely conservative because it assumes continuous, uninterrupted (steady-state) percolation of the maximum available water. Additionally, the analysis is conservative in that the results do not include mounding dissipation that would occur during times of diminished or no percolation, and do not account for other water losses such as evapotranspiration, which could significantly diminish the quantity of water reaching the groundwater table.

Conclusions

AECOM's mounding analysis results are consistent with our interpretation of the Weaver groundwater contour maps. Potential leakage from the pond system is not sufficient to alter groundwater flow conditions. Accordingly, as discussed in AECOM's March 17, 2016 memorandum, AMT's pond system does not appear to be a likely source of contaminant loading to the area aquifer. Any infiltration from the percolation field is not sufficient to materially alter local groundwater gradients.

Theoretically (based on the Hantush analysis), some groundwater mounding would be expected regardless of the volume of percolating water. However, the height of groundwater mounding associated with AMT's pond system appears to be relatively small, and is less than the magnitude of natural fluctuation/variation observed over one calendar year of groundwater level observation. According to the Weaver data, the observed fluctuation was approximately three (3) feet in the vicinity of the percolation field. AECOM's finding is consistent with groundwater flow conditions depicted in site groundwater contour maps produced by Weaver, and suggests that unsaturated flow conditions exist beneath the percolation field. The unsaturated flow condition increases the residence time of the discharge water in the soil zone between the ground surface and water table, and promotes increased attenuation (*e.g.,* via adsorption, volatilization, colloidal filtering, etc.) of any chemicals in the discharge water.

AECOM's mounding analysis is a highly conservative estimate, as the analysis assumes that all water discharged from the pond system reaches the water table at the percolation field, pond discharge is continuous and uninterrupted (mounding is never allowed to dissipate) and does not account for evapotranspiration (in the ponds or when discharged to the percolation field), losses to the unsaturated zone, losses during the coolant process, etc.

Groundwater contour maps developed by Weaver and AECOM's mounding analysis indicate that mounding is not significant, and associated impacts on existing groundwater contamination are unlikely.

Limitations

AMT requested that AECOM qualitatively evaluate AMT's pond system and potential effects of the system on area groundwater quality based on currently-available site information generated by others. The statements and opinions presented herein are based on professional judgment, previous experience at similar sites, and AECOM's review of the provided investigation documents describing the general design of the facility pond system and area groundwater conditions.

AECOM made several conservative assumptions in the evaluation where site-specific information was unavailable.

AECOM makes no warranties, either express or implied, regarding the estimates, opinions and conclusions presented herein.

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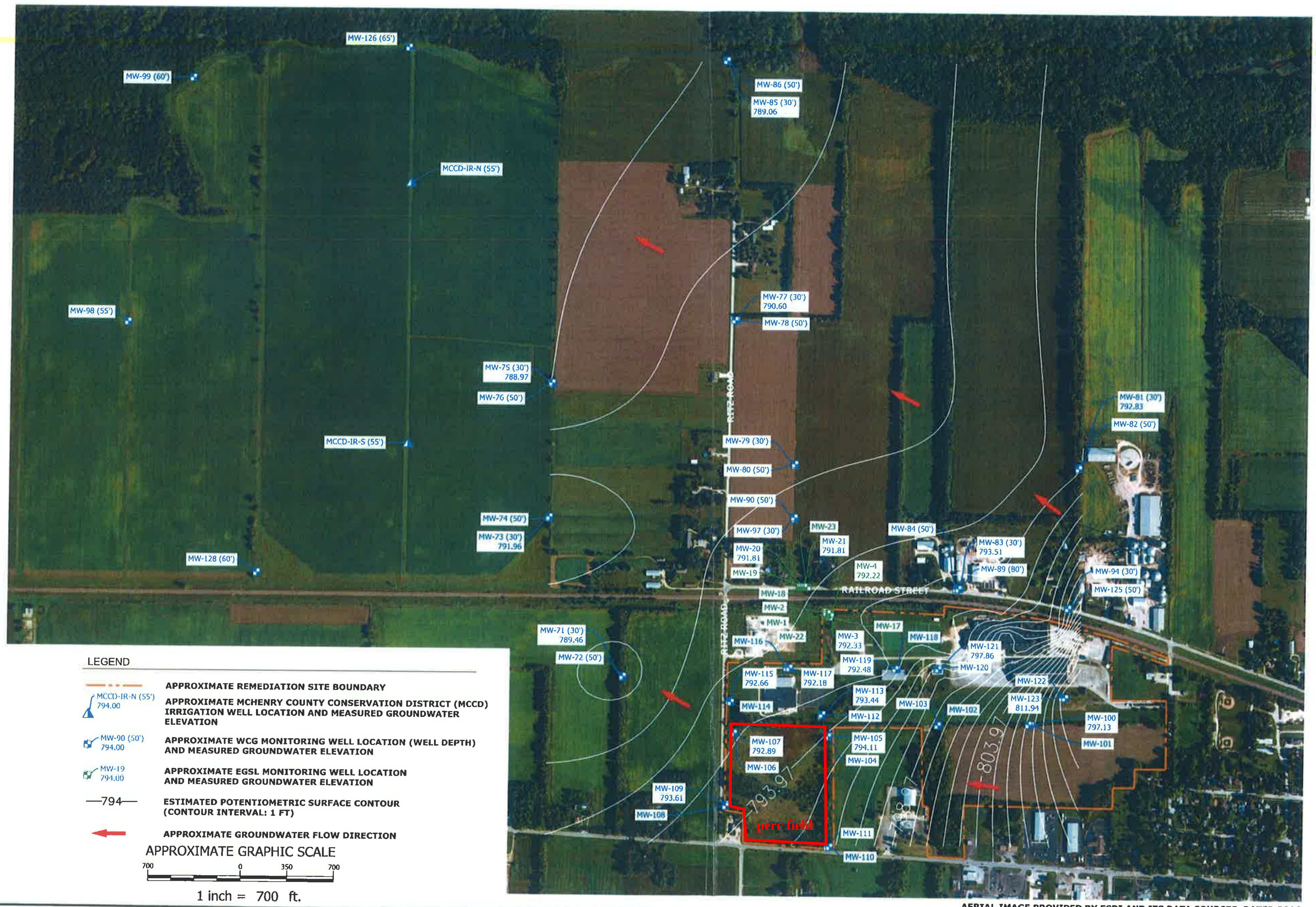
References

Hantush, M.S., 1967, *Growth and Decay of Groundwater Mounds in Response to Uniform Percolation*, Water Resources Research, v. 3, p. 227-234.

USGS Scientific Investigations Report 2010-5102, http://pubs.usgs.gov/sir/2010/5102/

Attachments

Attachment 1 – Groundwater Contour Maps (March 2016 Weaver CSI Report)
Attachment 2 – Mounding Analysis Results



PREPARED FOR:

300 WEST LLC

POTENTIOMETRIC SURFACE CONTOUR MAP (APRIL 2015)
SHALLOW GROUNDWATER ZONE (30 FEET)
ALONG RAILROAD STREET & RITZ ROAD NEAR 300 NORTH WEST STREET
MARENGO, MCHENRY COUNTY, ILLINOIS

Weaver Consultants Group
NAPERVILLE, ILLINOIS
(630) 717-4848 www.wcgrp.com

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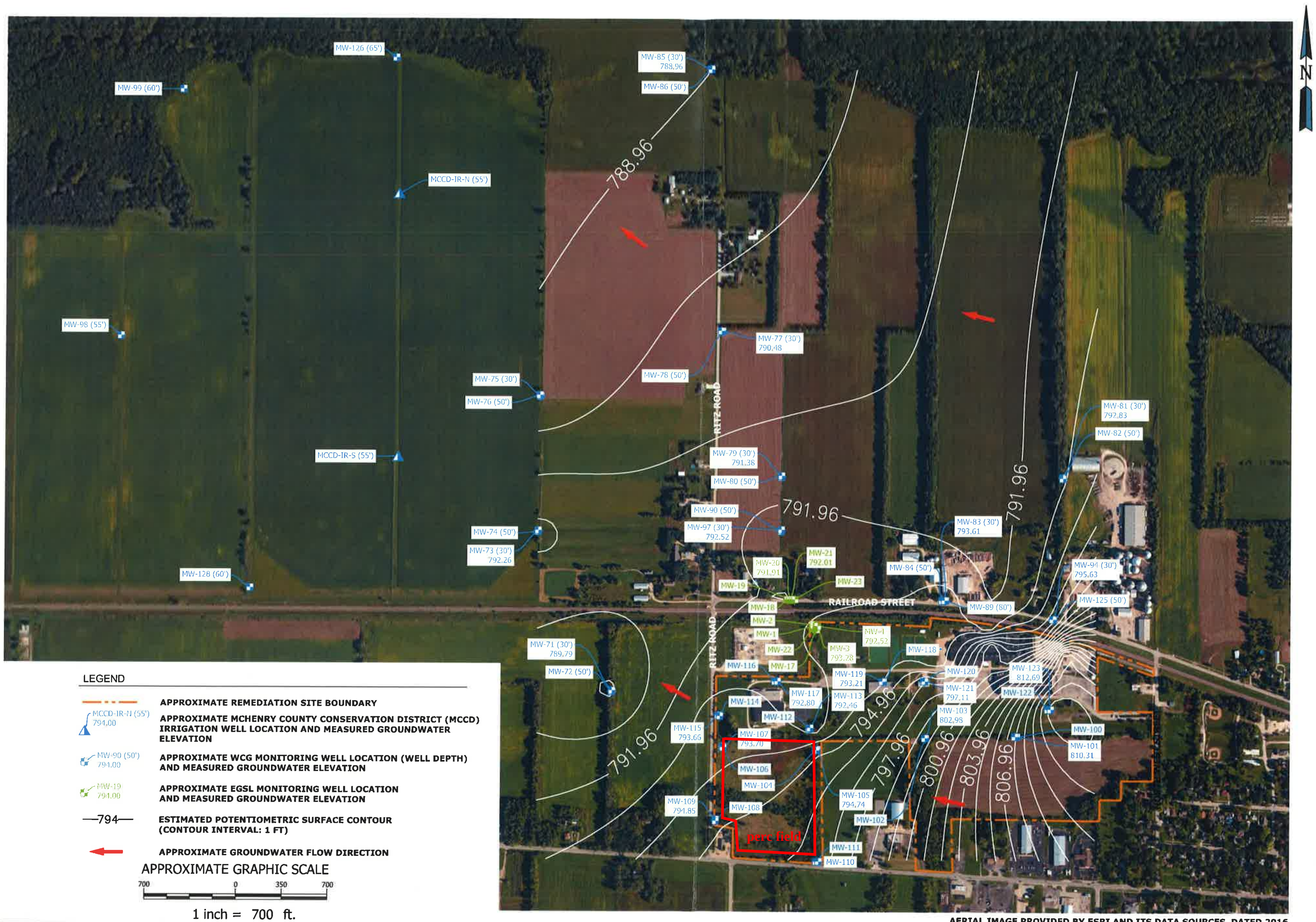
REVIEWED BY: CRD
DATE: 3/3/2016
FILE: 3892-300-03-06
CAD: MR0000021.dwg

FIGURE 14

percfield ≈ 794'



DRAWN BY: NTJ
REVIEWED BY: CRD
DATE: 3/3/2016
FILE: 3892-300-03-06
CAD: MR0000018.dwg

FIGURE 17

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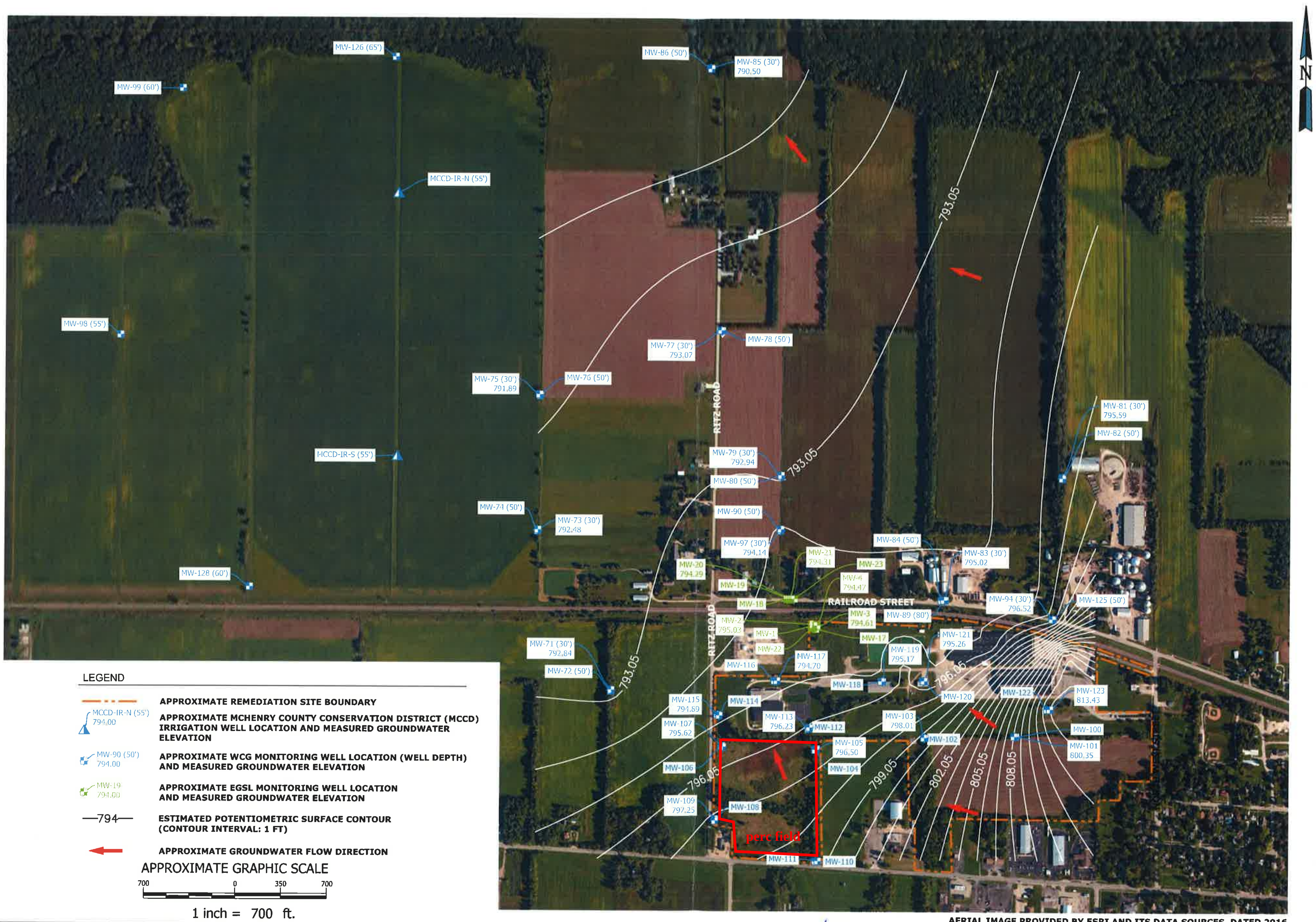
POTENTIOMETRIC SURFACE CONTOUR MAP (OCTOBER 2015)
SHALLOW GROUNDWATER ZONE (30 FEET)
ALONG RAILROAD STREET & RITZ ROAD NEAR 300 NORTH WEST STREET
MARENGO, MCHENRY COUNTY, ILLINOIS

PREPARED FOR:
300 WEST LLC

~795'



PREPARED FOR:

300 WEST LLC

POTENTIOMETRIC SURFACE CONTOUR MAP (FEBRUARY 2016)
SHALLOW GROUNDWATER ZONE (30 FEET)
ALONG RAILROAD STREET & RITZ ROAD NEAR 300 NORTH WEST STREET
MARENGO, MCHENRY COUNTY, ILLINOIS

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FIGURE 19

~797

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click the blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be done and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

use consistent units (e.g. feet & days or inches & hours)

Input Values		
0.0269	***R***	Recharge (infiltration) rate (feet/day)
0.200	Sy	Specific yield, Sy (dimensionless, between 0 and 1)
136.00	K	Horizontal hydraulic conductivity, Kh (feet/day)*
418.000	x	1/2 length of basin (x direction, in feet)
418.000	y	1/2 width of basin (y direction, in feet)
1000.000	t	duration of infiltration period (days)
70.000	hi(0)	initial thickness of saturated zone (feet)

Conversion Table

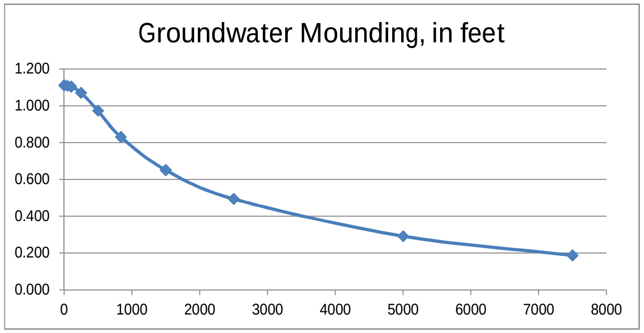
inch/hour	feet/day
0.67	1.33
2.00	4.00
hours	**days**
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

71.112	h(max)	maximum thickness of saturated zone (beneath center of basin at end of infiltration period)
1.112	Δh(max)	maximum groundwater mounding (beneath center of basin at end of infiltration period)

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
1.112	0
1.110	50
1.105	100
1.072	250
0.974	500
0.832	836
0.651	1500
0.495	2500
0.293	5000
0.189	7,500

Re-Calculate Now



Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

AECOM

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312 939 1000 tel
312 939 4198 fax

Technical Memorandum

To	Nadine Marion, Arnold Magnetic Technologies
CC	Julie Johnson, AECOM Pat Dunne, AECOM
Subject	Marengo Wastewater Permit Assistance 2016 Groundwater Mounding Analysis
From	Dan McHale, AECOM
Date	April 25, 2016

AECOM Technical Services, Inc. (AECOM) evaluated potential effects of percolating water from Arnold Magnetic Technologies' (AMT) wastewater pond system on groundwater contaminant transport in the vicinity of the Marengo, Illinois facility. As detailed below, AECOM's analysis indicates that potential leakage from the surface water ponds, as well as infiltration from the associated percolation field, has no significant impact on shallow groundwater flow gradients, and would therefore not significantly impact hydraulic contaminant transport at the site.

Approach

Water percolating at ground surface (a recharge area) generally has the potential to alter groundwater flow, and could consequently affect the movement of existing groundwater contamination by locally altering groundwater flow gradients. The mechanism by which this could occur includes:

- Water continuously discharged at ground surface percolates vertically through the unsaturated zone under influence of gravity to the shallow groundwater table;
- Over time, the groundwater table builds up (mounds) locally beneath the percolation area due to concentrated recharge;
- The mounded groundwater increases the local hydraulic gradient, thereby increasing groundwater contaminant velocity; and,
- Mounded groundwater possibly alters groundwater flow direction, thereby altering groundwater contaminant transport direction, relative to natural/background groundwater flow direction, typically by creating a radially-outward groundwater flow pattern emanating from the groundwater mound.

AECOM evaluated the potential for groundwater mounding impacts due to percolating water associated with AMT's pond system discharge. The pond system discharges water to a 16-acre percolation field located in the southwestern portion of the site. AECOM recognizes that leakage may also occur beneath the four-pond system itself, as well as beneath associated drainage ditches. We focused on evaluating the mounding associated with the percolation field, where the majority of the water likely percolates, as the worst-case scenario. AECOM evaluated mounding using groundwater contour maps presented in the March 2016 Weaver CSI Report, and by performing a groundwater mounding analysis using analytical techniques developed by Hantush (1967).

Groundwater Contour Map Interpretation

AECOM evaluated groundwater contour maps developed by Weaver which represent the shallow groundwater system at the site during April 2015, October 2015 and February 2016 field activities. The Weaver maps are provided as Attachment 1.

Localized groundwater recharge areas typically are characterized by groundwater contours with higher elevations than the surrounding aquifer, often with high elevation contour lines wrapping around the recharge area and associated groundwater flow lines diverging radially. These signature contours and flow lines are not apparent in the vicinity of the ponds or the percolation field. The groundwater contours are relatively smooth, and do not diverge or wrap around the percolation field. Divergence would be expected if the volume of percolating groundwater were sufficient to cause sustained groundwater mounding beneath the area. Groundwater flow directions (shown as red arrows in Attachment 1) generally indicate relatively straight downgradient flow directions with little radial deviation.

Based on review of the Weaver contour maps, AECOM concluded that percolating groundwater has a relatively minor impact on groundwater levels at the AMT site. The minor nature of any impact is likely due to the relatively high hydraulic conductivity of site soils, which has the effect of dampening and dissipating mounding buildup relatively quickly, as well as a limited volume of water percolating over a large area.

Mounding Analysis

AECOM performed a groundwater mounding analysis to confirm the accuracy of the groundwater contour maps. The mounding analysis is based on analytical techniques developed by Hantush (Hantush, 1967), and incorporated into a spreadsheet format by the United States Geological Survey (USGS, 2010). Inputs for AECOM's mounding analysis are provided below and in Attachment 2:

- Recharge (percolation) rate = 0.027 feet per day. This value is based on information in AMT's wastewater permit application: 140,000 gallons per day are pumped from the onsite deep well and added to the water recycling system.
- Specific yield of aquifer (S_y) = 0.2 (literature value).
- Hydraulic conductivity (K) = 136 feet per day (March 2016 Weaver CSI Report).
- Basin size = 16 acres or 696,960 square feet (March 2016 Weaver CSI Report).
- Aquifer thickness = 70 feet (March 2016 Weaver CSI Report).

The mounding analysis indicates a maximum groundwater mound of approximately one (1) foot after 1,000 days of continuous, uninterrupted groundwater percolation. Based on the Weaver groundwater contour maps, this value is less than natural variations observed in the groundwater level over the course of a calendar year.

AECOM's mounding analysis is likely conservative because it assumes continuous, uninterrupted (steady-state) percolation of the maximum available water. Additionally, the analysis is conservative in that the results do not include mounding dissipation that would occur during times of diminished or no percolation, and do not account for other water losses such as evapotranspiration, which could significantly diminish the quantity of water reaching the groundwater table.

Conclusions

AECOM's mounding analysis results are consistent with our interpretation of the Weaver groundwater contour maps. Potential leakage from the pond system is not sufficient to alter groundwater flow conditions. Accordingly, as discussed in AECOM's March 17, 2016 memorandum, AMT's pond system does not appear to be a likely source of contaminant loading to the area aquifer. Any infiltration from the percolation field is not sufficient to materially alter local groundwater gradients.

Theoretically (based on the Hantush analysis), some groundwater mounding would be expected regardless of the volume of percolating water. However, the height of groundwater mounding associated with AMT's pond system appears to be relatively small, and is less than the magnitude of natural fluctuation/variation observed over one calendar year of groundwater level observation. According to the Weaver data, the observed fluctuation was approximately three (3) feet in the vicinity of the percolation field. AECOM's finding is consistent with groundwater flow conditions depicted in site groundwater contour maps produced by Weaver, and suggests that unsaturated flow conditions exist beneath the percolation field. The unsaturated flow condition increases the residence time of the discharge water in the soil zone between the ground surface and water table, and promotes increased attenuation (*e.g.,* via adsorption, volatilization, colloidal filtering, etc.) of any chemicals in the discharge water.

AECOM's mounding analysis is a highly conservative estimate, as the analysis assumes that all water discharged from the pond system reaches the water table at the percolation field, pond discharge is continuous and uninterrupted (mounding is never allowed to dissipate) and does not account for evapotranspiration (in the ponds or when discharged to the percolation field), losses to the unsaturated zone, losses during the coolant process, etc.

Groundwater contour maps developed by Weaver and AECOM's mounding analysis indicate that mounding is not significant, and associated impacts on existing groundwater contamination are unlikely.

Limitations

AMT requested that AECOM qualitatively evaluate AMT's pond system and potential effects of the system on area groundwater quality based on currently-available site information generated by others. The statements and opinions presented herein are based on professional judgment, previous experience at similar sites, and AECOM's review of the provided investigation documents describing the general design of the facility pond system and area groundwater conditions.

AECOM made several conservative assumptions in the evaluation where site-specific information was unavailable.

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Further, AECOM does not warrant the veracity of the findings presented in the site documents completed by third parties and used by AECOM in the generation of this memorandum. Site conditions, or certain indicators of the presence of hazardous substances or other constituents, may have been latent, inaccessible, unobservable, or not reported. AECOM cannot represent that the pond system or the area aquifer do not contain chemicals at detectable concentrations beyond those documented in the reports provided for AECOM review.

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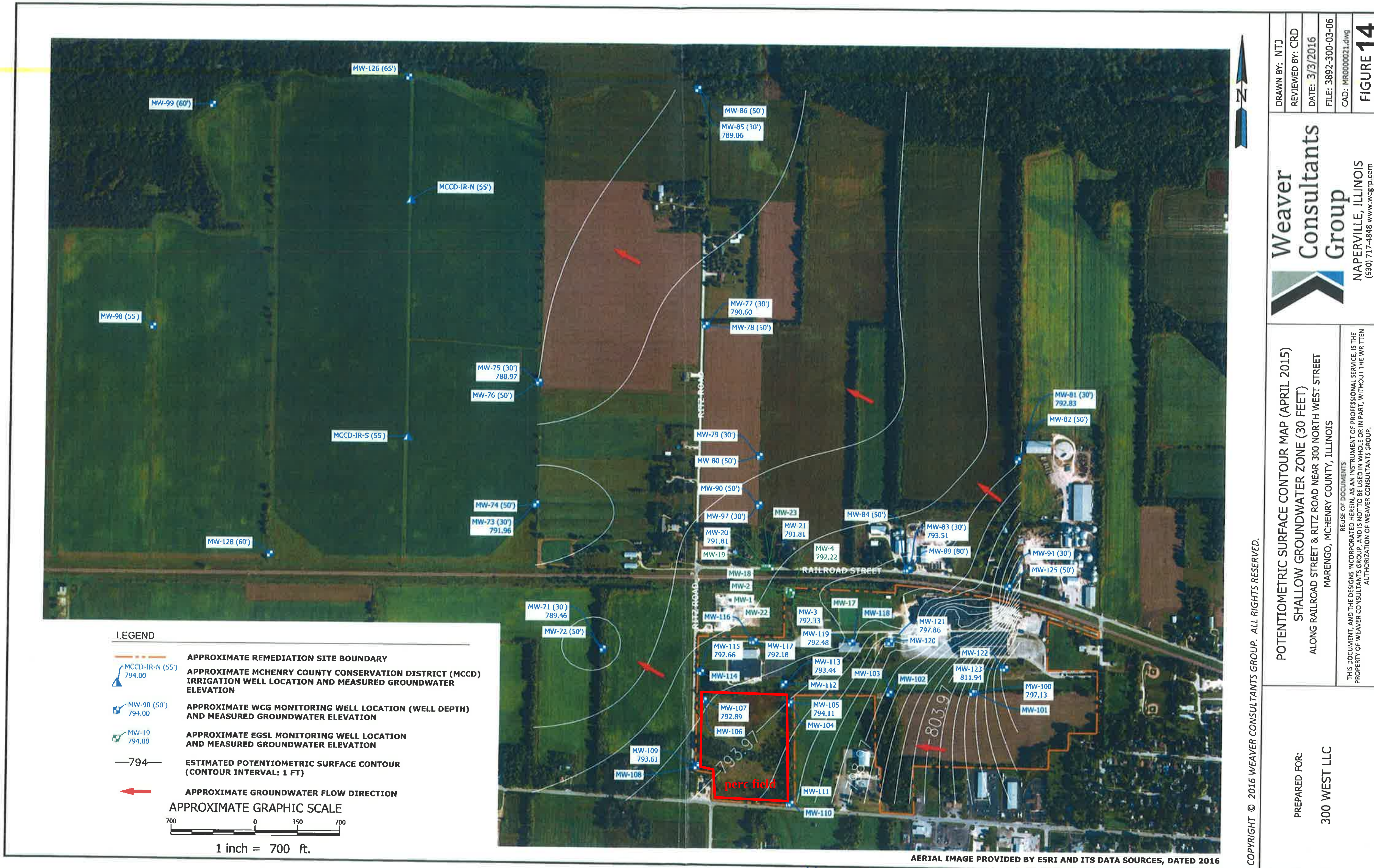
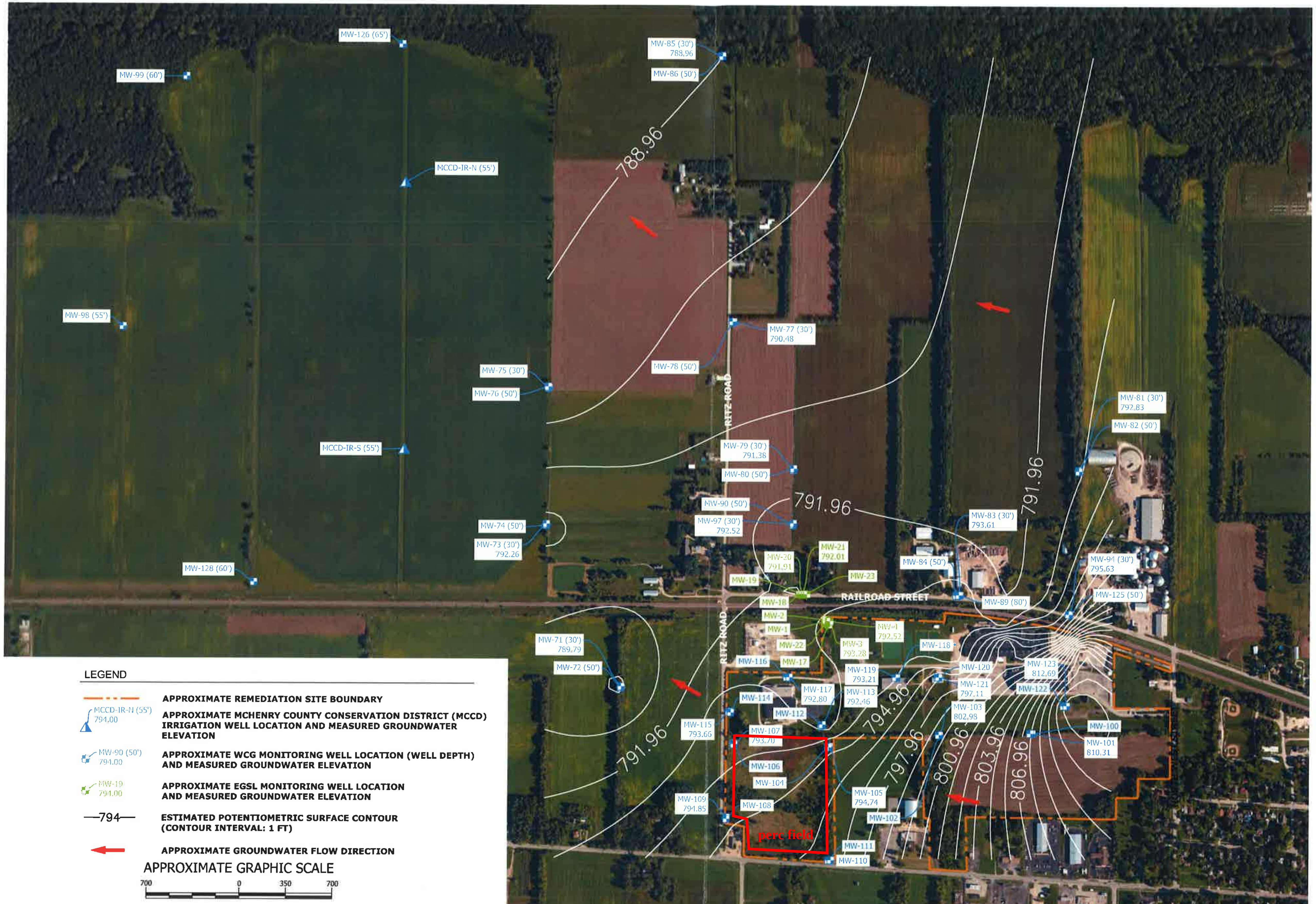
Attachment 2 – Mounding Analysis Results



percfield ≈ 794'



LEGEND

- APPROXIMATE REMEDIATION SITE BOUNDARY
- MCCD-IR-N (55') 794.00 — APPROXIMATE MCHENRY COUNTY CONSERVATION DISTRICT (MCCD) IRRIGATION WELL LOCATION AND MEASURED GROUNDWATER ELEVATION
- MW-90 (50') 794.00 — APPROXIMATE WCG MONITORING WELL LOCATION (WELL DEPTH) AND MEASURED GROUNDWATER ELEVATION
- MW-19 794.00 — APPROXIMATE EGSL MONITORING WELL LOCATION AND MEASURED GROUNDWATER ELEVATION
- —794— ESTIMATED POTENTIOMETRIC SURFACE CONTOUR (CONTOUR INTERVAL: 1 FT)
- APPROXIMATE GROUNDWATER FLOW DIRECTION

APPROXIMATE GRAPHIC SCALE

700 0 350 700

1 inch = 700 ft.

AERIAL IMAGE PROVIDED BY ESRI AND ITS DATA SOURCES, DATED 2016

PREPARED FOR:

300 WEST LLC

POTENTIOMETRIC SURFACE CONTOUR MAP (OCTOBER 2015)
SHALLOW GROUNDWATER ZONE (30 FEET)
ALONG RAILROAD STREET & RITZ ROAD NEAR 300 NORTH WEST STREET
MARENGO, MCHENRY COUNTY, ILLINOIS

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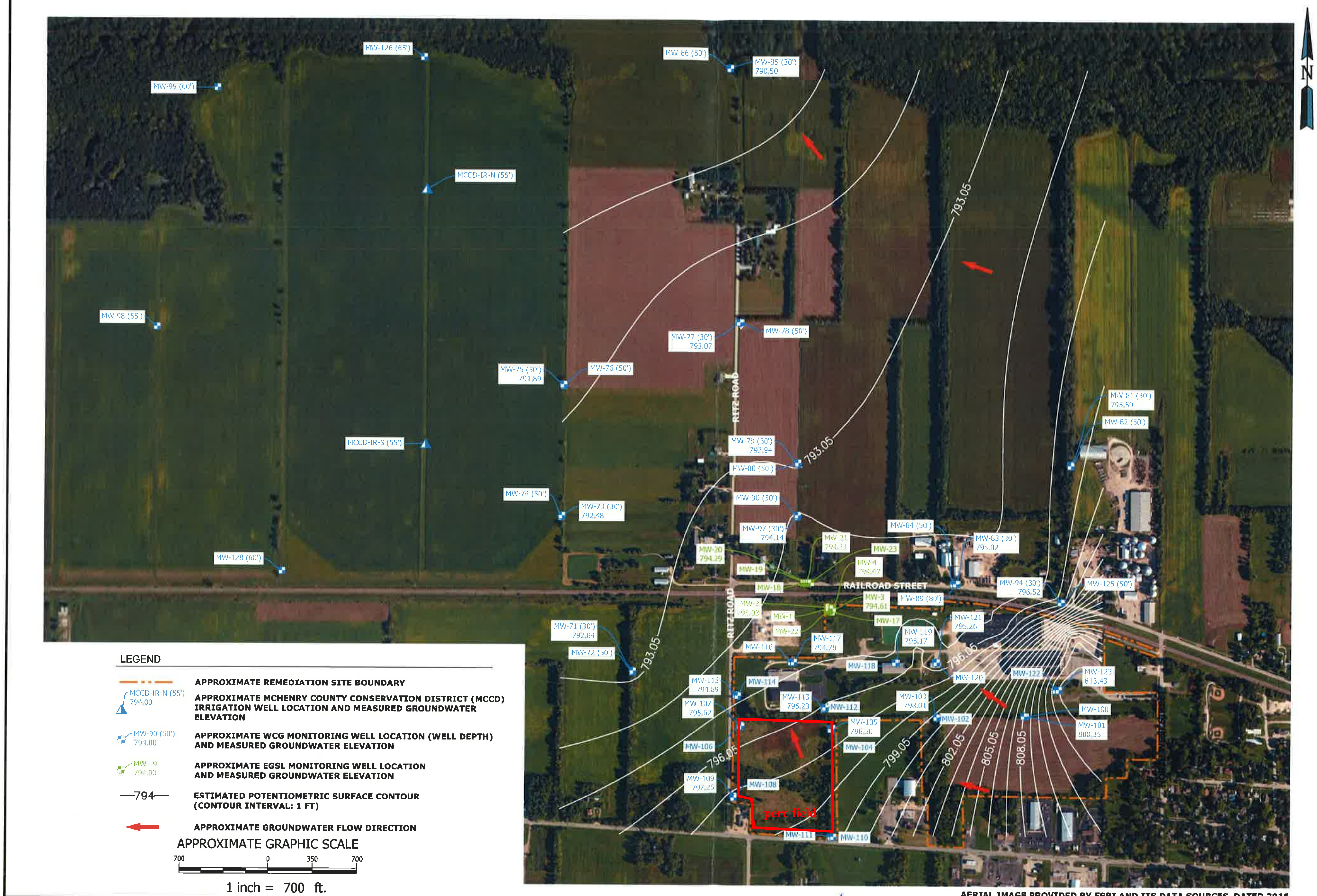
FIGURE 17

~795



PREPARED FOR:
300 WEST LLC

POTENTIOMETRIC SURFACE CONTOUR MAP (FEBRUARY 2016)
SHALLOW GROUNDWATER ZONE (30 FEET)
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FIGURE 19

~797

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36	1.50

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0.974	500
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0.651	1500
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0.293	5000
0.189	7,500

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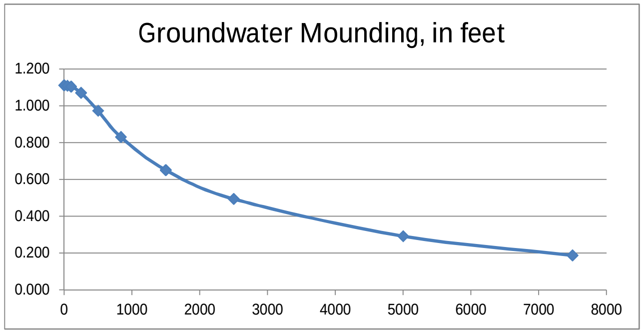

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