TECHNICAL MEMORANDUM

Date: December 2, 2014

To: Frank Dombrowski, We Energies

From: Chris Robb and Brian Hennings

Subject: Assessment of Fox River Canal Dewatering and Potential for DNAPL Mobilization
We Energies Appleton Former MGP Site

Executive Summary

From October 6, 2011 through November 10, 2011 portions of the Fox River Canal adjacent to the former Appleton manufactured gas plant (MGP) site were dewatered to facilitate maintenance activities at two downstream hydroelectric units owned by Neenah Paper. On behalf of We Energies, Natural Resource Technology, Inc. (NRT) prepared a Technical Memorandum titled *2011 Canal Dewatering Assessment*, dated July 12, 2012 to summarize observations collected by We Energies representatives during these canal dewatering activities (Attachment A). The key observations from this memorandum are summarized below:

> *We Energies observations suggest MGP residuals observed in the canal during dewatering are likely trapped in discrete pockets or fractures of the rock substrate that make up the bottom of the canal, as a result of past practice and the historic presence of source materials along the canal bottom for many years (removed from the canal in 2002 and 2003). The sheen only became apparent in the canal when the canal was dewatered, groundwater started to flow toward the canal,* ***and*** *the canal bottom was physically disturbed.*
>
> *No evidence of sheen or free phase MGP residuals in the canal has been reported to We Energies during normal flow conditions. Further, no natural processes, such as ebullition, have been observed that could mobilize MGP residuals from the lower till into the canal.*

The documented observations suggest that two conditions are necessary to mobilize MGP residuals from the lower till into the canal:

1. The canal must be entirely dewatered; and
2. The canal bottom must be physically disturbed

At We Energies request, NRT was asked to further assess and interpret mobilization of MGP residuals when a drawdown of the Fox River Canal adjacent to the MGP site is performed; and specifically mobility of residual dense, non-aqueous phase liquid (DNAPL) [residual coal tar known to exist in the lower till near the bottom of the Fox River Canal].

The results of this assessment are summarized below:

- The Monte Carlo statistical approach indicates with a 90% certainty the drawdown required to mobilize residual DNAPL could range from 5.4 feet in the winter to 8.7 feet in the Summer
- The minimum drawdown required to mobilize residual DNAPL is greater in the warmer months than in the winter. This is directly related to the permeating water dynamic viscosity, which increases as the water temperature decreases. The probability of a drawdown in the Fox River Canal is greater in the warmer months and may not be possible in the winter due to ice and low temperatures that limit operation of the Middle Appleton Dam
- The minimum drawdown predicted for the Fall season with 90% confidence – 6.8 feet, corresponds well with the conditions observed during the 2011 Fox River Canal drawdown
- The 90th percentile values from the Monte Carlo statistical approach correlate well with "real world" observations (e.g., *Canal Dewatering Assessment*). That is, the Fox River Canal must be entirely dewatered (approximately 7 feet) and the material in the bottom of the canal must be disturbed before residual DNAPL mobilization is observed – conditions that can only be achieved when a temporary coffer dam is placed in the Fox River Canal

The following memorandum narrative provides more detail of NRT's approach to further assess and interpret mobilization MGP residuals when a drawdown of the Fox River Canal adjacent to the MGP site is performed.

Assessment of MGP Residual and DNAPL Mobility

Assessment and interpretation of residual DNAPL (i.e., coal tar) mobility affected by drawdown of the Fox River Canal requires knowledge of several important factors that include:

- The <u>hydrologic conditions and soil conditions</u> (i.e., geology and stratigraphy) of the near shore – canal bank conditions, and conditions within the Fox River Canal
- The <u>hydraulic conductivity</u> of the geologic materials; that is a property that describes the ease with which a fluid can move through pore spaces or fractures in the geologic materials
- An understanding of the <u>forces that will drive residual DNAPL mobilization</u> including groundwater surface water interactions and groundwater gradients

We Energies understanding of these factors is summarized below:

<u>Hydrologic and Soil Conditions</u>:

Figure 1 provides a conceptual drawing of normal flow conditions of the Fox River Canal adjacent to the Appleton Former MGP Site. Important observations from normal flow conditions shown in Figure 1 include:

- The water level in the Fox River Canal has been measured at approximately 1 foot <u>higher</u> than the potentiometric surface of groundwater throughout all seasons

- Groundwater flow direction moves from higher water elevation to lower water elevation – thus, groundwater flow is from the canal towards the Appleton Former MGP Site (shown on the figure with blue arrows)
- The lower till and weathered bedrock zones are the stratigraphic units that contain the MGP residuals and DNAPL (i.e., coal tar)

Figure 2 provides a conceptual drawing of flow conditions when the canal is dewatered. Important observations from dewatered flow conditions shown in Figure 2 include:

- When the canal is dewatered, the water level in the Fox River canal is lower than the potentiometric surface of groundwater
- Canal dewatering causes a groundwater flow reversal - groundwater flow direction moves from higher water elevation to lower water elevation – thus, groundwater flow is from the Appleton Former MGP site and the lower till material beneath the canal towards the canal

Hydraulic Conductivity:

We Energies has measured the range of hydraulic conductivity of the material the groundwater flows through (lower till) near canal bank from 1.09×10^{-3} cm/s to 4.07×10^{-3} cm/s with a geometric mean of 2.09×10^{-3} cm/s (URS 2002).

Forces That Will Drive Residual DNAPL Mobilization:

The primary force that will actively mobilize residual DNAPL is groundwater flow. We Energies is interested in changes in groundwater flow induced by a drawdown of the water level in the Fox River Canal that could potentially mobilize residual DNAPL.

Groundwater flow is dependent on two key parameters: hydraulic conductivity (discussed above) and hydraulic gradient (the loss of groundwater elevation or head per unit distance of flow). Essentially, hydraulic gradient describes the common axiom “water flows downhill”.

The hydraulic conductivity of the near shore – canal bank soil and the material beneath the canal (the lower till) is known and does not change. Therefore, hydraulic gradient or the change in head is the principal driver for mobilization of residual DNAPL. Knowing this, the key question for interpreting the mobilization of residual DNAPL is: **what is the critical change in hydraulic gradient that can cause increased groundwater flow and initialize mobilization of residual DNAPL?**

Model for Calculation of Critical Hydraulic Gradient and Water Level Change in the Fox River Canal Needed to Potentially Mobilize Residual DNAPL

To interpret and calculate a theoretical hydraulic gradient and water level change in the Fox River Canal, we need to understand how residual DNAPL will behave in the site-specific soil conditions. Pankow and Cherry (1996) have researched and discuss the mechanics and mathematics of the movement of DNAPL in porous media in their text *Dense Chlorinated Solvents and other DNAPLs in Groundwater.* Their research after Wilson and Conrad (1984) reports that “residual phase DNAPL can begin to be mobilized at [a capillary number] $N_c \sim 2 \times 10^{-5}$ and practically all residual becomes mobilized at $N_c \sim 1.3 \times 10^{-3}$." The capillary number is the "ratio of forces opposing mobilization [of residual DNAPL] to the viscous forces promoting the movement of residual" as defined by the equation below where:

$$N_c = \frac{k \rho_w g}{\sigma} i \qquad \text{Equation 1}$$

N_c	Capillary Number
k	Intrinsic permeability
ρ_w	Density of water
g	Gravitational constant
σ	Interfacial tension (dyn/cm) of residual DNAPL
i	hydraulic gradient (critical hydraulic gradient to potentially mobilize residual DNAPL)

Further, the definition of intrinsic permeability is defined as (Fetter 1994):

$$k = K \frac{\mu_w}{\rho_w g} \qquad \text{Equation 2}$$

k	Intrinsic permeability
K	Hydraulic conductivity of soil
μ_w	permeating water dynamic viscosity
ρ_w	permeating water dynamic density
g	Gravitational constant

Substituting Equation 2 into Equation 1 for k, results in a solution for the critical hydraulic gradient needed to potentially mobilize residual DNAPL:

$$i = \frac{N_c \sigma}{K \mu_w} \qquad \text{Equation 3}$$

Each of the parameters in this equation is known with the exception of the interfacial tension (σ) of residual DNAPL. This parameter can be estimated based on research from EPRI (2004) who evaluated the properties of coal tar (i.e., residual DNAPL) at several former MGP sites. Their research reports a range of interfacial tension of coal tar from 22.37 to 27.83 dyn/cm. Therefore, the equation can be solved by:

N_c Capillary Number = $1.3 \times 10^{-3} > N_c > 2 \times 10^{-5}$

σ Interfacial tension (dyn/cm) of residual DNAPL = use EPRI (2004) reported values

K Hydraulic conductivity of soil = use site-specific values discussed above

μ_w permeating water dynamic viscosity = use published values

Understanding the critical hydraulic gradient necessary to begin mobilization of residual DNAPL, NRT rearranged the definition of hydraulic gradient to yield the necessary drawdown in the Fox River Canal. The definition of Hydraulic gradient is:

$$\boldsymbol{i} = \Delta \mathrm{H} / \Delta \mathrm{l}$$

i hydraulic gradient

ΔH Change in head

Δl Flow path length

Rearranging this equation, results in a solution for change in head:

$$\Delta \boldsymbol{H} = \boldsymbol{i} * \Delta \boldsymbol{l}$$

To calculate the drawdown necessary to begin mobilization of residual DNAPL, it is important to consider the hydrologic conditions of the Fox River Canal: *the water level in the Fox River Canal has been measured at approximately 1 foot higher than the potentiometric surface of groundwater throughout all seasons*. Therefore, the drawdown necessary to begin mobilization of residual DNAPL must first draw the water level in the canal down past the potentiometric surface of the groundwater table to reverse the flow of groundwater toward the canal. This is illustrated in Figures 3 and 4 and represented by the following equation:

$$\Delta \boldsymbol{H} = (\boldsymbol{i} * \Delta \boldsymbol{l}) + \boldsymbol{h}$$

ΔH Change in head (i.e., drawdown) necessary to mobilize residual DNAPL

i Hydraulic gradient necessary to mobilize residual DNAPL

Δl Flow path length (feet)

h Average difference in head between the canal and the wells on shore (feet)

Knowing the calculated hydraulic gradient necessary to mobilize residual DNAPL and the average head existing in the canal, the last parameter needed to calculate the drawdown necessary to mobilize residual

DNAPL is an estimate of the flow path length. Based on the second observation from the *Canal Dewatering Assessment* outlined in the executive summary "The canal bottom must be physically disturbed"; NRT made a conservative assumption based on actual observations: the residual DNAPL is very close to the bottom of the canal at approximately 0.1 feet (1.2 inches).

The model for calculation of critical hydraulic gradient and water level change in the Fox River Canal needed to potentially mobilize residual DNAPL outlined above and the equations are summarized in Table 1.

Statistical Evaluation of Water Level Change in the Fox River Canal Needed to Potentially Mobilize Residual DNAPL

After establishing the calculation model, NRT used a Monte Carlo statistical approach to determine the drawdown at which residual DNAPL could become mobilized. This approach accounts for the uncertainty to the input parameters. The Monte Carlo statistical method accomplishes this task by running the calculations discussed above over and over again, thousands of times, while randomly changing the values of the input parameters within the ranges for each parameter listed above. Pages 12 and 13 of the Crystal Ball Report for the Monte Carlo analysis discuss how the capillary number, hydraulic conductivity, interfacial tension and permeating water dynamic viscosity (four season analysis only) were varied. The full Crystal Ball Report for the Monte Carlo analysis is provided in Attachment B.

After 10,000 individual calculations, the results were plotted to identify the range of values that would result in DNAPL mobility with 90% certainty. This process was completed 5 times to simulate drawdown once for each season (Winter, Spring, Summer, and Fall) and once to simulate all four seasons which also included assumptions for potential drawdown by season. The results of the Monte Carlo statistical approach indicate the <u>minimum</u> drawdown required to mobilize DNAPL is:

- 7.5 feet across all Seasons
  (Page 2 – 4 Season Analysis of Necessary Drawdown, Certainty range is from 7.52 to 158.89)
- 6.3 feet in the Spring
  (Page 4 – April: Drawdown Necessary to Mobilize NAPL, Certainty range is from 6.34 to 118.56)
- 5.4 feet in the Winter
  (Page 6 – January: Drawdown Necessary to Mobilize NAPL, Certainty range is from 5.39 to 100.78)
- 8.7 feet in the Summer
  (Page 8 – July: Drawdown Necessary to Mobilize NAPL, Certainty range is from 8.67 to 178.80)
- 6.8 feet in the Fall
  (Page 10 – October: Drawdown Necessary to Mobilize NAPL, Certainty range is from 6.78 to 137.21)

Conclusions

The Monte Carlo statistical approach indicates with a 90% certainty the drawdown required to mobilize residual DNAPL could range from 5.4 feet in the winter to 8.7 feet in the Summer. Several points of interest can be gleaned from this analysis:

- The minimum drawdown required to mobilize residual DNAPL is greater in the warmer months than in the winter. This is directly related to the permeating water dynamic viscosity, which increases as the water temperature decreases (Table 1, Table A). The probability of a drawdown in the Fox River Canal is greater in the warmer months and may not be possible in the winter due to ice and low temperatures that limit operation of the Middle Appleton Dam
- The minimum drawdown predicted for the Fall season with 90% confidence – 6.8 feet, corresponds very well with the conditions observed during the 2011 Fox River Canal drawdown

When applying the results of this investigation to potential dewatering events in the future, is also important to recognize the physical limitations of dam operation not considered by this analysis. The Middle Appleton Dam and resultant dewatering of Fox River Canal cannot achieve a drawdown of 7 feet without the installation of temporary coffer dam. This observation is demonstrated by the photo of canal conditions during a drawdown without a coffer dam; Photo 1 provided in the *Canal Dewatering Assessment* (Attachment A). Installation of a temporary coffer dam has occurred only twice since 2000; once in 2003 and once in 2011; demonstrating the infrequency of a Fox River Canal drawdown with a temporary coffer dam.

Also, the steady state conditions needed to maintain a change in head (approximately 7 feet) great enough to begin mobilization of residual DNAPL are temporary and dissipate within 4 days of a canal drawdown event.

Finally, the 90th percentile values from the Monte Carlo statistical approach correlate well with “real world” observations (e.g., *Canal Dewatering Assessment*). That is, the Fox River Canal must be entirely dewatered (approximately 7 feet) and the material in the bottom of the canal must be disturbed before residual DNAPL mobilization is observed – conditions that can only be achieved when a temporary coffer dam is placed in the Fox River Canal.

References

Cohen and Mercer. 1993. DNAPL Site Evaluation.

Electric Power Research Institute (EPRI). April 2004. Residual Saturation of Coal Tar in Porous Media. Technical Report 1009426.

Fetter, C.W. 1994. Applied Hydrogeology. Macmillan College Publishing Company, Inc., New York, NY.

Pankow and Cherry. 1996. Dense Chlorinated Solvents and other DNAPLS in Groundwater. Waterloo Press, Portland, OR.

URS Corporation. March 25, 2002. Site Investigation Report, Former Manufactured Gas Plant (MGP) Site, Appleton, Wisconsin, prepared for Wisconsin Electric Power Company. Table 4-4.

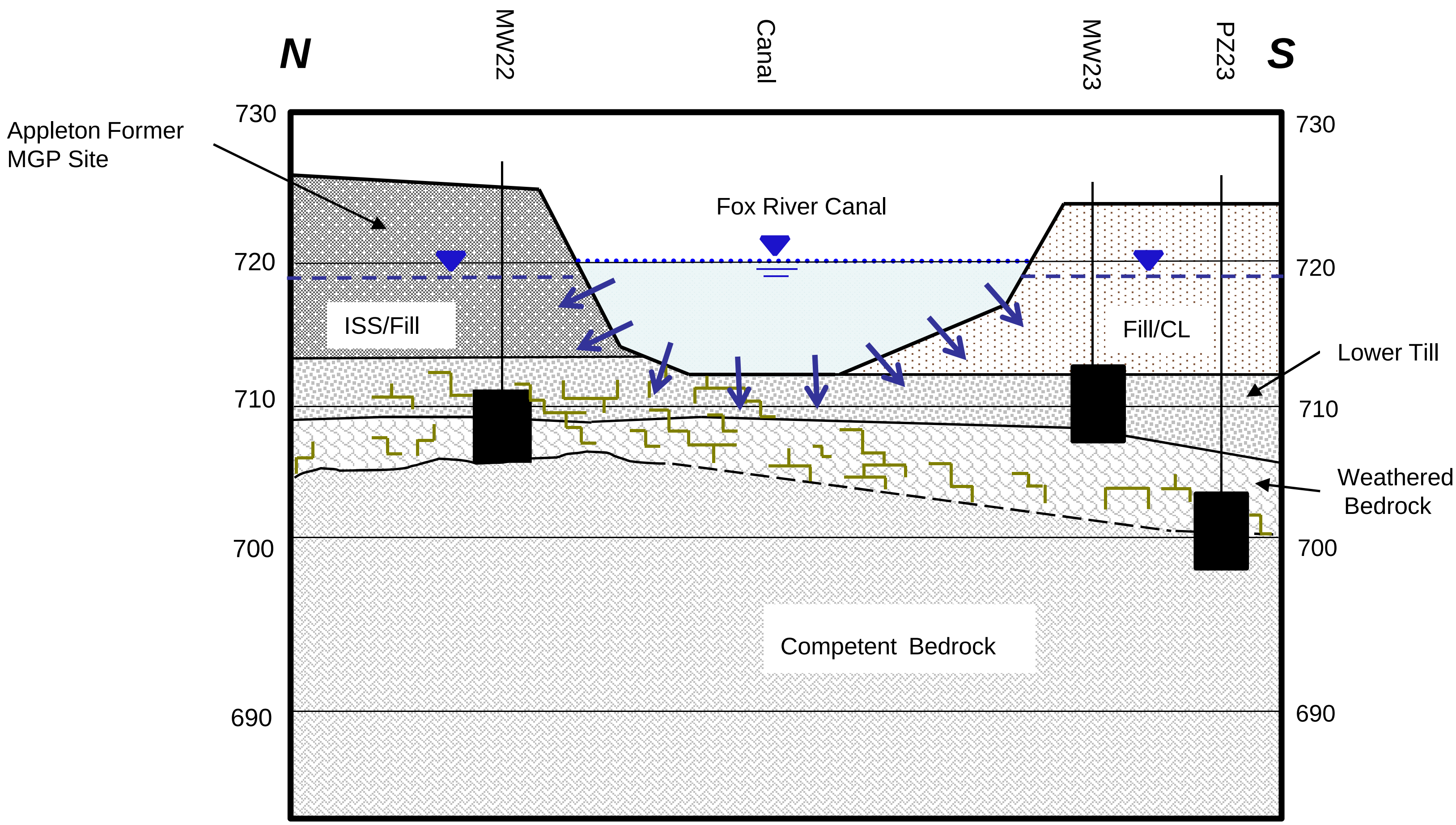
Figures

Tables

Attachments

FIGURES

Figure 1 - Conceptual Drawing of Normal Flow Conditions
Appleton Former MGP Site



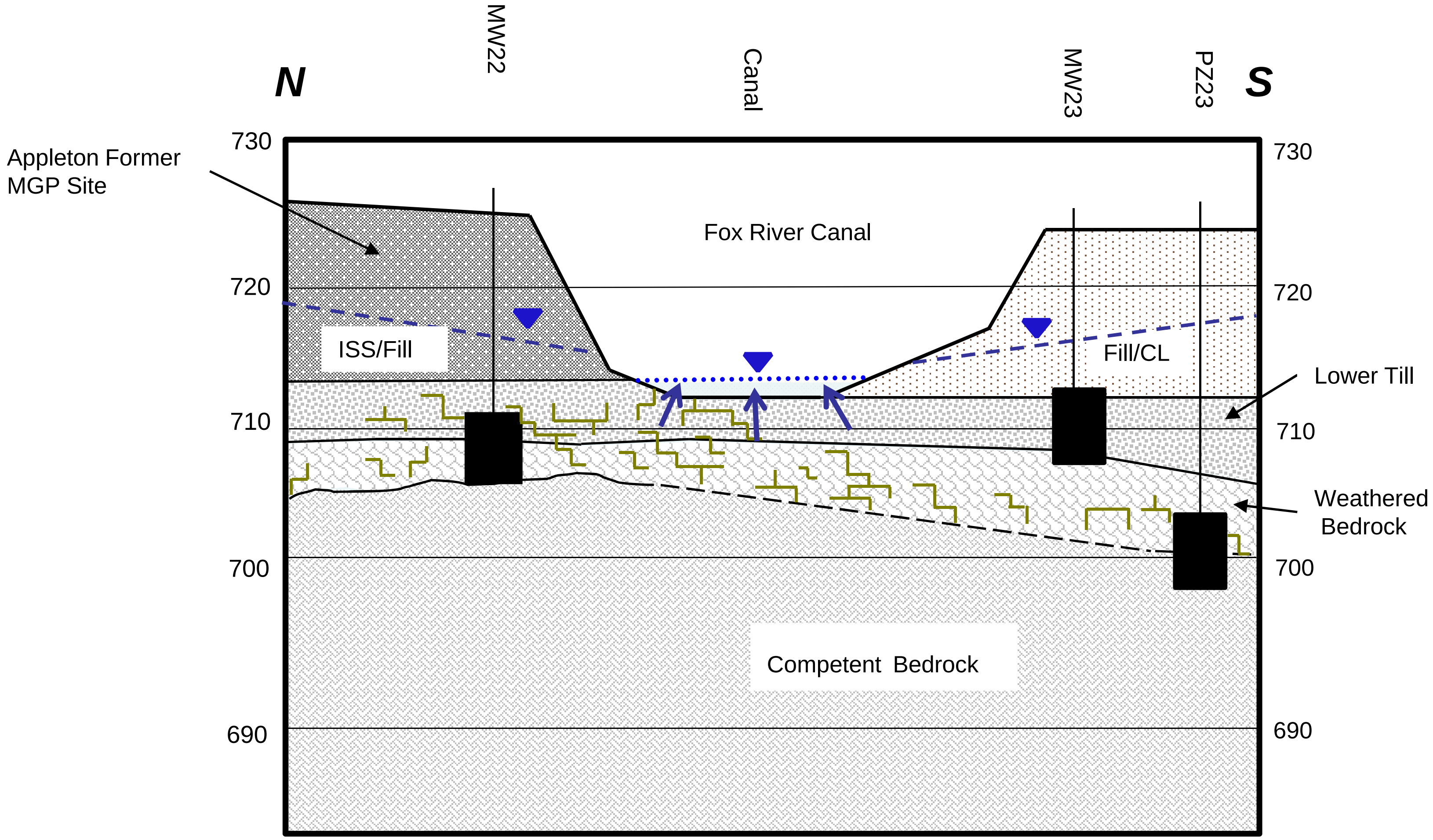
Conceptual drawing that illustrates the direction of water flow direction under normal conditions. Water flows from high head observed in the canal to low head observed in the materials on either side of the canal. In the absence of ebullition, NAPL mobilization is controlled by flow direction (blue arrows). Residual product is shown in green. Post-construction monitoring wells are in black.

Legend:

Not to Scale

11/18/2014

Figure 2 - Conceptual Drawing of Dewatered Flow Conditions
Appleton Former MGP Site



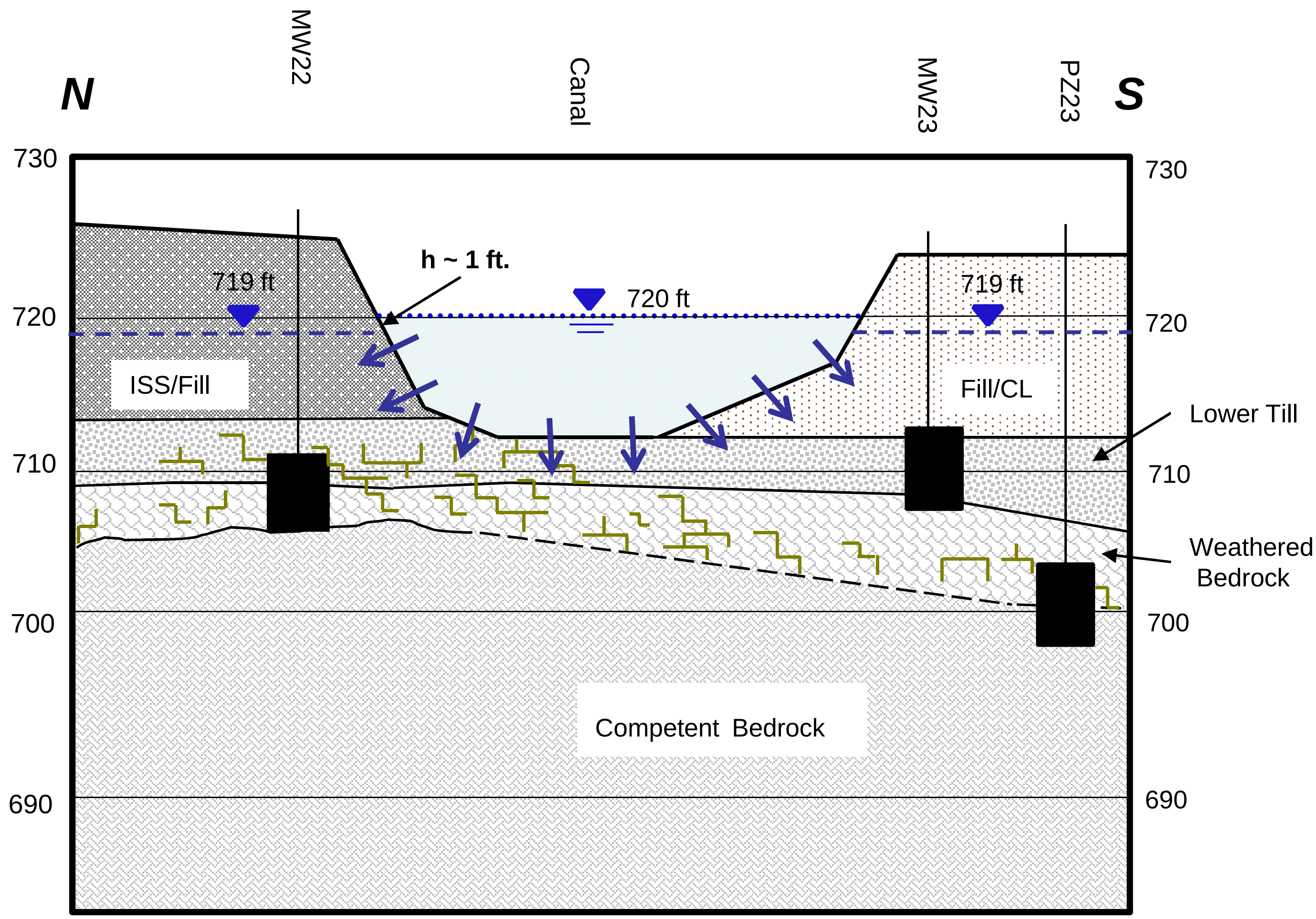
Conceptual drawing that illustrates the direction of water flow direction under dewatered conditions. Water flows from high head observed in the materials on either side of the canal to low head observed in the canal. Note the flow direction (blue arrows) is reversed from normal conditions. Residual product is shown in green. Post-construction monitoring wells are in black.

Legend:

Not to Scale

11/18/2014

Figure 3 - Conceptual Drawing Normal Flow Condition - Hydraulic Head
Appleton Former MGP Site



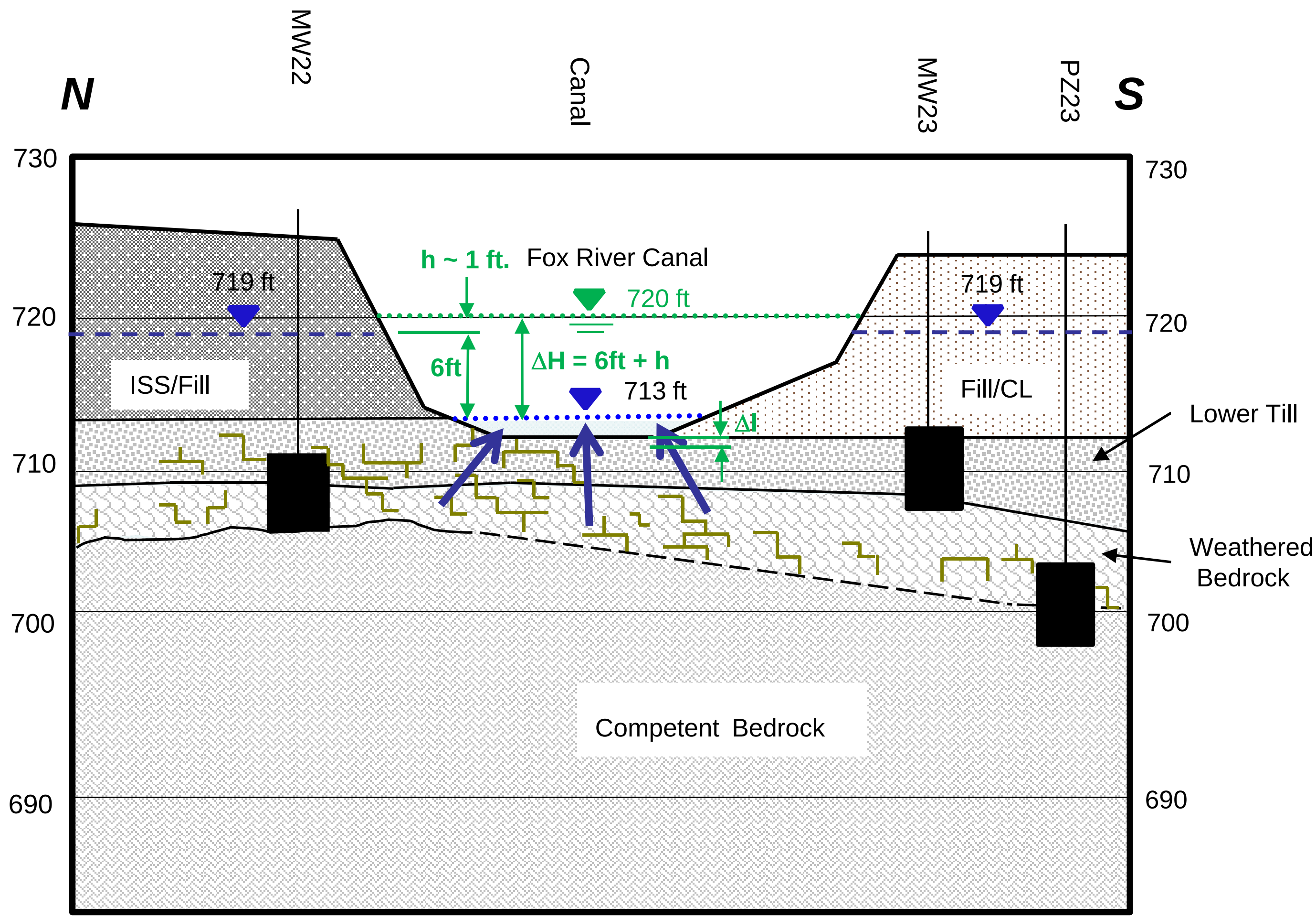
Conceptual drawing of normal hydraulic head. NAPL mobilization is influenced by the gradient of flow. Gradient is the change in head divided by the change in distance ($i = \Delta H / \Delta l$). Under normal conditions the difference in head between the canal and the materials on either side is approximately 1-foot. Residual product is shown in green. Post-construction monitoring wells are in black.

Legend:

Not to Scale

11/18/2014

Figure 4 - Conceptual Drawing of Estimated Maximum Hydraulic Head
Appleton Former MGP Site

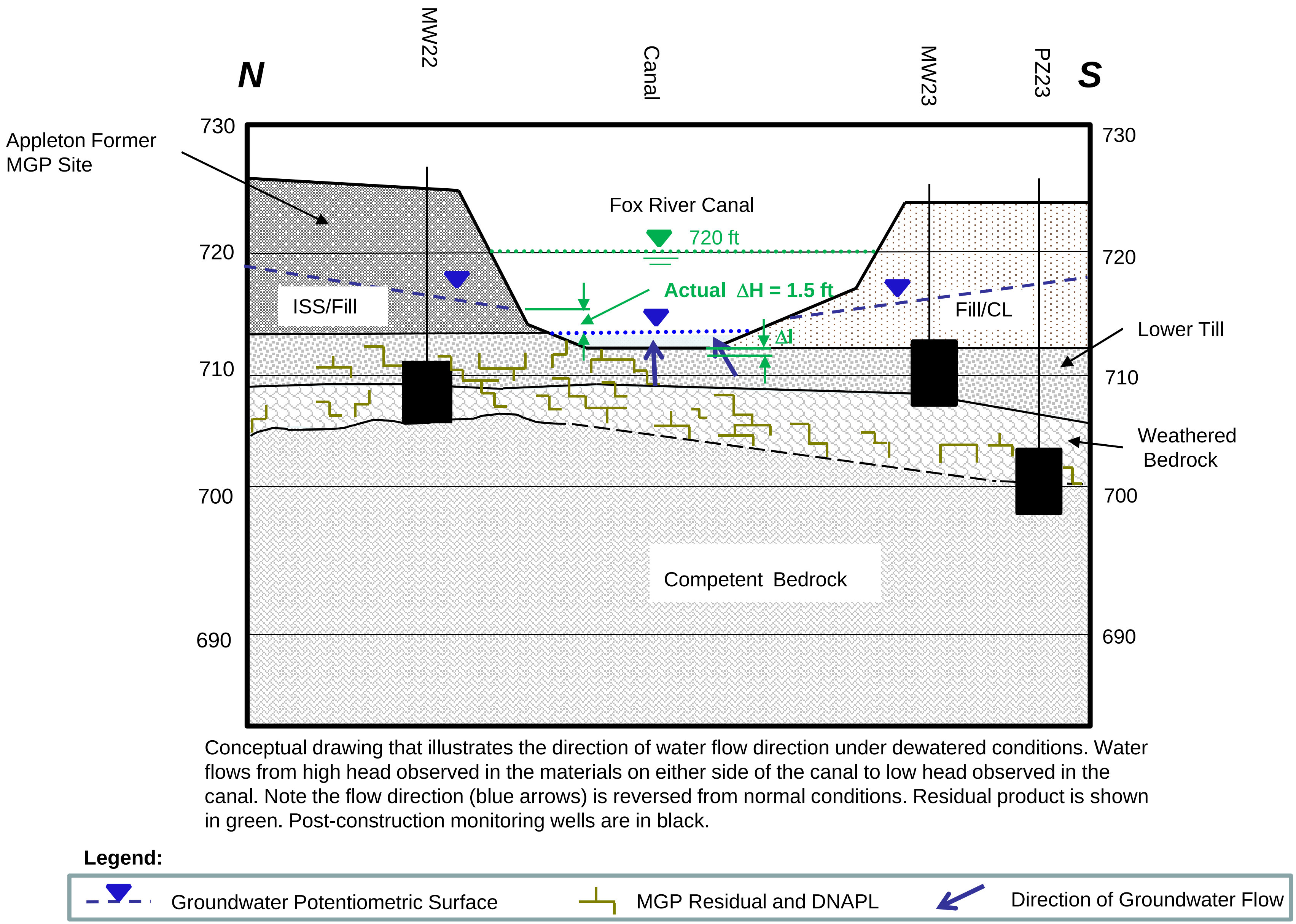


Conceptual drawing of estimated maximum hydraulic head. NAPL mobilization is influenced by the gradient of flow. Gradient is the change in head divided by the change in distance (**$i = \Delta H/\Delta l$**). The greatest potential difference in head occurs when the canal is completely dewatered. Under these conditions the difference in head between the canal and the materials on either side is approximately 6-feet. This results is a larger gradient (represented by larger flow arrows). Field measurements collected during the 2011 dewatering event indicate heads in the materials on either side of the canal decrease in response to the lower canal elevation within 4 days of dewatering which reduces the change in head to less than 1.5-feet (see conceptual drawing of dewatered flow conditions). Residual product is shown in green. Post-construction monitoring wells are in black.

Not to Scale

11/18/2014

Figure 5 - Conceptual Drawing of Actual Hydraulic Head
Appleton Former MGP Site



Conceptual drawing that illustrates the direction of water flow direction under dewatered conditions. Water flows from high head observed in the materials on either side of the canal to low head observed in the canal. Note the flow direction (blue arrows) is reversed from normal conditions. Residual product is shown in green. Post-construction monitoring wells are in black.

Not to Scale

11/18/2014

TABLES

Table 1 - Model for Calculation of Critical Hydraulic Gradient and Water Level Change in the Fox River Canal Needed to Potentially Mobilize Residual DNAPL
We Energies Former Appleton MGP Site
Appleton, WI

Pankow and Cherry (1996) *Wilson and Conrad (1984) reported that residual phase [DNAPL] can begin to be mobilized at $N_c \sim 2 \times 10^{-5}$ and that practically all residual becomes mobilized at $Nc \sim 1.3 \times 10^{-3}$*

Equation 1: Calculation of Capillary Number - Pankow and Cherry (1996) [3.36]:

$$N_c = \frac{k \rho_w g}{\sigma} i$$

N_c Capillary Number = 2×10^{-5}
k Intrinsic permeability
ρ_w Density of water
g Gravitational constant
σ interfacial tension (dyn/cm)
i hydraulic gradient

Equation 2: Definition of intrinsic permeability - Fetter (1994):

$$k = K \frac{\mu_w}{\rho_w g}$$

k Intrinsic permeability
K Hydraulic conductivity of soil
μ_w permeating water dynamic viscosity
ρ_w permeating water dynamic density
g Gravitational constant

Equation 3: Combine equations to solve for hydraulic gradient necessary to begin mobilization of D

$$i = \frac{N_c \sigma}{K \mu_w}$$

		Input Parameters		
		Low Range	**High Range**	**Reference**
i	**hydraulic gradient necessary to mobilize DNAPL**			
N_c	Capillary Number	2.0E-05	1.3E-03	Wilson and Conrad (1984) via Pankow and Cherry (1996)
σ	interfacial tension (dyn/cm)	22.37	27.83	EPRI (2004), Table 3-4, Range lowest to highest value
K	Hydraulic conductivity of soil (cm/s)	1.09E-03	4.07E-03	Table B
μ_w	permeating water dynamic viscosity (N s/m2)	0.001787	0.001002	Table A, Range Lowest Temperature (most conservative) to highest temperature (least conservative)
	i	**Soultion Predicted by Monte Carlo Statistical Approach**		

Definition of hydraulic gradient

$$i = \Delta H / \Delta l$$

i hydraulic gradient
ΔH Change in head
Δl Flow path length

Equation to solve for Drawdown (change in head) necessary to mobilize DNAPL:

$$\Delta H = (i * \Delta l) + h$$

		Input Parameters		
		Low Range	**High Range**	**Reference**
ΔH	**Drawdown necessary to mobilize DNAPL**			
i	hydraulic gradient necessary to mobilize DNAPL	Soultion Predicted by Monte Carlo Statistical Approach		
Δl	Flow path length (feet)	0.1	0.1	
h	Average head existing in Canal (feet)	-0.91	-0.91	Table D, Use Average at MW-22
	ΔH (feet)	**Soultion Predicted by Monte Carlo Statistical Approach**		

References:

1 URS Corporation, March 25, 2002, *Site Investigation Report,* Former Manufactured Gas Plant (MGP) Site, Appleton, Wisconsin, prepared for Wisconsin Electric Power Company. Table 4-4
2 Pankow and Cherry, 1996, *Dense Chlorinated Solvents and other DNAPLS in Groundwater*
3 Electric Power Research Institute (EPRI), April 2004, *Residual Saturation of Coal Tar in Porous Media,* Technical Report 1009426

NATURAL RESOURCE TECHNOLOGY

Table 1 - Model for Calculation of Critical Hydraulic Gradient and Water Level Change in the Fox River Canal Needed to Potentially Mobilize Residual DNAPL
We Energies Former Appleton MGP Site
Appleton, WI

Table A - Dynamic (Absolute) and Kinematic Viscosity of Water in SI Units:

Temperature - *t* - (° C)	Dynamic Viscosity - *μ* - (Pa s, N s/m²) x 10⁻³	Kinematic Viscosity - *v* - (m²/s) x 10⁻⁶	Temperature - *t* - (° F)
0	1.787	1.787	32
5	1.519	1.519	41
10	1.307	1.307	50
20	1.002	1.004	68
30	0.798	0.801	86
40	0.653	0.658	104
50	0.547	0.553	122
60	0.467	0.475	140
70	0.404	0.413	158
80	0.355	0.365	176
90	0.315	0.326	194
100	0.282	0.29	212

Table D - Evaluation of Water Elevations Adjacent to Fox River Canal

Date	MW-22 (feet, MSL)	MW-23 (feet, MSL)	SG-3 (feet, MSL)	Δ (MW-22 - SG-3) (feet)	Δ (MW-23 - SG-3) (feet)
Jan-13	719.4	719.24	720.36	-0.96	-1.12
Apr-13	720.76	719.88	721.79	-1.03	-1.91
Jul-13	719.77	719.37	720.55	-0.78	-1.18
Oct-13	719.25	719.17	719.8	-0.55	-0.63
Jan-14					
Apr-14	720.37	719.67	721.6	-1.23	-1.93
Jul-14					
Oct-14	719.51	718.92	720.42	-0.91	-1.5
			Average	-0.91	-1.38

Table B - Hydraulic Conductivity Ranges for Lower Till[1]

Location	Hydraulic Conductivity (cm/s)
MW-01-12D	2.13E-03
MW-01-13D	2.03E-03
MW-01-14D	1.09E-03
MW-01-15D	4.07E-03
Geometric Mean	**2.09E-03**

Table C - Range of interfacial tension (dyn/cm) [EPRI 2004]

Identifier	σ (dyn/cm)
1B	26.7
2B	27.83
4	22.55
7	25.79
9	22.37
10	24.43
Average Value	**24.945**

ATTACHMENT A

NATURAL RESOURCE TECHNOLOGY

TECHNICAL MEMORANDUM

Date: **July 12, 2012**

To: **Tiffany Goebel, We Energies**

From: **Chris Robb and Brian Hennings**

Subject: **2011 Canal Dewatering Assessment**
We Energies Appleton Former MGP Site

From October 6, 2011 through November 10, 2011 portions of the Fox River Canal adjacent to the former Appleton manufactured gas plant (MGP) site were dewatered to facilitate maintenance activities at two downstream hydroelectric units owned by Neenah Paper. This technical memorandum summarizes observations collected by We Energies representatives during these canal dewatering activities.

Relevant History

The Fox River Canal is located southeast and directly adjacent to We Energies' former Appleton MGP site (Site). The canal serves as a headrace for three hydroelectric power units located downstream of the Site; two owned by Neenah Paper. The MGP on the Site operated from approximately 1867 to 1954. Initial environmental investigations at the Site were completed in 1996 and 2001, and identified various MGP residuals including: BTEX, PAHs, tar or oil like materials, lighter phase oils or sheen, blue stained wood chips, and ash or clinkers. In April 2002, We Energies learned that in conjunction with Neenah Paper's annual maintenance shutdown, a substantial drawdown of the Fox River was planned for early August 2002. This allowed We Energies the unique opportunity to perform a visual assessment of conditions at the bottom of the canal and excavate approximately 400 to 450 cubic yards of previously identified weathered coal tar as documented in the *Interim Remedial Action Documentation Report*, November 2002. The drawdown did not result in complete dewatering of the canal and as shown in Photo 1 (Attachment A); water flowed through the canal at a depth of 6 inches to 3 feet.

Consequently, We Energies coordinated a second drawdown with Neenah Paper in 2003 to facilitate installation of a temporary dam to complete canal dewatering for full scale removal of MGP residuals (Photo 2, Attachment A); as documented in the *Phase I Remedial Construction Documentation Report*, April 19, 2004. The 2003 excavation procedure effectively removed 2,040 tons of MGP residuals from a 21,700 square foot area from the bottom of the Fox River Canal. Following completion of the removal operation, the excavated area was armored with 3-inch crushed, washed stone to restore the excavation to the original canal bottom grades and protect the excavated surface from scouring.

We Energies completed the remedial action at the site in 2004, which included *in situ* stabilization/solidification of approximately 34,000 cubic yards of soil located in upland areas adjacent to the Fox River Canal.

During these remedial actions, We Energies gathered the following information pertinent to discussion of the 2011 canal dewatering observations:

- Adjacent to the former MGP site, the Fox River Canal substrate consisted of rock, cobble and debris (*e.g.*, concrete pieces, asphalt, bottles), and had silt overlying most of the cobble and debris. Less than three inches of sand/silt substrate was present across the majority of the canal bottom. The sand/silt substrate and portions of the underlying weathered rock, including cobbles and large gravel, was removed during the remedial actions in 2002 and 2003.
- The excavated canal substrate was replaced with 3-inch crushed, washed stone to the original canal bottom grades (Photo 3, Attachment A).
- Prior to 2002 and since completion of the Fox River Canal remedial action in 2003, We Energies has not observed sheen, ebullition mobilizing MGP residuals, or free phase residuals appearing on the water surface within the canal.
- Drawdown of the Fox River Canal is not a regular occurrence. Drawdown of the canal is performed only as necessary since extended drawdowns of the canal and the Fox River necessitate shutdown of Neenah Paper's operations. Since 2002, We Energies is aware of only two additional drawdown events: one in 2003 to facilitate We Energies' remedial construction operations in the canal and the drawdown in 2011.

2011 Canal Dewatering

From October 6, 2011 through November 10, 2011 portions of the Fox River Canal adjacent to the former Appleton MGP site were dewatered to facilitate maintenance activities at two downstream hydroelectric units owned by Neenah Paper (Photo 4, Attachment A). We Energies recognized this as a unique opportunity to proactively inspect the integrity of the remedial action completed in 2003 and 2004, and collect groundwater levels to further evaluate the connection between groundwater in the lower till and surface water in the canal.

Neenah Paper arranged to have a contractor install an inflatable temporary dam approximately 380 feet upstream of their two hydroelectric units (Figure 1). This allowed inspection of the remedy and canal from approximately MW-21, the approximate mid-point of the Site (west to east), to the east past MW-22 (Photo 5, Attachment A). Areas upstream of MW-21 were not dewatered and could not be inspected.

The following timeline summarizes the dewatering activities pertinent to the canal observation activities:

- 10-6-2011: Temporary dam installed by Neenah Paper.
- 10-11-2011: We Energies representatives (NRT) perform first inspection of remedy and canal.
- 10-20-2011: NRT performs second inspection of canal.
- 10-31-2011: WDNR meets with We Energies on-site for canal inspection.

- 11-09-2011: Temporary dam overtopped by water in the canal. Temporary dam removed.
- 11-18-2011: Restoration of disturbed riverbank completed and inspected by NRT.

Groundwater levels were recorded on October 3, 10, 14, 20, and November 17, 2012.

Canal Inspections and Observations

October 11, 2011 Inspection

On October 11, 2011, NRT mobilized to the Site to inspect the integrity of the completed remedy. NRT's objectives during the inspection included:

- Evaluate riverbank stability/integrity along the Site.
- Evaluate canal bottom integrity along the Site.
- Evaluate repair requirements for the riverbank where the temporary dam was placed.
- Collect photographs and observations.

A secondary objective was to double check the total depths of the MW-21/PZ-21B well nest to support our evaluation of groundwater flow patterns for the *2011 Annual Report*.

NRT recorded the following observations during the inspection:

- The riverbank adjacent to the Site is in excellent condition. No evidence of scour, rip rap displacement, rip rap degradation, or river bank failure was observed during the inspection (Photo 6, Attachment A).
- No evidence of sheen or MGP residuals was observed along or at the toe of the riverbank.
- Leakage around the temporary dam resulted in water flowing along the canal bottom from 1 to 6 inches in depth (Photo 7, Attachment A).
- No evidence of sheen or MGP residuals were observed on the water surface in the dewatered canal (Photo 7, Attachment A) or upstream of the temporary dam.
- Some areas of the dewatered canal bottom exhibited sheen when disturbed or agitated (Photo 8, Attachment A). These areas were adjacent to the riverbank along the former MGP site near MW-21. No free phase MGP residuals were observed.
- A small amount of free product (dense NAPL [non-aqueous phase liquid]) was observed in MW-21 while recording the well's total depth. Thickness of the dense NAPL was not able to be accurately recorded. No dense NAPL was observed in PZ-21.

Observations of sheen along the canal bottom were not expected. We Energies elected to further evaluate the presence of sheen along and around the canal while the temporary dam was still in place.

October 20, 2011 Inspection

On October 20, 2011, NRT mobilized to the Site to perform a second inspection of the dewatered canal. NRT's objectives during the second inspection included:

- Evaluate the nature and extent of observed sheen in the dewatered canal.

- Evaluate additional monitoring wells surrounding the canal (MW-12, MW-13, MW-20, MW-22, and MW-23/PZ-23) for presence/absence of dense NAPL.
- Collect photographs and observations.

NRT initiated assessment of MGP residuals in the canal immediately downstream of the temporary dam, adjacent to the riverbank at MW-21. NRT used the following procedure to evaluate the extent of MGP residuals in the canal:

1. Start at riverbank adjacent to the Site. Walk transects perpendicular to riverbank and canal to determine extent.
2. While walking transects, periodically pole/disturb the rock substrate and record the presence/absence of sheen and MGP residuals (Photo 9 and 10, Attachment A).
3. Determine at each transect the lateral extent of observed residuals. Record the location of the extent with a hand held GPS unit (depicted with red dots on Figure 1).
4. Record observations and collect photographs as appropriate.

Using this procedure, NRT walked a total of 11 transects ranging from approximately 25 to 40 feet apart. NRT inspected the entire dewatered portion of the canal. The results of the assessment and limits of observed sheen are shown on Figure 1. In addition, NRT recorded the following observations:

- The canal substrate mostly consists of 3-inch clear stone, placed during the 2003 remedial action, and rock. A few small pockets of soft deposits (sand/silt/shells) 6 to 10 inches thick were observed. These soft pockets appeared to coincide with low areas along the canal bottom.
- Poling revealed sheen from near the river bank (adjacent to the Site) to the limits recorded on Figure 1.
- Two areas revealed small (up to dime sized) droplets of free phase residuals when disturbed (Figure 1 and Photo 11, Attachment A). These areas did not exhibit free phase residuals when left alone and free phase mobilization via ebullition was also not observed.

When the limits of observed sheen were mapped, NRT observed that these limits generally correlate with the limits of canal excavation performed in 2003 (Figure 1).

NRT also evaluated monitoring wells MW-12, MW-13, MW-20, MW-22, and MW-23/PZ-23 surrounding the canal for the presence/absence of dense NAPL. Dense NAPL was not observed in any of the wells except MW-20. At MW-20, a trace of dense NAPL was observed on the weight sent to the bottom of the well, but no thickness could be measured.

October 31, 2011 Meeting with WDNR

Following collection of these observations and processing of the GPS data, We Energies notified Ms. Jennifer Borski of the observations on October 25, 2011. On October 31, 2011, We Energies, WDNR representatives, and NRT met on-site to review the observations and provide WDNR the opportunity to inspect the canal.

Groundwater Levels and Evaluation

Groundwater measurements were collected before (October 3), during (October 10, 14, and 20), and after (November 17) the canal dewatering event to evaluate changes in groundwater flow and the hydraulic connection between groundwater in the lower till and surface water in the canal. Piezometric surface elevation maps (Figures 2 through 6) were created for each round of observations.

It was expected that the canal would be completely dewatered after installation of the temporary dam and the groundwater in the lower till would respond. Figure 2 indicates the water level in the canal was at 720.82 feet three days prior to dewatering. Following dewatering, the bed of the canal (which is at an elevation of approximately 713 feet) was mostly exposed. NRT photographed weathered bedrock in the canal bottom (Photo 12, Attachment A), which is likely connected to the lower till groundwater flow system.

Observations collected three days prior to dewatering (Figure 2) are representative of normal flow at the site north of the canal. The gradient is low across the site such that the piezometric surface is contoured 0.1-foot intervals to evaluate flow directions. The gradient is very flat west of MW-21, and past monitoring events indicate that flow direction can be variable in this area. The gradient is steeper east of MW-21 and groundwater flow is consistently northeast (parallel to flow in the canal) as it approaches the Middle Appleton Dam (located just off the map to the east of the Fox River Mills apartments). Under normal conditions, the potentiometric surface of the lower till unit in wells adjacent to the canal is lower than the surface water elevation of the canal (suggesting that the canal typically behaves as a losing stream).

Observations collected during dewatering of the canal (Figures 3, 4, and 5) suggest that dewatering rapidly changed groundwater flow direction and gradient north of the canal. The first round of measurements collected four days after dewatering indicate the piezometric surface of the lower till downstream of the temporary dam had decreased between 4 and 5 feet (Figure 3). The gradient across the site increased such that the piezometric surface could be contoured at 1-foot intervals.

The relationship between groundwater and surface water also changed within those four days after dewatering. Under normal conditions, the potentiometric surface of the lower till unit is lower than the surface water elevation of the canal and groundwater would flow roughly parallel to the canal northeast toward the Middle Appleton Dam. During dewatering the relationship was reversed and the potentiometric surface of the lower till was higher than the elevation of the bed of the canal (around 713 feet); which suggests that the dewatered section of the canal started behaving like a gaining stream. Groundwater flow direction changed during dewatering by rotating slightly eastward to flow sub-parallel with the canal.

The flow pattern present four days after dewatering (illustrated on Figure 3) is consistent with observations one week (Figure 4) and two weeks (Figure 5) after dewatering. This suggests that groundwater in the lower till had reached a new equilibrium within four days.

On the south side of the dewatered canal at well nest MW-23 and PZ-23 similar observations were made with respect to potentiometric surface elevation. MW-23 is screened in the lower till and PZ-23 is screened in the shallow bedrock just below MW-23. Under normal flow conditions, the groundwater elevation in PZ-23 is slightly lower than in MW-23 indicating a downward gradient. Groundwater elevations in both wells are also lower than surface water in the canal which is consistent with the canal behaving as a losing stream. Both wells experienced a decrease in groundwater elevation (around 5.5 feet) within four days of dewatering and remained at those levels. The relationship between groundwater and surface water also changed during dewatering as the surface water elevation dropped below the groundwater elevations in these wells indicating the canal was behaving like a gaining stream.

Observations collected eight days after dam removal (Figure 6) indicated a return to more normal flow conditions. The gradient across the Site returned to low levels such that the contours need to be plotted at 0.1-foot intervals to evaluate flow direction. West of MW-21, where groundwater flow direction is variable, MW-13R appeared to be recovering more slowly than the other wells. East of MW-21, it appeared that a full recovery to normal flow direction takes longer than eight days as flow direction is more northerly than northeasterly.

Summary

We Energies has performed extensive source removal in the canal during remedial operations performed in 2002 and 2003, and has been performing post remediation groundwater monitoring at the Site since 2004. As documented in annual groundwater monitoring reports submitted since that time, and most recently in the *2011 Annual Report*, MGP impacts to the lower till are known and have been previously identified in past submittals.

The groundwater elevations measured around the dewatering event suggest a solid hydraulic connection between the canal and the lower till. However, the presence of this connection does not mean that MGP residuals in the lower till are migrating from the site toward the canal. Past groundwater monitoring events and groundwater levels measured before and after canal dewatering suggest that the canal behaves as a losing stream when the surface water elevation in the canal is maintained for normal operation of the dams and paper mill. Under those normal conditions, water transfers from the canal into the lower till inhibiting migration of MGP residuals towards the canal. Only during the dewatering event did the groundwater elevation measurements suggest that the canal behaves like a gaining stream, allowing for migration toward the canal.

We Energies observations suggest MGP residuals observed in the canal during dewatering are likely trapped in discrete pockets or fractures of the rock substrate that make up the bottom of the canal, as a result of past practice and the historic presence of source materials along the canal bottom for many years (removed from the canal in 2002 and 2003). The sheen only became apparent in the canal when the canal was dewatered, groundwater started to flow toward the canal, and the canal bottom was physically disturbed.

No evidence of sheen or free phase MGP residuals in the canal has been reported to We Energies during normal flow conditions. Further, no natural processes, such as ebullition, have been observed that could mobilize MGP residuals from the lower till into the canal.

We Energies also has knowledge that water levels in the canal are maintained at very consistent elevations by Neenah Paper and that canal dewatering is an infrequent occurrence. Thus, conditions observed during canal dewatering, which could potentially mobilize MGP residuals from the lower till towards the canal, are rare and unlikely the source of the observations. In the absence of the significant shift in groundwater flow caused by canal dewatering combined with physical disturbance, MGP residuals will likely remain contained in the rock substrate as the canal loses water to the lower till.

Future Actions

Due to the presence of MGP residuals observed during the canal dewatering and the dense NAPL observed in MW-21, We Energies has implemented the following procedures to further evaluate the former Appleton MGP site and adjacent canal during the 2012 groundwater monitoring events:

- Measure presence/absence of dense NAPL and thickness at MW-2R, MW-12R, MW-13R, MW-19, MW-20, MW-21, MW-22, MW-23, and PZ-23 during each quarterly groundwater monitoring event.
- Observe the Fox River Canal and look for evidence of sheen, ebullition, or MGP residuals.
- Install a new staff gauge (SG-3) directly upstream of Neenah Paper's hydroelectric units (Figures 2 – 6) and measure the water level in the canal along with water levels in the lower till. These measurements will assist with further evaluation of the Fox River Canal/lower till hydraulic connection.
- Expand the quarterly sampling events for another year and include quarterly analysis of benzene and naphthalene at monitoring wells MW-20 and MW-21, and BTEX and naphthalene at MW-22.

Results of these future actions will be evaluated and summarized in the forthcoming annual groundwater monitoring report.

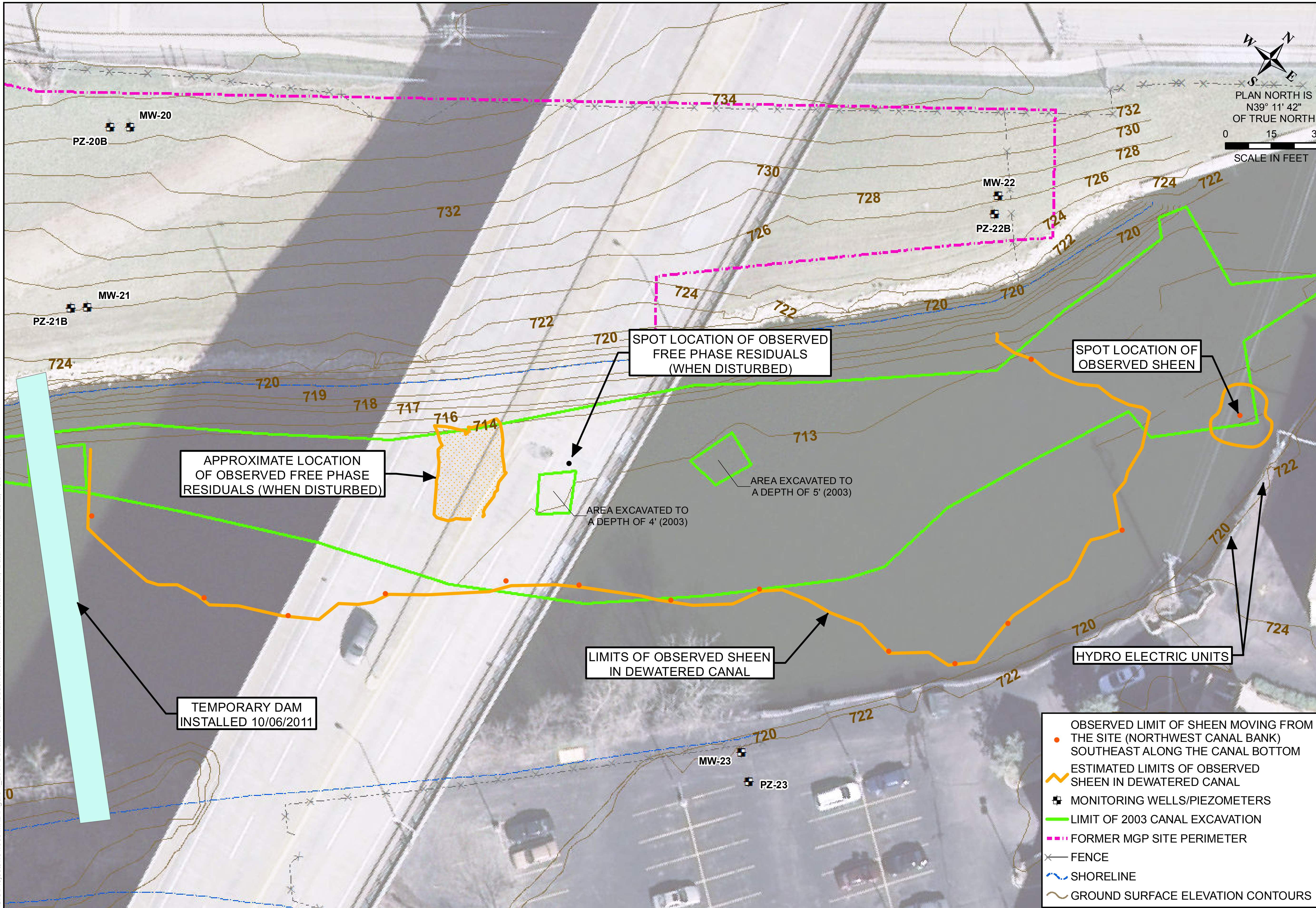
Figures

Figure 1 – 2011 Dewatered Canal Observations
Figure 2 – Lower Till Piezometric Surface Elevation – October 3, 2011
Figure 3 – Lower Till Piezometric Surface Elevation – October 10, 2011
Figure 4 – Lower Till Piezometric Surface Elevation – October 14, 2011
Figure 5 – Lower Till Piezometric Surface Elevation – October 20, 2011
Figure 6 – Lower Till Piezometric Surface Elevation – November 17, 2011

Attachments

Attachment A: Photographic Log

FIGURES



Y:\GIS\Projects\15\1508\MXD\Figure 1_2011 Dewatered Canal Observations.mxd Author: tcushman; Date/Time: 7/12/2012, 10:51:17 AM

DRAWN BY/DATE: TDC 7/9/12
REVIEWED BY/DATE: BGH 7/9/12
APPROVED BY/DATE: CAR 7/12/12

2011 DEWATERED CANAL OBSERVATIONS

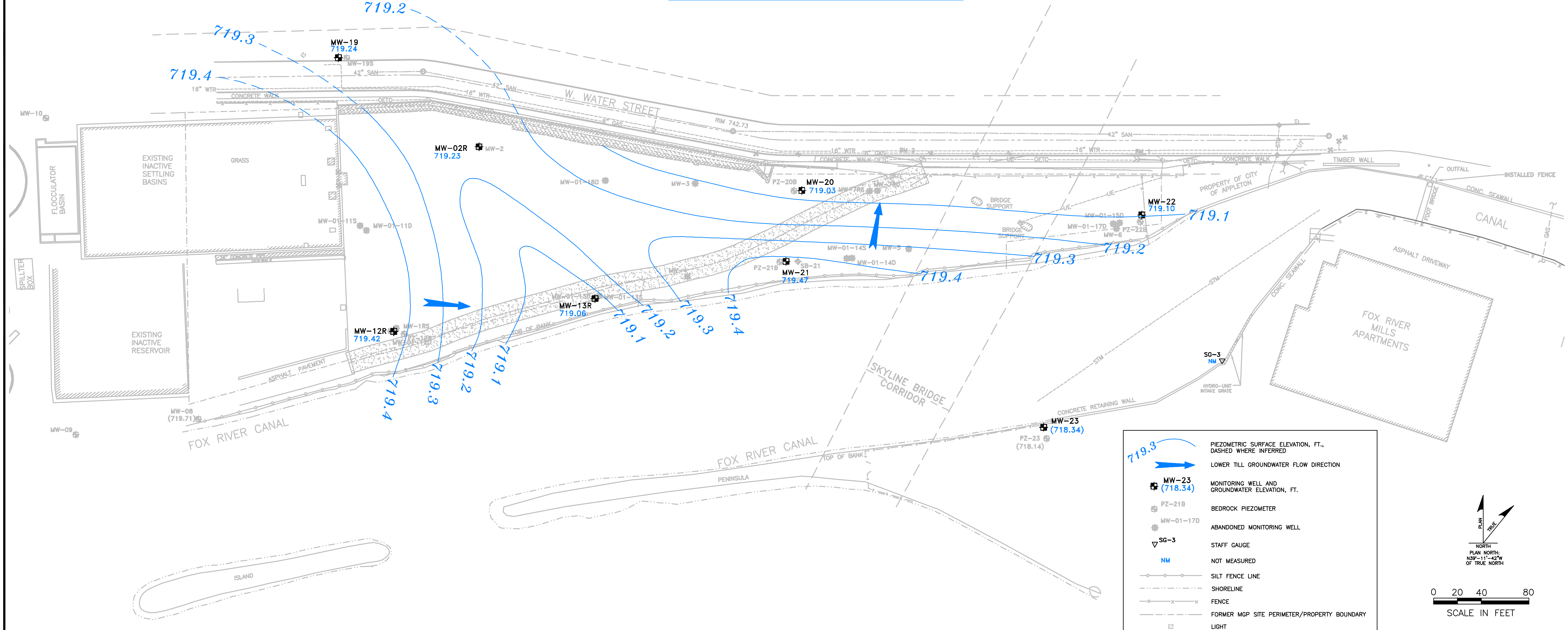
OCTOBER 20, 2011
FORMER APPLETON MANUFACTURED GAS PLANT (MGP) FACILITY
WE ENERGIES
APPLETON, WISCONSIN

PROJECT NO. 1508/19

FIGURE NO. 1

NATURAL RESOURCE TECHNOLOGY

CONTOUR INTERVAL = 0.1 FOOT
EIGHT DAYS AFTER DAM REMOVAL



719.3	PIEZOMETRIC SURFACE ELEVATION, FT., DASHED WHERE INFERRED
	LOWER TILL GROUNDWATER FLOW DIRECTION
MW-23 (718.34)	MONITORING WELL AND GROUNDWATER ELEVATION, FT.
PZ-21B	BEDROCK PIEZOMETER
MW-01-17D	ABANDONED MONITORING WELL
SG-3	STAFF GAUGE
NM	NOT MEASURED
	SILT FENCE LINE
	SHORELINE
	FENCE
	FORMER MGP SITE PERIMETER/PROPERTY BOUNDARY
	LIGHT
	POWER POLE
	GRAVEL ACCESS ROAD
SAN	SANITARY SEWER LINE
OETC	OVERHEAD ELECTRICAL, TELEPHONE & CABLE TV LINE
GAS	GAS MAIN LINE
STM	STORM SEWER LINE
UE	UNDERGROUND ELECTRICAL LINE
UT	UNDERGROUND TELEPHONE LINE
WTR	WATER MAIN LINE
	MGP GAS VALVE
	GAS VALVE
	FIRE HYDRANT
	WATER VALVE
	MANHOLE
	STORM CATCH BASIN
	DOWN GUY

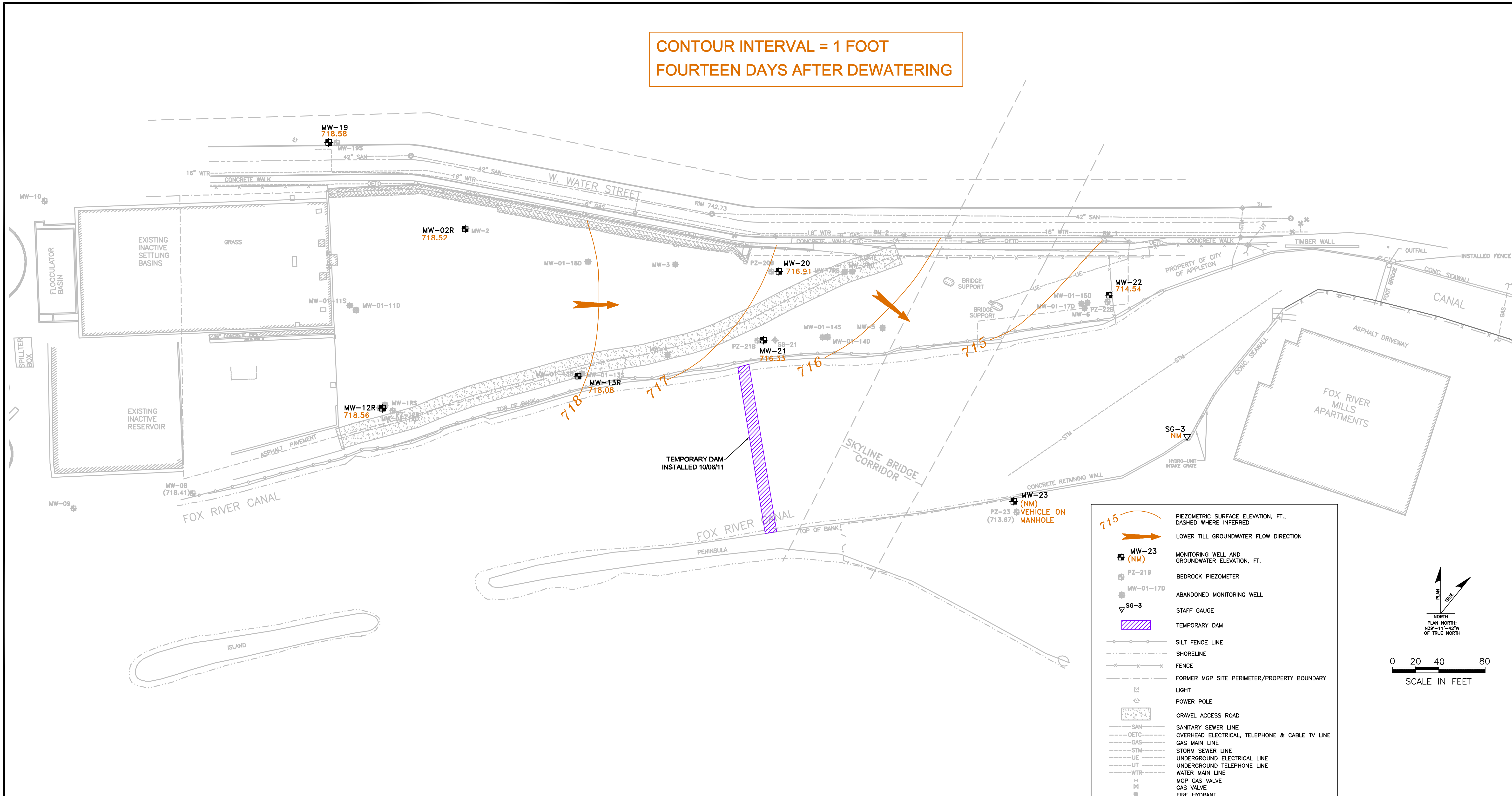
NOTE:
1. WATER LEVELS IN PARENTHESIS WERE NOT INCLUDED IN CONTOURS.

SOURCE NOTE:
1. THIS DRAWING WAS DEVELOPED FROM A SURVEY BY CAROW LAND SURVEYING CO., INC., APPLETON, WISCONSIN, PROJECT NO. C0111.11, DATED 11-30-01, REVISIONS, DECEMBER 2001, FEBRUARY 2002, AUGUST 2002 AND SEPTEMBER 2002, DIGITAL FILE WEWATER.DWG. REVISION RECEIVED FROM CAROW 8-15-02.
2. PORTIONS OF THIS DRAWING WERE DEVELOPED FROM A DRAWING BY STS CONSULTANTS LTD., PROJECT NO. 84703XB, PROJECT FILE G5Z003, FIGURE NO. 2, DATED 8-9-96.
3. ISLAND-PENINSULA LOCATIONS DEVELOPED FROM TOPOGRAPHIC MAP BY AERO-METRIC, INC., SHEBOYGAN, WISCONSIN, PROJECT NO.1991109, DATE OF PHOTOGRAPHY: 11-9-99.
4. SURVEYS FROM MARTENSON-EISELE JANUARY 2004, 157556INTGRD.DWG, 157556RIVFIN.DWG, 157556RIVSUB.DWG.
5. RECORD MONITORING WELL LOCATIONS, GRAVEL ROAD ALIGNMENT AND FINAL GRADES FROM SURVEYS BY WILLIAMS ENVIRONMENTAL SERVICES, INC., DIGITAL FILES DATED OCTOBER 5, 2004.

SURVEY NOTES:
1. BENCHMARK 1: NAIL IN POWER POLE #71-3183 LOCATED ALONG THE SOUTHEASTERLY RIGHT OF WAY LINE OF WATER STREET NEAR THE NORTHWEST PROPERTY CORNER, ELEVATION = 734.68 (CITY DATUM).
2. BENCHMARK 2: NAIL IN POWER POLE #71-3184 LOCATED ALONG THE SOUTHEASTERLY RIGHT OF LINE OF WATER STREET NEAR ENTRANCE, ELEVATION = 739.80 (CITY DATUM).
3. SUBJECT PROPERTY IS ZONED M-2 & PD/C2: GENERAL INDUSTRIAL DISTRICT & PLANNED DEVELOPMENT OVERLAY DISTRICT/GENERAL COMMERCIAL DISTRICT.
4. CURB ELEVATIONS SHOWN ARE TOP OF CURB, SUBTRACT 0.5'± TO OBTAIN GUTTER ELEVATIONS UNLESS NOTED OTHERWISE.

NATURAL RESOURCE TECHNOLOGY

PROJECT NO. 1508/19A	LOWER TILL PIEZOMETRIC SURFACE ELEVATIONS NOVEMBER 17, 2011
DRAWN BY: RLH 07/09/12	2011 CANAL DEWATERING ASSESSMENT FORMER APPLETON MANUFACTURED GAS PLANT (MGP) FACILITY WE ENERGIES CITY OF APPLETON, WISCONSIN
CHECKED BY: CAR 07/09/12	
APPROVED BY: CAR 07/12/12	DRAWING NO: 1508-19A-B05C REFERENCE: -
	FIGURE NO. 6



SOURCE NOTE:

1. THIS DRAWING WAS DEVELOPED FROM A SURVEY BY CAROW LAND SURVEYING CO., INC., APPLETON, WISCONSIN, PROJECT NO. C0111.11, DATED 11-30-01, REVISIONS, DECEMBER 2001, FEBRUARY 2002, AUGUST 2002 AND SEPTEMBER 2002, DIGITAL FILE WEWATER.DWG. REVISION RECEIVED FROM CAROW 8-15-02.
2. PORTIONS OF THIS DRAWING WERE DEVELOPED FROM A DRAWING BY STS CONSULTANTS LTD., PROJECT NO. 84703XB, PROJECT FILE G5Z003, FIGURE NO. 2, DATED 8-9-96.
3. ISLAND-PENINSULA LOCATIONS DEVELOPED FROM TOPOGRAPHIC MAP BY AERO-METRIC, INC., SHEBOYGAN, WISCONSIN, PROJECT NO.1991109, DATE OF PHOTOGRAPHY: 11-9-99.
4. SURVEYS FROM MARTENSON-EISELE JANUARY 2004, 157556INTGRD.DWG, 157556RIVFIN.DWG, 157556RIVSUB.DWG.
5. RECORD MONITORING WELL LOCATIONS, GRAVEL ROAD ALIGNMENT AND FINAL GRADES FROM SURVEYS BY WILLIAMS ENVIRONMENTAL SERVICES, INC., DIGITAL FILES DATED OCTOBER 5, 2004.

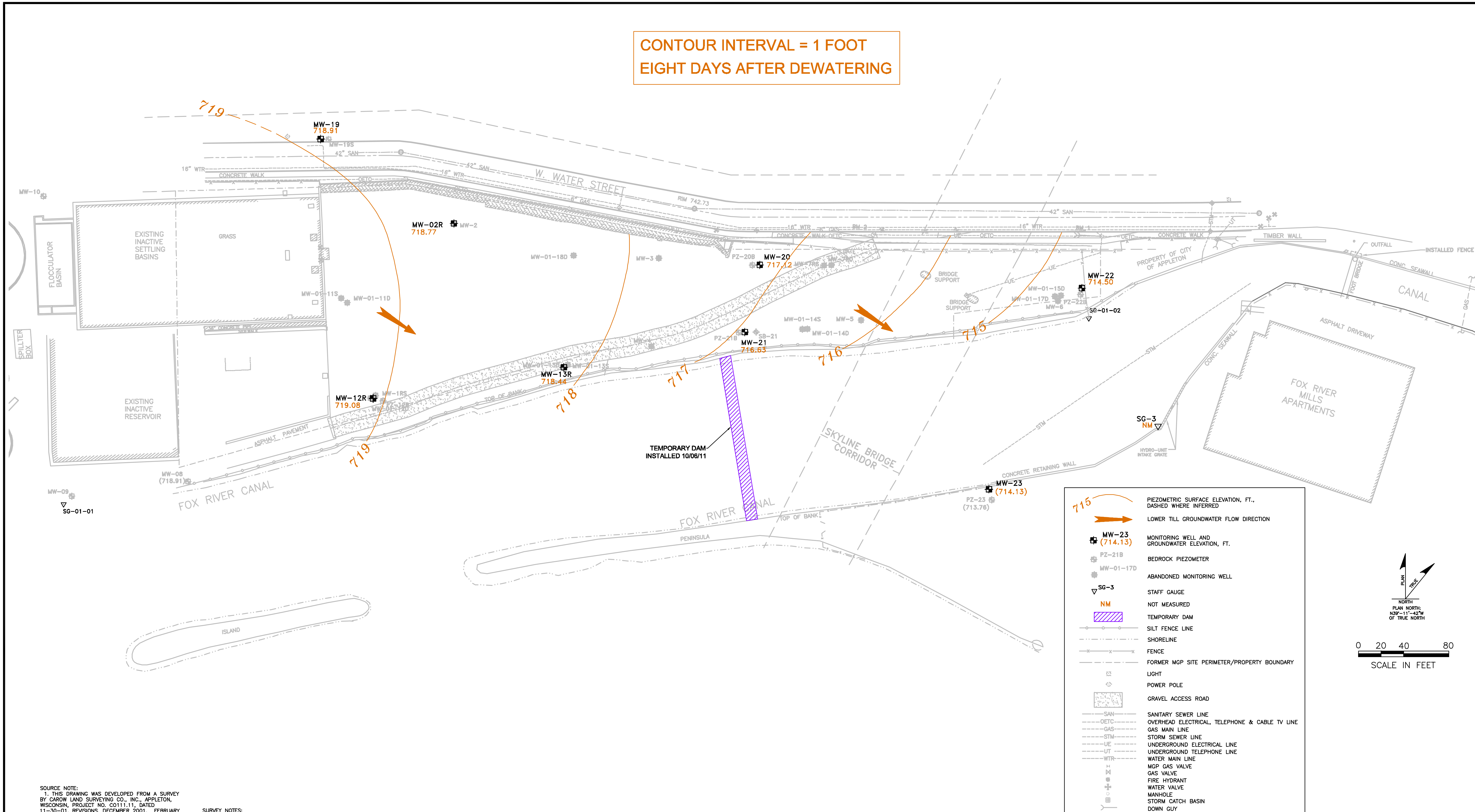
SURVEY NOTES:

1. BENCHMARK 1: NAIL IN POWER POLE #71-3183 LOCATED ALONG THE SOUTHEASTERLY RIGHT OF WAY LINE OF WATER STREET NEAR THE NORTHWEST PROPERTY CORNER, ELEVATION = 734.68 (CITY DATUM).
2. BENCHMARK 2: NAIL IN POWER POLE #71-3184 LOCATED ALONG THE SOUTHEASTERLY RIGHT OF LINE OF WATER STREET NEAR ENTRANCE, ELEVATION = 739.80 (CITY DATUM).
3. SUBJECT PROPERTY IS ZONED M-2 & PD/C2: GENERAL INDUSTRIAL DISTRICT & PLANNED DEVELOPMENT OVERLAY DISTRICT/GENERAL COMMERCIAL DISTRICT.
4. CURB ELEVATIONS SHOWN ARE TOP OF CURB, SUBTRACT 0.5'± TO OBTAIN GUTTER ELEVATIONS UNLESS NOTED OTHERWISE.

NOTE:

1. WATER LEVELS IN PARENTHESIS WERE NOT INCLUDED IN CONTOURS.

NATURAL RESOURCE TECHNOLOGY	PROJECT NO. 1508/19A	LOWER TILL PIEZOMETRIC SURFACE ELEVATIONS OCTOBER 20, 2011
	DRAWN BY: RLH 07/09/12	2011 CANAL DEWATERING ASSESSMENT FORMER APPLETON MANUFACTURED GAS PLANT (MGP) FACILITY WE ENERGIES CITY OF APPLETON, WISCONSIN
	CHECKED BY: CAR 07/09/12	
	APPROVED BY: CAR 07/12/12	DRAWING NO: 1508-19A-B04C REFERENCE: ·
		FIGURE NO. 5



NOTE:
1. WATER LEVELS IN PARENTHESIS WERE NOT INCLUDED IN CONTOURS.

SOURCE NOTE:
1. THIS DRAWING WAS DEVELOPED FROM A SURVEY BY CAROW LAND SURVEYING CO., INC., APPLETON, WISCONSIN, PROJECT NO. C0111.11, DATED 11-30-01, REVISIONS, DECEMBER 2001, FEBRUARY 2002, AUGUST 2002 AND SEPTEMBER 2002, DIGITAL FILE WEWATER.DWG. REVISION RECEIVED FROM CAROW 8-15-02.
2. PORTIONS OF THIS DRAWING WERE DEVELOPED FROM A DRAWING BY STS CONSULTANTS LTD., PROJECT NO. 84703XB, PROJECT FILE G5Z003, FIGURE NO. 2, DATED 8-9-96.
3. ISLAND-PENINSULA LOCATIONS DEVELOPED FROM TOPOGRAPHIC MAP BY AERO-METRIC, INC., SHEBOYGAN, WISCONSIN, PROJECT NO.1991109, DATE OF PHOTOGRAPHY: 11-9-99.
4. SURVEYS FROM MARTENSON-EISELE JANUARY 2004, 157556INTGRD.DWG, 157556RIVFIN.DWG, 157556RIVSUB.DWG.
5. RECORD MONITORING WELL LOCATIONS, GRAVEL ROAD ALIGNMENT AND FINAL GRADES FROM SURVEYS BY WILLIAMS ENVIRONMENTAL SERVICES, INC., DIGITAL FILES DATED OCTOBER 5, 2004.

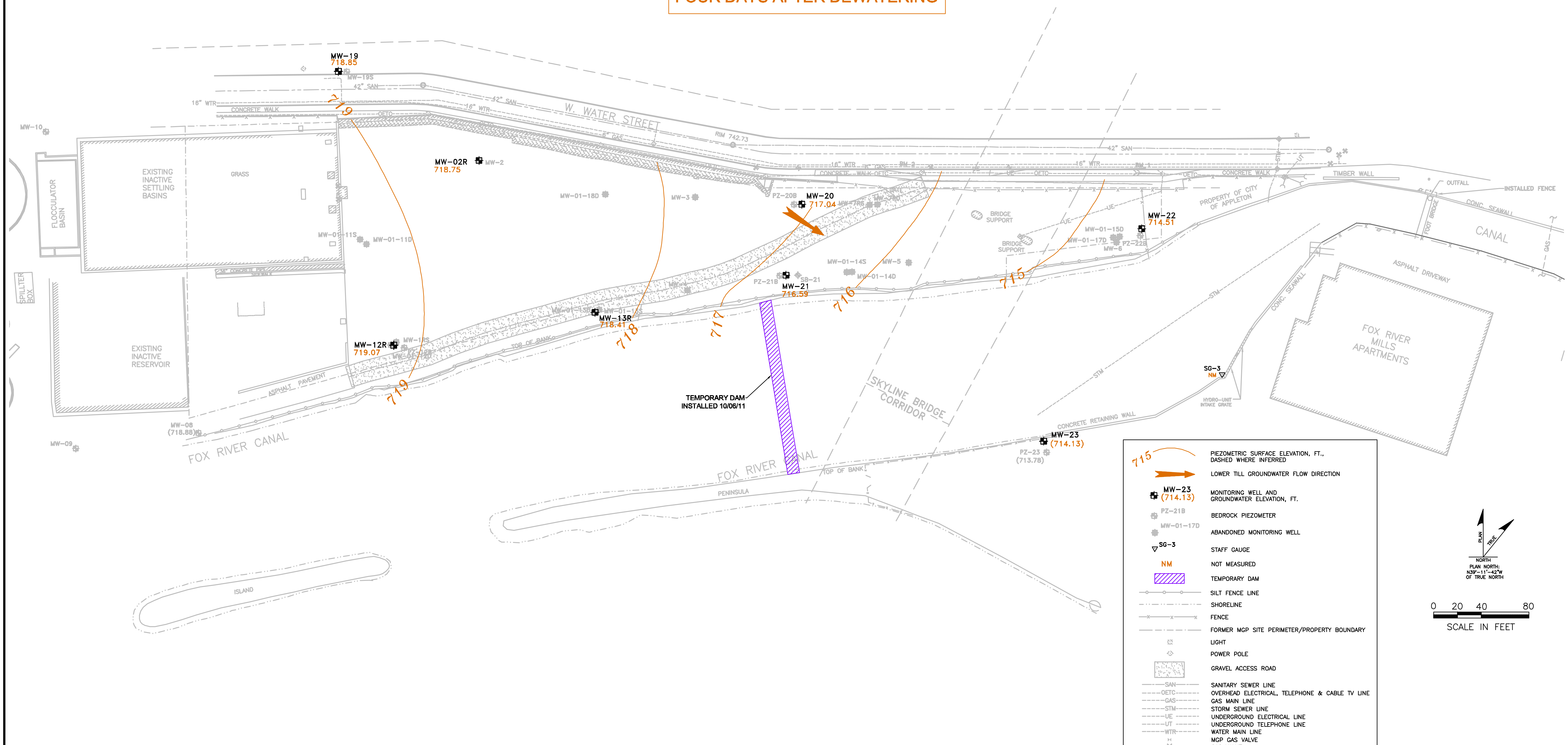
SURVEY NOTES:
1. BENCHMARK 1: NAIL IN POWER POLE #71-3183 LOCATED ALONG THE SOUTHEASTERLY RIGHT OF WAY LINE OF WATER STREET NEAR THE NORTHWEST PROPERTY CORNER, ELEVATION = 734.68 (CITY DATUM).
2. BENCHMARK 2: NAIL IN POWER POLE #71-3184 LOCATED ALONG THE SOUTHEASTERLY RIGHT OF LINE OF WATER STREET NEAR ENTRANCE, ELEVATION = 739.80 (CITY DATUM).
3. SUBJECT PROPERTY IS ZONED M-2 & PD/C2: GENERAL INDUSTRIAL DISTRICT & PLANNED DEVELOPMENT OVERLAY DISTRICT/GENERAL COMMERCIAL DISTRICT.
4. CURB ELEVATIONS SHOWN ARE TOP OF CURB, SUBTRACT 0.5'± TO OBTAIN GUTTER ELEVATIONS UNLESS NOTED OTHERWISE.

NATURAL RESOURCE TECHNOLOGY

PROJECT NO. 1508/19A	LOWER TILL PIEZOMETRIC SURFACE ELEVATIONS OCTOBER 14, 2011
DRAWN BY: RLH 07/09/12	2011 CANAL DEWATERING ASSESSMENT FORMER APPLETON MANUFACTURED GAS PLANT (MGP) FACILITY WE ENERGIES CITY OF APPLETON, WISCONSIN
CHECKED BY: BGH 07/09/12	
APPROVED BY: CAR 07/12/12	DRAWING NO: 1508-19A-B03C REFERENCE: ·

FIGURE NO. 4

CONTOUR INTERVAL = 1 FOOT
FOUR DAYS AFTER DEWATERING



SOURCE NOTE:
1. THIS DRAWING WAS DEVELOPED FROM A SURVEY BY CAROW LAND SURVEYING CO., INC., APPLETON, WISCONSIN, PROJECT NO. C0111.11, DATED 11-30-01, REVISIONS, DECEMBER 2001, FEBRUARY 2002, AUGUST 2002 AND SEPTEMBER 2002, DIGITAL FILE WEWATER.DWG. REVISION RECEIVED FROM CAROW 8-15-02.
2. PORTIONS OF THIS DRAWING WERE DEVELOPED FROM A DRAWING BY STS CONSULTANTS LTD., PROJECT NO. 84703XB, PROJECT FILE G5Z003, FIGURE NO. 2, DATED 8-9-96.
3. ISLAND-PENINSULA LOCATIONS DEVELOPED FROM TOPOGRAPHIC MAP BY AERO-METRIC, INC., SHEBOYGAN, WISCONSIN, PROJECT NO.1991109, DATE OF PHOTOGRAPHY: 11-9-99.
4. SURVEYS FROM MARTENSON-EISELE JANUARY 2004, 157556INTGRD.DWG, 157556RIVFIN.DWG, 157556RIVSUB.DWG.
5. RECORD MONITORING WELL LOCATIONS, GRAVEL ROAD ALIGNMENT AND FINAL GRADES FROM SURVEYS BY WILLIAMS ENVIRONMENTAL SERVICES, INC., DIGITAL FILES DATED OCTOBER 5, 2004.

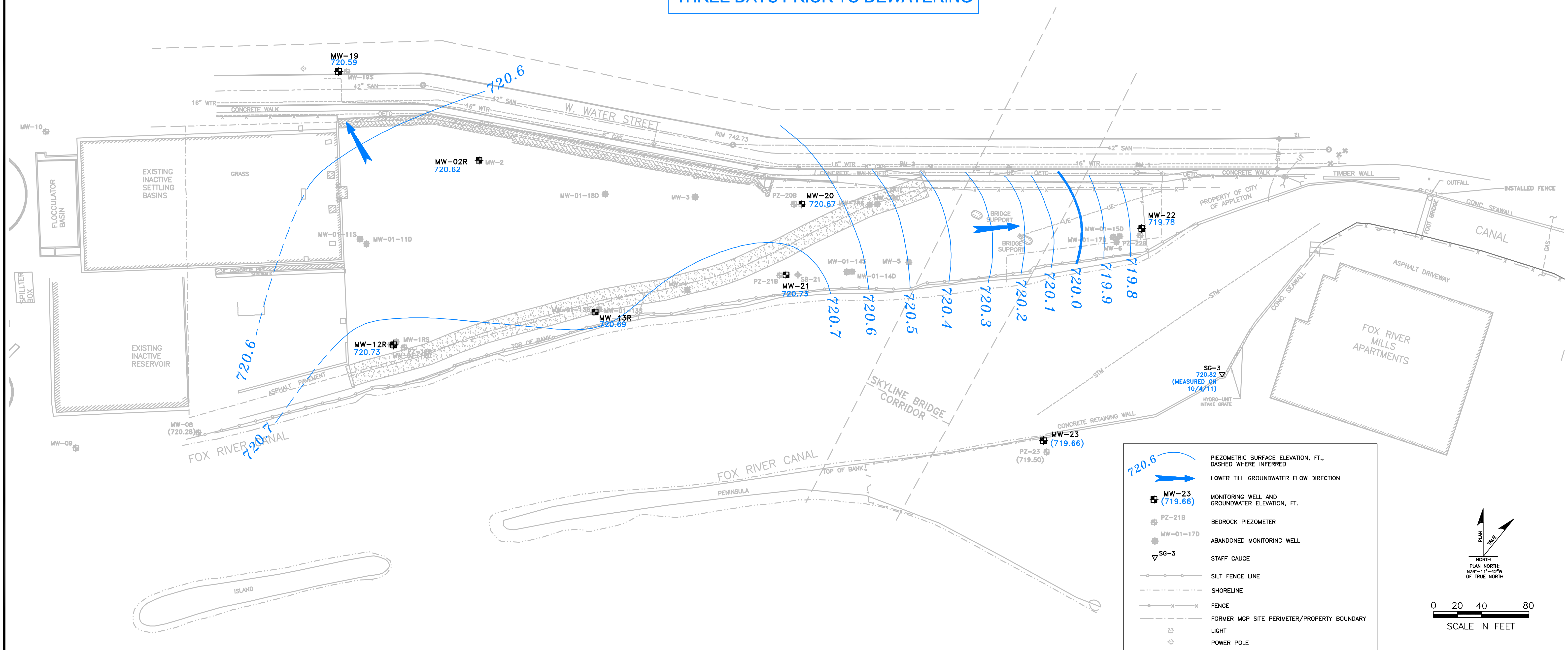
SURVEY NOTES:
1. BENCHMARK 1: NAIL IN POWER POLE #71-3183 LOCATED ALONG THE SOUTHEASTERLY RIGHT OF WAY LINE OF WATER STREET NEAR THE NORTHWEST PROPERTY CORNER, ELEVATION = 734.68 (CITY DATUM).
2. BENCHMARK 2: NAIL IN POWER POLE #71-3184 LOCATED ALONG THE SOUTHEASTERLY RIGHT OF LINE OF WATER STREET NEAR ENTRANCE, ELEVATION = 739.80 (CITY DATUM).
3. SUBJECT PROPERTY IS ZONED M-2 & PD/C2: GENERAL INDUSTRIAL DISTRICT & PLANNED DEVELOPMENT OVERLAY DISTRICT/GENERAL COMMERCIAL DISTRICT.
4. CURB ELEVATIONS SHOWN ARE TOP OF CURB, SUBTRACT 0.5'± TO OBTAIN GUTTER ELEVATIONS UNLESS NOTED OTHERWISE.

NOTE:
1. WATER LEVELS IN PARENTHESIS WERE NOT INCLUDED IN CONTOURS.

NATURAL RESOURCE TECHNOLOGY

PROJECT NO. 1508/19A	LOWER TILL PIEZOMETRIC SURFACE ELEVATIONS OCTOBER 10, 2011
DRAWN BY: RLH 07/09/12	2011 CANAL DEWATERING ASSESSMENT FORMER APPLETON MANUFACTURED GAS PLANT (MGP) FACILITY WE ENERGIES CITY OF APPLETON, WISCONSIN
CHECKED BY: CAR 07/09/12	
APPROVED BY: CAR 07/12/12	DRAWING NO: 1508-19A-B02C REFERENCE: -
	FIGURE NO. 3

CONTOUR INTERVAL = 0.1 FOOT
THREE DAYS PRIOR TO DEWATERING



720.6	PIEZOMETRIC SURFACE ELEVATION, FT., DASHED WHERE INFERRED
	LOWER TILL GROUNDWATER FLOW DIRECTION
MW-23 (719.66)	MONITORING WELL AND GROUNDWATER ELEVATION, FT.
PZ-21B	BEDROCK PIEZOMETER
MW-01-17D	ABANDONED MONITORING WELL
SG-3	STAFF GAUGE
	SILT FENCE LINE
	SHORELINE
	FENCE
	FORMER MGP SITE PERIMETER/PROPERTY BOUNDARY
	LIGHT
	POWER POLE
	GRAVEL ACCESS ROAD
SAN	SANITARY SEWER LINE
OETC	OVERHEAD ELECTRICAL, TELEPHONE & CABLE TV LINE
GAS	GAS MAIN LINE
STM	STORM SEWER LINE
UE	UNDERGROUND ELECTRICAL LINE
UT	UNDERGROUND TELEPHONE LINE
WTR	WATER MAIN LINE
	MGP GAS VALVE
	GAS VALVE
	FIRE HYDRANT
	WATER VALVE
	MANHOLE
	STORM CATCH BASIN
	DOWN GUY

NOTE:
1. WATER LEVELS IN PARENTHESIS WERE NOT INCLUDED IN CONTOURS.

PLAN NORTH / TRUE NORTH
PLAN NORTH: N39°-11'-42"W OF TRUE NORTH

0 20 40 80
SCALE IN FEET

SOURCE NOTE:
1. THIS DRAWING WAS DEVELOPED FROM A SURVEY BY CAROW LAND SURVEYING CO., INC., APPLETON, WISCONSIN, PROJECT NO. C0111.11, DATED 11-30-01, REVISIONS, DECEMBER 2001, FEBRUARY 2002, AUGUST 2002 AND SEPTEMBER 2002, DIGITAL FILE WEWATER.DWG. REVISION RECEIVED FROM CAROW 8-15-02.
2. PORTIONS OF THIS DRAWING WERE DEVELOPED FROM A DRAWING BY STS CONSULTANTS LTD., PROJECT NO. 84703XB, PROJECT FILE G5Z003, FIGURE NO. 2, DATED 8-9-96.
3. ISLAND-PENINSULA LOCATIONS DEVELOPED FROM TOPOGRAPHIC MAP BY AERO-METRIC, INC., SHEBOYGAN, WISCONSIN, PROJECT NO.1991109, DATE OF PHOTOGRAPHY: 11-9-99.
4. SURVEYS FROM MARTENSON-EISELE JANUARY 2004, 157556INTGRD.DWG, 157556RIVFIN.DWG, 157556RIVSUB.DWG.
5. RECORD MONITORING WELL LOCATIONS, GRAVEL ROAD ALIGNMENT AND FINAL GRADES FROM SURVEYS BY WILLIAMS ENVIRONMENTAL SERVICES, INC., DIGITAL FILES DATED OCTOBER 5, 2004.

SURVEY NOTES:
1. BENCHMARK 1: NAIL IN POWER POLE #71-3183 LOCATED ALONG THE SOUTHEASTERLY RIGHT OF WAY LINE OF WATER STREET NEAR THE NORTHWEST PROPERTY CORNER, ELEVATION = 734.68 (CITY DATUM).
2. BENCHMARK 2: NAIL IN POWER POLE #71-3184 LOCATED ALONG THE SOUTHEASTERLY RIGHT OF LINE OF WATER STREET NEAR ENTRANCE, ELEVATION = 739.80 (CITY DATUM).
3. SUBJECT PROPERTY IS ZONED M-2 & PD/C2: GENERAL INDUSTRIAL DISTRICT & PLANNED DEVELOPMENT OVERLAY DISTRICT/GENERAL COMMERCIAL DISTRICT.
4. CURB ELEVATIONS SHOWN ARE TOP OF CURB, SUBTRACT 0.5'± TO OBTAIN GUTTER ELEVATIONS UNLESS NOTED OTHERWISE.

NATURAL RESOURCE TECHNOLOGY

PROJECT NO. 1508/19A	LOWER TILL PIEZOMETRIC SURFACE ELEVATIONS OCTOBER 3, 2011
DRAWN BY: RLH 07/09/12	2011 CANAL DEWATERING ASSESSMENT FORMER APPLETON MANUFACTURED GAS PLANT (MGP) FACILITY WE ENERGIES CITY OF APPLETON, WISCONSIN
CHECKED BY: CAR 07/09/12	
APPROVED BY: CAR 07/12/12	DRAWING NO: 1508-19A-B01C REFERENCE: -
FIGURE NO. 2	

ATTACHMENTS

Photo Number: 1
Date of Photo: 8/10/2002
Description: Excavation operations during 2002 Interim Remedial Action
View Direction: SW toward Site

Photo Number: 2
Date of Photo: 8/21/2003
Description: Excavation operations during 2003 Fox River Canal Excavation
View Direction: S across Fox River Canal

Photo Number: 3
Date of Photo: 10/23/2003
Description: Restoration of Fox River Canal; near completion of stone placement along canal bottom
View Direction: SW along Site riverbank

Photo Number: 4
Date of Photo: 10/2011
Description: Repair activities at Neenah Paper Hydroelectric units
View Direction: E from Site across Fox river Canal

Photo Number: 5
Date of Photo: 10/2011
Description: Temporary dam installed by Neenah Paper
View Direction: SE from Site across Fox River Canal

Photo Number: 6
Date of Photo: 10/11/2011
Description: Riverbank inspection adjacent to former Appleton MGP site
View Direction: SW along riverbank

Photo Number: 7
Date of Photo: 10/11/2011
Description: Dewatered canal inspection adjacent to former Appleton MGP site
View Direction: W towards Site

Photo Number: 8
Date of Photo: 10/11/2011
Description: Dewatered canal inspection adjacent to former Appleton MGP site. Sheen observed when canal bottom disturbed.
View Direction: Down toward canal bottom

Photo Number: 9
Date of Photo: 10/20/2011
Description: Poling/disturbing canal bottom. Sheen observed when canal bottom disturbed.
View Direction: Down toward canal bottom

Photo Number: 10
Date of Photo: 10/20/2011
Description: Poling/disturbing canal bottom.
View Direction: SE from Site

Photo Number: 11
Date of Photo: 10/20/2011
Description: Poling/disturbing canal bottom. Red arrows indicate free phase droplets.
View Direction: Down toward canal bottom

Photo Number: 12
Date of Photo: 10/20/2011
Description: Evidence of upper weathered bedrock (“lower till”) at bottom of Fox River Canal. Green line outlines flat plane of upper weathered bedrock. Additional planes of upper weathered bedrock can be observed in photo.
View Direction: Down and S toward canal bottom

ATTACHMENT B

Crystal Ball Report - Full
Simulation started on 11/18/2014 at 12:14 PM
Simulation stopped on 11/18/2014 at 12:14 PM

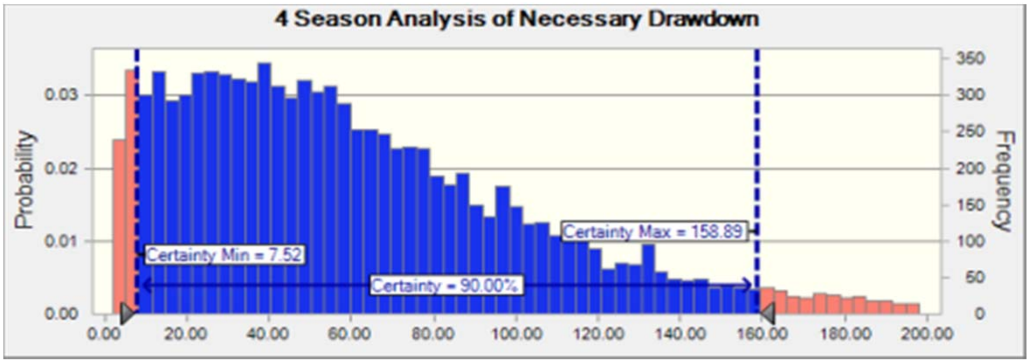
Run preferences:	
Number of trials run	10,000
Monte Carlo	
Random seed	
Precision control on	
Confidence level	95.00%
Run statistics:	
Total running time (sec)	7.51
Trials/second (average)	1,331
Random numbers per sec	5,324
Crystal Ball data:	
Assumptions	4
Correlations	0
Correlated groups	0
Decision variables	0
Forecasts	5

Forecasts

Worksheet: [NAPL mobility calculation CB analysis.xlsx]DNAPL Mbility Calculation

Forecast: 4 Season Analysis of Necessary Drawdown **Cell: H40**

Summary:
Certainty level is 90.00%
Certainty range is from 7.52 to 158.89
Entire range is from 1.86 to 353.66
Base case is 2.29
After 10,000 trials, the std. error of the mean is 0.48



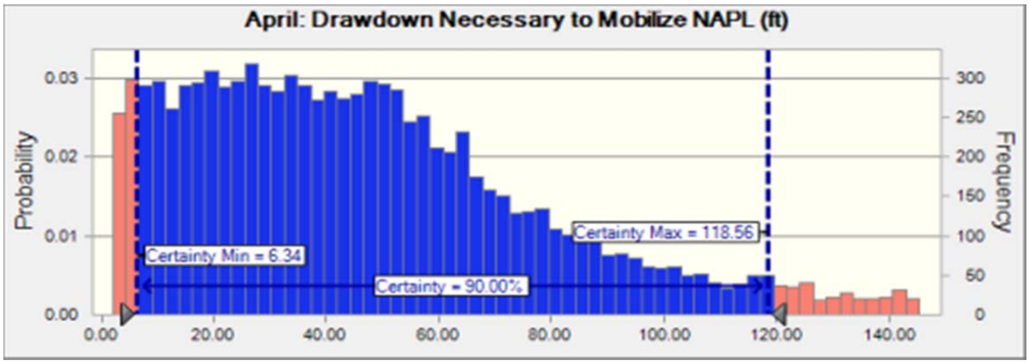
Statistics:	Forecast values
Trials	10,000
Base Case	2.29
Mean	63.66
Median	53.21
Mode	---
Standard Deviation	48.07
Variance	2310.59
Skewness	1.35
Kurtosis	5.29
Coeff. of Variability	0.7551
Minimum	1.86
Maximum	353.66
Range Width	351.80
Mean Std. Error	0.48

Forecast: 4 Season Analysis of Necessary Drawdown (cont'd) **Cell: H40**

Percentiles:	Forecast values
0%	1.86
10%	12.71
20%	23.26
30%	32.90
40%	42.77
50%	53.21
60%	64.68
70%	78.41
80%	96.93
90%	127.07
100%	353.66

Forecast: April: Drawdown Necessary to Mobilize NAPL (ft) **Cell: J40**

Summary:
Certainty level is 90.00%
Certainty range is from 6.34 to 118.56
Entire range is from 2.04 to 233.79
Base case is 2.70
After 10,000 trials, the std. error of the mean is 0.35



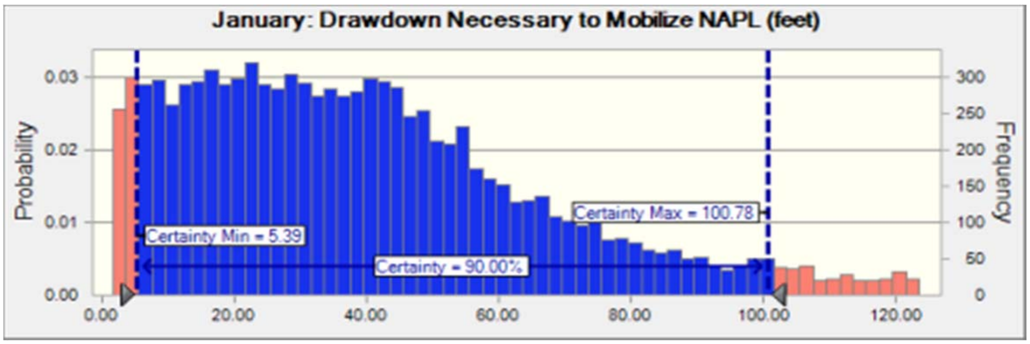
Statistics:	Forecast values
Trials	10,000
Base Case	2.70
Mean	48.73
Median	42.57
Mode	---
Standard Deviation	34.56
Variance	1194.47
Skewness	1.15
Kurtosis	4.43
Coeff. of Variability	0.7092
Minimum	2.04
Maximum	233.79
Range Width	231.74
Mean Std. Error	0.35

Forecast: April: Drawdown Necessary to Mobilize NAPL (ft) (cont'd) **Cell: J40**

Percentiles:	Forecast values
0%	2.04
10%	10.38
20%	18.67
30%	26.40
40%	34.24
50%	42.57
60%	50.92
70%	59.88
80%	72.74
90%	95.10
100%	233.79

Forecast: January: Drawdown Necessary to Mobilize NAPL (feet) **Cell: I40**

Summary:
Certainty level is 90.00%
Certainty range is from 5.39 to 100.78
Entire range is from 1.74 to 198.73
Base case is 2.29
After 10,000 trials, the std. error of the mean is 0.29



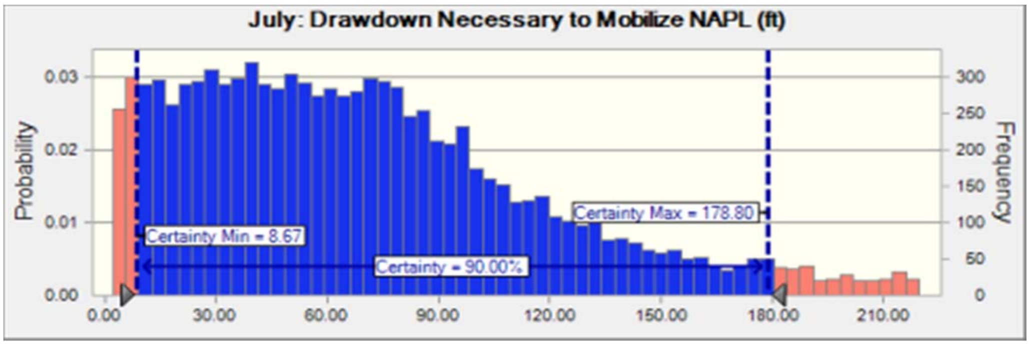
Statistics:	Forecast values
Trials	10,000
Base Case	2.29
Mean	41.42
Median	36.18
Mode	---
Standard Deviation	29.38
Variance	863.06
Skewness	1.15
Kurtosis	4.43
Coeff. of Variability	0.7093
Minimum	1.74
Maximum	198.73
Range Width	196.99
Mean Std. Error	0.29

Forecast: January: Drawdown Necessary to Mobilize NAPL (feet) (cont'd) **Cell: I40**

Percentiles:	Forecast values
0%	1.74
10%	8.82
20%	15.87
30%	22.44
40%	29.11
50%	36.18
60%	43.29
70%	50.90
80%	61.83
90%	80.84
100%	198.73

Forecast: July: Drawdown Necessary to Mobilize NAPL (ft) **Cell: K40**

Summary:
Certainty level is 90.00%
Certainty range is from 8.67 to 178.80
Entire range is from 2.17 to 353.48
Base case is 3.16
After 10,000 trials, the std. error of the mean is 0.52



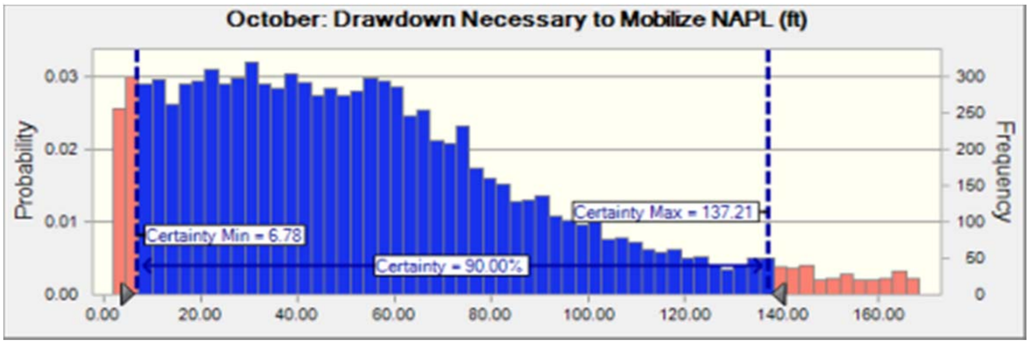
Statistics:	Forecast values
Trials	10,000
Base Case	3.16
Mean	72.94
Median	63.60
Mode	---
Standard Deviation	52.39
Variance	2745.07
Skewness	1.15
Kurtosis	4.43
Coeff. of Variability	0.7183
Minimum	2.17
Maximum	353.48
Range Width	351.32
Mean Std. Error	0.52

Forecast: July: Drawdown Necessary to Mobilize NAPL (ft) (cont'd) **Cell: K40**

Percentiles:	Forecast values
0%	2.17
10%	14.80
20%	27.37
30%	39.09
40%	50.98
50%	63.60
60%	76.27
70%	89.85
80%	109.34
90%	143.24
100%	353.48

Forecast: October: Drawdown Necessary to Mobilize NAPL (ft) **Cell: L40**

Summary:
Certainty level is 90.00%
Certainty range is from 6.78 to 137.21
Entire range is from 1.79 to 271.12
Base case is 2.55
After 10,000 trials, the std. error of the mean is 0.40



Statistics:	Forecast values
Trials	10,000
Base Case	2.55
Mean	56.05
Median	48.89
Mode	---
Standard Deviation	40.17
Variance	1613.39
Skewness	1.15
Kurtosis	4.43
Coeff. of Variability	0.7166
Minimum	1.79
Maximum	271.12
Range Width	269.33
Mean Std. Error	0.40

Forecast: October: Drawdown Necessary to Mobilize NAPL (ft) (cont'd) **Cell: L40**

Percentiles:	Forecast values
0%	1.79
10%	11.48
20%	21.12
30%	30.10
40%	39.22
50%	48.89
60%	58.60
70%	69.01
80%	83.96
90%	109.95
100%	271.12

End of Forecasts

Assumptions

Worksheet: [NAPL mobility calculation CB analysis.xlsx]DNAPL Mbility Calculation

Assumption: Capillarry Number **Cell: H23**

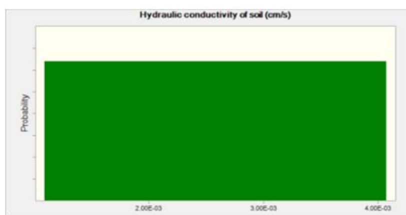
Uniform distribution with parameters:

Minimum	2.0E-05	(=H10)
Maximum	1.3E-03	(=H11)

Assumption: Hydraulic conductivity of soil (cm/s) **Cell: H25**

Uniform distribution with parameters:

Minimum	1.09E-03	(=W30)
Maximum	4.07E-03	(=W31)

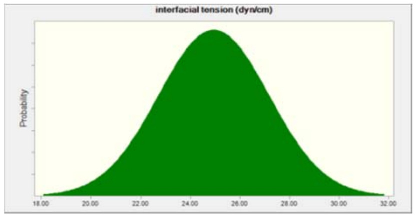


Assumption: interfacial tension (dyn/cm) **Cell: H24**

Normal distribution with parameters:

Mean	24.95	(=V39)
Std. Dev.	2.22	(=V40)

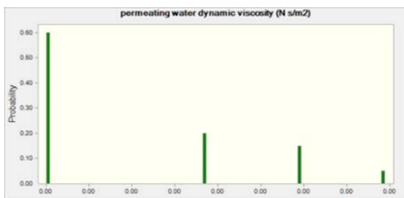
Assumption: interfacial tension (dyn/cm) (cont'd) **Cell: H24**



Assumption: permeating water dynamic viscosity (N s/m2) **Cell: H26**

Custom distribution with parameters:

Value	Probability
0.00	0.60
0.00	0.20
0.00	0.15
0.00	0.05



End of Assumptions