ANDREWS ENVIRONMENTAL ENGINEERING INC. 3535 Mayflower Blvd., Springfield, Illinois 62707/(217) 787-2334

November 8, 2005

Maria Race
Senior Environmental Engineer
Midwest Generation EME, LLC
One Financial Place
440 South LaSalle Street
Chicago, IL 60605

re: Former Griess-Pfleger Tannery Site
Monitoring Results Review

Dear Ms. Race:

Enclosed is a report reviewing the groundwater monitoring results at the former Griess-Pfleger Tannery Site in Waukegan, Illinois. The RETEC Group, Inc. (RETEC) prepared reports dated January 16, 2004, July 20, 2004, January 5, 2004 (sic) and June 30, 2005 presenting the groundwater monitoring results with regards to the Environmental Land Use Control (ELUC) at the Midwest Generation, LLC Waukegan Generating Station.

Also enclosed is the January 16, 2004 RETEC report containing the original Plat of Survey.

If you have any questions regarding this report, do not hesitate to contact me at (217) 787-2334. Thank you.

Sincerely,

Sean C. Chisek

Sean C. Chisek, P.E.
Project Engineer

SCC:scc:sjb

enclosure(s)

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MONITORING RESULTS ANALYSIS

Former Griess-Pfleger Tannery

Midwest Generation, LLC

November 2005

Prepared for:
Midwest Generation, LLC
Chicago, Illinois

Prepared by:
Andrews Environmental Engineering Inc.
3535 Mayflower Boulevard
Springfield, IL 62707

1.0 INTRODUCTION

Andrews Environmental Engineering, Inc. (Andrews Engineering) was retained by Midwest Generation, LLC (Midwest Generation) to review groundwater monitoring reports prepared by The RETEC Group, Inc. (RETEC) for a portion of Midwest Generation property that is contained in an Environmental Land Use Control (ELUC) for the former Griess-Pfleger Tannery site located in Waukegan, Illinois. This report contains a brief background discussing the groundwater remediation objectives developed by RETEC and a discussion of the semiannual groundwater monitoring results from December 2003 through June 2005.

2.0 TACO 1-DIMENTIONAL STEADY STATE GROUNDWATER TRANSPORT MODEL

RETEC has previously determined the extent of the affected areas requiring institutional control by using the quantitative fate and transport Tiered Approach to Corrective Action Objectives (TACO) Equation R26 found in 35 Ill. Adm. Code 742.Appendix C, Table C. Long-term, steady-state concentration along the centerline of a groundwater contaminant plume can be evaluated using TACO Equation R26. TACO Equation R26 is shown below.

$$C(x) = C_o \exp\left[\left(\frac{x}{2\alpha_x}\right)\left(1-\sqrt{1+\frac{4\lambda\alpha_x}{U}}\right)\right] erf\left[\frac{S_w}{4\sqrt{\alpha_y x}}\right] erf\left[\frac{S_d}{2\sqrt{\alpha_z x}}\right]$$

where:

C_o = source concentration (mg/L)

X = distance downgradient from the source (L)

α_x = L coefficient of longitudinal dispersivity (L)

α_y = L coefficient of transverse dispersivity parallel with the stratification (L)

α_z = L coefficient of transverse dispersivity perpendicular to the stratification (L)

λ = first-order biochemical decay constant (T^{-1})

U = the sorption-retarded advective velocity (L/T)

S_w = source width (L)

S_d = source depth (L)

The source is assumed to be a rectangular area adjacent to the ground surface, perpendicular to the x-axis and constant in time. The lateral distance and depth extents of

the aquifer are assumed to be infinite. The assumption of infinite depth is often critical to the results and is not conservative.

For elemental compounds, such as arsenic, iron, manganese and total dissolved solids (TDS), there is no biochemical decay (i.e., $\lambda = 0$) and TACO Equation R26 reduces to the following:

$$C(x) = C_o erf\left[\frac{S_w}{4\sqrt{\alpha_y x}}\right] erf\left[\frac{S_d}{2\sqrt{\alpha_z x}}\right]$$

Solute attenuation is dependent on distance, source width, source depth and the two coefficients of dispersivity (α_y and α_z). In TACO, the transverse and vertical coefficients of mechanical dispersivity are given by equations R17 and R18, as shown below.

R17 $\alpha_y = x/30$

R18 $\alpha_z = x/200$

3.0 MODEL PARAMETERS AND SITE SCENARIO

TACO Equation R26 is valid only to predict contaminant concentration along the center line of the pollution plume, downgradient of the source in the direction of groundwater flow. The downgradient distance for each monitoring well located within the Midwest Generation property boundary is measured from the source boundary (i.e., the former Griess-Pfleger tannery site) in the west-east direction. The downgradient distance for monitoring well MW-15 is measured from the former tannery property corner near MW-5.

As proposed by RETEC, the source concentration for arsenic and iron is based upon an area-weighted average concentration over the width of the plume. For manganese and TDS, source concentrations are the maximum detected concentrations of the site, excluding background wells MW-7 and MW-7A. The reason for this conservative approach is due to the wide distribution of manganese and TDS over the site at relatively low concentrations. The source concentrations, along with other model parameters proposed by RETEC and the TACO Tier 1 standards are listed in Table 1.

Parameter	Source Concentration C_o (mg/L)	Source Width S_w (ft)	Source Depth S_d (ft)	TACO Tier 1 (mg/L)
Arsenic	0.485	1330	10	0.05
Iron	7.532	535	10	5.0
Manganese	0.99	2,200	20	0.15
TDS	1,700	2,200	20	1,200

Table 1. Source Concentrations and Model Parameters.

4.0 RESULTS

Using parameters previously derived by RETEC, the contaminant concentrations downgradient from the source can be calculated utilizing TACO Equation R26. The calculations, specific to each monitoring well, are shown in Table 2. Table 2 also contains the monitoring results from sampling events on December 13, 2003, June 16, 2004, December 9, 2004 and June 16, 2005, as well as the TACO Tier 1 standard.

5.0 SUMMARY OF ANALYTICAL RESULTS

The RETEC Remediation Objectives Report (2002) only predicts contaminant concentrations at specific distances between 500 and 3100 feet. This analysis provides predictive results at each monitoring well within Midwest Generation property.

5.1 Arsenic

Arsenic concentrations at monitoring wells MW-10 and MW-11 exceeded the concentration predicted by TACO Equation R26. This is likely an artifact of the source concentration calculation. RETEC utilized an area-weighted average concentration over the width of the plume as the source concentration for arsenic. However, the arsenic concentration is not evenly distributed throughout the former tannery area. Thus, an area-weighted average concentration does not accurately represent the varying arsenic concentrations within the source area. Monitoring well MW-1, located directly upgradient of monitoring well MW-11, historically has exhibited high arsenic concentrations in groundwater (6.47 mg/L in May 1993, 2.1 mg/L in February 1995 and 1.3 mg/L in November 1997). This indicates that the source concentration at this location is higher than the average value of 0.485 mg/L used by RETEC.

5.2 Iron

Iron concentrations in wells MW-12 and MW-15 exceeded the model predicted concentration of 0.68 mg/L. This is likely an artifact of the source concentration calculation.

RETEC utilized an area-weighted average concentration over the width of the plume as the source concentration for iron. However, the iron concentration is not evenly distributed throughout the former tannery area. Thus, an area-weighted average concentration does not accurately represent the varying iron concentrations within the source area.

It should be noted, the iron concentrations in wells MW-12 and MW-13 reported in the January 16, 2004 RETEC report, and carried over into subsequent reports, is inconsistent with the laboratory reports. Laboratory results provided by Severn Trent Laboratories, Inc. indicates the iron concentration during the December 17, 2003 monitoring event was 13 mg/L at well MW-12 and 0.18 mg/L at well MW-13. The summary tables prepared by RETEC indicate the iron concentration during the December 17, 2003 monitoring event was 0.296 mg/L at well MW-12 and 0.296 mg/L at well MW-13.

5.3 Manganese

Manganese concentrations in wells MW-12, MW-13 and MW-15 exceeded the TACO Equation R26 predicted concentration of 0.21 mg/L. In well MW-12, the manganese concentration exceeded the predicted concentration during the December 17, 2003 (0.54 mg/L) and the December 9, 2004 (0.24 mg/L) sampling events. In well MW-13, the manganese concentration exceeded the predicted concentration during the December 9, 2004 sampling event (0.74 mg/L). In well MW-15, the manganese concentration exceeded the predicted concentration during the December 17, 2003 (0.64 mg/L), June 16, 2004 (0.51 mg/L), December 9, 2004 (0.53 mg/L) and the June 16, 2005 (0.73 mg/L) sampling events.

It should be noted the manganese concentrations in wells MW-12 and MW-13 reported in the January 16, 2004 RETEC report, and carried over into subsequent reports, are inconsistent with the laboratory reports. Laboratory results provided by Severn Trent Laboratories, Inc. indicates the manganese concentration during the December 17, 2003 monitoring event was 0.54 mg/L at well MW-12 and 0.031 mg/L at well MW-13. The summary tables prepared by RETEC indicate the manganese concentrations during the December 17, 2003 monitoring event was 0.055 mg/L at wells MW-12 and MW-13.

5.4 TDS

TDS concentrations in wells MW-12, MW-13 and MW-15 exceeded the TACO Equation R26 predicted concentration of 362.41 mg/L. In well MW-12, the TDS concentration exceeded

the predicted concentration during the December 17, 2003 (1,900 mg/L), June 16, 2004 (1,300 mg/L), December 9, 2004 (950 mg/L) and June 16, 2005 (860 mg/L) sampling events. In well MW-13, the TDS concentration exceeded the predicted concentration during the December 17, 2004 sampling event (1,500 mg/L). In well MW-15, the TDS concentration exceeded the predicted concentration during the December 17, 2003 (740 mg/L), June 16, 2004 (1,000 mg/L), December 9, 2004 (940 mg/L) and the June 16, 2005 (920 mg/L) sampling events.

The TACO groundwater fate and transport model was established in terms of advection, dispersion and natural attenuation. However, TDS levels in groundwater, mostly composed of inorganic chemicals, appear to be affected by the adsorption, desorption, dissolution of chemicals between groundwater and soil. In addition to these chemical processes, TDS monitoring results may also be influenced by local manufacturing activities. Based on this, predicted TDS concentrations calculated using TACO Equation R26 may not be representative.

It should be noted the TDS concentrations in wells MW-12 and MW-13 reported in the January 16, 2004 RETEC report, and carried over into subsequent reports, are inconsistent with the laboratory reports. Laboratory results provided by Severn Trent Laboratories, Inc. indicates the TDS concentration during the December 17, 2003 monitoring event was 1,900 mg/L at well MW-12 and 1,500 mg/L at well MW-13. The summary tables prepared by RETEC indicate the TDS concentration during the December 17, 2003 monitoring event was 0.02 mg/L at wells MW-12 and MW-13. In addition, the TDS concentration reported in the summary table of the January 5, 2004 (sic) RETEC report, for the December 9, 2004 monitoring event, is also inconsistent with the laboratory results provided by Severn Trent Laboratories, Inc. The laboratory reports indicate the TDS concentration in well MW-12 during the December 9, 2004 monitoring event was 950 mg/L. The summary tables prepared by RETEC indicate the TDS concentration in well MW-12 was 1,300 mg/L.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Arsenic continues to exceed the TACO predicted concentration in well MW-11. Iron also exceeded the TACO predicted concentration in wells MW-12 and MW-15. As discussed previously, these exceedences may be related to the method by which RETEC developed the arsenic source concentration.

Manganese sporadically exceeded the TACO predicted concentration in wells MW-12 and MW-13, and consistently exceeded the TACO predicted concentration in well MW-15. TDS consistently exceeded the TACO predicted concentration in wells MW-12 and MW-15. However, it should be noted some of the TDS exceedences were below the Class I Groundwater Quality Standards found in 35 Ill. Adm. Code 620.410.

Due to the consistent exceedences of arsenic and iron, it is recommended RETEC either: (1) re-evaluate whether or not an area weighted average source concentration is still applicable; and/or (2) investigate the exceedences to determine their extent and verify the accuracy of the monitoring results.

7.0 REFERENCES

Illinois Administrative Code 35. Subtitle G, Chapter I, Subchapter f, Part 742. Tiered Approach to Corrective Action Objectives.

RETEC. August 2002. Remediation Objectives Report.

MIDWEST GENERATION, LLC
(FORMER GRIESS-PFLEGER TANNERY SITE)
WAUKEGAN, ILLINOIS

TABLE 2. MONITORING RESULTS ANALYSIS

Hydraulic Conductivity:	15	ft/day =	457.2	cm/day
Hydraulic Gradient:	0.0016	ft/ft =	0.0016	cm/cm
Effective Porosity:	0.32			
Eqn. R19, Specific Discharge:	2.286	cm/day		

ARSENIC

Co	0.485	mg/l		
Source Width, Sw	1,330	ft =	40,538.4	cm
Source Depth, Sd	10	ft =	304.8	cm

MONITORING WELL	x (ft)	x (cm)	Longitudinal Dispersivity α_x	Transverse Dispersivity α_y	Vertical Dispersivity α_z	$Sw/4(\alpha_y x)^{1/2}$	erf 1	$Sd/2(\alpha_z x)^{1/2}$	erf 2	C(x)	TACO Tier 1 (mg/L)	MONITORING RESULTS (mg/L) Dec. 17, 2003	June 16, 2004	Dec. 9, 2004	June 16, 2005
MW-10	200.00	6,096.00	609.60	203.20	30.48	9.11	1.0000	0.3536	0.3829	0.1857	0.05	0.15	0.22	0.078	0.041
MW-11	90.00	2,743.20	274.32	91.44	13.72	20.24	1.0000	0.7857	0.7335	0.3557	0.05	0.86	0.7	1.1	0.7
MW-12	750.00	22,860.00	2,286.00	762.00	114.30	2.43	0.9994	0.0943	0.1061	0.0514	0.05	0.003	0.0043	0.001	0.044
MW-13	750.00	22,860.00	2,286.00	762.00	114.30	2.43	0.9994	0.0943	0.1061	0.0514	0.05	< 0.002	0.0021	0.001	< 0.004
MW-14	50.00	1,524.00	152.40	50.80	7.62	36.42	1.0000	1.4142	0.9545	0.4629	0.05	0.16	0.11	0.2	0.21
MW-15	750.00	22,860.00	2,286.00	762.00	114.30	2.43	0.9994	0.0943	0.1061	0.0514	0.05	0.0022	0.0018	0.0024	< 0.004

IRON

Co	7.532	mg/l		
Source Width, Sw	535	ft =	16,306.8	cm
Source Depth, Sd	10	ft =	304.8	cm

MONITORING WELL	x (ft)	x (cm)	Longitudinal Dispersivity α_x	Transverse Dispersivity α_y	Vertical Dispersivity α_z	$Sw/4(\alpha_y x)^{1/2}$	erf 1	$Sd/2(\alpha_z x)^{1/2}$	erf 2	C(x)	TACO Tier 1 (mg/L)	MONITORING RESULTS Dec. 17, 2003	June 16, 2004	Dec. 9, 2004	June 16, 2005
MW-10	200.00	6,096.00	609.60	203.20	30.48	3.66	1.0000	0.3536	0.3829	2.88	5.0	1.40	2.70	0.22	0.99
MW-11	90.00	2,743.20	274.32	91.44	13.72	8.14	1.0000	0.7857	0.7335	5.52	5.0	2.90	2.10	2.30	4.60
MW-12	750.00	22,860.00	2,286.00	762.00	114.30	0.98	0.8328	0.0943	0.1061	0.67	5.0	13.00	2.70	5.30	5.10
MW-13	750.00	22,860.00	2,286.00	762.00	114.30	0.98	0.8328	0.0943	0.1061	0.67	5.0	0.180	0.09	0.25	0.56
MW-14	50.00	1,524.00	152.40	50.80	7.62	14.65	1.0000	1.4142	0.9545	7.19	5.0	0.83	0.87	1.30	3.10
MW-15	750.00	22,860.00	2,286.00	762.00	114.30	0.98	0.8328	0.0943	0.1061	0.67	5.0	1.30	2.50	2.00	4.50

MIDWEST GENERATION, LLC
(FORMER GRIESS-PFLEGER TANNERY SITE)
WAUKEGAN, ILLINOIS

TABLE 2. MONITORING RESULTS ANALYSIS

MANGANESE

Co	0.99	mg/l		
Source Width, Sw	2,200	ft =	67,056.0	cm
Source Depth, Sd	20	ft =	609.6	cm

MONITORING WELL	x (ft)	x (cm)	Longitudinal Dispersivity α_x	Transverse Dispersivity α_y	Vertical Dispersivity α_z	$Sw/4(\alpha_y x)^{\wedge}1/2$	erf 1	$Sd/2(\alpha_z x)^{\wedge}1/2$	erf 2	C(x)	TACO Tier 1 (mg/L)	MONITORING RESULTS Dec. 17, 2003	June 16, 2004	Dec. 9, 2004	June 16, 2005
MW-10	200.00	6,096.00	609.60	203.20	30.48	15.06	1.0000	0.7071	0.6827	0.6759	0.15	0.19	0.12	0.0028	0.0058
MW-11	90.00	2,743.20	274.32	91.44	13.72	33.47	1.0000	1.5713	0.9737	0.9640	0.15	0.35	0.41	0.35	0.43
MW-12	750.00	22,860.00	2,286.00	762.00	114.30	4.02	1.0000	0.1886	0.2103	0.2082	0.15	0.54	0.17	0.24	0.19
MW-13	750.00	22,860.00	2,286.00	762.00	114.30	4.02	1.0000	0.1886	0.2103	0.2082	0.15	0.031	0.0013	0.74	0.054
MW-14	50.00	1,524.00	152.40	50.80	7.62	60.25	1.0000	2.8284	0.9999	0.9899	0.15	0.14	0.12	0.13	0.16
MW-15	750.00	22,860.00	2,286.00	762.00	114.30	4.02	1.0000	0.1886	0.2103	0.2082	0.15	0.64	0.51	0.53	0.73

TOTAL DISSOLVED SOLIDS (TDS)

Co	1,700	mg/l		
Source Width, Sw	2,200	ft =	67,056.0	cm
Source Depth, Sd	20	ft =	609.6	cm

MONITORING WELL	x (ft)	x (cm)	Longitudinal Dispersivity α_x	Transverse Dispersivity α_y	Vertical Dispersivity α_z	$Sw/4(\alpha_y x)^{\wedge}1/2$	erf 1	$Sd/2(\alpha_z x)^{\wedge}1/2$	erf 2	C(x)	Class I Groundwater Quality Standard (mg/L)	MONITORING RESULTS Dec. 17, 2003	June 16, 2004	Dec. 9, 2004	June 16, 2005
MW-10	200.00	6,096.00	609.60	203.20	30.48	15.06	1.0000	0.7071	0.6827	1,160.57	1,200	560.00	560.00	430.00	400.00
MW-11	90.00	2,743.20	274.32	91.44	13.72	33.47	1.0000	1.5713	0.9737	1,655.34	1,200	600.00	1,200.00	1,200.00	1,200.00
MW-12	750.00	22,860.00	2,286.00	762.00	114.30	4.02	1.0000	0.1886	0.2103	357.47	1,200	1,900.00	1,300.00	950.00	860.00
MW-13	750.00	22,860.00	2,286.00	762.00	114.30	4.02	1.0000	0.1886	0.2103	357.47	1,200	1,500.00	220.00	280.00	250.00
MW-14	50.00	1,524.00	152.40	50.80	7.62	60.25	1.0000	2.8284	0.9999	1,699.89	1,200	560.00	680.00	600.00	690.00
MW-15	750.00	22,860.00	2,286.00	762.00	114.30	4.02	1.0000	0.1886	0.2103	357.47	1,200	740.00	1,000.00	940.00	920.00