

<p align="center">Table N-3 (Continued) Input Values for Industrial/Commercial Calculations Remediation Objectives for Carcinogenic PAHs Revised Site Investigation/Remediation Objectives Report/Remedial Action Plan Mendota MGP - Black Brothers Company Site</p>				
Symbol	Parameter	Units	Equation/Reference	Input Value ⁽¹⁾
Soil Outdoor Inhalation Exposure Parameters				
AT_c	Averaging time for carcinogens	year	TACO Appendix C, Table B	70
AT_{nc}	Averaging time for noncarcinogens	year	TACO Appendix C, Table B	25
ED	Exposure duration	year	TACO Appendix C, Table B	25
EF	Exposure frequency	day/year	TACO Appendix C, Table B	250
PEF	Particulate emission factor	m ³ /kg	TACO Appendix C, Table B	1.24×10^9
RIC	Reference concentration	mg/m ³	TACO Website ⁽²⁾	Chemical-Specific
THQ	Target hazard quotient	unitless	TACO Appendix C, Table B	1
TR	Target risk	unitless	TACO Appendix C, Table B	1×10^{-6}
URF	Unit risk factor	($\mu\text{g}/\text{m}^3$) ⁻¹	TACO Website ⁽²⁾	Chemical-Specific
Soil Outdoor Inhalation Remediation Objectives Equations⁽¹⁾				
$RO_{\text{inhalation}}^{\text{carc}}$ (Fugitive Dust) Residential and Industrial/Commercial	Soil outdoor inhalation remediation objective for carcinogenic chemicals	mg/kg	$TR \cdot AT_c \cdot 365 \frac{d}{yr}$ $URF \cdot 1,000 \frac{\mu\text{g}}{\text{mg}} \cdot EF \cdot ED \cdot \frac{1}{PEF}$	
Equation S13 $RO_{\text{inhalation}}^{\text{nc}}$ (Fugitive Dust) Residential and Industrial/Commercial	Soil outdoor inhalation remediation objective for noncarcinogenic chemicals	mg/kg	$THQ \cdot AT \cdot 365 \frac{d}{yr}$ $EF \cdot ED \cdot \left(\frac{1}{RIC} \cdot \frac{1}{PEF} \right)$	

Notes:

- 1) Numerical values are TACO, Appendix C, Table B default values.
- 2) Illinois EPA TACO website "Toxicity Values for Tier 2 and 3 Calculations" (see references).
- 3) Equations are from TACO, Appendix C, Table A.
- 4) carc - carcinogenic chemicals
- 5) nc - noncarcinogenic chemicals
- 6) Noncarcinogenic equation used for benzo(a)pyrene, the only carcinogenic PAH with noncarcinogenic toxicity in Illinois EPA toxicity tables.

<p align="center"> Table N-4 Input Values for Construction Worker Calculations Remediation Objectives for Carcinogenic PAHs Revised Site Investigation/Remediation Objectives Report/Remedial Action Plan Mendota MGP - Black Brothers Company Site </p>				
Symbol	Parameter	Units	Equation/Reference	Input Value ⁽¹⁾
Soil Ingestion Exposure Parameters				
AT _c	Averaging time for carcinogens	year	TACO Appendix C, Table B	70
AT _{nc}	Averaging time for noncarcinogens	year	TACO Appendix C, Table B	0.115
BW _c	Body weight for carcinogens	kg	TACO Appendix C, Table B	70
BW _{nc}	Body weight for noncarcinogens	kg	TACO Appendix C, Table B	70
ED	Exposure duration	year	TACO Appendix C, Table B	1
EF	Exposure frequency	day/year	TACO Appendix C, Table B	30
IR _{soil}	Ingestion rate	mg/day	TACO Appendix C, Table B	480
RD _{o-sc}	Reference dose (subchronic)	mg/kg-day	TACO Website ⁽²⁾	Chemical-Specific
SF _o	Oral slope factor	(mg/kg-day) ⁻¹	TACO Website ⁽²⁾	Chemical-Specific
THQ	Target hazard quotient	unitless	TACO Appendix C, Table B	1
TR	Target risk	unitless	TACO Appendix C, Table B	1 x 10 ⁻⁶
Soil Ingestion Remediation Objectives Equations⁽³⁾				
RO _{ingestion} ^{carc} Equation S3	Soil ingestion remediation objective for carcinogenic chemicals	mg/kg	$\frac{TR \cdot BW \cdot AT_c \cdot 365 \frac{d}{yr}}{SF_o \cdot 10^{-6} \frac{kg}{mg} \cdot EF \cdot ED \cdot IR_{soil}}$	
RO _{ingestion} ^{nc} Equation S1	Soil ingestion remediation objective for noncarcinogenic chemicals	mg/kg	$\frac{THQ \cdot BW \cdot AT \cdot 365 \frac{d}{yr}}{\frac{1}{RfDo} \cdot 10^{-6} \frac{kg}{mg} \cdot EF \cdot ED \cdot IR_{soil}}$	

Notes:

- 1) Numerical values are TACO, Appendix C, Table B default values.
- 2) Illinois EPA TACO website "Toxicity Values for Tier 2 and 3 Calculations" (see references).
- 3) Equations are from TACO, Appendix C, Table A.
- 4) carc - carcinogenic chemicals
- 5) nc - noncarcinogenic chemicals
- 6) Noncarcinogenic equation used for benzo(a)pyrene, the only carcinogenic PAH with noncarcinogenic toxicity in Illinois EPA toxicity tables.

Table N-4 (Continued) Input Values for Construction Worker Calculations Remediation Objectives for Carcinogenic PAHs Revised Site Investigation/Remediation Objectives Report/Remedial Action Plan Mendota MGP - Black Brothers Company Site			
Symbol	Parameter	Units	Equation/Reference
Soil Outdoor Inhalation Exposure Parameters			
AT _c	Averaging time for carcinogens	year	TACO Appendix C, Table B
AT _{nc}	Averaging time for noncarcinogens	year	TACO Appendix C, Table B
ED	Exposure duration	year	TACO Appendix C, Table B
EF	Exposure frequency	day/year	TACO Appendix C, Table B
PEF ¹	Particulate emission factor adjusted for agitation for construction worker	m ³ /kg	TACO Appendix C, Table B
RfC _{sc}	Reference concentration (subchronic)	mg/m ³	TACO Website ⁽²⁾
THQ	Target hazard quotient	unitless	TACO Appendix C, Table B
TR	Target risk	unitless	TACO Appendix C, Table B
URF	Unit risk factor	(μg/m ³) ⁻¹	TACO Website ⁽²⁾
Soil Outdoor Inhalation Remediation Objectives Equations⁽³⁾			
RO _{Inhalation} ^{carc} (Fugitive Dust) Construction Worker Equation S12	Soil outdoor inhalation remediation objective for carcinogenic chemicals	mg/kg	$TR \cdot AT_c \cdot 365 \frac{d}{yr}$ $URF \cdot 1,000 \frac{\mu g}{mg} \cdot EF \cdot ED \cdot \frac{1}{PEF}$
RO _{Inhalation} ^{nc} (Fugitive Dust) Construction Worker Equation S14	Soil outdoor inhalation remediation objective for noncarcinogenic chemicals	mg/kg	$THQ \cdot AT \cdot 365 \frac{d}{yr}$ $EF \cdot ED \cdot \left(\frac{1}{RfC} \cdot \frac{1}{PEF} \right)$

Notes:

- 1) Numerical values are TACO, Appendix C, Table B default values.
- 2) Illinois EPA TACO website "Toxicity Values for Tier 2 and 3 Calculations" (see references).
- 3) Equations are from TACO, Appendix C, Table A.
- 4) carc - carcinogenic chemicals
- 5) nc - noncarcinogenic chemicals
- 6) Noncarcinogenic equation used for benzo(a)pyrene, the only carcinogenic PAH with noncarcinogenic toxicity in Illinois EPA toxicity tables.

<p align="center">Table N-5 Input Values for Soil Component of Class I Groundwater Ingestion Calculations Remediation Objectives for Carcinogenic PAHs Revised Site Investigation/Remediation Objectives Report/Remedial Action Plan Mendota MGP - Black Brothers Company Site</p>			
Symbol	Parameter	Units	Equation/Reference
Soil Component of the Groundwater Ingestion Exposure Parameters			
C_w	Target soil leachate concentration	mg/L	TACO Appendix C, Table A
H'	Henry's Law constant	unitless	TACO Appendix C, Table E
K_d	Soil-water partition coefficient	cm^3/g or L/kg	TACO Appendix C, Table A
θ_a subsurface	Air-filled soil porosity	$L_{\text{air}}/L_{\text{soil}}$	TACO Appendix C, Table B
θ_w subsurface	Water-filled soil porosity	$L_{\text{water}}/L_{\text{soil}}$	TACO Appendix C, Table B
ρ_b	Dry soil bulk density	kg/L or g/cm^3	TACO Appendix C, Table B
Soil Component of Groundwater Ingestion Remediation Objectives Equation⁽²⁾			
$RO_{\text{sc-gw}}$ Equation S17	Soil component of groundwater ingestion remediation objective	mg/kg	$C_w \cdot \left[K_d + \frac{(\theta_w + \theta_a \cdot H')}{\rho_b} \right]$
Variables for Calculated Soil Component of Groundwater Ingestion Remediation Objectives Parameters			
DF	Dilution factor	unitless	TACO Appendix C, Table B
f_{oc} subsurface	Organic carbon content	g/g	20
GW_{obj}	Groundwater remediation objective	mg/L	TACO Appendix C, Table B
K_{oc}	Organic carbon partition coefficient	cm^3/g or L/kg	0.002
			Calculated value
			Chemical-Specific
			Chemical-Specific
Equations for Calculated Soil Component of Groundwater Ingestion Remediation Objectives Parameters⁽²⁾			
C_w Equation S18	Target soil leachate concentration	mg/L	$C_w = DF \cdot GW_{\text{obj}}$
K_d Equation S19	Soil-water partition coefficient	(m^3/kg)	$K_d = K_{oc} \cdot f_{oc}$

Notes:

- 1) Numerical values are TACO, Appendix C, Table B default values.
- 2) Equations are from TACO, Appendix C, Table A.
- 3) See table N-14 for calculated groundwater remediation objectives.

<p align="center"> Table N-6 Input Values for Class I Groundwater Ingestion Calculations Remediation Objectives for Carcinogenic PAHs Revised Site Investigation/Remediation Objectives Report/Remedial Action Plan Mendota MGP - Black Brothers Company Site </p>				
Symbol	Parameter	Units	Equation/Reference	Input Value ⁽¹⁾
Groundwater Ingestion Exposure Parameters				
AT _c	Averaging time for carcinogens	year	TACO Appendix C, Table D	70
AT _{nc}	Averaging time for noncarcinogens	year	TACO Appendix C, Table D	30
BW	Adult body weight	kg	TACO Appendix C, Table D	70
ED	Exposure duration	year	TACO Appendix C, Table D	30
EF	Exposure frequency	day/year	TACO Appendix C, Table D	350
IR _{water}	Ingestion rate	L/day	TACO Appendix C, Table D	2
RfD _o	Reference dose	mg/kg-day	TACO Website ⁽²⁾	Chemical-Specific
SF _o	Oral slope factor	(mg/kg-day) ⁻¹	TACO Website ⁽²⁾	Chemical-Specific
THQ	Target hazard quotient	unitless	TACO Appendix C, Table B	1
TR	Target risk	unitless	TACO Appendix C, Table D	1 x 10 ⁻⁶
Groundwater Ingestion Remediation Objectives Equations⁽³⁾				
Class I RO _{ingestion} ^{carc} Equation S23	Groundwater ingestion remediation objective for carcinogenic chemicals	mg/L	$\frac{TR \cdot BW \cdot AT_c \cdot 365 \frac{d}{yr}}{SF_o \cdot IR_w \cdot EF \cdot ED}$	
Class I RO _{ingestion} ^{nc} Equation S1 (adapted for groundwater)	Groundwater ingestion remediation objective for noncarcinogenic chemicals	mg/L	$\frac{THQ \cdot BW \cdot AT \cdot 365 \frac{d}{yr}}{RfD_o \cdot EF \cdot ED \cdot IR_{water}}$	

Notes:

- 1) Numerical values are TACO, Appendix C, Table D default values, residential.
- 2) Illinois EPA TACO website "Toxicity Values for Tier 2 and 3 Calculations" (see references).
- 3) Equations are from TACO, Appendix C, Table C; noncarcinogenic ingestion RO adapted from Equation S1.
- 4) carc - carcinogenic chemicals
- 5) nc - noncarcinogenic chemicals
- 6) Noncarcinogenic equation used for benzo(a)pyrene, the only carcinogenic PAH with noncarcinogenic toxicity in Illinois EPA toxicity tables.

<p align="center">Table N-7 Calculation of Residential Soil Ingestion Remediation Objectives for Carcinogenic PAHs Revised Site Investigation/Remediation Objectives Report/Remedial Action Plan Mendota MGP - Black Brothers Company Site</p>					
Compound/Analyte	Chemical-Specific Input Parameters		Calculation of Soil Ingestion Remediation Objectives		
	SF ₆ (mg/kg-day) ¹	RfD _o (mg/kg-day)	RO _{ingestion} ^{carc} (mg/kg)	RO _{ingestion} ^{nc} (mg/kg)	Selected RO _{ingestion} [*] (mg/kg)
Benzo(a)anthracene	0.10	NA	6.4	NC	6.4
Benzo(b)fluoranthene	0.10	NA	6.4	NC	6.4
Benzo(k)fluoranthene	0.01	NA	64	NC	64
Benzo(a)pyrene	1.00	0.0003	0.64	23	0.64
Chrysene	0.00	NA	640	NC	640
Dibenzo(a,h)anthracene	1.00	NA	0.64	NC	0.64
Indeno(1,2,3-c,d)pyrene	0.10	NA	6.4	NC	6.4

Notes:

- 1) RO - remediation objective
- 2) See Table N-2 for chemical-specific parameter sources and RO equations.
- 3) * - If carcinogenic and non-carcinogenic ROs were calculated for a chemical, the lower of the two ROs was selected to evaluate the exposure route.
- 4) NA - Toxicity information is not available.
- 5) NC - Not calculated because toxicity information is not available.

<p align="center">Table N-8 Calculation of Residential Soil Outdoor Inhalation Remediation Objectives for Carcinogenic PAHs Revised Site Investigation/Remediation Objectives Report/Remedial Action Plan Mendota MGP - Black Brothers Company Site</p>						
Compound/Analyte	Chemical-Specific Input Parameters		Calculation of Soil Outdoor Inhalation Remediation Objectives			
	URF ($\mu\text{g}/\text{m}^3 \cdot \text{h}^{-1}$)	RIC (mg/m^3)	RO _{Inhalation} ^{carc} (mg/kg)	RO _{Inhalation} ^{nc} (mg/kg)	Selected RO _{Inhalation} [*] (mg/kg)	
Benzo(a)anthracene	6.0E-05	NA	5.4E+04	NC	54,000	
Benzo(b)fluoranthene	6.0E-05	NA	5.4E+04	NC	54,000	
Benzo(k)fluoranthene	6.0E-06	NA	5.4E+05	NC	540,000	
Benzo(a)pyrene	6.0E-04	2E-06	5.4E+03	2.8E+03	2,800	
Chrysene	6.0E-07	NA	5.4E+06	NC	1,000,000	
Dibenzo(a,h)anthracene	6.0E-04	NA	5.4E+03	NC	5,400	
Indeno(1,2,3-c,d)pyrene	6.0E-05	NA	5.4E+04	NC	54,000	

Notes:

- 1) RO - remediation objective
- 2) See Table N-2 for chemical-specific parameter sources and RO equations.
- 3) * - If carcinogenic and non-carcinogenic ROs were calculated for a chemical, the lower of the two ROs was selected to evaluate the exposure route, unless selected RO was greater than 1,000,000, in which case 1,000,000 mg/kg is RO.
(RO cannot be greater than 1,000,000 mg/kg because 1,000,000 mg equals 1 kg.)
- 4) NA - Toxicity information is not available.
- 5) NC - Not calculated because toxicity information is not available.

Table N-9 Calculation of Industrial/Commercial Soil Ingestion Remediation Objectives for Carcinogenic PAHs Revised Site Investigation/Remediation Objectives Report/Remedial Action Plan Mendota MGP - Black Brothers Company Site						
Compound/Analyte	Chemical-Specific Input Parameters Ingestion		Calculation of Soil Ingestion Remediation Objectives			
	SF _o (mg/kg-day) ¹	RfD _o (mg/kg-day)	RO _{Ingestion} ^{canc} (mg/kg)	RO _{Ingestion} ^{nc} (mg/kg)	Selected RO _{Ingestion} [*] (mg/kg)	
Semivolatile Organic Compounds (SVOCs)						
Benzo(a)anthracene	1.0E-01	NA	5.7E+01	NC	57	
Benzo(b)fluoranthene	1.0E-01	NA	5.7E+01	NC	57	
Benzo(k)fluoranthene	1.0E-02	NA	5.7E+02	NC	570	
Benzo(a)pyrene	1.0E+00	3E-04	5.7E+00	610	5.7	
Chrysene	1.0E-03	NA	5.7E+03	NC	5,700	
Dibenzo(a,h)anthracene	1.0E+00	NA	5.7E+00	NC	5.7	
Indeno(1,2,3-c,d)pyrene	1.0E-01	NA	5.7E+01	NC	57	

Notes:

- 1) RO - remediation objective
- 2) See Table N-3 for chemical-specific parameter sources and RO equations.
- 3) * - If carcinogenic and non-carcinogenic ROs were calculated for a chemical, the lower of the two ROs was selected to evaluate the exposure route.
- 4) NA - Toxicity information is not available.
- 5) NC - Not calculated because toxicity information is not available.

Table N-10 Calculation of Industrial/Commercial Soil Outdoor Inhalation Remediation Objectives for Carcinogenic PAHs Revised Site Investigation/Remediation Objectives Report/Remedial Action Plan Mendota MGP - Black Brothers Company Site						
Compound/Analyte	Chemical-Specific Input Parameters Outdoor Inhalation		Calculation of Soil Outdoor Inhalation Remediation Objectives			
	URF ($\mu\text{g}/\text{m}^3\cdot\text{d}$)	RfC (mg/m^3)	RO _{Inhalation} ^{carc} (mg/kg)	RO _{Inhalation} ^{nc} (mg/kg)	Selected RO _{Inhalation} [*] (mg/kg)	
Volatile Organic Compounds (VOCs)						
Benzo(a)anthracene	6.0E-05	NA	8.4E+04	NC	84,000	
Benzo(b)fluoranthene	6.0E-05	NA	8.4E+04	NC	84,000	
Benzo(k)fluoranthene	6.0E-06	NA	8.4E+05	NC	840,000	
Benzo(a)pyrene	6.0E-04	2E-06	8.0E+03	3,600	3,600	
Chrysene	6.0E-07	NA	1.0E+06	NC	1,000,000	
Dibenzo(a,h)anthracene	6.0E-04	NA	8.4E+03	NC	8,400	
Indeno(1,2,3-c,d)pyrene	6.0E-05	NA	8.4E+04	NC	84,000	

Notes:

- 1) RO - remediation objective
- 2) See Table N-3 for chemical-specific parameter sources and RO equations.
- 3) * - If carcinogenic and non-carcinogenic ROs were calculated for a chemical, the lower of the two ROs was selected to evaluate the exposure route, unless selected RO was greater than 1,000,000, in which case 1,000,000 mg/kg is RO.
(RO cannot be greater than 1,000,000 mg/kg because 1,000,000 mg equals 1 kg.)
- 4) NA - Toxicity information is not available.
- 5) NC - Not calculated because toxicity information is not available.

Table N-11 Calculation of Construction Worker Soil Ingestion Remediation Objectives for Carcinogenic PAHs Revised Site Investigation/Remediation Objectives Report/Remedial Action Plan Mendota MGP - Black Brothers Company Site					
Compound/Analyte	Chemical-Specific Input Parameters Ingestion		Soil Ingestion Remediation Objectives		
	SF _o (mg/kg-day) ⁻¹	RfD _{o-sc} (mg/kg-day)	RO _{ingestion} ^{carc} (mg/kg)	RO _{ingestion} ^{nc} (mg/kg)	Selected RO _{ingestion} [*] (mg/kg)
Benzo(a)anthracene	1.0E-01	NA	1.2E+03	NC	1,200
Benzo(b)fluoranthene	1.0E-01	NA	1.2E+03	NC	1,200
Benzo(k)fluoranthene	1.0E-02	NA	1.2E+04	NC	12,000
Benzo(a)pyrene	1.0E+00	3E-04	1.2E+02	6.1E+01	61
Chrysene	1.0E-03	NA	1.2E+05	NC	120,000
Dibenzo(a,h)anthracene	1.0E+00	NA	1.2E+02	NC	120
Indeno(1,2,3-c,d)pyrene	1.0E-01	NA	1.2E+03	NC	1,200

Notes:

- 1) RO - remediation objective
- 2) See Table N-4 for chemical-specific parameter sources and RO equations.
- 3) * - If carcinogenic and non-carcinogenic ROs were calculated for a chemical, the lower of the two ROs was selected to evaluate the exposure route.
- 4) NA - Toxicity information is not available.
- 5) NC - Not calculated because toxicity information is not available.

Table N-12 Calculation of Construction Worker Soil Outdoor Inhalation Remediation Objectives for Carcinogenic PAHs Revised Site Investigation/Remediation Objectives Report/Remedial Action Plan Mendota MGP - Black Brothers Company Site					
Compound/Analyte	URF ($\mu\text{g}/\text{m}^3\cdot\text{d}$)	RfC _{sc} (mg/m^3)	Calculation of Soil Outdoor Inhalation Remediation Objectives		
			RO _{Inhalation} ^{carc} (mg/kg)	RO _{Inhalation} ^{nc} (mg/kg)	Selected RO _{Inhalation} [*] (mg/kg)
Benzo(a)anthracene	6.0E-05	NA	1.8E+06	NC	1,000,000
Benzo(b)fluoranthene	6.0E-05	NA	1.8E+06	NC	1,000,000
Benzo(k)fluoranthene	6.0E-06	NA	1.8E+07	NC	1,000,000
Benzo(a)pyrene	6.0E-04	3E-05	1.8E+05	5.2E+03	5,200
Chrysene	6.0E-07	NA	1.8E+08	NC	1,000,000
Dibenzo(a,h)anthracene	6.0E-04	NA	1.8E+05	NC	180,000
Indeno(1,2,3-c,d)pyrene	6.0E-05	NA	1.8E+06	NC	1,000,000

Notes:

- 1) RO - remediation objective
- 2) See Table N-3 for chemical-specific parameter sources and RO equations.
- 3) * - If carcinogenic and non-carcinogenic ROs were calculated for a chemical, the lower of the two ROs was selected to evaluate the exposure route, unless selected RO was greater than 1,000,000, in which case 1,000,000 mg/kg is RO.
(RO cannot be greater than 1,000,000 mg/kg because 1,000,000 mg equals 1 kg.)
- 4) NA - Toxicity information is not available.
- 5) NC - Not calculated because toxicity information is not available.

Table N-13 Calculation of Soil Component of Class I Groundwater Ingestion Remediation Objectives for Carcinogenic PAHs Revised Site Investigation/Remediation Objectives Report/Remedial Action Plan Mendota MGP - Black Brothers Company Site						
Compound/Analyte	Chemical-Specific Input Parameters			Calculated Input Parameters		Calculation of Class I Soil
	GW _{obj} (mg/L)	K _{oc} (cm ² /g)	H ¹ (unitless)	C _w (mg/L)	K _d (cm ² /g)	Soil Component of Groundwater Ingestion RO _{sc-gw} (mg/kg)
Semivolatile Organic Compounds (SVOCs)						
Benzo(a)anthracene	8.5E-04	4.00E+05	1.39E-04	1.7E-02	8.0E+02	14
Benzo(b)fluoranthene	8.5E-04	1.05E+06	4.55E-03	1.7E-02	2.1E+03	36
Benzo(k)fluoranthene	8.5E-03	1.00E+06	3.40E-05	1.7E-01	2.0E+03	340
Benzo(a)pyrene*	8.5E-05	7.90E+05	4.50E-05	1.7E-03	1.6E+03	2.7
Chrysene	8.5E-02	4.00E+05	3.90E-03	1.7E+00	8.0E+02	1,400
Dibenzo(a,h)anthracene	8.5E-05	2.50E+06	6.10E-07	1.7E-03	5.0E+03	8.5
Indeno(1,2,3-c,d)pyrene	8.5E-04	3.10E+06	6.56E-05	1.7E-02	6.2E+03	110

Notes:

- 1) RO - remediation objective
- 2) See Table N-5 for chemical-specific parameter sources.
- 3) See Table N-5 for calculated input parameter equations and RO equations.
- 4) GWobj calculated using the new SFO (see Table N-14)
- 5) * - The carcinogenic groundwater ingestion RO was more conservative than the noncarcinogenic RO for benzo(a)pyrene; therefore, it was used to calculate the the soil component of groundwater ingestion RO.

Table N-14 Calculation of Class I Groundwater Ingestion Remediation Objectives for Carcinogenic PAHs Revised Site Investigation/Remediation Objectives Report/Remedial Action Plan Mendota MGP - Black Brothers Company Site						
Compound/Analyte	Chemical Specific Input Parameters		Groundwater Ingestion ROs			
	SF ₀ (mg/kg-day) ⁻¹	RfD ₀ (mg/kg-day)	RO _{ingestion} ^{carc} (mg/L)	RO _{ingestion} ^{nc} (mg/L)	TACO ADL (mg/L)	Selected RO _{ingestion} [*] (mg/kg)
Benzo(a)anthracene	1.0E-01	NA	0.00085	NC	0.00013	0.00085
Benzo(b)fluoranthene	1.0E-01	NA	0.00085	NC	0.00018	0.00085
Benzo(k)fluoranthene	1.0E-02	NA	0.0085	NC	0.00017	0.0085
Benzo(a)pyrene	1.0E+00	3.0E-04	0.000085	0.011	0.0002	0.0002
Chrysene	1.0E-03	NA	0.085	NC	0.0015	0.085
Dibenzo(a,h)anthracene	1.0E+00	NA	0.000085	NC	0.0003	0.0003
Indeno(1,2,3-c,d)pyrene	1.0E-01	NA	0.00085	NC	0.00043	0.00085

Notes:

- 1) RO - remediation objective
- 2) See Table N-6 for chemical-specific parameter sources and RO equations.
- 3) Acceptable detection limit (ADL) values are from TACO, Appendix B, Table E.
- 4) * - If carcinogenic and non-carcinogenic ROs were calculated for the ingestion exposure route, the lower of the two ROs was selected to evaluate the exposure route. If the ADL was greater than the selected calculated RO, it was selected as the RO.

APPENDIX O
Tier 3 Elemental Mercury Evaluation
Mendota MGP - Black Brothers Company Site
Revised SI/ROR/RAP

Appendix O

Statistical Evaluation of Correlation between Total Mercury and Elemental Mercury

OBJECTIVE

The objective of this evaluation is to develop an empirical relationship between total mercury and elemental mercury concentrations.

INTRODUCTION

Mercury in environmental samples, such as soils and groundwater, is typically measured as total mercury after hot-acid digestion. For example, United States Environmental Protection Agency (USEPA) SW-846 Method 7471 is a standard method for measuring total mercury (USEPA 1986). However, mercury compounds differ greatly in their toxicity and environmental mobility. For instance, HgCl_2 is much more toxic and mobile than HgS , which is stable in ore bodies for geologic time periods. Thus, total mercury is not an accurate indicator of the toxicological and environmental hazards associated with mercury-impacted sites. Furthermore, under Illinois EPA's Tiered Approach to Corrective Action Objectives (TACO) (35 Illinois Administrative Code [IAC] Part 742, 2013), the remediation objective for the construction worker inhalation pathway for mercury refers to the detected elemental mercury concentration rather than total mercury. Using the total mercury concentration instead of elemental mercury to assess the risk of the construction worker inhalation pathway is certainly over-estimating, since not all, or even any of the detected total mercury is in the form of elemental mercury. In order to estimate the elemental mercury concentration in impacted soil, a speciation of mercury in soil by sequential extraction using USEPA SW-846 Method 3200 (USEPA 1986) can be utilized. Once elemental mercury is extracted from soil, the concentration of elemental mercury can be estimated by USEPA SW-846 Method 7471.

APPROACH

To develop the relationship between total and elemental mercury, 44 soil samples were collected during site investigation (SI) activities conducted between 2011 and 2013. Each sample was analyzed for total mercury using USEPA SW-846 Method 7471 and speciated for elemental mercury using USEPA SW-846 Method 3200 (USEPA 1986) and then analyzed using USEPA SW-846 Method 7471 (USEPA 1986). Thirty-four of the 44 soil samples resulted in detected values for both total and elemental mercury and were used in the evaluation. Analytical results of both total and elemental mercury for these 34 soil samples are presented in Table 1.

The correlation between elemental and total mercury was developed using the least squares method of linear regression analysis (Chapra and Canale 2001). In this analysis, the linear regression model assumes that the response (elemental mercury) is obtained by taking a specific linear combination of the predictors (total mercury) and adding random variation (error). The error is assumed to have a Gaussian (normal) distribution with constant variance, and is independent of the predictor values. In the least squares method, a line is fit that minimizes the sum of squared residuals. A set of n observations of the

response variable Y_i (elemental mercury) is assumed to correspond to a set of values of the predictor X_i (total mercury) according to the model $Y = f(x)$, where $Y = (Y_1, Y_2, \dots, Y_n)$ and $X = (X_1, X_2, \dots, X_n)$. The i th residual r is defined as the difference between the i th observation Y_i and i th fitted value $Y_i = f(X_i)$: or

$r_i = Y_{\text{observed}} - Y_{\text{predicted}}$. The method of least squares finds a set of fitted values that minimizes $\sum_{i=1}^n r_i^2$.

To carry out the regression analysis, a statistical program S-PLUS was used (Insightful Corporation, 2001). In the least squares analysis, the detected total mercury concentration is assigned to be an independent variable and the corresponding detected elemental mercury is treated as the dependent variable.

RESULTS

The output of the regression analysis is presented in Table 2. A value of 0.9685 for the coefficient of determination (CD ; also referred to as multiple R-Squared) indicated that there is a very close relationship between elemental and total mercury. In other words, the elemental mercury concentration is dependent upon the total mercury concentration detected in soil. Based upon the regression analysis, the empirical equation qualifying the relationship between elemental and total mercury is illustrated in the following equation:

$$C_{\text{Hg-0}} = 0.0636 C_{\text{Hg total}} + 0.0053 \quad \text{Eq-1}$$

Where:

$C_{\text{Hg-0}}$ = elemental mercury concentration in soil (milligrams per kilograms [mg/kg])

$C_{\text{Hg total}}$ = total mercury concentration in soil (mg/kg)

The equation can predict the elemental mercury concentration with 96.85% certainty based on the total mercury concentration detected in the same soil. In addition, with an F-statistic: 767.7 on 1 and 25 degrees of freedom, this ratio indicates that the elemental mercury concentration is dependent on the total mercury in soil.

The linear model provided in Equation 1 can be used to estimate elemental mercury concentration at the Site with a high level of confidence as long as the detected total mercury concentration is within the data set concentration range. Similarly, Equation 1 can be used to estimate a total mercury concentration from an elemental mercury concentration as long as the calculated total mercury concentration is within the data set concentration range. Using 0.1 mg/kg of elemental mercury (the TACO construction worker Tier 1 outdoor inhalation remediation objective for soil) as the input to Equation 1, a corresponding value of 1.48 mg/kg of total mercury was calculated. Therefore, the remediation objective for total mercury in soil was established as 1.48 mg/kg, indicating that a construction worker exposed to soil with total mercury at 1.48 mg/kg or lower will not be exposed to elemental mercury greater than 0.1 mg/kg.

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Table O-1
Analytical Result of Total and Elemental Mercury Concentrations
Revised Site Investigation/Remediation Objectives Report/ Remedial Action Plan
Mendota MGP - Black Brothers Company Site

Sample Name and Interval (feet below ground surface)	Mercury Concentration – Total (mg/kg)	Mercury Concentration – Elemental (mg/kg)
SB04 (1.1-1.7)	0.35	0.035
SB11 (2-2.9)	0.2	0.0064
SB11 (4-5)	0.19	0.013
SB18 (2-3)	0.078	0.0035
SB21 (2.2-3)	0.85	0.12
SB23 (1-1.5)	0.21	0.030
SP12 (0.5-1.5)	0.55	0.13
SP14 (2-3)	0.11	0.0038
SP16 (0.5-1.5)	0.23	0.0081
SP17 (2-3)	0.28	0.026
SP18 (0-1)	11	0.70
SP28 (1-1.9)	0.093	0.0025
SP29 (2-3)	0.26	0.012
SP30 (2-3)	0.073	0.005
SP31B (0.6-1.4)	0.23	0.0085
SP33 (2-3)	0.18	0.016
SP47 (3-4)	0.47	0.0049
SP59 (1-2)	0.13	0.025
SP60 (1.5-2.5)	0.23	0.019
SP62 (1.2-2.2)	0.22	0.028
SP64 (0.5-1.5)	0.30	0.042
SP67 (1.7-2.7)	0.20	0.019
SP68B (1.5-2.5)	0.18	0.031
SP69 (1.5-2)	0.38	0.34
SP101 (0.4-1.2)	0.042	0.0048
SP106 (0.8-1.6)	0.076	0.0072
SP107 (0-1)	0.18	0.012
SP113 (4-5)	0.071	0.015
SP115 (2-3)	0.55	0.017
SP116 (2.3-3)	0.40	0.0074
SP126 (5-6)	0.086	0.012
SP135 (1-2)	0.087	0.014
SP136 (0.5-1.5)	0.14	0.0082
SP136 (5-6)	0.10	0.0065

Table O-2 Least Squares Analysis Result Revised Site Investigation/Remediation Objectives Report/ Remedial Action Plan Mendota MGP - Black Brothers Company Site				
Coefficients	Value	Standard Error	t Value	Pr (> t)
Intercept	0.0053	0.0049	1.0711	0.2943
Slope/Total Mercury	0.0636	0.0023	27.7076	0.0000
Residual Standard Error	0.02436 on 25 degree of freedom			
Multiple R-Squared (CD)	0.9685			
F-statistic	767.7 on 1 and 25 degrees of freedom. The p-value is 0			

APPENDIX P
Tier 3 Further Evaluation of the Indoor Inhalation Exposure Route
Mendota MGP - Black Brothers Company Site
Revised SI/ROR/RAP

APPENDIX P

Calculation of Tier 3 Soil Gas and Groundwater Remediation Objectives for the Indoor Inhalation Exposure Pathway

1.0 INTRODUCTION

The Tier 1 remediation objectives (ROs) for the indoor inhalation exposure route presented in TACO, Appendix B, Tables H and I (35 IAC 742) were developed using the Johnson and Ettinger (1991) model (J&E) for subsurface vapor intrusion into buildings. This model includes analytical solutions for phase partitioning and attenuation of constituent vapor concentrations based on physical processes, including diffusion through subsurface soil and advection of soil gas into indoor air.

The TACO Tier 1 default model parameters used for calculation of soil gas and groundwater ROs assume that current or future buildings have a full concrete slab-on-grade that is a minimum of 10 centimeters thick, or have full concrete basement floor and walls. Consequently, TACO specifies that use of the Tier 1 ROs for the indoor inhalation exposure route requires the implementation of an institutional control that ensures current or future buildings on the subject property will be constructed to meet these assumed criteria. Additionally, TACO presents Tier 1 remediation objectives for “diffusion only” and “diffusion and advection” scenarios. The “diffusion only” scenario is less conservative, and requires implementation of an additional institutional control requiring any current or future building to be greater than 5 feet vertically and horizontally from contamination.

The objective of this Tier 3 evaluation is to develop ROs for soil gas and groundwater for the indoor inhalation exposure route that do not require the implementation of an institutional control. A mass flux vapor model was used to simulate conditions where the full concrete slab-on-grade or the full concrete basement floor and walls specified in Tier 1 TACO assumptions are absent. Furthermore, this Tier 3 evaluation uses the more conservative “diffusion and advection” scenario. Therefore, the resultant Tier 3 ROs developed do not require the building to be greater than 5 feet away from the contaminants, and they allow the Site to be evaluated using either soil gas or groundwater sample analytical results. As shown in Table P-1, Tier 3 ROs for residential receptors in buildings constructed with no concrete slab (i.e., earthen floor) were calculated for soil gas and for two groundwater scenarios.

2.0 MODEL SELECTION

Three mass flux transport models were outlined in a paper by Little, Daisey, and Nazaroff (1992). One of these models (hereafter referred to as the LDN Model), which describes transport from a planar source and, like the J&E Model, includes diffusion and advection transport mechanisms, was selected to calculate the Tier 3 ROs. Unlike the J&E model, which assumes there is attenuation of soil gas constituent concentrations across a building concrete slab or basement floor and walls, the LDN model

conservatively assumes that the entire flux of constituents arriving at the zone near the building is transported into the building. Therefore, the LDN Model, as described in the 1992 paper, is appropriate to evaluate the scenario where no concrete slab or no basement with concrete floor and walls are present to limit vapor transport into the building (e.g. an earthen floor). The LDN Model is also appropriate for evaluation of other building foundation construction types that may provide little resistance to vapor transport like stone foundations, partial concrete floors, or crawl spaces.

3.0 TRANSPORT MECHANISMS: DIFFUSION AND ADVECTION

As required in 35 IAC 742.935(c), this Tier 3 evaluation using the LDN Model accounts for diffusive transport from the contaminant source to areas near the building (i.e., the zone of building pressure influence), and then advective transport from the zone of advective influence into indoor air, as summarized below:

- *Diffusive transport through soils (i.e., total effective diffusion coefficient, D_T^{eff}):* The LDN Model accounts for diffusive transport using the same relationship for diffusion through soils that is used in published mass flux models and by the United States Environmental Protection Agency (USEPA) and Illinois EPA to assess diffusive transport through soils. This relationship for calculation of D_T^{eff} , is consistent with TACO Equations J&E9a and J&E11. The diffusion-related input assumptions used in the TACO Tier 1 default model have been used as input assumptions in the LDN Model.
- *Advective transport:* The LDN Model accounts for advective transport by conservatively assuming that constituents in soil gas are “swept into the building as fast as they arrive at the zone of influence” rather than by using a specific input value for the advective flow rate of soil gas into the building (Little, Daisey, and Nazaroff 1992). This assumption is equivalent to assuming a high soil gas advection rate from soil into the building (i.e., assuming an infinite value for the volumetric flow rate of soil gas into the enclosed space [Q_{soil}]).

The Tier 3 ROs are more conservative than the Tier 1 “diffusion and advection” ROs because the assumption for advective transport that all constituents in soil gas are swept into the building is more conservative than the Tier 1 assumption of an empirically established advective flow rate ($Q_{soil} = 83.33 \text{ cm}^3/\text{sec}$). The Tier 3 ROs should not be compared to the Tier 1 “diffusion only” ROs, which assume that constituents only enter the building by diffusing across the slab and no advective migration occurs at all ($Q_{soil} = 0 \text{ cm}^3/\text{sec}$).

Because the LDN Model assumes that there are no transport limitations due to the presence of a concrete slab, and instead all subsurface constituents in soil gas are swept into the building, the overall rate of movement of soil gas to indoor air is limited by the rate of diffusion in soil (i.e., diffusion-limited conditions for constituent transport).

4.0 INPUT VALUES

As shown in Table P-2, the input parameters to the LDN Model were based on TACO default physical setting input values for Tier 1 ROs for parameters that are not related to the slab; however, the following parameters are not included in the LDN Model because no slab is present:

- Area of total cracks (A_{crack});
- Slab thickness (L_{crack});
- Air-filled porosity for soil in cracks ($\theta_{a,\text{crack}}$);
- Total porosity for soil in cracks ($\theta_{T,\text{crack}}$);
- Water-filled porosity for soil in cracks ($\theta_{w,\text{crack}}$); and
- Floor-wall seam gap (w).

Additionally, as previously discussed, no value was needed for the volumetric flow rate of soil gas into the enclosed space (Q_{soil}), because the LDN Model assumes that all constituents in soil gas beneath the building floor are swept into the building. This is similar to assuming an infinite value for Q_{soil} .

Tier 3 ROs for residential receptors were calculated for soil gas and for two groundwater scenarios. For calculation of the Tier 3 soil gas ROs, the TACO default distance from ground surface to top of contamination (D_{source}) of 5 feet was used. Two sets of groundwater ROs were calculated. One set used the TACO default D_{source} value of 10 feet, and to maintain conservatism for sites with water tables less than 10 feet bgs, a second set of Tier 3 groundwater ROs was calculated using a D_{source} value of 5 feet.

As recommended by Illinois EPA, the chemical-specific physical parameters and toxicity parameters used for the calculations were the values in the USEPA *Regional Screening Levels (RSLs) – Generic Tables* (June 2017).

5.0 CALCULATED TIER 3 REMEDIATION OBJECTIVES

As listed in Table P-1, ROs were calculated for constituents that are listed on the focused list of MGP compounds and analytes that appears on the TACO Indoor Inhalation Volatile Chemicals List (35 IAC 742, Appendix A, Table J). Risk-based carcinogenic or non-carcinogenic indoor air target concentrations (or both) were calculated as appropriate based on the toxicological effects of each chemical, using the same equations and exposure scenario input values as specified in TACO for Tier 1 and Tier 2 applications. For chemicals exhibiting both carcinogenic and non-carcinogenic effects, the minimum of the carcinogenic and non-carcinogenic target concentrations was selected as the target concentration in indoor air, $RO_{\text{indoor air}}$.

Using the input parameters presented in Table P-2, the LDN Model was used to calculate the vapor intrusion attenuation factors, α , for soil gas and groundwater source scenarios. Because the attenuation factor is the ratio of the concentration in indoor air to the concentration in soil gas, the attenuation factors

were then used to calculate residential and industrial/commercial remediation objectives for soil gas as follows:

$$RO_{soil\ gas} = \frac{RO_{indoor\ air}}{\alpha}$$

The attenuation factors were used similarly to calculate groundwater remediation objectives, with the additional use of the Henry's Law equilibrium constant at the system temperature (H'_{TS}) and a unit conversion from liters (L) to cubic meters (m^3) to calculate partitioning between the groundwater phase and the soil gas phase:

$$RO_{gw} = \frac{RO_{indoor\ air}}{\alpha \times H'_{TS} \times 1000 \frac{L}{m^3}}$$

Table P-3 present the calculations for soil gas ROs. Table P-4 present the calculations for groundwater ROs using a D_{source} input value of 5 feet; these remediation objectives are applicable for sites at which the water table is equal to or greater than 5 feet but less than 10 feet bgs. Table P-5 present the calculations for groundwater remediation objectives using a D_{source} input value of 10 feet; these remediation objectives are applicable for sites at which the water table is equal to or greater than 10 feet bgs. Table P-1 summarizes the Tier 3 ROs that were calculated for soil gas and groundwater.

6.0 CONCLUSIONS

The LDN Model was used to develop Tier 3 ROs for soil gas and groundwater for the indoor inhalation exposure route for buildings without a concrete slab on grade or full concrete basement floor and walls (i.e. an earthen floor). The resultant Tier 3 ROs facilitate closure of a site without the use of institutional controls.

7.0 REFERENCES

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Files Accessed: (1) Summary Table, Excel format, (2) Chemical Specific Parameters, Excel format, and (3) User's Guide, HTML format.

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Table P-1
Summary of Residential Remediation Objectives
Tier 3 Indoor Inhalation Exposure Route

Compound/Analyte	Tier 3 Soil Gas ROs (D _{source} = 5 feet)	Tier 3 Groundwater ROs Water Table at 5 feet bgs (D _{source} = 5 feet)	Tier 3 Groundwater ROs Water Table at 10 feet bgs (D _{source} = 10 feet)
	Residential (mg/m ³)	Residential (mg/L)	Residential (mg/L)
Volatile Organic Compounds (VOCs)			
Benzene	0.23	0.10	0.103
Ethylbenzene	0.93	0.36	0.37
Styrene	960	310	310
Toluene	4,400	530	530
Xylenes, Total	100	30	30
Semivolatile Organic Compounds (SVOCs)			
2-Methylnaphthalene	410	25	25
2-Methylphenol	310	11,900	26,000
Phenol	49	5,600	14,000
Naphthalene	0.077	0.055	0.065
Mercury			
Mercury	0.67	0.060	0.060

Notes:

- 1) bgs - below ground surface; mg/m³ - milligrams per cubic meter; mg/L - milligrams per liter
- 2) ROs shown in *italics* are based on the solubility limit of the chemical because no inhalation toxicity criteria were available.

Table P-2
Input Values for Residential Calculations
Tier 3 Indoor Inhalation Exposure Route

Symbol	Parameter	Units	Residential Tier 3 Input Values	
			Equation/Reference	Input Value
Building-Related Parameters				
A_B	Surface area of enclosed space at or below grade	cm ²	$A_B = (L_B \times W_B)$ (same as TACO Equation J&E12a)	1,000 x 1
ER	Air exchange rate	exchanges per hour	TACO Appendix C, Table M	0.53
H_B	Height of building	cm	TACO Appendix C, Table M	244
L_B	Length of building	cm	TACO Appendix C, Table M	1,000
L_F	Distance from ground surface to bottom of floor	cm	TACO Appendix C, Table M	10*
Q_{bldg}	Building ventilation rate	cm ³ /s	$Q_{bldg} = \left(\frac{L_B \times W_B \times H_B \times ER}{3600 \frac{sec}{hr}} \right)$ (same as TACO Equation J&E13)	3.59 x 1
W_B	Width of building	cm	TACO Appendix C, Table M	1,000

Note:

- 1) * - Although the Tier 3 model assumes no slab is present, setting $L_F = 10$ cm is conservative (shortens the diffusion path length) and results in the appropriate value for L_T to maintain consistency with Tier 1 for non-building-related parameters (see page 2 of this table).

Table P-2 (Continued)
Input Values for Residential Calculations
Tier 3 Indoor Inhalation Exposure Route

Symbol	Parameter	Units	Residential Tier 3 Input Values	
			Equation/Reference	Input Value
Exposure Parameters				
AT _c	Averaging time for carcinogens	year	TACO Appendix C, Table M	70
AT _{nc}	Averaging time for noncarcinogens	year	TACO Appendix C, Table M	30
ED	Exposure duration	year	TACO Appendix C, Table M	30
EF	Exposure frequency	day/year	TACO Appendix C, Table M	350
RfC	Reference concentration	µg/m ³	USEPA RSL Tables ⁽¹⁾	Chemical Specific
RO _{indoor air} ^{carc}	Indoor Air Target Concentration for carcinogenic chemicals	mg/m ³	$RO_{indoor\ air} = \frac{TR \times AT_c \times 365 \frac{days}{yr}}{ED \times EF \times URF \times 1000 \frac{\mu g}{mg}}$ (same as TACO Equation J&E1)	Calculated value
RO _{indoor air} ^{nc}	Indoor Air Target Concentration for non-carcinogenic chemicals	mg/m ³	$RO_{indoor\ air} = \frac{THQ \times AT_{nc} \times 365 \frac{days}{yr} \times RfC}{ED \times EF}$ (same as TACO Equation J&E2)	Calculated value
RO _{gw-calc}	Groundwater remediation objective	mg/L	$RO_{gw} = \frac{RO_{indoor\ air}}{\alpha \times H'_{TS} \times 1000 \frac{L}{m^3}}$ (derived from TACO Equations J&E4 and J&E6)	Calculated value
RO _{sg-calc}	Soil gas remediation objective	mg/m ³	$RO_{soil\ gas} = \frac{RO_{indoor\ air}}{\alpha}$ (same as TACO Equation J&E4)	Calculated value
THQ	Target hazard quotient	unitless	TACO Appendix C, Table M	1
TR	Target risk	unitless	TACO Appendix C, Table M	1 x 10 ⁻⁶
URF	Unit risk factor	(µg/m ³) ⁻¹	USEPA RSL Tables ⁽¹⁾	Chemical Specific

Note:

(1) "USEPA RSL Tables" refers to *Regional Screening Level (RSL) Chemical-specific Parameters Supporting Table June 2017* and *Regional Screening Level Summary Table June 2017* published by USEPA, <https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-june-2017>

Table P-2 (Continued)
Input Values for Residential Calculations
Tier 3 Indoor Inhalation Exposure Route

Symbol	Parameter	Units	Residential Tier 3	
			Equation/Reference	Input Value
Attenuation and Partitioning Parameters				
D_i	Diffusivity in air	cm ² /s	USEPA RSL Tables ⁽¹⁾	Chemical Specific
D_{soil}^{eff}	Effective diffusion coefficient for the soil layer	cm ² /s	$D_i^{eff} = D_i \left(\frac{\theta_{a,i}^{3.33}}{\theta_{T,i}^2} \right) + \left(\frac{D_w}{H'_{TS}} \right) \left(\frac{\theta_{w,i}^{3.33}}{\theta_{T,i}^2} \right)$ (same as TACO Equation J&E11)	Calculated Value
D_{capp}^{eff}	Effective diffusion coefficient for the capillary fringe	cm ² /s	$D_i^{eff} = D_i \left(\frac{\theta_{a,i}^{3.33}}{\theta_{T,i}^2} \right) + \left(\frac{D_w}{H'_{TS}} \right) \left(\frac{\theta_{w,i}^{3.33}}{\theta_{T,i}^2} \right)$ (same as TACO Equation J&E11)	Calculated Value
D_{source}	Distance from ground surface to top of contamination	cm	Site Specific Value	Soil Gas Model Groundwater Model Groundwater Model
D_T^{eff}	Total overall effective diffusion coefficient	cm ² /s	$D_T^{eff} = \frac{L_r}{\sum_{i=1}^n L_i / D_i^{eff}}$ (same as TACO Equation J&E9a)	Calculated Value
D_w	Diffusivity in water	cm ² /s	USEPA RSL Tables ⁽¹⁾	Chemical Specific
H'_{TS}	Dimensionless Henry's law constant at 13°C	unitless	TACO Appendix C Table E	Chemical Specific

Note:

(1) "USEPA RSL Tables" refers to *Regional Screening Level (RSL) Chemical-specific Parameters Supporting Table June 2017* and *Regional Screening Level Summary Table June 2017* published by USEPA, <https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-june-2017>

Table P-2 (Continued)
Input Values for Residential Calculations
Tier 3 Indoor Inhalation Exposure Route

Symbol	Parameter	Units	Residential Tier 3	
			Equation/Reference	Input Value
Attenuation and Partitioning Parameters (Continued)				
L _{capp}	Thickness of capillary fringe	cm	TACO Appendix C, Table M	Soil Gas Model Groundwater Model
L _{soil}	Thickness of vadose zone soil	cm	$L_{soil} + L_{capp} = L_T$ therefore $L_{soil} = L_T - L_{capp}$ (based on TACO Equation J&E9b: $\sum_{i=1}^n L_i = L_T$)	Soil Gas Model Groundwater Model Groundwater Model
L _T	Distance from bottom of floor to top of contamination	cm	$L_T = D_{source} - L_F$ (same as TACO Equation J&E10)	Soil Gas Model Groundwater Model Groundwater Model
n	Total number of layers of different types of soil vapors migrate through from source to building	unitless	TACO Appendix C, Table M	Soil Gas Model Groundwater Model (vadose zone and capillary fringe)
S	Solubility in water	mg/L	USEPA RSL Tables ⁽¹⁾	Chemical Specific
α	Attenuation factor	unitless	$\alpha = \frac{A_{bldg} \times D_T^{eff}}{Q_{bldg} \times L_T}$ Little, Daisey, and Nazaroff (1992): equation 5, steady state form	Calculated Value
θ _{a,soil}	Air-filled soil porosity	cm ³ /cm ³	TACO Appendix C, Table M	0.28
θ _{a,capp}	Air-filled porosity of capillary fringe	cm ³ /cm ³	TACO Appendix C, Table M (Capillary Fringe = 0.1 x θ _{T,i})	0.043
θ _{T,i}	Total porosity of soil layer i	cm ³ /cm ³	TACO Appendix C, Table M	0.43
θ _{w,soil}	Water-filled soil porosity	cm ³ /cm ³	TACO Appendix C, Table M	0.15
θ _{w,capp}	Water-filled porosity of capillary fringe	cm ³ /cm ³	TACO Appendix C, Table M (Capillary Fringe = 0.9 x θ _{T,i})	0.387

Note:

(1) "USEPA RSL Tables" refers to *Regional Screening Level (RSL) Chemical-specific Parameters Supporting Table June 2017* and *Regional Screening Level Summary Table June 2017* published by USEPA, <https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-june-2017>

Table P-2 (Continued)
Input Values for Residential Calculations
Tier 3 Indoor Inhalation Exposure Route

Symbol	Parameter	Units	Residential Tier 3	
			Equation/Reference	Input Value
Vapor Saturation Parameters				
C_v^{sat}	Vapor saturation limit	mg/m ³	$C_v^{sat} = \frac{P \times MW}{R \times T} \times 10^6$ (same as TACO Equation J&E5)	Calculated
VP	Vapor pressure	atm	USEPA RSL Tables ⁽¹⁾ (with unit conversion from mm Hg to atm)	Chemical Sp
MW	Molecular Weight	g/mol	USEPA RSL Tables ⁽¹⁾	Chemical Sp
R	Ideal gas constant	L-atm/K-mol	TACO Appendix C, Table M	0.0820
T	Temperature	K	USEPA RSL Tables ⁽¹⁾	298

Note:

(1) "USEPA RSL Tables" refers to *Regional Screening Level (RSL) Chemical-specific Parameters Supporting Table June 2017* and *Regional Screening Level Summary Table June 2017* published by USEPA, <https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-june-2017>

Compound/Analyte	Chemical-Specific Parameters							
	D _i (cm ² /sec)	D _w (cm ² /sec)	H' _{TS} (unitless)	MW (g/mole)	VP (mm Hg)	URF (µg/m ³)	RfC (mg/m ³)	
Volatile Organics								
Benzene	9.0E-02	1.0E-05	1.34E-01	7.8E+01	9.5E+01	7.8E-06	3.0E-02	
Ethylbenzene	6.8E-02	8.5E-06	1.64E-01	1.1E+02	9.6E+00	2.5E-06	1.0E+00	
Styrene	7.1E-02	8.8E-06	5.48E-03	1.0E+02	6.4E+00	NA	1.0E+00	
Toluene	7.8E-02	9.2E-06	1.49E-01	9.2E+01	2.8E+01	NA	5.0E+00	
Xylenes, Total	6.9E-02	8.5E-06	2.71E-01	1.1E+02	8.0E+00	NA	1.0E-01	
Semivolatile Organics								
2-Methylnaphthalene	5.2E-02	7.8E-06	6.95E-03	1.4E+02	5.5E-02	NA	NA	
2-Methylphenol	7.3E-02	9.3E-06	2.00E-05	1.1E+02	3.0E-01	NA	6.0E-01	
Phenol	8.3E-02	1.0E-05	6.67E-06	9.4E+01	3.5E-01	NA	2.0E-01	
Naphthalene	6.0E-02	8.4E-06	8.29E-03	1.3E+02	8.5E-02	3.4E-05	3.0E-03	
Mercury	3.1E-02	6.3E-06	1.59E-01	2.0E+02	2.0E-03	NA	3.0E-04	

Notes:

- 1) Chemical-specific parameters are from the USEPA Regional Screening Levels (RSLs) Summary Table, revised June 2017.
- 2) Dimensionless Henry's Law Constants (H'_{TS}) are the values contained in TACO Appendix C, Table E for a system temperature (TS) of 13°C.
- 3) Chemicals shown are the SRP target compounds and analytes that appear on the TACO indoor inhalation volatile chemicals list (TACO, Appendix A, Table 1).
- 4) NA - Toxicity information is not available for this chemical for the inhalation route of exposure.
- 5) For the soil gas model, $D_T^{eff} = D_{soil}^{eff}$ because only one layer is modeled in the system.
- 6) carc - carcinogenic
- 7) nc - non-carcinogenic
- 8) NC - Not calculated because toxicity information is not available for the inhalation route of exposure.
- 9) $RO_{indoor\ air}$ is the lesser of the calculated carcinogenic and non-carcinogenic ROs for indoor air.
- 10) Vapor saturation limits are calculated as described in Table P-2.
- 11) Selected Tier 3 RO is the lesser of the calculated Tier 3 RO and the vapor saturation limit. If no toxicity criteria were available for the inhalation route of exposure, the RO is based on the vapor saturation limit. ROs based on the vapor saturation limit are shown in *italics*.
- 12) * - Although a URF is provided in the USEPA RSLs Summary Table, chemical does not meet the statutory definition of a carcinogen as specified in the TACO Appendix A, Table 1.

Compound/Analyte	Chemical-Specific Parameters					Littl	
	D _i (cm ² /sec)	D _w (cm ² /sec)	H' _{TS} (unitless)	URF (µg/m ³)	RfC (mg/m ³)	D _{sol} ^{eff} (cm ² /sec)	
Volatile Organic							
Benzene	9.0E-02	1.0E-05	1.34E-01	7.8E-06	3.0E-02	7.0E-03	
Ethylbenzene	6.8E-02	8.5E-06	1.64E-01	2.5E-06	1.0E+00	5.3E-03	
Styrene	7.1E-02	8.8E-06	5.48E-03	NA	1.0E+00	5.6E-03	
Toluene	7.8E-02	9.2E-06	1.49E-01	NA	5.0E+00	6.1E-03	
Xylenes, Total**	6.9E-02	8.5E-06	2.71E-01	NA	1.0E-01	5.3E-03	
Semivolatile Organic							
2-Methylnaphthalene	5.2E-02	7.8E-06	6.95E-03	NA	NA	4.1E-03	
2-Methylphenol	7.3E-02	9.3E-06	2.00E-05	NA	6.0E-01	1.0E-02	
Phenol	8.3E-02	1.0E-05	6.67E-06	NA	2.0E-01	2.2E-02	
Naphthalene	6.0E-02	8.4E-06	8.29E-03	3.4E-05	3.0E-03	4.7E-03	
Mercury	3.1E-02	6.3E-06	1.59E-01	NA	3.0E-04	2.4E-03	

Notes:

- 1) Chemical-specific parameters are from the USEPA Regional Screening Levels (RSLs) Summary Table, revised June 2017.
- 2) Dimensionless Henry's Law Constants (H'_{TS}) are the values contained in TACO Appendix C, Table E for a system temperature (TS) of 13°C.
- 3) Chemicals shown are the focused list of MGP compounds and analytes that appear on the TACO indoor inhalation volatile chemicals list (Table 1).
- 4) NA - Toxicity information is not available for this chemical for the inhalation route of exposure.
- 5) carc - carcinogenic
- 6) nc - non-carcinogenic
- 7) NC - Not calculated because toxicity information is not available for the inhalation route of exposure.
- 8) RO_{indoor air} is the lesser of the calculated carcinogenic and non-carcinogenic ROs for indoor air.
- 9) Solubility limits are from the USEPA RSLs Summary Table, revised June 2017.
- 10) Selected Tier 3 RO is the lesser of the calculated Tier 3 RO and the solubility limit. If no toxicity criteria were available for the inhalation route of exposure, the RO is based on the solubility limit in the same manner as used in Tier 1 (TACO, Appendix B, Table H, Footnote f). ROs based on the solubility limit are shown in *italics*.
- 11) ** - No Dimensionless Henry's law constant (H'_{TS}) is provided within TACO for Total Xylenes at 13°C. The value used for the Dimensionless Henry's Law Constant is from TACO for total xylenes at 25°C, which results in a more conservative groundwater remediation objective for the indoor inhalation route of exposure.

Calculation of Residential Groundwater Table at 10 feet
 Tier 3 Indoor Inhalation

Compound/Analyte	Chemical-Specific Parameters					Little	
	D _i (cm ² /sec)	D _w (cm ² /sec)	H' _{TS} (unitless)	URF (μg/m ³)	RfC (mg/m ³)	D _{soil} ^{eff} (cm ² /sec)	
Volatile Organic							
Benzene	9.0E-02	1.0E-05	1.34E-01	7.8E-06	3.0E-02	7.0E-03	
Ethylbenzene	6.8E-02	8.5E-06	1.64E-01	2.5E-06	1.0E+00	5.3E-03	
Styrene	7.1E-02	8.8E-06	5.43E-03	NA	1.0E+00	5.6E-03	
Toluene	7.8E-02	9.2E-06	1.49E-01	NA	5.0E+00	6.1E-03	
Xylenes, Total	6.9E-02	8.5E-06	2.71E-01	NA	1.0E-01	5.3E-03	
Semivolatile Organic							
2-Methylnaphthalene	5.2E-02	7.8E-06	6.95E-03	NA	NA	4.1E-03	
2-Methylphenol	7.3E-02	9.3E-06	2.00E-05	NA	6.0E-01	1.0E-02	
Phenol	8.3E-02	1.0E-05	6.67E-06	NA	2.0E-01	2.2E-02	
Naphthalene	6.0E-02	8.4E-06	8.29E-03	3.4E-05	3.0E-03	4.7E-03	
Mercury	3.1E-02	6.3E-06	1.59E-01	NA	3.0E-04	2.4E-03	

Notes:

- 1) Chemical-specific parameters are from the USEPA Regional Screening Levels (RSLs) Summary Table, revised June 2017.
- 2) Dimensionless Henry's Law Constants (H'_{TS}) are the values contained in TACO Appendix C, Table E for a system temperature (TS) of 1.
- 3) Chemicals shown are the SRP target compounds and analytes that appear on the TACO indoor inhalation volatile chemicals list (TACO).
- 4) NA - Toxicity information is not available for this chemical for the inhalation route of exposure.
- 5) carc - carcinogenic
- 6) nc - non-carcinogenic
- 7) NC - Not calculated because toxicity information is not available for the inhalation route of exposure.
- 8) RO_{indoor air} is the lesser of the calculated carcinogenic and non-carcinogenic ROs for indoor air.
- 9) Solubility limits are from the USEPA RSLs Summary Table, revised June 2017.
- 10) Selected Tier 3 RO is the lesser of the calculated Tier 3 RO and the solubility limit. If no toxicity criteria were available for the inhalation route of exposure, the RO is based on the solubility limit. ROs based on the solubility limit are shown in *italics*.
- 11) * - Although a URF is provided in the USEPA RSLs Summary Table, chemical does not meet the statutory definition of a carcinogen as defined in 42 USC 9601(2)(A).

APPENDIX Q
R26 Evaluation of Groundwater and Surface Water
Mendota MGP - Black Brothers Company Site
Revised SI/ROR/RAP

APPENDIX Q

EVALUATION FOR GROUNDWATER AND SURFACE WATER

This appendix describes the procedures used in the determination of the lateral extent of COCs in groundwater by developing isoconcentration plume maps at the Site and to estimate the concentrations of certain COCs at Mendota Creek, the nearest water body.

Q.1 GROUNDWATER EVALUATION

The extent of dissolved COCs in groundwater was evaluated to determine if the groundwater concentrations of any COCs exceeded the groundwater remediation objectives at the downgradient site boundaries.

Plume maps were developed for each groundwater COC which exceeded groundwater remediation objectives to determine the extent of dissolved constituents. Isoconcentration plume maps were constructed using the groundwater flow directions and the groundwater data from upgradient monitoring wells (SMW01 and SMW02) and downgradient wells (SMW03 and SMW04). The most recent concentration for each COC was plotted at each monitoring well to determine the lateral extent of the groundwater plume, taking into consideration visual observations of tar saturation, analytical data from water table samples and soil sample analytical results.

If a constituent only exceeded its remediation objectives in the upgradient wells (SMW01 or SMW02), then the remediation objective was used for the isoconcentration line and the COC was contained within the Site. COCs contained within the Site include styrene, toluene, 2,4-dimethylphenol, 2-methylphenol, 4-methylphenol, phenol, acenaphthylene, dibenzo(a,h)anthracene, phenanthrene, and arsenic. If concentrations in one of the downgradient wells (SMW03 or SMW04) exceeded the remediation objective, then the maximum downgradient concentration from these two wells was used for the isoconcentration line. Constituents which exceeded in a downgradient well include benzene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, naphthalene, dibenzofuran and 2-methylnaphthalene.

The plume maps show that the concentrations at the furthest downgradient wells (SMW03 and SMW04) exceed remediation objectives for benzene, acenaphthylene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, naphthalene, dibenzofuran, and 2-methylnaphthalene. In order to determine the extent of constituents, Equation R26 and associated equations (TACO Appendix C Table C) were used to calculate the approximate distances from the edge of the plumes to reach the remediation objective. The details of input parameters and calculated distances are presented in Table Q-1. A plume with an isoconcentration line equal to the remediation objective was developed using the estimated distances. The isoconcentration line equal to the remediation objective for all constituents were contained within the Site boundaries. Benzene is the only COC that extends to the boundary of the Site at the concrete retaining wall that extends into the clay till that stops the migration of dissolved constituents past the Site boundary. The groundwater plume maps are presented as Figures Q-1 through Q-20.

Q.2 SURFACE WATER EVALUATION

The extent of dissolved COCs in groundwater was evaluated to determine if the groundwater concentrations of any COCs exceeded the surface water standard at the downgradient Site boundaries. Groundwater concentrations at the boundary of Mendota Creek were calculated regardless if the plume was contained on Site.

Plume maps were developed for each COC for which a surface water standard exists (35 IAC 302.208) to determine the extent of dissolved constituents and the groundwater concentration at the surface water discharge point. Isoconcentration plume maps were constructed using the groundwater flow directions and the groundwater data from upgradient monitoring wells (SMW01 and SMW02) and downgradient monitoring wells (SMW03 and SMW04). The most recent concentration for each COC was plotted at each monitoring well to determine the lateral extent of the groundwater plume, taking into consideration visual observations of tar saturation, analytical data from water table samples and soil sample analytical results.

If the concentration in groundwater only exceeded the surface water standard in the upgradient wells (SMW01 or SMW02), then the surface water standard was used for the isoconcentration line. COCs that only exceeded upgradient include benzene, ethylbenzene, toluene, and total xylenes.

If the concentration in groundwater in one of the down gradient wells (SMW03 or SMW04) exceeded the surface water standard, then the maximum downgradient concentration from these two wells was used for the isoconcentration line. Cyanide was the only constituent to exceed in a downgradient monitoring well. Arsenic and barium groundwater concentrations did not exceed surface water standards, however in order to use equation R26 to calculate a groundwater concentration at the creek, the maximum downgradient concentration was used to create a plume. Plumes for 2,4-dimethylphenol, 2-methylphenol, 4-methylphenol, and phenol were developed based on the surface water standard for total phenols because individual surface water standards do not exist.

In order to evaluate any potential risk to nearby surface water receptors, RBCA equation R26 and associated equations (TACO Appendix C Table C) were used to calculate the approximate distances from the edge of the plumes to reach the surface water standard. The R26 modeling was performed for the COCs which have surface water objectives listed in 35IAC, Part 302 including benzene, ethylbenzene, toluene, xylenes, total phenols (2,4-dimethylphenol, 2-methylphenol, 4-methylphenol, phenol), arsenic, barium and cyanide. The equations and input parameters are presented below and the results of this evaluation are presented in Table Q-2.

Additionally, RBCA equation R26 was also used to calculate a concentration in groundwater at the surface water discharge point for comparison to the surface water standard. The sum of the calculated concentrations for 2,4-dimethylphenol, 2-methylphenol, 4-methylphenol and phenol were compared to the surface water standard for total phenols. For COCs which exceeded groundwater remediation objectives, the Tier 1 plumes were used as the concentration at the source and to measure the distance to Mendota Creek since these plumes were closer to the creek and provided a more accurate estimate. The

equations and input parameters are presented below and the results of this evaluation are presented in Table Q-3. The calculated concentrations of COCs at Mendota Creek are all below their respective surface water standards except cyanide.

Q.3 RBCA EQUATIONS

EQUATION R26

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

Where:

Parameter	Description	Value	Units	Values Used
$C(X_{sw})$	Concentration of Contaminant in Groundwater at Distance X_{sw} from the source	Equation R26 Output	mg/L _{water}	Chemical / Location Specific
$C(X_{Tier 1})$	Concentration of Contaminant in Groundwater at Distance $X_{Tier 1}$ from the source	Equation R26 Output	mg/L _{water}	Chemical / Location Specific
$C(X_{sur})$	Concentration of Contaminant in Groundwater at Distance X_{sur} from the source.	Equation R26 Output	mg/L _{water}	Chemical / Location Specific
X_{sw}	Distance Along Centerline of Groundwater Plume Emanating from a Source to Surface Water Discharge Point. The X direction is the direction of groundwater flow.	Field Measurement	cm	Location Specific
$X_{Tier 1}$	Distance Along Centerline of Groundwater Plume Emanating from a Source to reach Tier 1 remediation objective. The X direction is the direction of groundwater flow.	Field Measurement	cm	Location Specific
X_{sur}	Distance Along Centerline of Groundwater Plume Emanating from a Source to reach Surface Water Standard. The X direction is the direction of groundwater flow.	Field Measurement	cm	Location Specific
α_x	Longitudinal Dispersivity	Equation R16 in Appendix C, Table C	cm	Location Specific
λ	First Order Degradation Constant	Appendix C, Table E	d ⁻¹	Chemical Specific
U	Specific Discharge	Equation R19 in Appendix C, Table C	cm/d	0.125

S_w	Source Width Perpendicular to Groundwater Flow Direction in Horizontal Plane	Field Measurement	cm	Chemical Specific
α_y	Transverse Dispersivity	Equation R17 in Appendix C, Table C	cm	Location Specific
S_d	Source Width Perpendicular to Groundwater Flow Direction in Vertical Plane	Field Measurement	cm	274.32
α_z	Vertical Dispersivity	Equation R18 in Appendix C, Table C	cm	Location Specific
erf	Error Function	Appendix C, Table G	Mathematical Function	Function Specific
C_{source}	The greatest potential concentration of the contaminant of concern in the groundwater at the source of the contamination, based on the concentrations of the contaminants in groundwater due to the release and the projected concentration of the contaminant migrating from the soil to the groundwater.	Field Measurement	mg/L	Chemical Specific

EQUATION R16

$$\alpha_x = 0.10 \cdot X$$

Where:

Parameter	Description	Value	Units	Values Used
X_{sw}	Distance Along Centerline of Groundwater Plume Emanating from a Source to Surface Water Boundary	Field Measurement	cm	Location Specific
$X_{property}$	Distance Along Centerline of Groundwater Plume Emanating from a Source to Property Line	Field Measurement	cm	Location Specific

EQUATION R19

$$U = \frac{k \cdot i}{\theta_r}$$

Where:

Parameter	Description	Value	Units	Values Used
θ_T	Total Soil Porosity	RBCA	$\text{cm}^3/\text{cm}^3_{\text{oil}}$	0.43
i	Hydraulic Gradient	Field Measurement	cm/cm (unitless)	0.008585
k	Aquifer Hydraulic Conductivity	Field Measurement	cm/d	7.08

The maximum Hydraulic Gradient was used based on calculations from groundwater elevations from each sampling event. *Source:* EPA On-line Tools for Site Assessment Calculation [accessed May 27, 2014] <http://www.epa.gov/athens/learn2model/part-two/onsite/gradient4plus-ris.html>

Equation R17

$$\alpha_y = \frac{\alpha_x}{3}$$

Where:

Parameter	Description	Value	Units	Values Used
α_x	Longitudinal Dispersivity	Equation R16 in Appendix C, Table C	cm	Location Specific

Equation R18

$$\alpha_z = \frac{\alpha_x}{20}$$

Where:

Parameter	Description	Value	Units	Values Used
α_x	Longitudinal Dispersivity	Equation R16 in Appendix C, Table C	cm	Location Specific

Q.4 REFERENCES

IAC, 2012. Title 35: Environmental Protection, Subtitle C: Water Pollution, Chapter I: Pollution Control Board, Part 302: Water Quality Standards.

IAC, 2012. Title 35: Environmental Protection, Subtitle F: Public Water Supplies, Chapter I: Pollution Control Board, Part 742, Tiered Approach to Corrective Action Objectives.

Table Q-1
R-26 Evaluation for Groundwater
Chemical and Location Specific Input Parameters
Revised Site Investigation/Remediation Objectives Report/Remedial Action Plan
Mendota MGP - Black Brothers Company Site

Analyte/Compound	C _{source} (mg/L)	λ (days ⁻¹)	S _d (feet)	S _w (feet)	- C(X _{Tier 1}) (mg/L)	
Volatile Organic Compounds						
Benzene	1.0	9.00E-04	9	161.0	0.005	
Styrene	0.1	3.30E-03	9	141.0	0.1	
Toluene	1	1.10E-02	9	37.6	1	
Semi-Volatile Organic Compounds						
2,4-Dimethylphenol	0.14	4.95E-02	9	108.5	0.14	
2-Methylphenol	0.35	4.95E-02	9	186.0	0.35	
4-Methylphenol	0.7	4.95E-02 *	9	98.0	0.7	
Phenol	0.1	9.90E-02	9	186.0	0.1	
Acenaphthylene	0.21	3.40E-03 *	9	178.0	0.21	
Benzo(a)pyrene	0.00041	6.50E-04	9	198.0	0.0002	
Dibenzo(a,h)anthracene	0.0003	3.70E-04	9	187.0	0.0003	
Indeno(1,2,3-cd)pyrene	0.0025	4.70E-04	9	139.7	0.00085 †	
Naphthalene	2.2	2.70E-03	9	169.6	0.14	
Phenanthrene	0.21	7.50E-04	9	136.0	0.21	
Dibenzofuran	0.037	1.69E-02 **	9	181.9	0.007	
2-Methylnaphthalene	0.070	2.70E-03 *	9	196.0	0.028	
Metals						
Arsenic	0.01	0.00E+00	9	151.0	0.01	

Notes:

- 1) C_{source} - Concentration from groundwater plume for analyte/compound.
- 2) X_{Tier 1} - Estimated distance along centerline of groundwater plume emanating from site to reach Tier 1 concentration.
- 3) λ - First Order Degradation Constant.
- 4) S_d - Source Width Perpendicular to Groundwater Flow Direction in Vertical Plane.
- 5) S_w - Source Width Perpendicular to Groundwater Flow Direction in Horizontal Plane.
- 6) C(X_{Tier 1}) - Concentration is the Tier 1 Remediation Objective at distance X_{Tier 1}.
- 7) * - Degradation constant not available for 4-methylphenol, acenaphthylene or 2-methylnaphthalene. Based on similar chemical structure and properties, the values for 2-methylphenol and naphthalene were used.
- 8) ** - Value obtained from King, 1999.
- 9) mg/L - Milligrams per liter.
- 10) † - Value is a Tier 2 Remediation Objective

Table Q-2
R-26 Evaluation for Surface Water
Chemical and Location Specific Input Parameters
Revised Site Investigation/Remediation Objectives Report/Remedial Action Plan
Mendota MGP - Black Brothers Company Site

Analyte/Compound*	C _{source} (mg/L)	λ (days ⁻¹)	S _d (feet)	S _w (feet)	C(X _{sur}) (mg/L)
Volatile Organic Compounds					
Benzene	1.0	9.00E-04	9	161	4.2
Ethylbenzene	0.15	3.00E-03	9	181	0.15
Toluene	1.0	1.10E-02	9	38	2
Xylenes, Total	0.92	1.90E-03	9	72	0.92
Semi-Volatile Organic Compounds					
2,4-Dimethylphenol	0.1	4.95E-02	9	109	0.1
2-Methylphenol	0.1	4.95E-02	9	186	0.1
4-Methylphenol	0.1	4.95E-02 **	9	98	0.1
Phenol	0.1	9.90E-02	9	186	0.1
Metals					
Arsenic	0.01	0.00E+00	9	151	0.36
Barium	0.15	0.00E+00	9	136	5
Cyanide, Amenable	0.074	0.00E+00	9	232	0.022

Notes:

- 1) C_{source} - Concentration from groundwater plume for analyte/compound.
- 2) X_{sur} - Estimated distance Along Centerline of Groundwater Plume Emanating from site to reach surface water standard.
- 3) λ -First Order Degradation Constant.
- 4) S_d - Source Width Perpendicular to Groundwater Flow Direction in Vertical Plane.
- 5) S_w - Source Width Perpendicular to Groundwater Flow Direction in Horizontal Plane.
- 6) C(X_{sur}) - Concentration is the surface water standard at distance X_{sur}, or the maximum concentration detected onsite.
- 7) * - Analyte/compound listed if a surface water exists per 35 IAC, Part 303.
- 8) ** - Degradation constant not available for 4-methylphenol. Based on similar chemical structure and properties, the values for 2-methylphenol are used.
- 9) mg/L - Milligrams per liter.

Table Q-3
Groundwater Concentration at Surface Water Boundary
Chemical and Location Specific Input Parameters
Revised Site Investigation/Remediation Objectives Report/Remedial Action Plan
Mendota MGP - Black Brothers Company Site

Analyte/Compound*	C _{source} (mg/L)	X _{sw} (feet)	λ (days ⁻¹)	S _d (feet)	S _w (feet)
Volatile Organic Compounds					
Benzene	1.0	0.0	9.00E-04	9	161
Ethylbenzene	0.15	32.3	3.00E-03	9	181
Toluene	1.0	30.0	1.10E-02	9	38
Xylenes, Total	0.92	55.3	1.90E-03	9	72
Semi-Volatile Organic Compounds					
2,4-Dimethylphenol	0.1	18.0	4.95E-02	9	109
2-Methylphenol	0.1	29.5	4.95E-02	9	186
4-Methylphenol	0.1	83.5	4.95E-02 **	9	98
Phenol	0.1	26.0	9.90E-02	9	186
Metals					
Arsenic	0.01	30.0	0.00E+00	9	151
Barium	0.15	30.0	0.00E+00	9	136
Cyanide, Amenable	0.074	18.9	0.00E+00	9	232

Notes:

- 1) C_{source} - Concentration from groundwater plume for analyte/compound.
- 2) X_{sw} - Estimated distance Along Centerline of Groundwater Plume Emanating from site to surface water discharge point.
- 3) λ -First Order Degradation Constant.
- 4) S_d - Source Width Perpendicular to Groundwater Flow Direction in Vertical Plane.
- 5) S_w - Source Width Perpendicular to Groundwater Flow Direction in Horizontal Plane.
- 6) C(X_{sw}) - Calculated Concentration of analyte/compound at surface water discharge point.
- 7) * - Analyte/compound listed if a surface water exists per 35 IAC, Part 303.
- 8) ** - Degradation constant not available for 4-methylphenol. Based on similar chemical structure and properties, the values for 2-methylphenol were used.
- 9) mg/L - Milligrams per liter.

5TH STREET

$X_{\text{Site}} = 14.53'$

CL MENDOTA CREEK

$X_{\text{SW}} = 0'$

SMW03
1.0 mg/L

0.005 mg/L

1.0 mg/L

PLUME WIDTH=161.0'

SP46
10 mg/L

9TH AVENUE

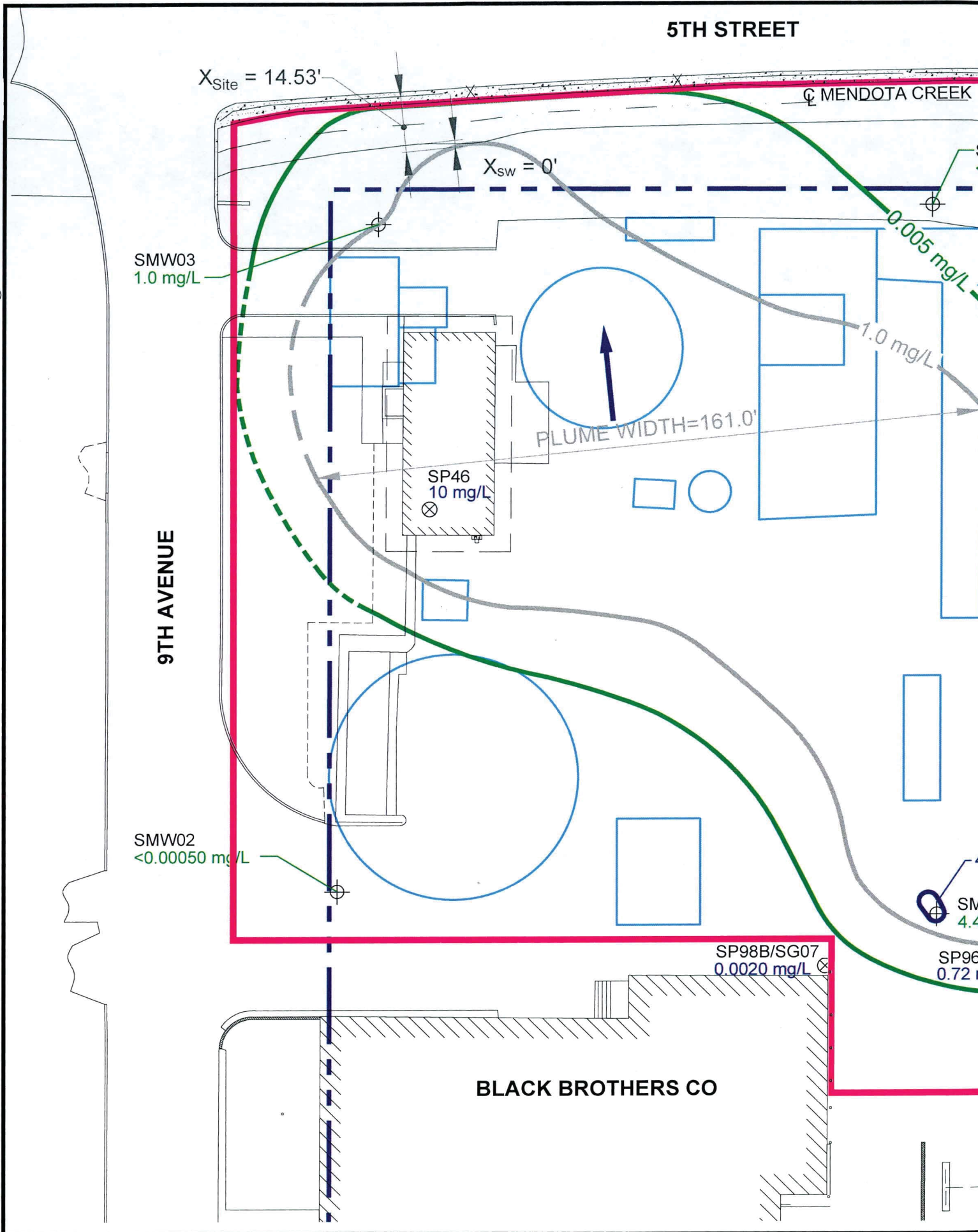
SMW02
<0.00050 mg/L

SP98B/SG07
0.0020 mg/L

SM
4.4

SP96
0.72

BLACK BROTHERS CO



5TH STREET

Q MENDOTA CREEK

$X_{Site} = 44.8'$

$X_{SW} = 32.3'$

SMW01
0.033 mg/L

0.15 mg/L

PLUME WIDTH = 180.8'

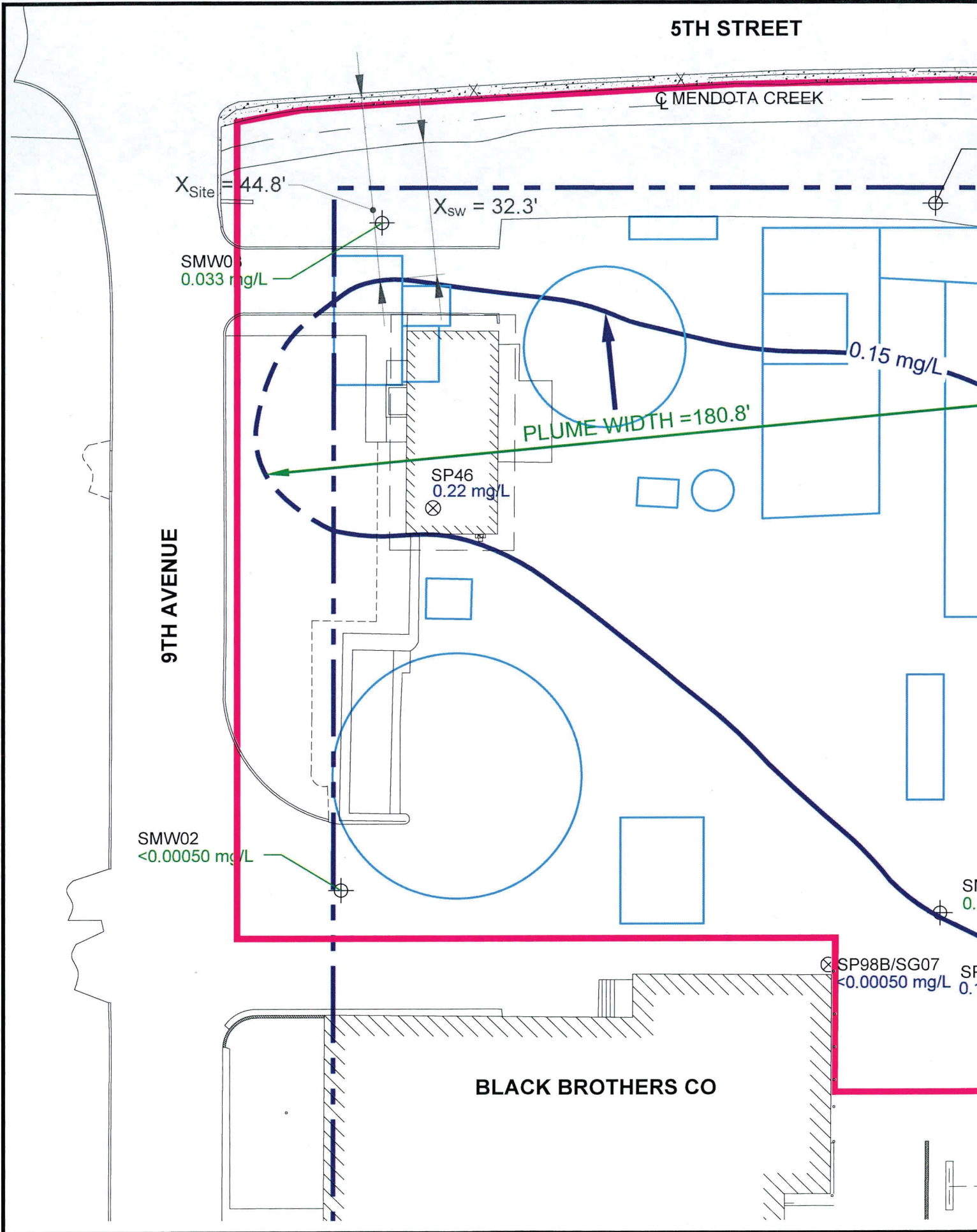
SP46
0.22 mg/L

9TH AVENUE

SMW02
<0.00050 mg/L

SP98B/SG07
<0.00050 mg/L

BLACK BROTHERS CO



5TH STREET

CL MENDOTA CREEK

SMW03
0.010 mg/L

$X_{SW} = 56.72'$

$X_{Site} = 69.7'$

SP46
0.53 mg/L

PLUME WIDTH=82.2'

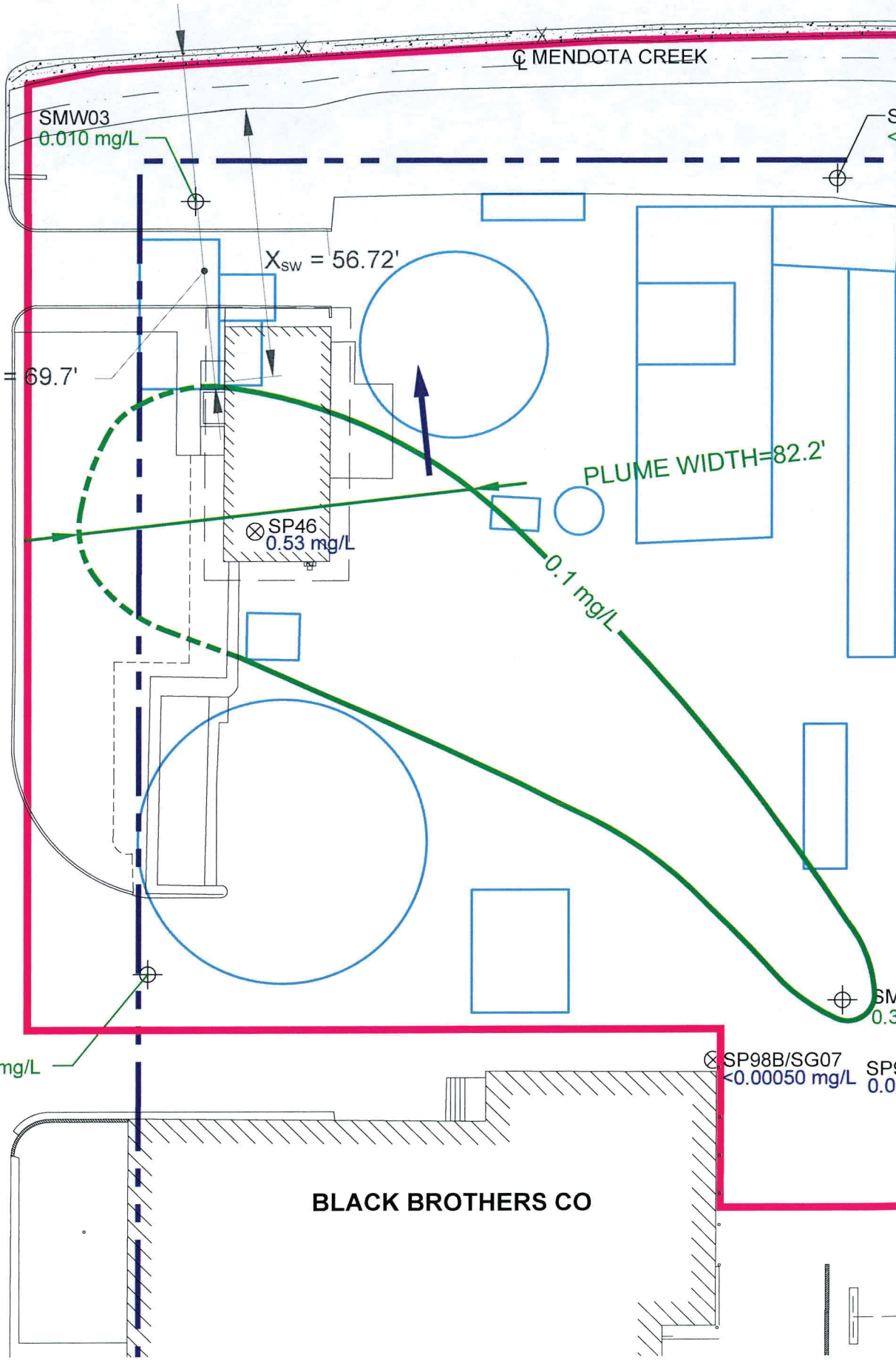
0.1 mg/L

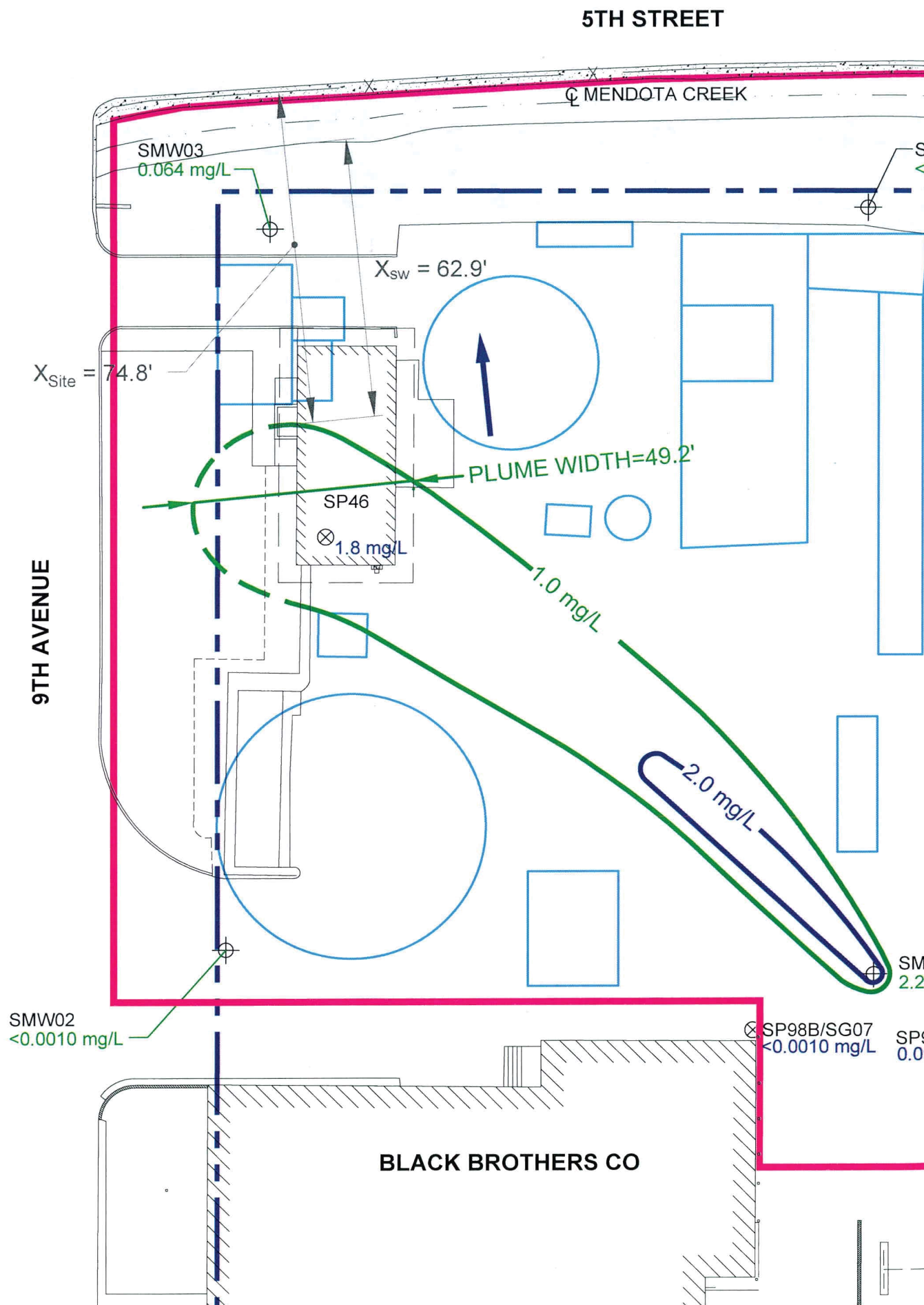
9TH AVENUE

SMW02
<0.00050 mg/L

SP98B/SG07
<0.00050 mg/L
SP98B/SG07
0.0

BLACK BROTHERS CO

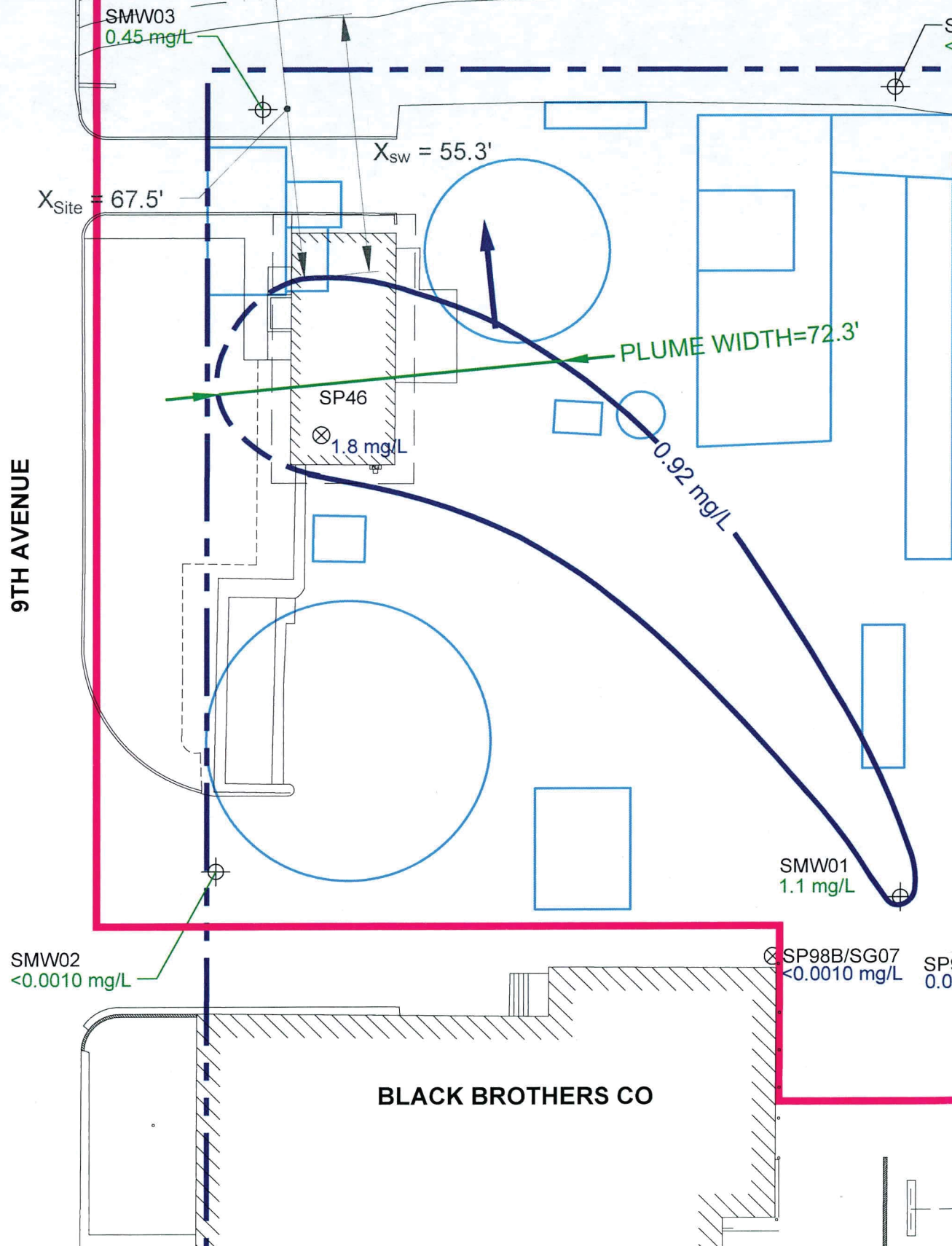


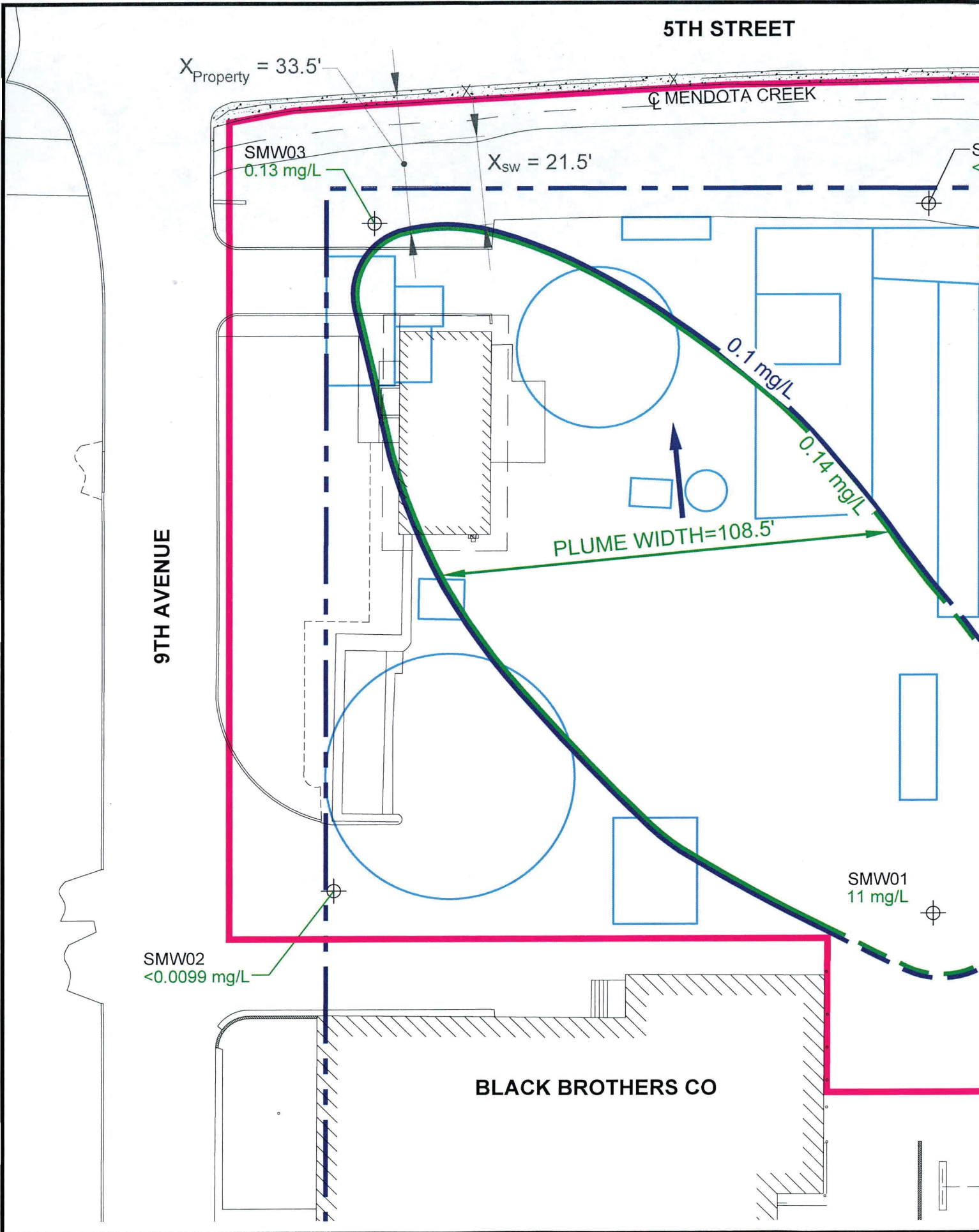


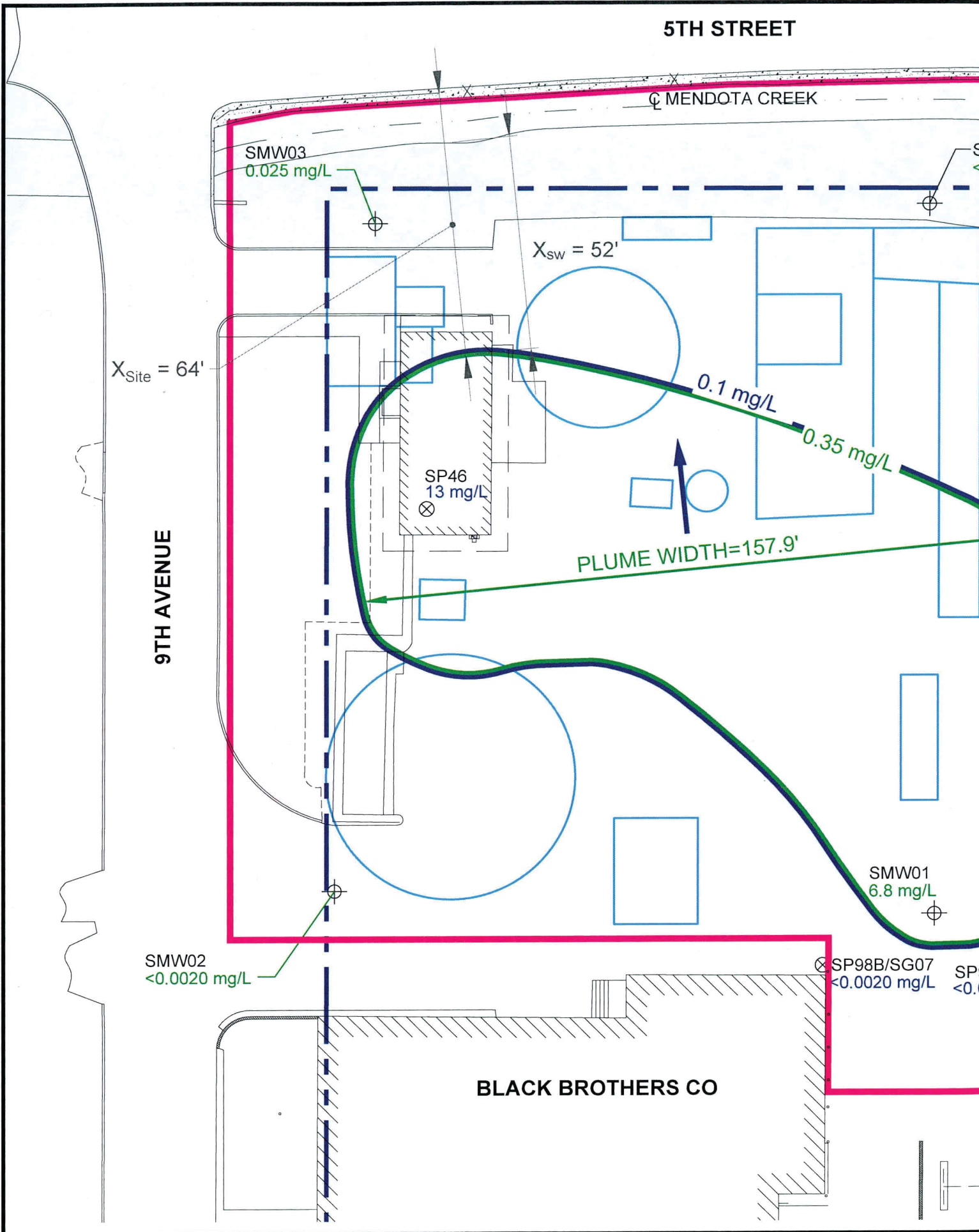
5TH STREET

CL MENDOTA CREEK

9TH AVENUE







5TH STREET

☐ MENDOTA CREEK

SMW03
0.0038 mg/L

$X_{sw} =$

$X_{Site} = 135.2'$

9TH AVENUE

PLUME WIDTH=51.2'

0.7 mg/L
0.1 mg/L

SMW01
12 mg/L

SMW02
<0.0020 mg/L

BLACK BROTHERS CO

5TH STREET

MENDOTA CREEK

SMW03
0.0048 mg/L

$X_{SW} = 64.8'$

$X_{Site} = 77'$

PLUME WIDTH = 58.3'

SP46
12 mg/L

0.1 mg/L

0.1 mg/L

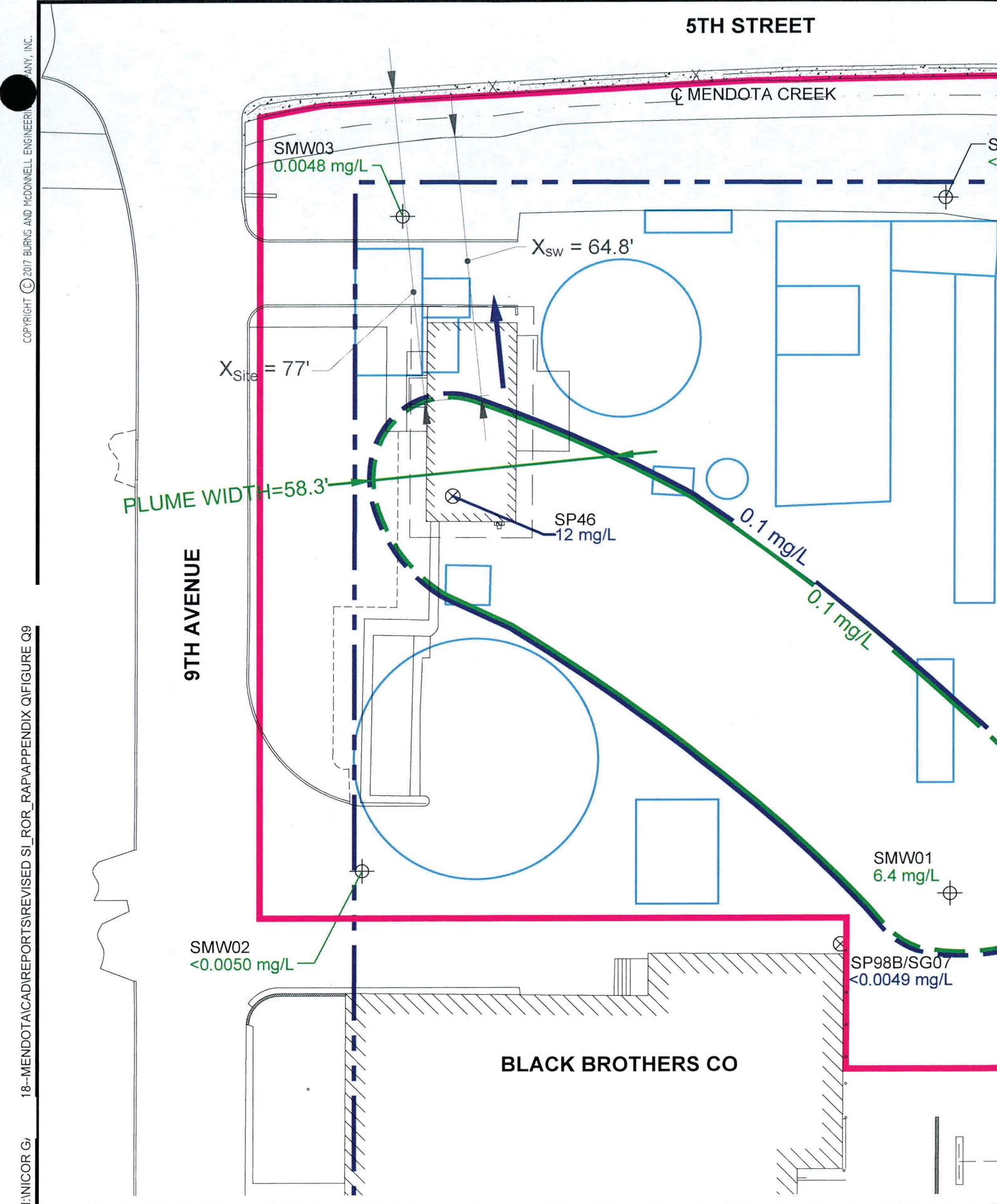
9TH AVENUE

SMW01
6.4 mg/L

SMW02
<0.0050 mg/L

SP98B/SG07
<0.0049 mg/L

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9TH AVENUE

5TH STREET

CL MENDOTA CREEK

SMW03
0.053 mg/L

$X_{\text{Site}} = 147.6'$

$X_{\text{SW}} = 135.2'$

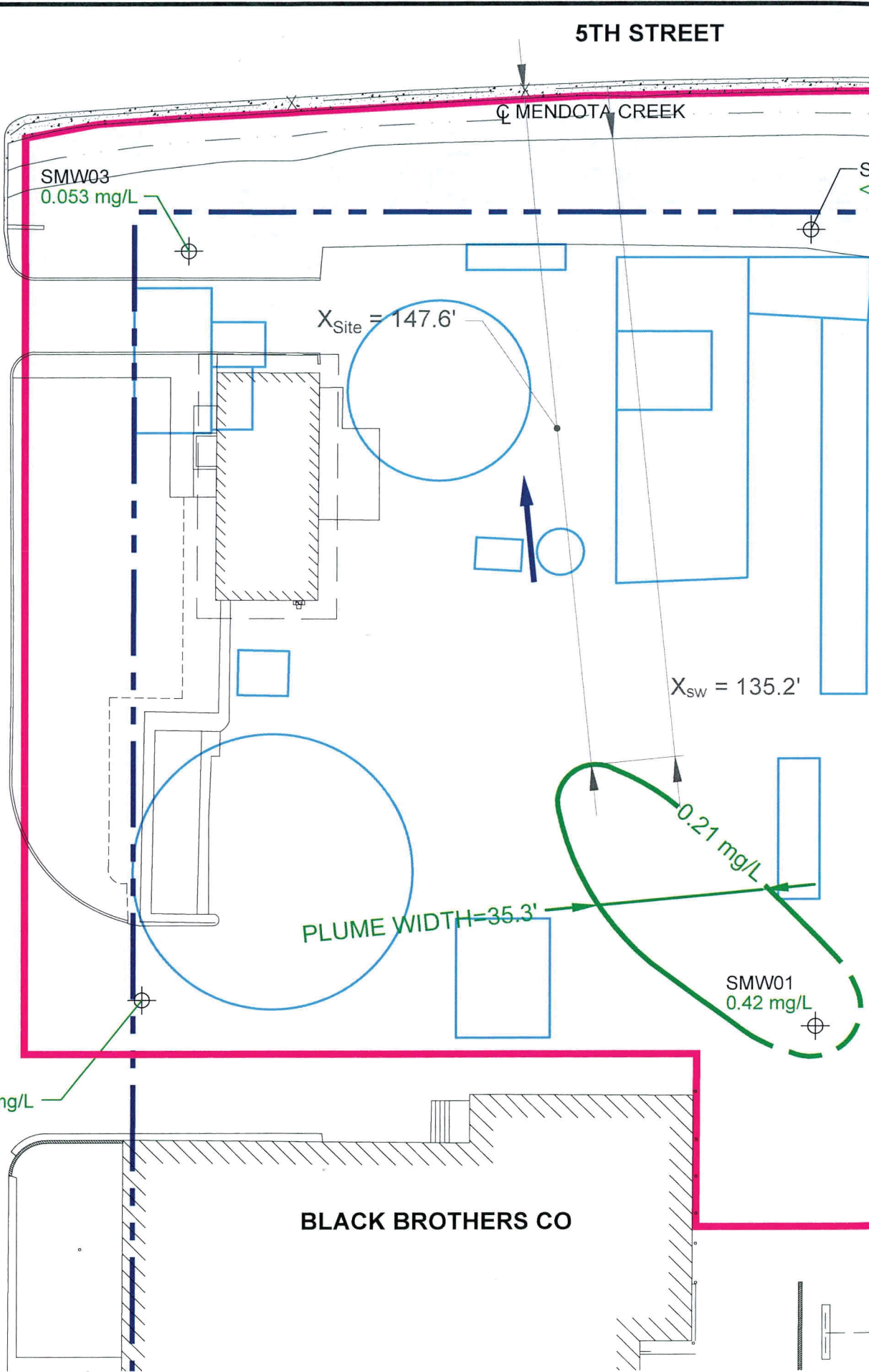
0.21 mg/L

PLUME WIDTH=35.3'

SMW01
0.42 mg/L

SMW02
<0.001 mg/L

BLACK BROTHERS CO



5TH STREET

$X_{\text{Site}} = 30.3'$

CL MENDOTA CREEK

SMW03
0.00041 mg/L

$X_{\text{SW}} = 17.2'$

9TH AVENUE

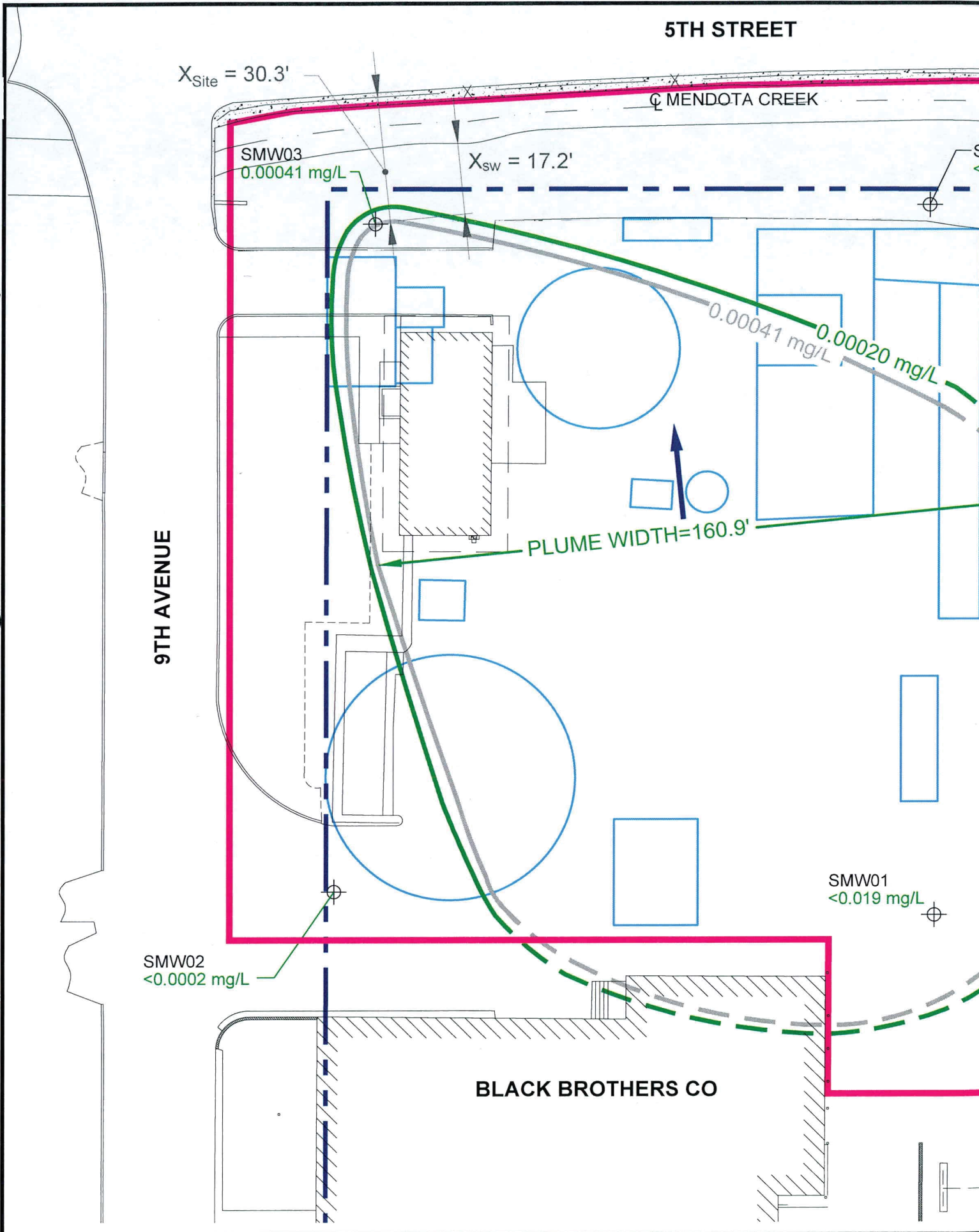
PLUME WIDTH=160.9'

0.00041 mg/L
0.00020 mg/L

SMW02
<0.0002 mg/L

SMW01
<0.019 mg/L

BLACK BROTHERS CO



5TH STREET

☐ MENDOTA CREEK

$X_{\text{Site}} = 64.9'$

$X_{\text{SW}} = 53.7'$

SMW03
<0.00029 mg/L

0.00030 mg/L

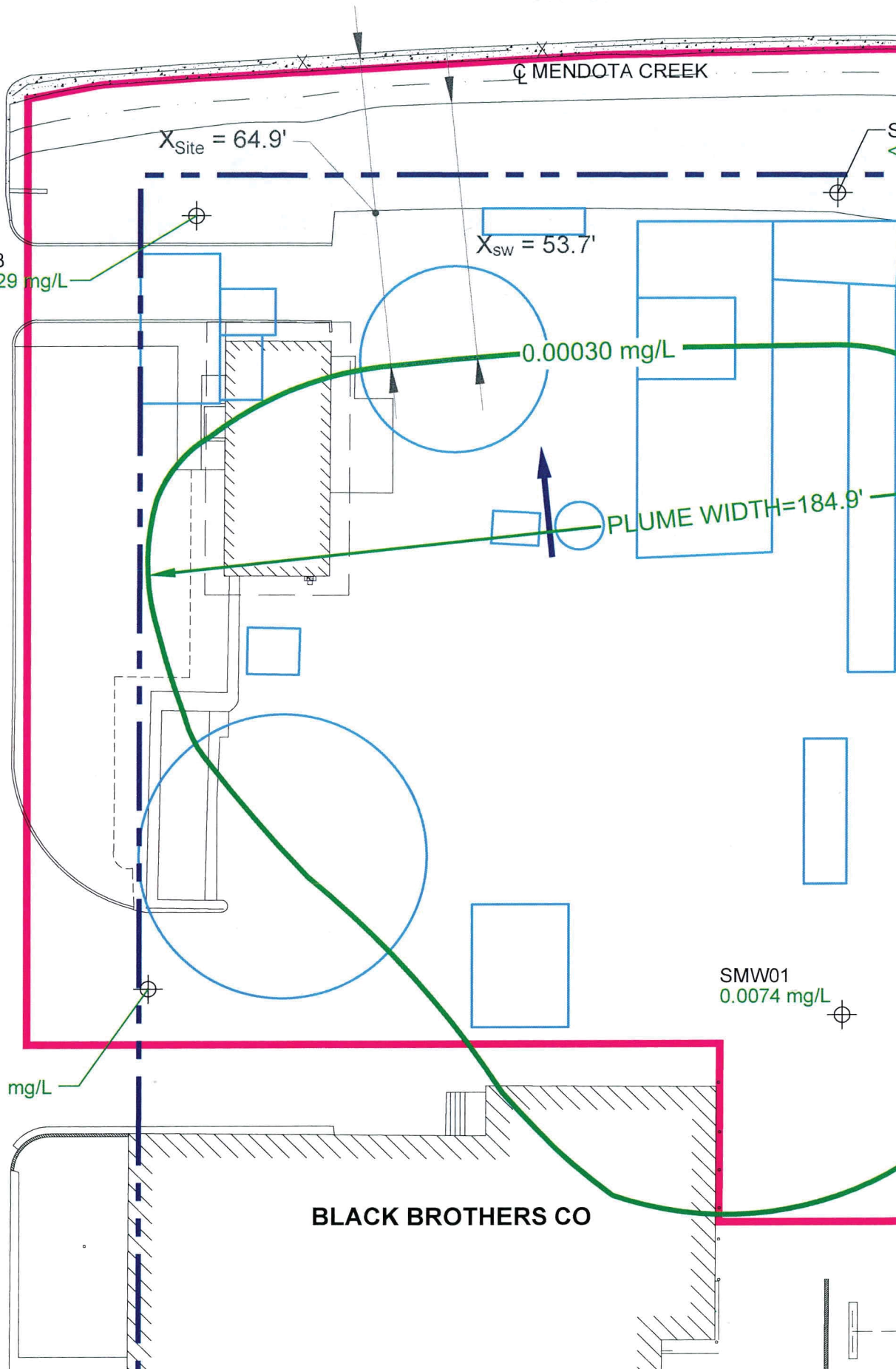
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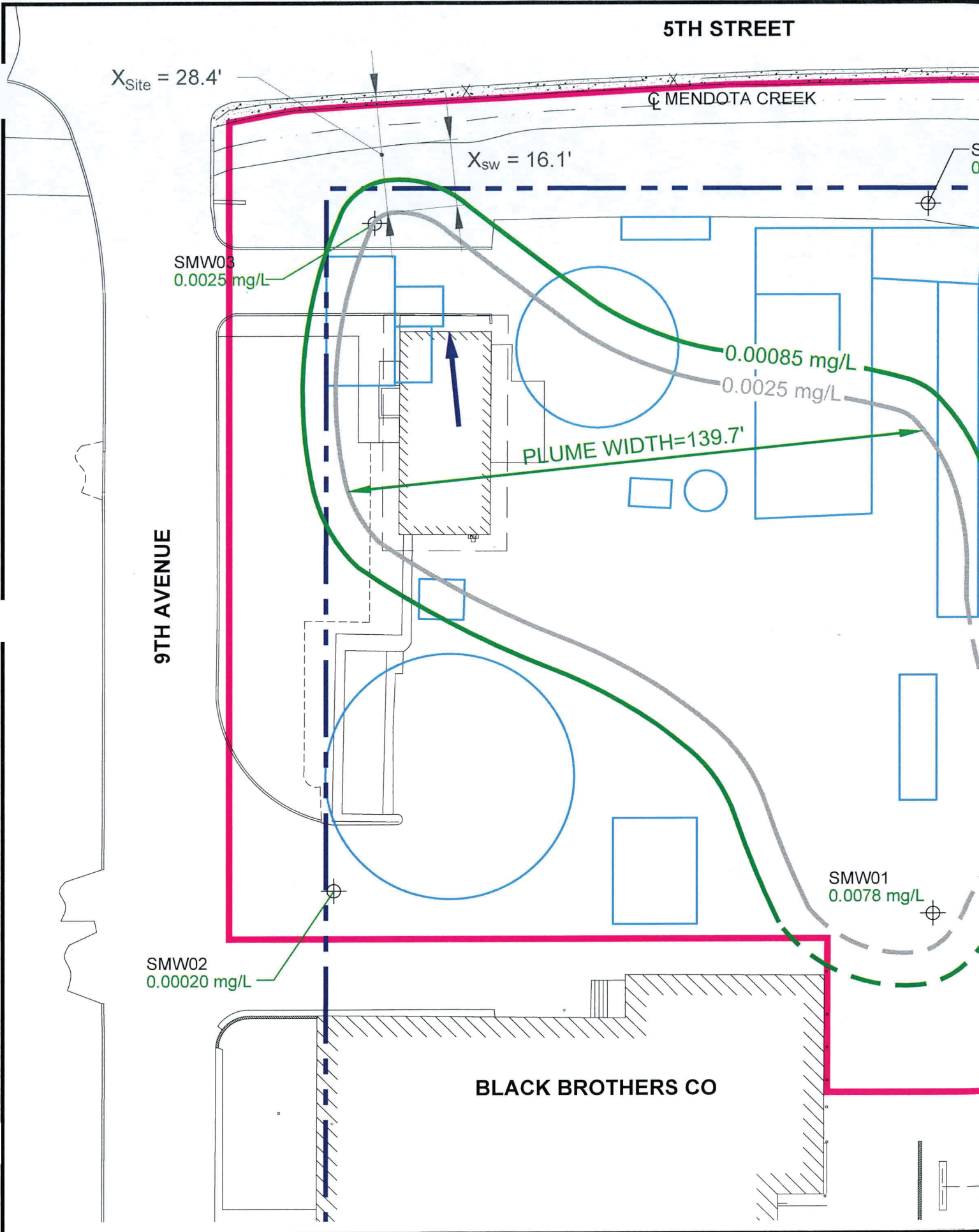
9TH AVENUE

SMW02
<0.00030 mg/L

SMW01
0.0074 mg/L

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5TH STREET

$X_{Site} = 28.4'$

MENDOTA CREEK

$X_{SW} = 16.1'$

SMW03
0.0025 mg/L

0.00085 mg/L

0.0025 mg/L

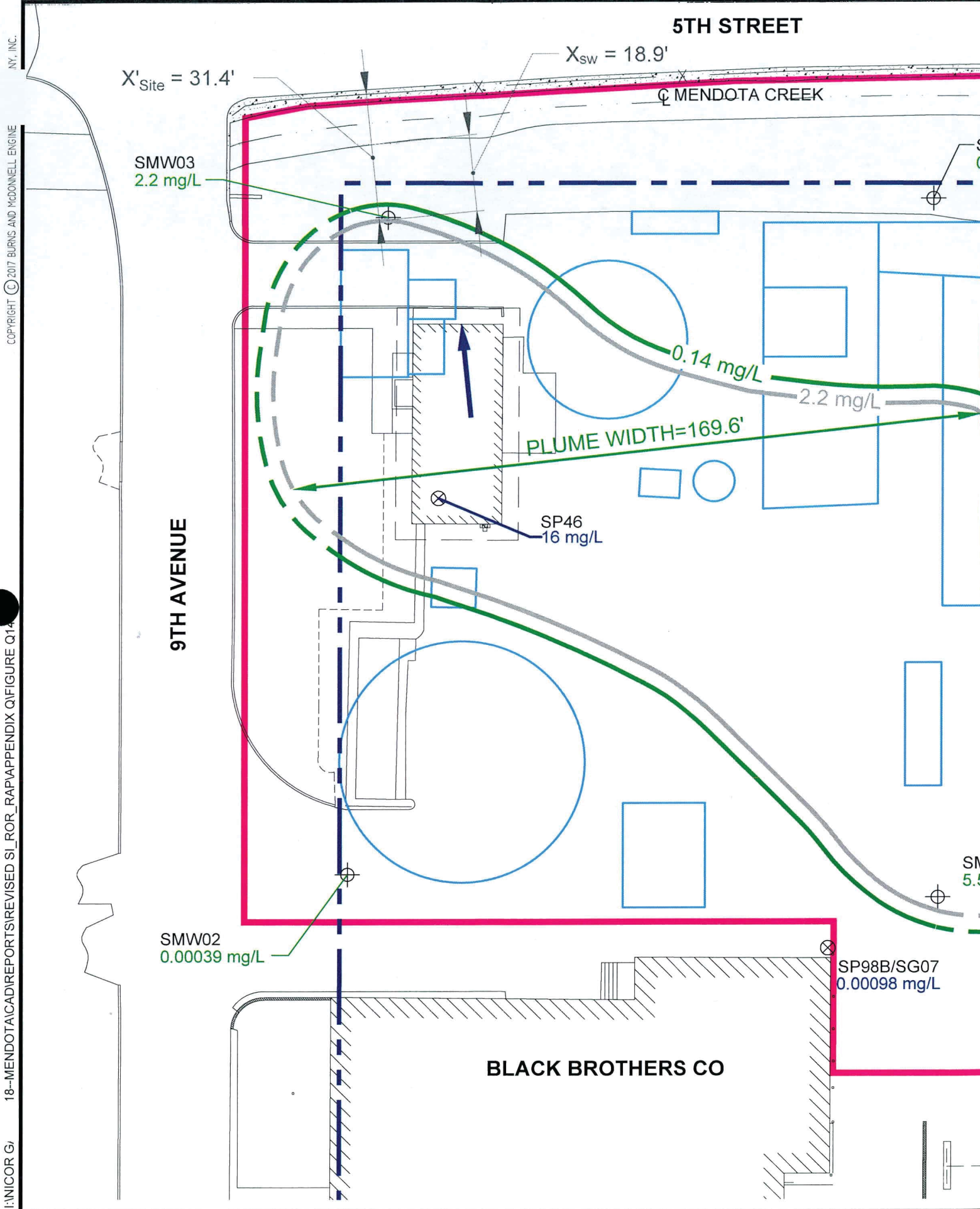
PLUME WIDTH=139.7'

9TH AVENUE

SMW01
0.0078 mg/L

SMW02
0.00020 mg/L

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18--MENDOTAICADIREPORTS(REVISED SI_ROR_RAPIAPPENDIX Q)FIGURE Q14
I:\NICOR G/

5TH STREET

X' Site = 31.4'

X_{SW} = 18.9'

CL MENDOTA CREEK

SMW03
2.2 mg/L

0.14 mg/L

2.2 mg/L

PLUME WIDTH=169.6'

SP46
16 mg/L

9TH AVENUE

SMW02
0.00039 mg/L

SP98B/SG07
0.00098 mg/L

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9TH AVENUE

5TH STREET

☐ MENDOTA CREEK

SMW03
0.025 mg/L

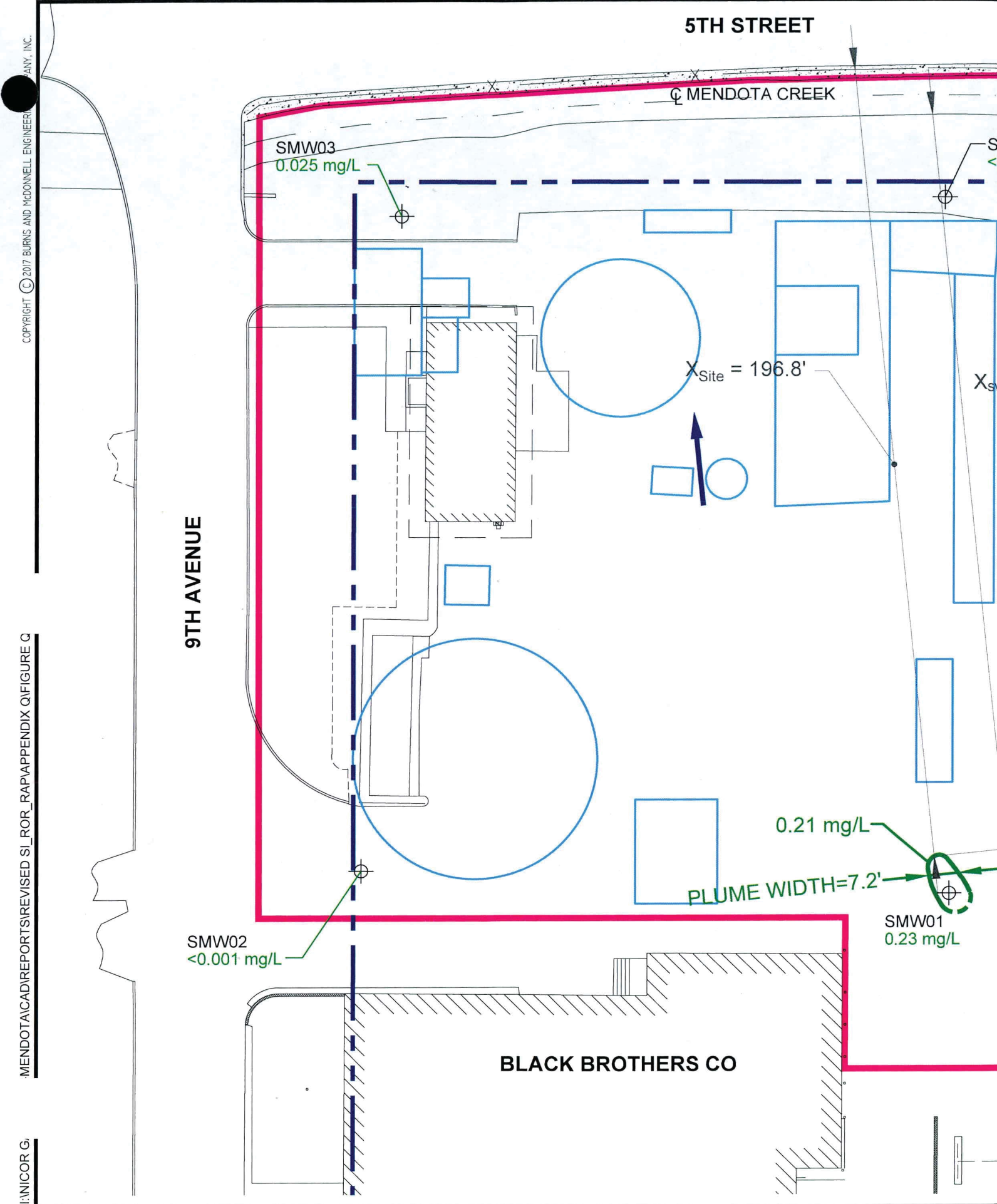
$X_{\text{Site}} = 196.8'$

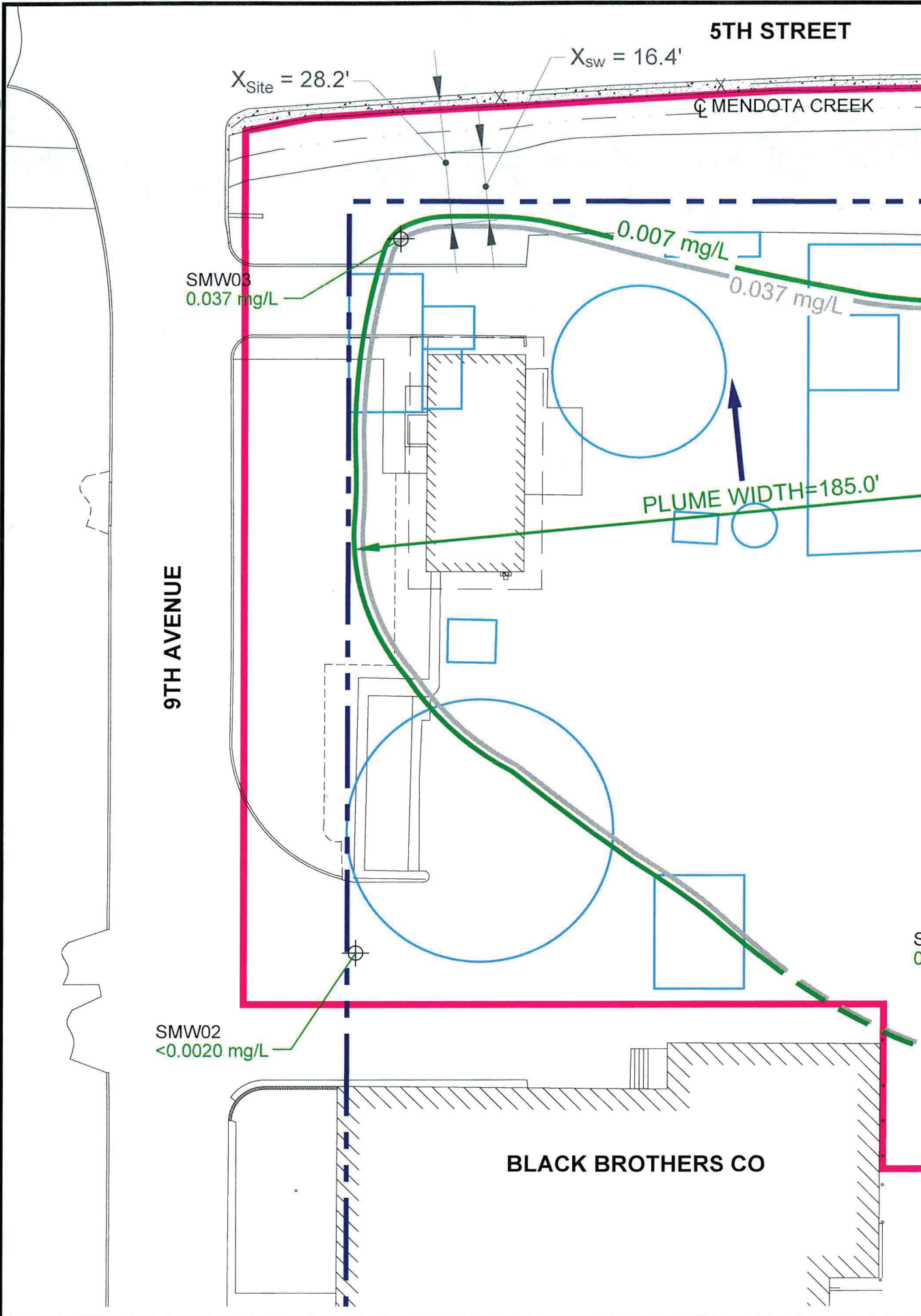
0.21 mg/L
PLUME WIDTH=7.2'

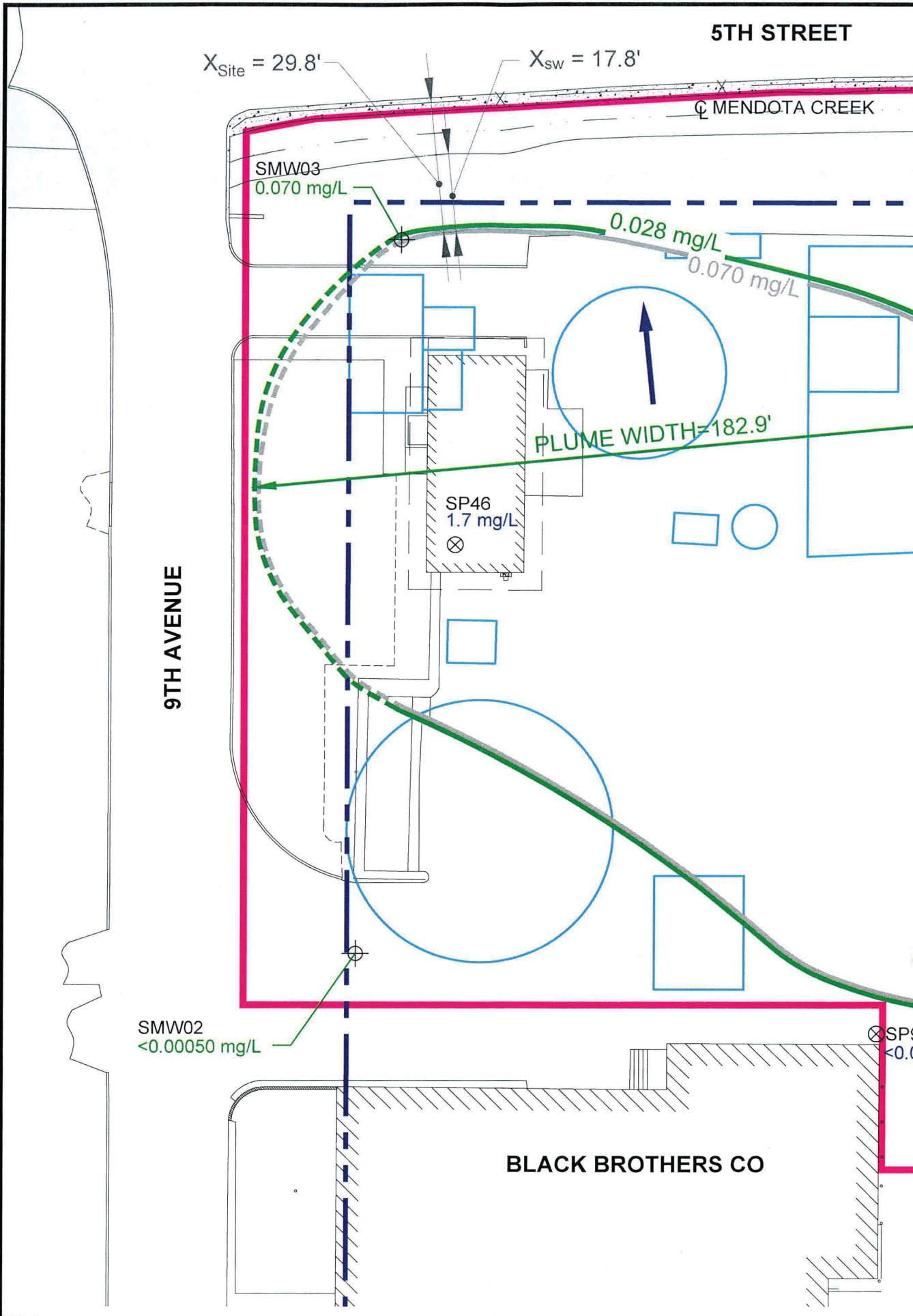
SMW02
<0.001 mg/L

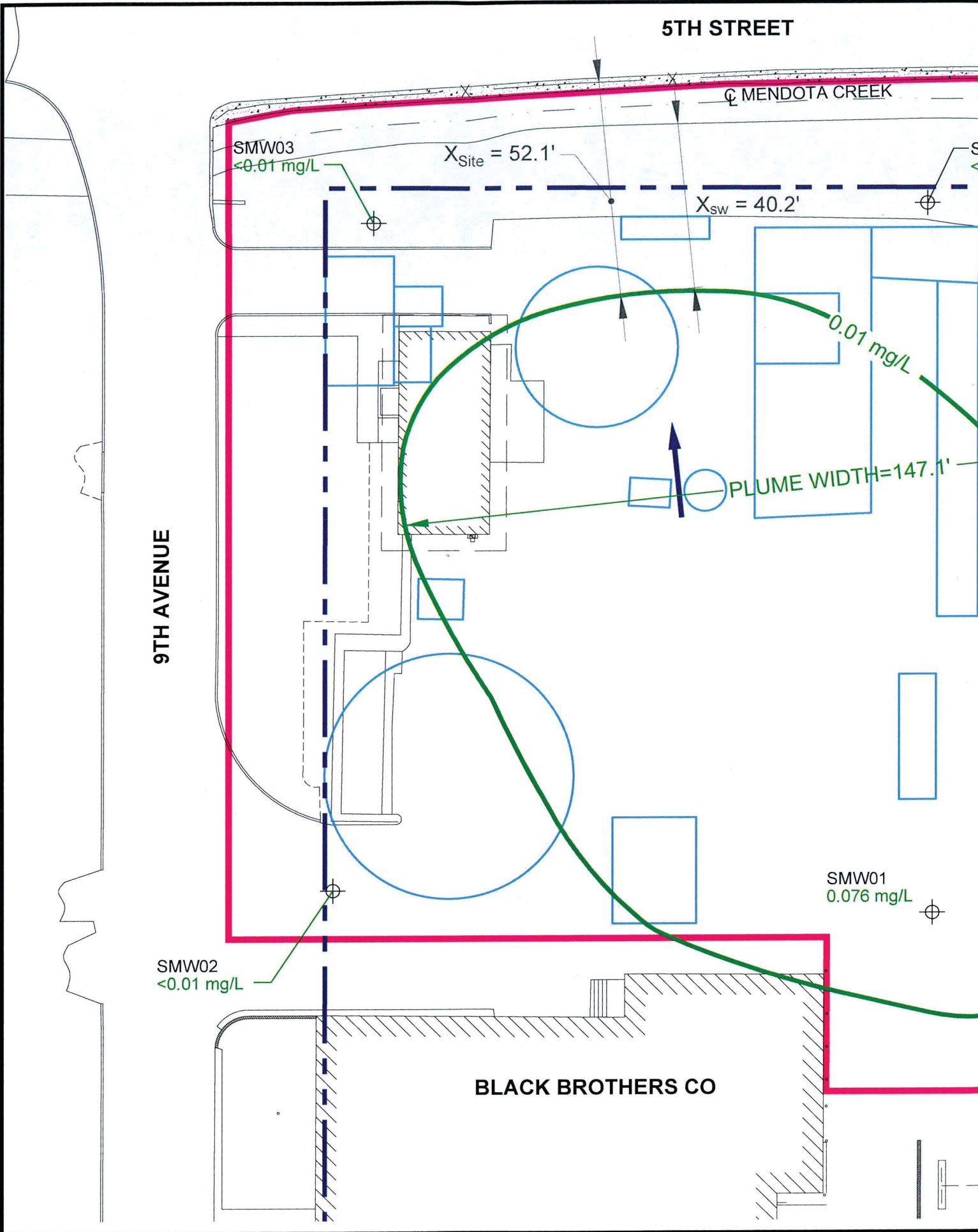
SMW01
0.23 mg/L

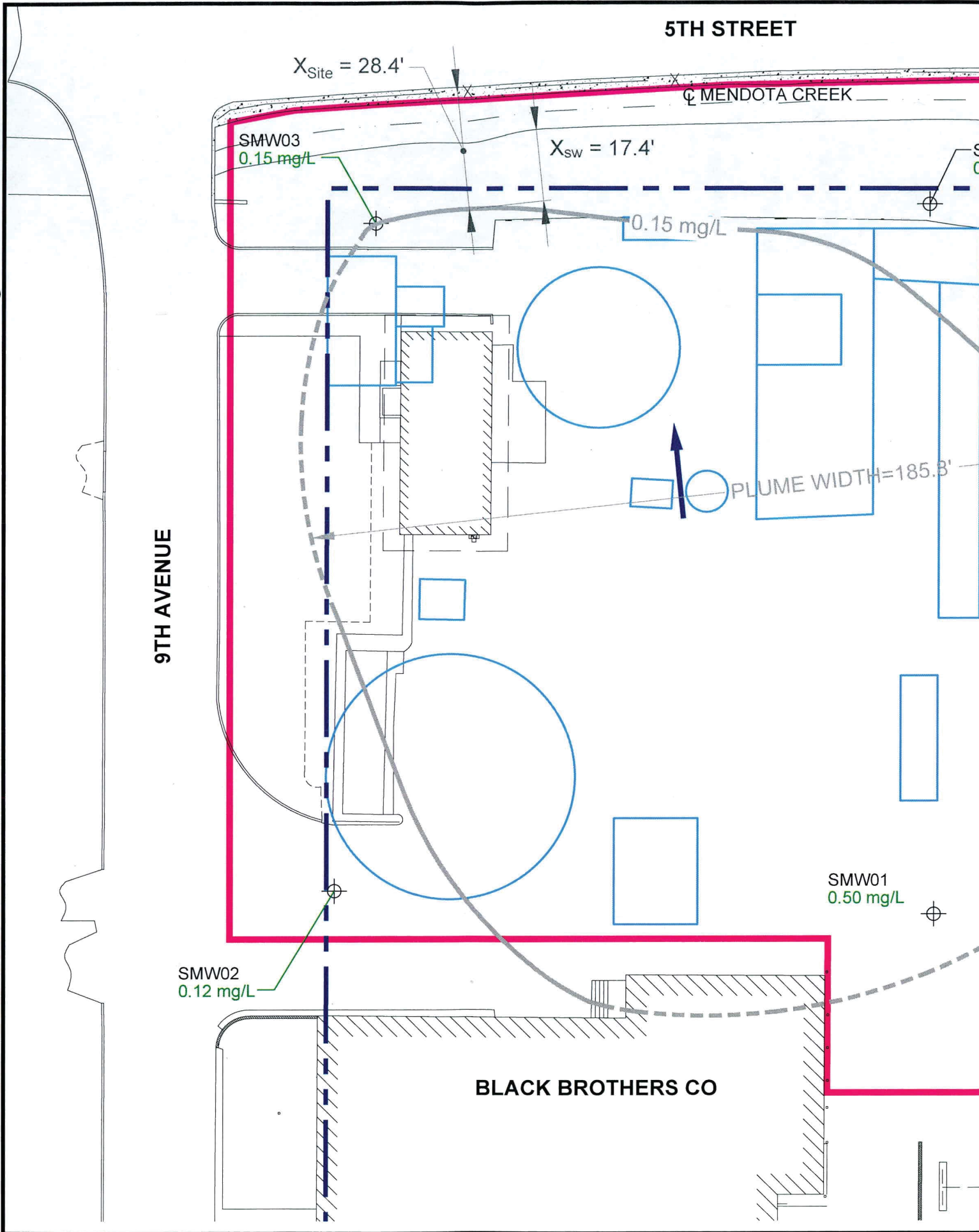
BLACK BROTHERS CO











5TH STREET

CL MENDOTA CREEK

$X_{site} = 28.4'$

$X_{sw} = 17.4'$

SMW03
0.15 mg/L

0.15 mg/L

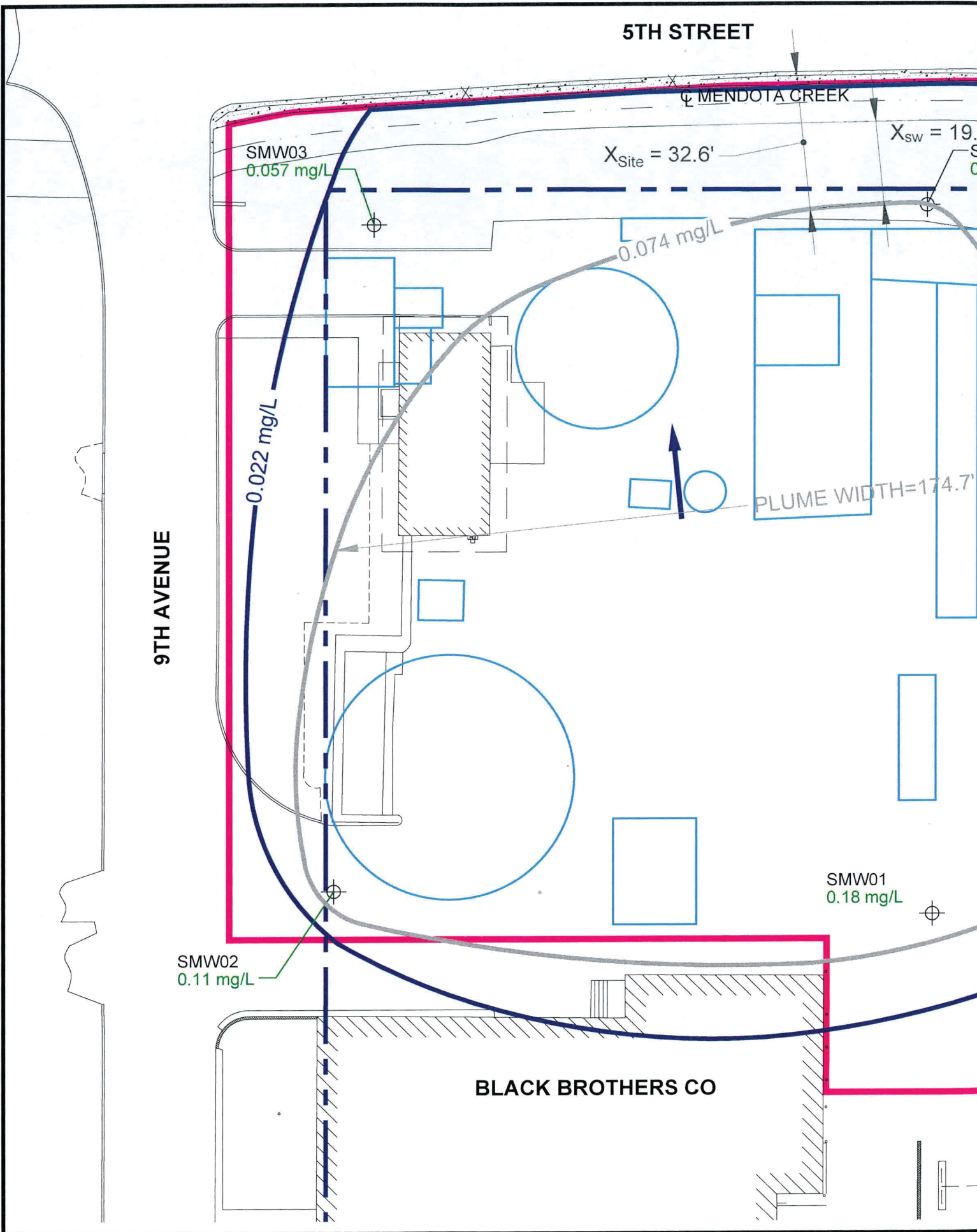
PLUME WIDTH=185.3'

9TH AVENUE

SMW02
0.12 mg/L

SMW01
0.50 mg/L

BLACK BROTHERS CO



APPENDIX R
Remedial Action Ambient Air Monitoring Work Plan
Mendota MGP - Black Brothers Company Site
Revised SI/ROR/RAP

**Mendota MGP - Black Brothers Company Site
Remedial Action Ambient Air Monitoring Work Plan**

Prepared June 2018

ACRONYMS AND ABBREVIATIONS

BBC	Black Brothers Company
BMcD	Burns & McDonnell
BTEX/styrene	benzene, toluene, ethylbenzene, total xylenes and styrene
°C	degrees Celsius
DQI	data quality index
DQO	data quality objective
GC	gas chromatograph
LCS/LCSD	laboratory control sample/laboratory control sample duplicate
MGP	manufactured gas plant
PAH	polynuclear aromatic hydrocarbon
PID	photoionization detector
PUF	polyurethane foam
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RPD	relative percent difference
SOP	standard operating procedure
Summa canisters	originally a trademarked name for passivated canisters used to collect air samples; currently used generically to denote any passivated canister used to collect air samples
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
µg/m ³	micrograms per cubic meter

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Attachments

Attachment A	Field Data Sheets and Instrument Calibration Log Forms
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always been zoned for industrial uses and over time has all been purchased by BBC. Before BBC owned the property, the area south of the former MGP consisted of two small buildings. In 1900, BBC moved to its present location in Mendota and enlarged its factory facilities to include a machine shop building crossing 4th Street. BBC then expanded the machine shop north. Immediately to the east of the former MGP property were railroad tracks running north/south, that were present at least through 1949, but do not currently exist. In the 1988, no historic MGP structures were on the Site but the existing BBC warehouse building was present; and in 2005 the BBC buildings expanded further east and southeast.

1.3 PROPOSED REMEDIAL ACTION

Remedial action activities will consist of the demolition of the one-story building and BBC company warehouse on the Site, earth retention installation, surface and subsurface soil excavation, truck loading and offsite disposal at an Illinois Environmental Protection Agency approved landfill, followed by backfilling of excavations. Excavation activities will be conducted on all areas of the Site at various depths to a maximum anticipated depth of approximately 28 feet below ground surface (bgs). Upon completion of remedial action activities, the property will be backfilled with certified clean material.

Real-time and time-integrated ambient air monitoring will be performed during remedial action activities. Section 3.0 presents additional detailed information regarding ambient air monitoring sampling locations and monitoring activities.

1.4 REPORT ORGANIZATION

This plan contains the following seven sections:

- **Section 1.0 – Introduction**

This section presents the ambient air monitoring objective, site background information and proposed remedial activities.

- **Section 2.0 – Ambient Air Monitoring Program Overview**

This section presents the data quality objectives process used to design the ambient air monitoring program, specific objectives of the program, and a general program overview.

- **Section 3.0 – Project-Specific Ambient Air Monitoring Plan**

This section presents project-specific ambient air monitoring parameters; sampling and monitoring descriptions and locations; sample designation; record keeping and ambient air monitoring schedule.

- **Section 4.0 – Ambient Air Monitoring Management Personnel, Responsibilities, and Communication**

This section defines project team organization, key personnel and contact information.

- **Section 5.0 – Sampling Procedures and Equipment**

This section presents ambient air monitoring sampling procedures, equipment required and equipment calibration/operation procedures.

2.0 AMBIENT AIR MONITORING PROGRAM OVERVIEW

This section provides an overview of the ambient air monitoring program and its major components.

2.1 DATA QUALITY OBJECTIVES PROCESS

The USEPA's data quality objectives (DQO) process (USEPA 2006) was the basis for planning the ambient air monitoring program. A conceptual site model was developed to organize information already known about conditions on the Site and identify additional information necessary to support decisions that will achieve the goals of the ambient air monitoring program. Using this information, a site-specific ambient air monitoring program was designed to obtain a set of ambient air data of sufficient quality and quantity to satisfy the program objectives.

2.2 AMBIENT AIR MONITORING PROGRAM OBJECTIVES

The objectives of the ambient air monitoring program are:

- To monitor the presence or absence of airborne MGP constituents during remedial action activities;
- To document ambient air conditions at the perimeter of the ambient air monitoring zone; and
- To identify the need to implement onsite abatement actions.

2.3 PROGRAM OVERVIEW

Remedial action activities at the Site will consist of surface and subsurface soil excavation, earth retention installation, temporary stockpiling, demolition of the one-story building and demolition of the BBC warehouse. Onsite activities including mobilization, remedial action activities, restoration and demobilization will continue for approximately 24 months. The site-specific ambient air monitoring program will consist of both real-time monitoring and time-integrated sampling activities during remedial action activities.

Real-time ambient air monitoring will be performed using automated or hand-held direct-reading instruments to obtain concentrations of airborne MGP constituents in real-time. In addition, odors and visible dust emissions will be qualitatively monitored by field personnel during real-time ambient air monitoring. Real-time results will be screened against action levels designed to trigger field abatement actions to reduce emissions to ambient air.

Time-integrated sampling will be performed by collecting air samples for off-site laboratory analysis. Time-integrated sampling results provide quantitative results at lower reporting limits than real-time instruments. The results are used to document ambient air conditions at the perimeter of the ambient air monitoring zone and to provide ongoing information for ambient air program management as the remediation progresses. Time-integrated samples will be collected before commencement of remedial actions to provide a baseline ambient air conditions data set and will be used in evaluations of remedial

action ambient-air monitoring results. Additional baseline ambient air samples will be collected following the completion of remedial action activities, as needed.

* * * * *

3.0 PROJECT-SPECIFIC AMBIENT AIR MONITORING PLAN

This section describes the components of the project-specific ambient air monitoring program developed for the Site.

3.1 METEOROLOGICAL MONITORING

Meteorological data for Rockford from National Weather Service station number 94822 at the Greater Rockford Airport was reviewed to establish an anticipated prevailing wind speed and direction during the remedial action activities and to assist in the ambient air monitoring program design. The prevailing winds in the Rockford area are from the south and south southwest with an average speed of 10.7 miles per hour. Winds from the west northwest and northwest also occur with a relatively high frequency in Rockford (Illinois State Climatologist Office 2004).

A portable weather station will be installed within the ambient air monitoring zone to continuously measure ambient air temperature, wind speed, wind direction and barometric pressure. Site-specific temperature and barometric pressure will be used to calculate time-integrated sample concentrations.

3.2 PROJECT AMBIENT AIR MONITORING PARAMETERS

Real-time monitoring will be conducted for total volatile organic compounds (VOCs), benzene, and suspended particulate matter. Time-integrated sampling will be conducted for benzene, ethylbenzene, toluene, total xylenes, and styrene (BTEX/styrene) and polynuclear aromatic hydrocarbons (PAHs).

3.3 AMBIENT AIR SAMPLING AND MONITORING LOCATIONS

Real-time ambient air monitoring and time-integrated sampling activities will be performed at locations along the ambient air monitoring zone perimeter. A review of land use, meteorological data, nearby potential receptors and remedial action activities will be conducted to establish the station locations prior to the start of the remedial actions. Locations may be added or changed by the project management team during field activities if conditions warrant.

3.4 PRE-REMEDIATION ACTIVITIES

Prior to the start of remediation activities, the stations for the time-integrated samples will be erected, and all equipment will be calibrated. Seven sets of 24-hour time-integrated ambient air monitoring samples will be collected and analyzed for BTEX/styrene and PAHs. These samples will be collected to establish pre-construction ambient air conditions. The onsite meteorological station will be installed and calibrated. During mobilization to the Site, a fence that encloses the remedial action activity area will be erected and carbon filament fabric will be placed over this fencing to help limit odor and dust. Access to the Site will be limited to authorized project personnel and gates, also covered with carbon filament fabric, will be closed and locked during non-working hours.

3.5 REAL-TIME MONITORING

During each remedial action activity work period, real-time air monitoring will be performed using a photoionization detector (PID) for VOCs, a portable gas chromatograph (GC) for benzene, and an aerosol (dust) monitoring instrument for suspended particulate matter. Additionally, qualitative monitoring of odorous and visible dust emission will also be conducted by field personnel.

3.5.1 Real-Time Action Levels

Real-time action levels for total VOCs, benzene and suspended particulate matter have been developed to limit potential effects to ambient air quality from airborne MGP constituents that may be emitted during remedial action activities. These action levels will allow appropriate abatement actions to be implemented in a timely manner during field activities. Action levels have been established based on applicable published health-related exposure limits, site-specific information and professional judgment of the project management team. Table R-1 presents the action levels.

3.5.2 Real-Time Data Evaluation

Real-time data will be evaluated throughout the work day. A standard process for conducting real-time monitoring, reporting action level exceedances and taking abatement actions was developed that provides a continuous loop approach to real-time monitoring. In this process, appropriate abatement actions will be taken if an action level is exceeded until such time as the measured total VOC, benzene or suspended particulate matter concentration is below the action level. Figures R-2 through R-5 present the monitoring and notification/abatement action process diagrams. Table R-2 presents the abatement action options to be taken to mitigate emissions onsite. Accumulated real-time data will be reviewed periodically by the project team for ongoing project management.

3.6 TIME-INTEGRATED SAMPLING

Time-integrated samples will be collected over a 24-hour sampling period at each of the ambient air sampling stations for analysis. Samples of BTEX/styrene will be collected in passivated stainless-steel canisters (Summa canisters) in accordance with USEPA Method TO-15 (USEPA 1999a). High-volume samplers equipped with polyurethane foam (PUF)/XAD-2 resin sampling media will be used to collect PAH samples in accordance with USEPA Method TO-13A (USEPA 1999b). Samples will be shipped to an off-site laboratory for analysis. Time-integrated sampling data will be reviewed throughout the remedial action activities to assist with project management, and will be summarized at the conclusion of the project.

3.7 SAMPLE DESIGNATION

Each real-time instrument measurement will be identified by monitoring location, date and time as recorded on the real-time field data log, an example of which is presented in Attachment A. If monitoring data is electronically recorded by an automated real-time system, it will include these same identifying elements.

A sample designation system will be applied to each 24-hour, time-integrated ambient air sample that includes a site identification code, sample station location, sample analysis type, and sample collection date

(month/day/year). For example, a sample started at the Site on January 3, 2018 at sampling station 1 to be analyzed for VOCs will have the following sample designation number: MEN-VOC-1-010318. A label containing the appropriate designation number and other applicable information will be affixed to each sample.

3.8 RECORD KEEPING

Ambient air monitoring field activities and data will be recorded daily in field log books, on field data sheets, or recorded electronically by the automated system. Examples of field data sheets to be used are presented in Attachment A. Files specific to the ambient air monitoring program will be maintained at the onsite project office. Electronic meteorological files and real-time data files will be copied and sent to the BMcD office weekly for permanent storage. After completion of field activities, field files will be transferred to active project files in the BMcD office.

3.9 AMBIENT AIR MONITORING SCHEDULE

Seven sets of pre-activity 24-hour time-integrated ambient air monitoring samples will be collected prior to commencement of remedial action activities as discussed in Section 3.4. Real-time ambient air monitoring instrument readings will be obtained and results recorded during all remedial action activity work periods. Aerosol monitoring for suspended particulate matter will begin during the demolition of the building. Real-time monitoring for total VOCs, benzene and suspended particulate matter will be conducted from the commencement of soil excavation following the building demolition until the soil excavation is completed. In addition, 24-hour, time-integrated sampling for BTEX, styrene, and PAHs will be performed seven days per week following the building demolition and will continue at a minimum until soil excavation is completed.

* * * * *

4.0 AMBIENT AIR MONITORING MANAGEMENT PERSONNEL, RESPONSIBILITIES AND COMMUNICATION

BMcD key personnel for the Site remedial action activities are Joan Gonzalez, Amanda Haugen, Construction Manager, to be determined, and Eileen Perry. Ms. Gonzalez is responsible for overall direction of project operations. She will monitor and check overall project quality. Ms. Haugen will manage daily activities and be responsible for ensuring that project deliverables meet work plan and quality assurance project plan (QAPP) objectives. She will also be responsible for coordinating project activities with Nicor Gas, overseeing subcontractors and coordinating field activities. Ms. Haugen will also be responsible for project technical support. The Construction Manager will be responsible for overseeing field activities, subcontractors and sampling activities. Ms. Perry will be responsible for auditing ambient air monitoring procedures. Ms. Linda Josupait, Tall Oak Associates, will be the Nicor Gas contact for this project. Mr. Jeff Guy is the Illinois Environmental Protection Agency (Illinois EPA) Project Manager.

Table R-3 contains company addresses and phone numbers for key personnel.

* * * * *

5.0 SAMPLING PROCEDURES AND EQUIPMENT

This section provides additional details of the procedures and equipment to be used to conduct the ambient air monitoring program.

5.1 METEOROLOGICAL MONITORING

A portable weather station will be used for measuring and recording wind speed, direction, barometric pressure and ambient temperature. The station consists of a wind sensor assembly, barometer and thermometer. The weather station will be located in an open area of the ambient air monitoring zone with the anemometer and wind vane positioned at a sufficient vertical and horizontal distance from obstructions to minimize interference with wind measurements. Data will be recorded at 30-minute intervals on the weather station data logger and downloaded daily. A copy of the downloaded data will be transmitted to the BMCD office on a daily basis to be archived.

5.2 REAL-TIME MONITORING

Real-time air monitoring will be performed using a combination of instruments in automated real-time monitoring stations and hand-held instruments. The following instruments will be used to conduct real time monitoring.

- A PID will be used for real-time ambient air monitoring of total VOCs. The PID requires an isobutylene gas standard for calibration.
- A portable GC will be used for real-time ambient air monitoring of benzene. The GC requires a benzene gas standard for calibration.
- An aerosol monitoring instrument (dust monitor) will be used for monitoring suspended particulate matter. The aerosol monitor does not require calibration gas.

Real-time results will be recorded on real-time ambient air field data sheets or electronically by the automated monitoring system. Attachment A presents field log forms for real-time instruments.

The real-time automated system will use fixed-station protective metal housing units each containing a PID to monitor total VOCs and an aerosol monitoring instrument. The units will be set up adjacent to the 24-hour sampling station locations. The samples will be obtained by drawing air through metal canes which protrude from the top of the shelter and are attached to each instrument. Samples are then automatically analyzed on a continuous basis during daily remedial action activities. Results are transmitted via a radio-based communication system to a central computer in the field project office for immediate review and subsequent archiving.

Each of the real-time automated stations will be set to analyze total VOCs and particulate matter and calculate 15-minute averaged concentrations. Each time the total VOC or particulate matter 15-minute

averaged concentration exceeds a predetermined limit at an air station, an alert will be sent to air monitoring personnel who will use the portable GC to sample specifically for benzene at that station. Benzene will be analyzed three times in approximately 15 minutes and a 15-minute average will be calculated from the three results. The benzene results will be recorded on real-time ambient air field data sheets. Hand-held instruments will be available for use, as needed.

Action levels for target constituents have been developed to identify emissions from excavation activities that may affect ambient air quality at or beyond the ambient air monitoring zone. Table R-2 presents the onsite abatement action options to be taken to mitigate emissions. If concentrations exceeding the total VOC, benzene, or suspended particulate matter action level are measured, appropriate abatement actions will be taken until such time as the measured total VOC, benzene or suspended particulate matter concentration is below the action level. Abatement actions taken will be recorded on field data sheets. Figures R-2 through R-5 present the real-time monitoring sampling sequences and action level exceedance notification processes for total VOCs, benzene, and suspended particulate matter.

Real-time instruments will be calibrated or field-checked according to the manufacturer's instructions prior to the start of each day of remedial action activities. Attachment A presents examples of calibration and field-check log forms. All real-time instruments will be kept in proper working order with preventative maintenance performed as recommended by the manufacturer.

5.3 TIME-INTEGRATED SAMPLING

Time-integrated ambient air sample collection will be performed over 24-hour sampling periods by USEPA Method TO-15 (USEPA 1999a) for VOCs and USEPA Method TO-13A (USEPA 1999b) for PAHs.

Field data pertinent to each method will be recorded on time-integrated ambient air monitoring field data sheets, which are presented in Attachment A. Pertinent field data includes, but is not limited to, sample location identification number, date, sample start time, sample end time, and flow rate or vacuum gauge reading. Barometric pressure and ambient air temperature required for concentration calculations will be recorded by the onsite meteorological station.

Time-integrated samples will be collected at the end of the 24-hour sampling period. Each sample will be labeled according to criteria discussed in Section 3.7 and appropriately stored onsite per method protocol until shipment to an analytical laboratory. Samples will be packaged according to the methods and shipped to an analytical laboratory with overnight delivery specified. Samples that are not shipped to the laboratory on the day of collection will be stored in a limited access location onsite. PAH samples stored onsite will be kept at 4 degrees Celsius ($^{\circ}\text{C}$) \pm 2 $^{\circ}\text{C}$. Summa canisters will be kept at room temperature, but will not be submitted to temperature extremes. Field and laboratory QC samples for Methods TO-15 and TO-13A are discussed in Section 6.5.

All time-integrated sampling equipment will be checked daily before use to verify proper working conditions. Manufacturer's operating instructions for each instrument will be kept onsite for the duration of 24-hour time-integrated monitoring.

5.3.1 VOC Time-Integrated Sampling Equipment

A 6-liter sub-atmospheric pressure Summa sampling canister will be used specifically for the 24-hour VOC sampling, according to USEPA Method TO-15. Ambient air intake is regulated by a flow controller set to collect 4.5 to 5.5 liters of air over the 24-hour sampling period. The canisters are provided pre-cleaned and evacuated by the analytical laboratory, along with pre-set flow controllers. Method TO-15 Summa canisters do not need to be field calibrated.

5.3.2 PAH Time-Integrated Sampling Equipment

A Tisch TE-1000 PUF high-volume sampler, or equivalent, will be used for 24-hour PAH sampling in accordance with Method TO-13A. The instrument uses a glass sample cartridge containing PUF/XAD-2 resin sampling media and a quartz fiber pre-filter to collect the sample. The sample cartridge with sampling media and filter are provided by the analytical laboratory.

Time-integrated stationary PAH monitoring equipment will be calibrated in accordance with the manufacturer's specifications and Method TO-13A requirements. Calibration results will be recorded on field calibration log forms presented in Attachment A.

* * * * *

6.0 AMBIENT AIR MONITORING PLAN ELEMENTS

This section presents the data quality objectives for the ambient air monitoring plan and presents general procedures for the following:

- sample custody;
- sample preservation and holding time;
- instrument and equipment calibration; and
- collection, preparation and analysis of QC samples.

Data reduction, validation and data reporting are also discussed.

6.1 QUALITY OBJECTIVES FOR DATA MEASUREMENT AND COLLECTION

Project-specific ambient air monitoring data measurement performance criteria have been established to determine if the data are of sufficient quality and quantity for use in meeting the goals of the ambient air monitoring plan. These measurement performance criteria pertain to data quality indices (DQIs) of precision, accuracy/bias, representativeness, comparability and completeness.

6.1.1 Precision

Precision measures the reproducibility of measurements of the same chemical or physical property under a given set of conditions. Analytical precision is assessed by performing duplicate sample analysis. Chemical concentration data from field duplicate samples and laboratory control sample/laboratory control sample duplicates (LCS/LCSD) will be compared to evaluate analytical precision. Field duplicate samples measure precision of sample collection and analysis. The LCS/LCSD samples measure laboratory analytical precision. Precision is expressed in terms of relative percent difference (RPD). The RPD will be calculated for each pair of duplicate analyses using Equation 1.

$$RPD = \left| \frac{S - D}{(S + D)/2} \right| \times 100 \quad (\text{Eqn. 1})$$

Where: S = concentration of primary sample
D = concentration of duplicate sample

Any result outside acceptance criteria for field duplicates requires evaluation of the sample collection method for any likely sources of sample non-homogeneity. If the field team does not identify any likely sources of non-homogeneity, the laboratory will be contacted and requested to verify their results. During the data validation process, data may be qualified based on field duplicate RPD results.

The laboratory must evaluate any LCS/LCSD RPDs outside the laboratory-established acceptance limits, provide a narrative of the deviation, and if warranted, re-prepare and re-analyze the LCS/LCSD sample. During the data validation process, data may be qualified based on LCS/LCSD RPD results.

6.1.2 Accuracy/Bias

Accuracy measures the bias of a measurement system and may be defined as the degree of agreement between the value of the reported data and the accepted or true value of the parameter being measured. To measure accuracy, samples are spiked with a known concentration of target analytes, or surrogates similar to a target analytes (deuterated compounds) prior to analysis. Following the analysis, the recovery of the spike analytes are calculated ($[\text{amount measured} \div \text{amount spiked}] \times 100 = \text{percent recovery}$). Accuracy for VOC analyses will be assessed by the LCS spike recoveries. Accuracy of PAH analyses will be assessed by spiking samples with surrogate chemicals and evaluating the percent of the spiked amount that is detected in the analysis (percent recovery). Both field surrogates (spiked on to the media before shipment to the field) and laboratory surrogates will be analyzed and evaluated.

Analysis of trip blank samples (VOCs), field blank samples (PAHs), and method blank samples will be performed to assess the potential for contamination of samples due to sample shipment, storage, preparation, or analysis that may result in false positive results or high-biased data. During the data validation process, data may be qualified for bias based on spike recoveries or chemicals detected in the blank sample analyses.

6.1.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent ambient air conditions. Representativeness is a qualitative parameter, which is dependent on both the proper design of the sampling program and proper laboratory protocol. The determination of data representativeness will be performed in the following manner:

- Qualitative comparison of actual sampling procedures to those delineated in the ambient air monitoring work plan, USEPA methods, and manufacturer's specifications.
- Quantitative comparison of field duplicate analytical results to determine parameter variation at sampling points.
- Verification that sample holding times and analytical procedures are consistent with approved methodologies.
- Verification that sample preservation requirements are being met.
- Examination of the QC blank results for evidence of contamination; contamination may cause invalidation or qualification of affected samples.

6.1.4 Comparability

Comparability expresses the confidence with which one data set can be compared to another. To produce comparable data, standard methods to collect and analyze data will be used consistently throughout the project, data will be reported in the same units, and reports will be consistently formatted. Comparability will be evaluated after completion of sampling, analysis, data review and data assessment of the samples. Only ambient air data that meets project accuracy and precision criteria will be used for comparability determination.

6.1.5 Completeness

Completeness measures the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. Completeness will be assessed for both field and laboratory activities. A goal of 90% completeness for both field and laboratory activities is anticipated for the time-integrated ambient air sampling. Completeness of the data set will be calculated using Equation 2:

$$\% \text{ Completeness} = \frac{\text{Number of acceptable samples collected and analyzed}}{\text{Number of samples planned}} \times 100 \quad (\text{Eqn. 2})$$

6.2 CUSTODY PROCEDURES

6.2.1 Field Sample Custody

The following presents the procedure for sample packaging and shipment:

- a) After sample collection, securely attach the appropriate preprinted sample label to the sampling media container or attached sample tag (Summa canisters).
- b) Prepare chain-of-custody forms, listing all sample designations and sample locations on the form.
- c) Place sample media in coolers or shipping containers accompanied by the original completed and signed chain-of-custody forms for shipment to the analytical laboratory for analysis. Retain copies of the chain-of-custody forms in the field.
- d) Prior to shipping, secure each cooler and shipping container with packaging tape and attach two custody seals. Cover the custody seals with clear plastic packaging tape.
- e) Send the packed samples to the laboratory by common carrier (overnight express service) using the carrier's bill of lading. Copies of bills of lading will be retained in the project files as part of the permanent documentation. Commercial carriers are not required to sign the custody form as long as the chain-of-custody forms are sealed inside the sample cooler and the custody seals remain intact.

6.2.2 Field Records Custody

BMcD is the custodian of data generated onsite and will maintain the contents of the field files. Data files including all ambient air monitoring activity records, field log sheets and field notebooks will be kept in a

secured, limited access area onsite. At the conclusion of field activities, all field files will be transferred to the BMcD office active project files or the files will be archived.

6.2.3 Laboratory Custody

Laboratory custody will conform to the following:

- Designation of a sample custodian;
- Completion of chain-of-custody forms, sample tags and laboratory request sheets including documentation of sample conditions upon receipt by the custodian;
- Tracking and documentation procedures for laboratory samples;
- Sample storage in an appropriate environment;
- Proper data logging of all original laboratory records; and
- Documentation procedures including custody of all original records.

6.2.4 Data Report Custody

Final laboratory analytical data packages and associated reports will be sent electronically from the laboratory to the site manager at the BMcD office. Analytical data will be stored electronically in the project file on the BMcD secure computer system. Hard copies of the analytical data packages will be maintained in project files.

6.3 SAMPLE PRESERVATION AND HOLDING TIMES

6.3.1 VOC Method TO-15

Summa canisters need to be closed tightly after sample recovery. No special preservation is required by the method. Canisters should be shipped back to the laboratory for analysis in the same containers in which they were received from the laboratory within 48 hours of sampling, preferably on the same day as sample collection. If canisters are not shipped the same day as collection, they should be stored indoors, and extremes in temperature during storage should be avoided. The method does not specify a holding time, but analysis within 14 days of sampling is recommended.

6.3.2 PAH Method TO-13A

When sampling is complete, samples are wrapped in the original hexane-rinsed aluminum foil and placed in the original shipping container. Samples are stored and shipped at $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$ until receipt at the analytical laboratory. At the laboratory, samples and extracts should be refrigerated at $\leq 4^{\circ}\text{C}$. Extraction must be performed within 7 days of sample collection; extracts must be analyzed within 40 days of extraction.

6.4 CALIBRATION PROCEDURES AND FREQUENCY

6.4.1 Real-time Monitoring Instruments

Each real-time monitoring instrument will be calibrated in accordance with the manufacturer's instruction manual. If a calibration gas is required for calibration, the concentration of the calibration gas will be within the range of the expected concentrations in ambient air during remedial action activities. Prior to calibration, each monitoring instrument will be zeroed in a controlled environment. The PID and GC should be zeroed away from exhaust fumes and other volatile organic sources which bias the zero setting. At a minimum, each instrument will be zeroed and calibrated or field checked at the beginning of each work day. Recalibration should be performed when field conditions change, instrument maintenance is performed, or the instrument is turned off for an extended period.

6.4.2 Time-Integrated Sampling Equipment

6.4.2.1 VOC Method TO-15

No field calibration is necessary. The laboratory will provide flow controllers that have been calibrated to provide the necessary air flow to collect a 4.5- to 5.5-liter sample over 24 hours in the 6-liter Summa canister.

6.4.2.2 PAH Method TO-13A

Calibration of the high-volume air sampler is conducted using a flow rate transfer standard that is calibrated annually by the manufacturer or vendor certified to conduct the calibration. A multi-point calibration of the high-volume sampler is conducted in the field using the calibrated flow rate transfer standard following the manufacturer's instruction manual and Method TO-13A requirements. The multi-point calibration is conducted when the sampler is initially installed, after repairs or maintenance (e.g. replacement of motor brushes), whenever an audit single-point calibration check deviates from the calibration curve by more than 10%, or when a sampling media, other than the one the sampler was originally calibrated to, will be used for sampling.

An audit single-point calibration check will be performed once per week on each sampler. TO-13A recommends performing this calibration before and after each sample is collected; however, BMcD field experience has shown that a once-per-week single-point calibration check, used in conjunction with daily review of flow rates for samplers, is sufficient to audit the sampler flow rate when conducting continuous 24-hour sampling.

6.4.3 Laboratory Analytical Instruments

Laboratory personnel will be responsible for calibration procedures and frequency of calibration for laboratory instruments. Calibration procedures and frequencies will comply with the USEPA Method TO-15 and Method TO-13A specifications.

6.5 QUALITY CONTROL SAMPLES

6.5.1 Field Quality Control Samples

Field QC samples include field duplicate or collocated samples, field blanks and trip blanks. Table R-4 presents the field QC samples required for methods TO-15 and TO-13A.

6.5.2 Laboratory Quality Control Samples

The laboratory will follow QC procedures specified in each USEPA method protocol and the laboratory standard operating procedures (SOP) for the method. The following QC documentation will be provided by the laboratory as required by each method:

- Surrogate recoveries – name of each compound and analytical result.
- Method/instrument blanks – name of each compound and analytical result.
- LCS or LCS/LCSD – name of each compound, analytical result, and, if LCSD is analyzed, the RPD between primary sample and duplicate.

6.6 DATA REDUCTION AND VALIDATION

Data reduction and validation activities shall be performed in a planned and controlled manner. The BMcD project manager or the site manager shall discuss the scope of work, contractual and regulatory requirements, and applicable QA/QC procedures with assigned personnel prior to initiating the activities. The results of data reduction and validation shall be completely documented to provide evidence of satisfactory work performance and usability of ambient air monitoring data.

6.6.1 Data Reduction

6.6.1.1 Real-Time Data

In general, instruments used for real-time ambient air monitoring produce direct readings without additional data manipulation. Any calculations performed must be legible and in a form suitable for reproduction, filing, and retrieval. Documentation will be sufficient to permit a technically qualified individual to review and understand the calculations and verify the results. The results of data analysis may be presented in logs and tables of various forms. The format of the logs and tables will be governed by the information presented.

6.6.1.2 Time-Integrated Analytical Data

The laboratory will perform data reduction as required by its SOP for the method. Data conversion to report results from VOC analyses by Method TO-15 in units of micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) for samples analyzed will be the responsibility of the laboratory. The laboratory will report PAH analyses by Method TO-13A in units of micrograms per sampling media unit ($\mu\text{g}/\text{PUF}$). Data will be converted by BMcD using field data (volume of air sampled, temperature and barometric pressure) to units of $\mu\text{g}/\text{m}^3$ at standard temperature and pressure.

6.6.2 Data Validation and Reduction

6.6.2.1 Field Data

Calculations, logs and tables shall be formally checked using the standard BMcD process. For calculations, assignments for checking shall be made or approved by the project manager or site manager. An individual other than the person who performed the original work, or specified the method or input parameters to be used, shall verify the calculations. In addition to performing a numerical check, the individual who reviews the calculations shall check every item on every sheet, including the completion of the title block and page numbers. The project manager shall assign a senior member of the project group to verify field logs and tables. The verification will confirm that the field logs are complete and have accurately recorded real-time ambient air monitoring results and calibrations. Any changes to the logs and tables required by the verification process shall be made by the person who originally recorded the data on the log or input the data to the table.

Data reduction includes processes that change either the form of expression, quantity of data volumes or number of data items. Reduction of field data is not expected to be required; however, any reduction of field data performed will be annotated in a data reduction table.

6.6.2.2 Laboratory Data

Validation of laboratory data will be accomplished by comparing the contents of data packages and QA/QC results to the requirements contained in each specific USEPA method protocol. All data will be reviewed and evaluated to the DQIs of precision, accuracy/bias, representativeness, comparability and completeness as discussed in Section 6.1. Laboratory data will be validated by BMcD personnel in accordance with the method QC requirements and USEPA guidelines for evaluating organic analyses. The process must be satisfactorily completed for the data to be considered valid. Data validation findings and qualifications will be reported in data validation memoranda. Any required data qualifiers will be added to the data with an explanation for qualification.

Data reduction performed by the laboratory will be performed in compliance with analytical methods and laboratory SOP requirements and narrated in the analytical reports. Laboratory data reduction performed by BMcD will be described in the data validation memorandum.

* * * * *

7.0 REFERENCES

Brown's Directory of American Gas Companies, Moore Publishing Company, Inc., New York, N.Y., 1887-1942 editions.

Illinois State Climatologist Office, 2004. Wind Rose Plot, Station #94822 – Greater Rockford Arpt, IL. Accessed at http://www.isws.illinois.edu/atmos/statecli/Roses/wind_climatology.htm on February 10, 2015.

United States Environmental Protection Agency (USEPA), 1999a. *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air: Method TO-15*, 2nd ed., January.

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USEPA, 2006. *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA/240/B-06/001, February.

* * * * *

TABLES
Remedial Action Ambient Air Monitoring Work Plan
Mendota MGP – Black Brothers Company Site

<p>Table R-1 Real Time Ambient Air Monitoring Action Levels Mendota MGP - Black Brothers Company Site</p>		
Constituent	Action Level	Corrective Action
Total VOCs	≥ 1 ppm (15 min average)	Collect benzene sample and evaluate abatement actions
	≥ 10 ppm (15 min average)	Take appropriate abatement action*
Benzene	≥ 0.100 ppm (15 min average)	Take appropriate abatement action*
Particulate Matter	≥ 500 µg/m3 (15 min average)	Take appropriate abatement action*
Dust	Visible Observation	Take appropriate abatement action*

Note:

1) * - Abatement actions are described in Table R-2

Table R-2
Real-Time Ambient Air Monitoring Abatement Action Options
Mendota MGP – Black Brothers Company Site

Abatement Action Type	Site Activity
Emission Diversion / Dispersion	<ul style="list-style-type: none"> • Extend ambient air monitoring zone beyond what is needed for personal health & safety. • Extend ambient air monitoring zone to all areas where action levels are exceeded.
Work Procedures / Work Reduction	<ul style="list-style-type: none"> • Temporarily relocate work to an excavation area with potentially lower emission levels. • Slow the pace of site activity. • Modify work sequence or equipment to alternates that minimize air emissions. • Perform work during cold weather only, if feasible. • Limit on-site blending/processing. • Cease site activities.
Cover Work / Emission Suppression	<ul style="list-style-type: none"> • Apply water to area of activity/haul roads to minimize dust emissions. • Cover portions of the emission sources such as excavation area. • Cover exposed impacted materials. • Apply VOC and particulate matter emission suppressant such as foam over the surface of inactive open areas/surfaces/pits. • Cover stockpiles with polypropylene sheeting or containerize excavated material. • Encapsulate removal area(s) and filter/treat air exhaust prior to discharge to surroundings (e.g., place under a temporary building structure).

Note:

- 1) The abatement activities listed can be implemented in the order that is most appropriate to site conditions. Additional abatement activities not listed may also be implemented based on site conditions.

Table R-3
Key Personnel–Address and Phone Number List
Mendota MGP – Black Brothers Company Site

Burns & McDonnell 1431 Opus Place, Suite 400 Downers Grove, IL 60515	Joan Gonzalez	(630) 724-3226
	Amanda Haugen	(630) 724-3238
	Eileen Perry	(630) 724-3399
	FAX	(630) 724-3201
Tall Oak Associates (on behalf of Nicor Gas) 1844 Ferry Road Naperville, IL 60563	Linda Josupait	(630) 926-4093
	FAX	(630) 983-4345
Illinois EPA Bureau of Land 1001 North Grand Ave. East P.O. Box 19276 Springfield, IL 62794-9276	Jeff Guy	(217) 785-8724
	FAX	(217) 557-8728

<p>Table R-4 Field Quality Control Samples for Laboratory Analysis Mendota MGP – Black Brothers Company Site</p>			
Method	Duplicate or Collocated Sample	Field Blank	Trip Blank
TO-15	5% of samples taken or once per week, whichever is greater	NA	5% of samples taken or once per week, whichever is greater
TO-13A	5% of samples taken or once per week, whichever is greater	5% or more of samples taken	NA

Note:

1) NA – QC sample not applicable to this method.

FIGURES
Remedial Action Ambient Air Monitoring Work Plan
Mendota MGP – Black Brothers Company Site

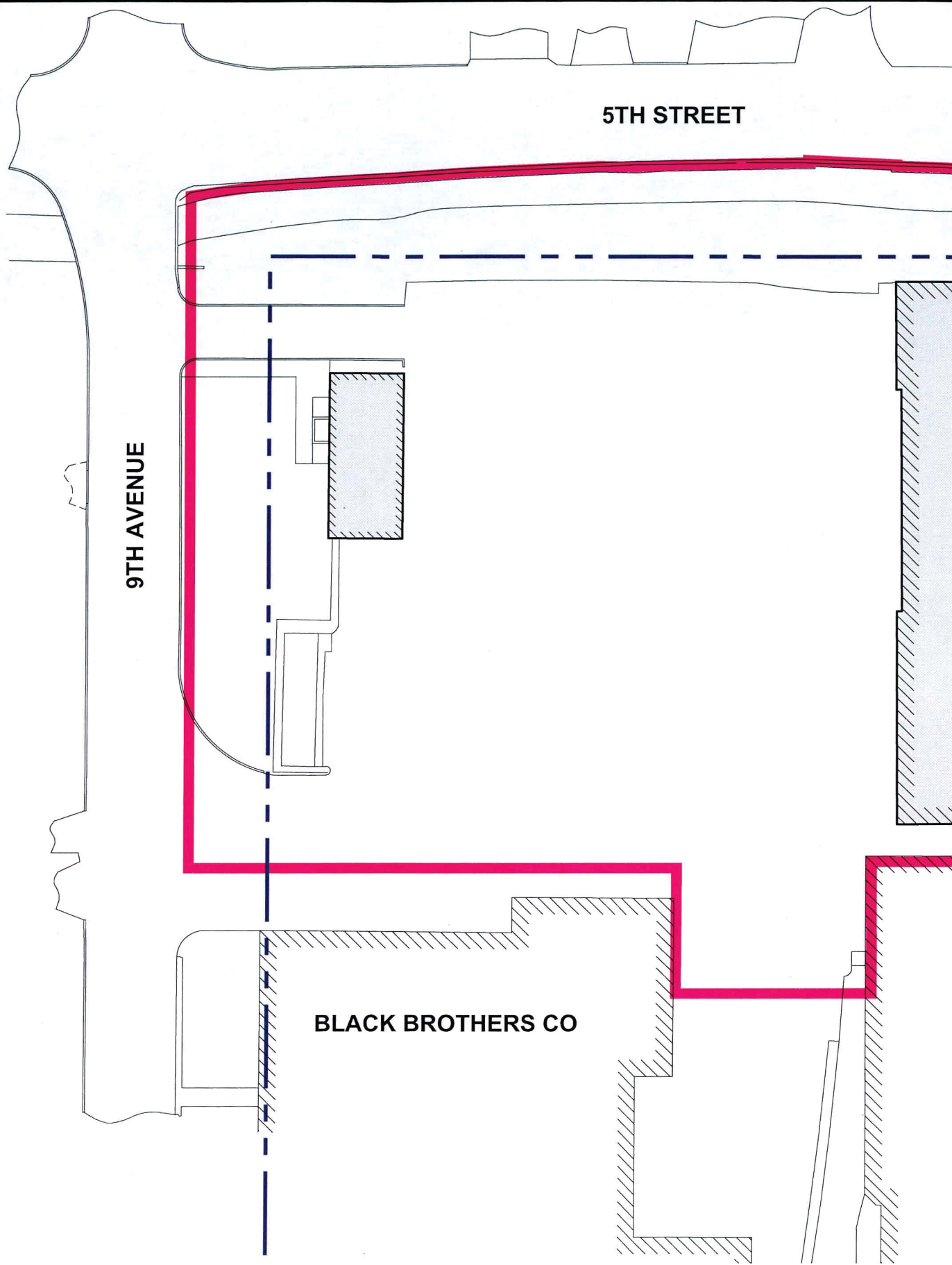
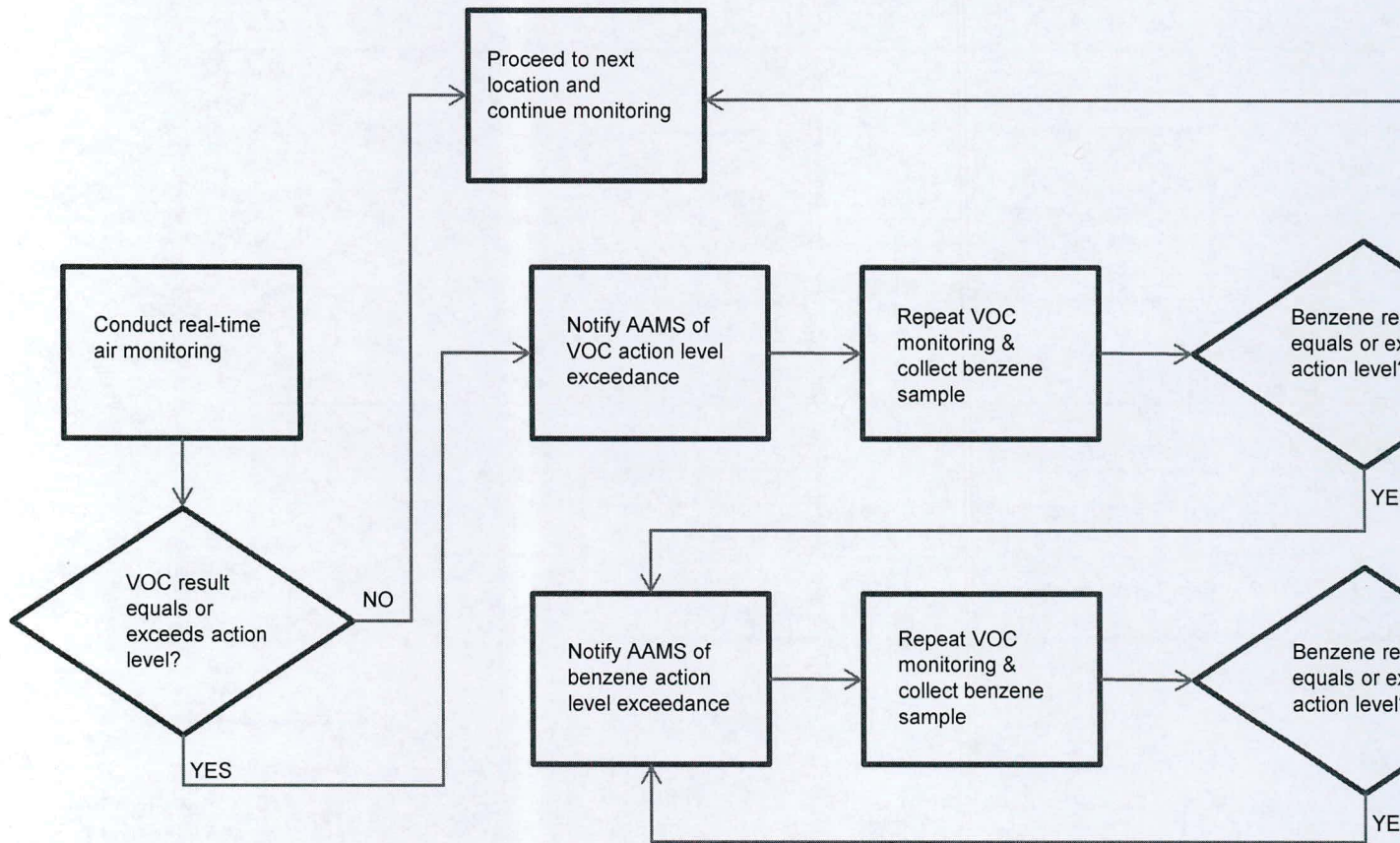


Figure R-2
 Real-Time Monitoring Process Diagram for VOCs and Benzene
 Monitoring Technician Procedures
 Remedial Action Ambient Air Monitoring Work Plan



Notes:

- 1) AAMS – Ambient Air Monitoring Supervisor

Figure R-3
Real-Time Monitoring Action Level Exceedance
Notification Procedures for VOCs and Benzene
Remedial Action Ambient Air Monitoring Work Plan

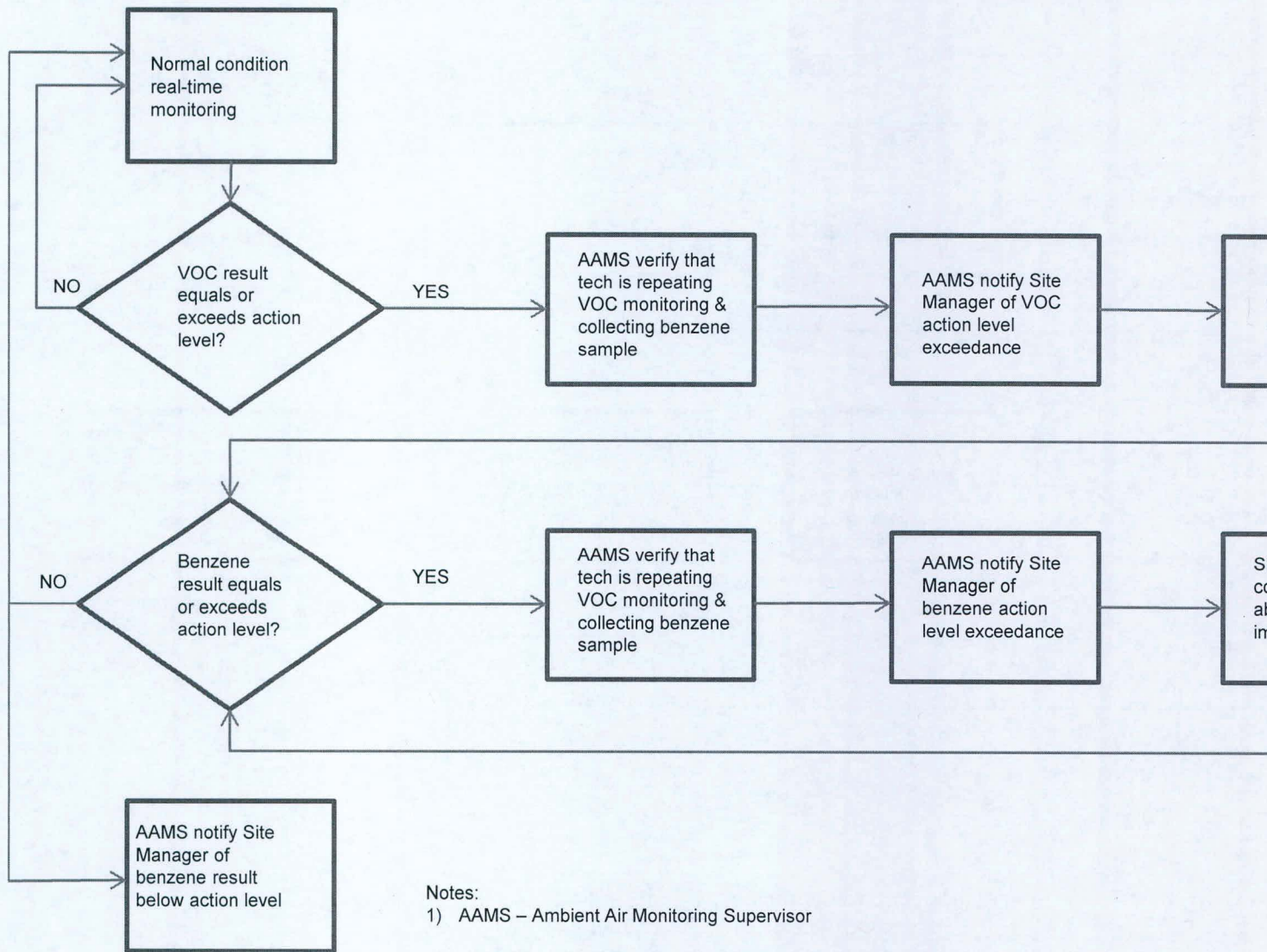
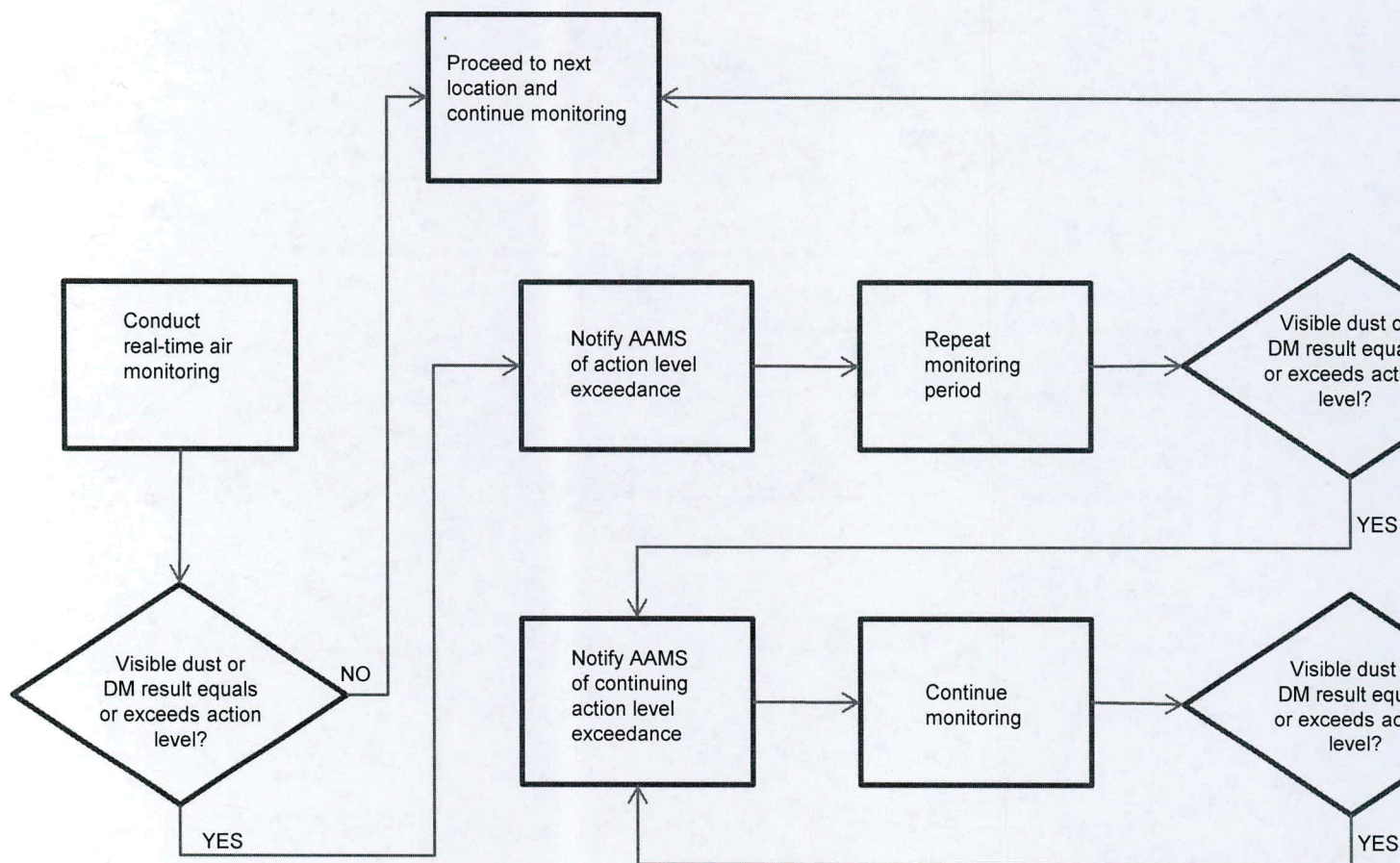


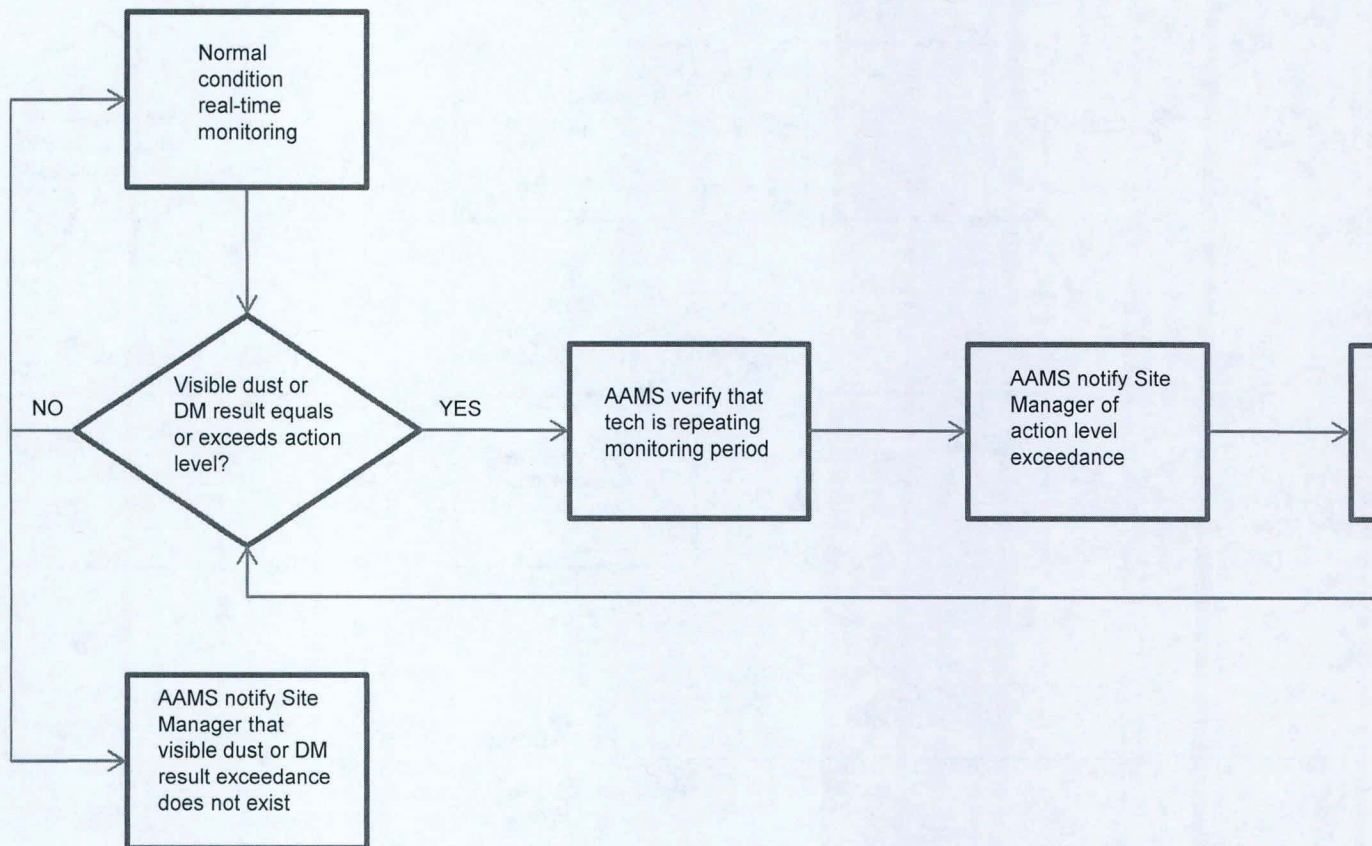
Figure R-4
 Real-Time Monitoring Process Diagram for Suspended Particulate Matter
 Monitoring Technician Procedures
 Remedial Action Ambient Air Monitoring Work Plan



Notes:

- 1) DM – Dust Monitor
- 2) AAMS – Ambient Air Monitoring Supervisor

Figure R-5
 Real-Time Monitoring Action Level Exceedance
 Notification Procedures for Suspended Particulate Matter
 Remedial Action Ambient Air Monitoring Work Plan



Notes:

- 1) DM – Dust Monitor
- 2) AAMS – Ambient Air Monitoring Supervisor

ATTACHMENT A
Field Data Sheets and Instrument Calibration Log Forms
Remedial Action Ambient Air Monitoring Work Plan
Mendota MGP – Black Brothers Company Site

Real-Time Ambient Air Sampling Field Data Sheet

Project: **Mendota MGP Site**

Sampling Location: _____

Sampler: _____

Project #:

Date: _____

Weather: _____

Time	PID (ppm) Manufacturer: _____ Model: _____ Serial #: _____	Dust Meter (mg/m ³) Manufacturer: _____ Model: _____ Serial #: _____	Benzene (ppm) Serial #: _____	Remarks (Note odor/visible dust)

Notes:

- 1) Action required if PID instantaneous reading exceeds 1.0 ppm.
- 2) Action required if GC instantaneous reading exceeds 0.100 ppm.
- 3) Action required if dust meter instantaneous reading exceeds 0.150 mg/m³.

4) Possible corrective actions:

- A) Cover soil cuttings with polypropylene sheeting or contain.
- B) Apply VOC emission suppressant foam to excavations.
- C) Apply water to areas of activity/roads to minimize dust.
- D) Re-sample air and find concentrations to be below action.
- E) Contact project manager.
- F) Cease excavation activities.

Hand-Held Real-Time Instrument Calibration Log
Mendota MGP - Black Brothers Company Site

Project #: _____ Instrument: **PID** _____
 Manufacturer/Model #: _____ Calibration Gas Lot #: _____
 Serial #: _____ Calibration Gas Expiration Date: _____

Instrument: PID

Manufacturer/Model #: _____

Serial #: _____

Calibration Gas Lot #: _____

Calibration Gas Expiration Date:_____

[illegible]

Project #: _____ Instrument: _____
 Manufacturer/Model #: _____ Calibration Gas Lot #: _____
 Serial #: _____ Calibration Gas Expiration Date: _____

[illegible]

[illegible]Instrument: Aerosol/Dust Monitor

Serial #:

Automated Real-Time Ambient Air Monitoring Systems Daily Field Log
Mendota MGP - Black Brothers Company Site

System Operations	General Observations
Sampling Date: _____	General Weather Conditions: _____
Site Activity Start Time: _____	General Description of Site Activities: _____
Site Activity Stop Time: _____	

Action Level Log

[illegible]

General Notes:

NOTES: _____ POSSIBLE CORRECTIVE ACTIONS: _____

- 1) SPM = Suspended particulate matter
- 2) Wind direction is recorded as the direction from which the wind is blowing
- 3) If total VOC concentration exceeds 1.0 ppm (15 min average), take benzene sample using GC
- 4) Action required if total VOC concentration exceeds 10.0 ppm (15 min average)
- 5) Action required if benzene concentration exceeds 0.100 ppm (15 min average)
- 6) Action required if SPM concentration exceeds 0.500 mg/m³ (15 min average).

POSSIBLE CORRECTIVE ACTIONS:

- POSSIBLE CORRECTIVE ACTIONS:
- A) Re-sample air and obtain results below action levels.
 - B) Slow down Site activities.
 - C) Use dust control measures (e.g. apply water to roads).
 - D) Use VOC/benzene control measures (e.g. vapor-suppressing foam, cover excavations/soil stockpiles, etc.).
 - E) Contact project manager.
 - F) Cease Excavation Activity.
 - NA - Not applicable

WIND LOCATION KEY:

U = Upwind
C = Crosswind
D = Downwind

Automated Real-Time Ambient Air Monitoring Systems Daily Calibrations Mendota MGP - Black Brothers Company Site

Sampling Date: _____

Comments: _____

Station 1 Time	Station 2 Time	Station 3 Time	Station 4 Time
VOC zero check ppm	VOC zero check ppm	VOC zero check ppm	VOC zero check ppm
VOC calibration ppm	VOC calibration ppm	VOC calibration ppm	VOC calibration ppm
Aerosol monitor	Aerosol monitor	Aerosol monitor	Aerosol monitor

Calibrated by: _____

Sampling Date: _____

Comments: _____

Station 1 Time	Station 2 Time	Station 3 Time	Station 4 Time
VOC zero check ppm	VOC zero check ppm	VOC zero check ppm	VOC zero check ppm
VOC calibration ppm	VOC calibration ppm	VOC calibration ppm	VOC calibration ppm
Aerosol monitor	Aerosol monitor	Aerosol monitor	Aerosol monitor

Calibrated by: _____

Sampling Date: _____

Comments: _____

Station 1 Time	Station 2 Time	Station 3 Time	Station 4 Time
VOC zero check ppm	VOC zero check ppm	VOC zero check ppm	VOC zero check ppm
VOC calibration ppm	VOC calibration ppm	VOC calibration ppm	VOC calibration ppm
Aerosol monitor	Aerosol monitor	Aerosol monitor	Aerosol monitor

Calibrated by: _____

Sampling Date: _____

Comments: _____

Station 1 Time	Station 2 Time	Station 3 Time	Station 4 Time
VOC zero check ppm	VOC zero check ppm	VOC zero check ppm	VOC zero check ppm
VOC calibration ppm	VOC calibration ppm	VOC calibration ppm	VOC calibration ppm
Aerosol monitor	Aerosol monitor	Aerosol monitor	Aerosol monitor

Calibrated by: _____

Sampling Date: _____

Comments: _____

[illegible]

* Final pressure should be greater than or equal to -12"Hg, but not 0" Hg or positive pressure. If final pressure is not between -12"Hg and -0.1"Hg, discuss with site manager or air mon

PAHs
24-Hour Ambient Air Sampling
Field Data Sheet
Mendota MGP - Black Brothers Company Site

[illegible]

PAHs
24-Hour Ambient Air Sampling
Field Multi-Point Calibration Data Sheet
Mendota MGP - Black Brothers Company Site

	Dial Gage ("H ₂ O)	Manometer ("H ₂ O)
Station: _____		
Date: _____	70	
Time: _____	60	
Temperature (°F): _____	50	
Pressure ("Hg): _____	40	
Calibrated by: _____	30	
	Set Point	
Station: _____		
Date: _____	70	
Time: _____	60	
Temperature (°F): _____	50	
Pressure ("Hg): _____	40	
Calibrated by: _____	30	
	Set Point	
Station: _____		
Date: _____	70	
Time: _____	60	
Temperature (°F): _____	50	
Pressure ("Hg): _____	40	
Calibrated by: _____	30	
	Set Point	
Station: _____		
Date: _____	70	
Time: _____	60	
Temperature (°F): _____	50	
Pressure ("Hg): _____	40	
Calibrated by: _____	30	
	Set Point	

PAHs
24-Hour Ambient Air Sampling
Field Single-Point Calibration Check Data Sheet
Mendota MGP - Black Brothers Company Site

Set Dial Gage at 110% of sampler set point for single-point calibration.

	110% Current Set Point ("H ₂ O)	Dial Gage ("H ₂ O)	Manometer ("H ₂ O)
Station: _____	<div style="border: 1px solid black; width: 100px; height: 20px;"></div>	<div style="border: 1px solid black; width: 100px; height: 20px;"></div>	<div style="border: 1px solid black; width: 100px; height: 20px;"></div>
Date: _____			
Time: _____			
Temperature (°F): _____			
Pressure ("Hg): _____	% Difference _____ OK? _____		
Checked by: _____			

	110% Current Set Point ("H ₂ O)	Dial Gage ("H ₂ O)	Manometer ("H ₂ O)
Station: _____	<div style="border: 1px solid black; width: 100px; height: 20px;"></div>	<div style="border: 1px solid black; width: 100px; height: 20px;"></div>	<div style="border: 1px solid black; width: 100px; height: 20px;"></div>
Date: _____			
Time: _____			
Temperature (°F): _____			
Pressure ("Hg): _____	% Difference _____ OK? _____		
Checked by: _____			

	110% Current Set Point ("H ₂ O)	Dial Gage ("H ₂ O)	Manometer ("H ₂ O)
Station: _____	<div style="border: 1px solid black; width: 100px; height: 20px;"></div>	<div style="border: 1px solid black; width: 100px; height: 20px;"></div>	<div style="border: 1px solid black; width: 100px; height: 20px;"></div>
Date: _____			
Time: _____			
Temperature (°F): _____			
Pressure ("Hg): _____	% Difference _____ OK? _____		
Checked by: _____			

	110% Current Set Point ("H ₂ O)	Dial Gage ("H ₂ O)	Manometer ("H ₂ O)
Station: _____	<div style="border: 1px solid black; width: 100px; height: 20px;"></div>	<div style="border: 1px solid black; width: 100px; height: 20px;"></div>	<div style="border: 1px solid black; width: 100px; height: 20px;"></div>
Date: _____			
Time: _____			
Temperature (°F): _____			
Pressure ("Hg): _____	% Difference _____ OK? _____		
Checked by: _____			

PAHs
24-Hour Ambient Air Sampling
Duplicate PUF Sampler Field Multi-Point Calibration Data Sheet
Mendota MGP - Black Brothers Company Site

Duplicate Sampler		Dial Gage	Manometer
At Station _____		("H ₂ O)	("H ₂ O)
Date:		70	
Time:		60	
Temperature (°F):		50	
Pressure ("Hg):		40	
Calibrated by:		30	
		Set Point	
Duplicate Sampler		Dial Gage	Manometer
At Station _____		("H ₂ O)	("H ₂ O)
Date:		70	
Time:		60	
Temperature (°F):		50	
Pressure ("Hg):		40	
Calibrated by:		30	
		Set Point	
Duplicate Sampler		Dial Gage	Manometer
At Station _____		("H ₂ O)	("H ₂ O)
Date:		70	
Time:		60	
Temperature (°F):		50	
Pressure ("Hg):		40	
Calibrated by:		30	
		Set Point	
Duplicate Sampler		Dial Gage	Manometer
At Station _____		("H ₂ O)	("H ₂ O)
Date:		70	
Time:		60	
Temperature (°F):		50	
Pressure ("Hg):		40	
Calibrated by:		30	
		Set Point	

APPENDIX S
Remedial Action Quality Assurance Project Plan
Mendota MGP - Black Brothers Company Site
Revised SI/ROR/RAP

**Mendota MGP – Black Brothers Company Site
Remedial Action Quality Assurance Project Plan**

Prepared June 2017

ACRONYMS AND ABBREVIATIONS

BMcD	Burns & McDonnell
CLP	Contract Laboratory Program
DQOs	data quality objectives
IAC	Illinois Administrative Code
IL ELAP	Illinois Environmental Laboratory Accreditation Program
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
MDL	method detection limit
MGP	manufactured gas plant
MS	matrix spike sample
MSD	matrix spike duplicate sample
% R	percent recovery
QA	quality assurance
QAM	quality assurance manual
QAPP	quality assurance project plan
QC	quality control
PDF	Portable Document File format
RACR	remedial action completion report
RPD	relative percent difference
RO	remediation objective
SI/ROR/RAP	site investigation report, remediation objectives report and remedial action plan
SOP	standard operating procedure
SRP	Site Remediation Program
SVOC	semivolatile organic compound
USEPA	U. S. Environmental Protection Agency
VOC	volatile organic compound

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1.0 INTRODUCTION

This quality assurance project plan (QAPP) establishes consistent field and laboratory procedures and methods for collection of confirmation samples during remedial action activities at the Mendota Manufactured Gas Plant (MGP) – Black Brothers Company Site. This plan will be used in conjunction with the *Revised Site Investigation/Remediation Objectives Report/Remedial Action Plan* (Revised SI/ROR/RAP).

The QAPP has 15 sections:

- **Section 1.0–Introduction**

This section presents the purpose and organization of the QAPP.

- **Section 2.0–Project Description and Objectives**

This section outlines data quality and overall objectives of the project and identifies sections in the Revised SI/ROR/RAP where additional project specific information can be found.

- **Section 3.0–Project Organization and Responsibility**

This section defines the roles and responsibilities of the Burns & McDonnell (BMcD) senior project manager, project manager/review team leader and site manager.

- **Section 4.0–Quality Assurance Objectives for Measurement Data**

This section presents the level of quality control (QC) that will be adhered to; analytical detection limits; and precision, accuracy, representativeness, completeness, and comparability criteria and objectives.

- **Section 5.0–Sampling and Decontamination Procedures**

This section presents sampling and decontamination procedures.

- **Section 6.0–Sample Custody**

This section presents sample documentation and custody procedures.

- **Section 7.0–Calibration Procedures and Frequency**

This section presents procedures for maintaining the accuracy of instruments and measuring equipment used to perform field measurements and laboratory analyses.

- **Section 8.0–Sample Transport and Analytical Procedures**

This section discusses sample transport and laboratory analytical procedures.

- **Section 9.0–Internal Quality Control Checks**

This section presents the methods used to verify that field and laboratory QC procedures are followed for sample collection and analysis, as specified, to provide high quality data.

- **Section 10.0–Data Reduction, Validation and Reporting**

This section presents data reduction, validation procedures, and data reporting methods.

- **Section 11.0–Performance and System Audits**

This section describes auditing procedures that will be performed to ensure adherence to field and laboratory procedures.

- **Section 12.0–Preventative Maintenance Procedures**

This section defines procedures that will be followed by field and laboratory personnel to maintain equipment and instruments in proper working condition.

- **Section 13.0–Procedures to Assess Data Precision, Accuracy and Completeness**

This section discusses procedures that will be used to assess compliance with precision, accuracy and completeness criteria.

- **Section 14.0–Corrective Actions**

This section defines corrective actions to be implemented if QC procedures are not met.

- **Section 15.0–Quality Assurance Reports**

This section details quality assurance (QA) reporting procedures.

* * * * *

2.0 PROJECT DESCRIPTION AND OBJECTIVES

2.1 PROJECT OBJECTIVES

Revised SI/ROR/RAP presents project objectives for remedial action activities.

2.2 DATA QUALITY OBJECTIVES

The data quality objectives (DQOs) for confirmation sampling are to provide sampling data that is technically sound, valid, and properly documented to establish that remediation objectives (ROs) have been met. Data must meet criteria established in the QAPP for precision, accuracy, representativeness, completeness and comparability of laboratory analytical results to comply with the DQOs. It is expected that at least 95% of confirmation samples collected during the remedial action activities will meet the DQO requirements.

2.3 SITE BACKGROUND AND CURRENT INFORMATION

Section 1.2 and 1.3 of the Revised SI/ROR/RAP presents the Mendota MGP – Black Brothers Company Site description and history.

2.4 PREVIOUS INVESTIGATIONS

Section 2 of the Revised SI/ROR/RAP presents information on past investigations performed at the Mendota MGP – Black Brothers Company Site.

2.5 PLANNED REMEDIATION ACTIVITIES

Revised SI/ROR/RAP describes proposed remedial action activities and the rationale for confirmation sample collection.

2.6 PROJECT SCHEDULE

Revised SI/ROR/RAP provides the anticipated project schedule for the remediation of the Mendota MGP – Black Brothers Company Site.

* * * * *

3.0 PROJECT ORGANIZATION AND RESPONSIBILITY

Burns & McDonnell key personnel for the Mendota MGP – Black Brothers Company Site remedial action activities are Joan Gonzalez, Amanda Haugen, Site Manager and Construction Manager, to be determined. Ms. Gonzalez is responsible for overall direction of project operations. She will monitor and check overall project quality. Ms. Haugen will manage daily activities and be responsible for ensuring that project deliverables meet work plan and QAPP objectives. She will also be responsible for coordinating project activities with Nicor Gas, overseeing subcontractors and coordinating field activities. Ms. Haugen will be responsible for project quality assurance/quality control and technical support. The Site Manager will be responsible for overseeing field activities and sampling activities. The Construction Manager will be responsible for onsite construction activities.

Ms. Linda Josupait of Tall Oak Associates and Mr. Greg Corbett of AGL Resources will be the Nicor Gas contacts for this project, and Mr. Jeff Guy is the Illinois EPA Project Manager. Table S-1 contains company addresses and phone numbers for key BMcD, Nicor Gas and Illinois EPA personnel.

Table S-1 Key Personnel–Address and Phone Number List		
Burns & McDonnell 1431 Opus Place, Suite 400 Downers Grove, IL 60515	Joan Gonzalez	(630) 724-3226
	Amanda Haugen	(630) 724-3238
	Construction Manager	TBD
	FAX	(630) 724-3201
Tall Oak Associates (on behalf of Nicor Gas) 1844 Ferry Road Naperville, IL 60563	Linda Josupait	(630) 926-4093
	FAX	(630) 983-4345
Illinois EPA Bureau of Land 1001 North Grand Ave. East P.O. Box 19276 Springfield, IL 62794-9276	Jeff Guy	(217) 785-8724
	FAX	(217) 782-3258

4.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The overall QA objective is to develop and implement procedures for confirmation sampling, laboratory analysis and data reporting that will achieve the DQOs described in Section 2.2 of this QAPP. This section addresses analytical methods; preservation and holding times; and analytical detection limits. Methods for determining precision, accuracy, representativeness, completeness, and comparability of the sample data are discussed. Specific QA/QC requirements for sample collection and analysis at sites enrolled in the Illinois Site Remediation Program (SRP) as stated in 35 Illinois Administrative Code [IAC], Part 740, Section 740.415 will be met, as applicable, during the remedial action confirmation sampling. To provide sample analyses and laboratory QA/QC procedures that are consistent with Illinois EPA protocols, laboratories performing soil and water chemical analyses will be accredited by the Illinois Environmental Laboratory Accreditation Program (IL ELAP) as required by the SRP (35 IAC 740.415).

4.1 ANALYTICAL METHODS, PRESERVATION AND HOLDING TIMES

The analytical methods to be used to determine chemical concentrations are presented in Table S-2 below.

Table S-2 Laboratory Analytical Methods, Preservation and Holding Times			
Analyte	Laboratory Analysis Method¹	Sample Preservation	Holding Times
Volatile Organic Compounds (VOCs)	SW-846 8260B	Cool to 4°C (soil); Cool to 4°C and HCl (groundwater)	48 hours to sample preservation ² ; 14 days from sampling to analysis
Semivolatile Organic Compounds (SVOCs)	SW-846 8270D	Cool to 4°C	14 days to extraction; 40 days from extraction to analysis (soil); 7 days to extraction; 40 days from extraction to analysis (groundwater)
Metals	SW-846 6010C or 6020A	None (soil); HNO ₃ (groundwater)	6 months to analysis
Mercury	SW-846 7471 (soil); SW-846 7470 (groundwater)	Cool to 4°C (soil); Cool to 4°C and HNO ₃ (groundwater)	28 days from sampling to analysis
SPLP Metals (soil)	SW-846 6010C or 6020A, 1312 (preparation)	None	6 months to preparation and 6 months from preparation to analysis

Notes:

- 1) USEPA Publication No. SW-846: *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods*, Third Edition, as amended by updates through January 2008.
- 2) Soil Samples to be collected in EnCore samplers require preservation upon receipt at the laboratory.

4.2 DETECTION LIMITS

The laboratory detection limits will not exceed the concentrations established as the Site ROs in the tables of the Revised SI/ROR/RAP. Detection limits should be two to five times lower than the RO for each analyte except where limited by instrument sensitivity.

4.3 ACCURACY AND PRECISION

Accuracy and precision measure the reproducibility of analytical results and the bias of the measurement method. Data accuracy and precision will be monitored through the analysis of QC samples including surrogates (organic compounds only), laboratory control samples (LCS) and laboratory control sample duplicates (LCSD), and laboratory-selected matrix spike (MS) and matrix spike duplicate samples (MSD).

Accuracy is the ability of a measurement to match an accepted reference value. This is typically measured as percent recovery (% R). Laboratory surrogates are used to measure accuracy of the method for recovering specific organic compounds, and LCS are used to measure accuracy of instrument detection of the organic and inorganic analytes. Percent recoveries of surrogates and LCS are calculated using Equation 4-1.

$$\% R = \frac{Q_d}{Q_a} \times 100 \quad \text{Equation 4 - 1}$$

Where: Q_d = Quantity determined by analysis
 Q_a = Quantity added to sample/blank.

Precision is the ability of a measurement to be consistently reproduced. This is typically measured as a relative percent difference (RPD) in recovery for a pair of samples. Laboratory LCS/LCSD or MS/MSD pairs are used to measure precision. Relative percent difference is calculated using Equation 4-2.

$$\% RPD = \frac{S - D}{(S + D)/2} \times 100 \quad \text{Equation 4 - 2}$$

Where: S = First sample value (LCS or MS value).
 D = Second sample value (LCSD or MSD value).

Evaluating laboratory method and reagent/preparation blanks assists in assessing accuracy and precision by measuring the presence of any compounds/analytes due to laboratory contamination that might bias the sample results.

The laboratory establishes statistically-valid acceptance criteria for % R and RPD for the methods used to analyze the confirmation soil samples. The acceptance criterion is a range of values for % R or an upper

limit value for RPD. When QC sample results are within acceptance criteria, associated primary sample results are valid without bias. QC sample results that fall marginally outside the acceptance criteria may indicate that a bias is present in the primary sample results and data will be considered valid with bias. (Bias may be high or low depending on QC sample results.) QC sample results that fall grossly outside the acceptance may indicate a problem with the sample or the analytical procedure that causes the data to be considered invalid.

Laboratory data will be validated in accordance with the procedures presented in Section 10.0 of this QAPP. Results of the accuracy and precision analysis will be documented in a data validation memorandum.

4.4 COMPLETENESS, REPRESENTATIVENESS, COMPARABILITY AND SENSITIVITY

4.4.1 Completeness

Completeness measures the amount of valid data obtained compared to the amount expected to be obtained under normal conditions. A goal of 95% completeness is anticipated for the remedial action confirmation soil sampling. The percent completeness will be calculated using Equation 4-3.

$$\text{Completeness (\%)} = \frac{\text{Valid data obtained}}{\text{Total data set}} \times 100 \quad \text{Equation 4 - 3}$$

4.4.2 Representativeness

Representativeness is the degree to which data accurately and precisely represent site conditions. The determination of the data representativeness will be performed in the following manner:

- Compare actual sampling procedures to those delineated in the QAPP.
- Verify that analytical procedures and sample holding times are consistent with the methodologies specified in this QAPP.
- Since confirmation samples will be collected in similar soil and post-excavation environmental conditions throughout the Site, compare analytical results from multiple sample locations to determine the consistency of analytical results.
- Examine the results of laboratory blanks for evidence of sample contamination during analysis. Contamination may cause invalidation or qualification of affected samples.

Results of the representativeness analysis will be documented in a data validation memorandum.

4.4.3 Comparability

Comparability expresses the confidence with which one analytical data set may be compared with another. Comparability is maintained by being aware of previous analytical work and through the use of standard analytical methods and units. Comparability will be achieved through adherence to procedures specified in this QAPP.

4.4.4 Sensitivity

Sensitivity or method detection limit (MDL) is the minimum amount of a substance that can be measured with a 99% confidence that the amount is greater than zero using a specific measurement system. The MDL should be achievable by all instruments that are to be used in routine performance of the test method. The MDL must be verified, and the MDL study records shall be retained as part of the laboratory's quality records for the same required period as analytical data.

* * * * *

5.0 SAMPLING AND DECONTAMINATION PROCEDURES

5.1 SOIL SAMPLING PROCEDURES

Confirmation soil samples for laboratory analysis will be collected as presented in the following subsections.

5.1.1 VOCs

A fresh exposure of soil several inches beneath the excavation surface will be made. Soil samples for VOC analysis will be collected immediately following exposure of fresh soil. Samples will be collected in accordance with SW-846 Method 5035 using EnCore 5-gram samplers. Sampling procedures associated with the EnCore sampling methods are as follows.

- Remove the EnCore sampler and cap from its re-sealable pouch and attach T-handle to sampler body. (When dealing with soft or sandy solid, it may be necessary to retract the plunger in the sampler before sample collection.)
- Using the T-handle for leverage, push the sampler into a freshly exposed surface of soil until the sampler is full.
- Brush any soil off the sampler head and securely attach the sampler cap by pushing with a twisting motion.
- Place the labeled sampler in its re-sealable pouch and seal the pouch.
- Repeat the procedure for two additional samples collected from the same soil stratum or the same area. (This step may be eliminated or the number of samples reduced if the suspected level of VOCs is known [i.e., low or high concentration sample]. Consult method 5035 or discuss procedure with an analytical laboratory for further details.)
- Use a stainless steel spoon or similar tool to collect an additional sample from the same soil stratum or the same area. Place collected material in a 2-ounce, wide-mouth jar with no preservatives for measurement of soil moisture content.
- Immediately place samples in a cooler with ice for transport to the laboratory. Volatile EnCore soil samples must be sent to the lab within 24 hours to ensure compliance with the 48-hour holding time for preservation.

5.1.2 SVOCs and Metals

Soil samples for SVOCs and metals will be collected after collecting VOCs. Samples will be collected using clean stainless steel mixing bowls, spoons, knives, etc. Sample aliquots will be placed directly from the sample retrieval device into a stainless steel bowl. The soil will be thoroughly mixed in the bowl to homogenize the sample and then placed directly into appropriate sample containers. Appropriate amounts of soil will then be placed in clean sampling jars, the jar lids secured, samples labeled and placed on ice in a cooler for transport to the laboratory.

5.2 GROUNDWATER SAMPLE PROCEDURES

Groundwater samples will be collected from the shallow monitoring wells that will be installed at the previous locations of the shallow monitoring wells on Site following excavation activities. Following static water level determination and measurement, wells will be purged until the following parameters stabilize: turbidity, dissolved oxygen, pH, specific conductance and temperature. Purged water will be collected and managed as liquid waste. A peristaltic pump and dedicated, disposable tubing will be used to collect the sample, and low-flow groundwater sampling procedures will be used. Sample containers for VOCs analysis will be filled first. Forty milliliter (mL) vials will be filled completely, with no visible air bubbles, labeled and placed in an iced cooler for preservation. Next, containers for SVOCs and metals will be filled, labeled and placed in an iced cooler for preservation. Samples will be transported to the laboratory under proper chain of custody procedures.

5.3 SAMPLING EQUIPMENT DECONTAMINATION PROCEDURES

Procedures for equipment decontamination will be implemented to avoid cross-contamination of soil and groundwater samples. All non-disposable sampling equipment (e.g. bowls for sample homogenization and mixing tools) will be thoroughly cleaned and decontaminated before initial use.

Decontamination for sampling equipment includes the following steps:

- Wash with laboratory detergent and potable water.
- Rinse with potable water.
- Rinse with reagent grade ethanol or isopropanol if tar, grease or oil is observed.
- Rinse with distilled water.
- Air dry.
- Wrap in aluminum foil, if necessary, to prevent contamination before use.

Equipment used for field groundwater measurements, such as pH meter probe, specific conductance probe and thermometer, will be rinsed with ethanol or isopropanol, if necessary to remove visible oil or grease, and washed with distilled water after each use.

Water from equipment decontamination will be properly disposed of. Accumulated water will be transferred to a temporary onsite holding tank for containment, and either pumped to an onsite water treatment system and discharged to sewers in accordance with a general industrial discharge permit, or disposed offsite.

* * * * *

6.0 SAMPLE CUSTODY

Each confirmation sample must be properly documented to identify, track and monitor it from the point of collection through final data reporting. Proper sample documentation and custody procedures help ensure data are accurate and usable. This section discusses the following areas of field investigation documentation: field logbook, photographs, sample numbering system, sample documentation and custody, corrections to documentation, document control and project files.

6.1 SAMPLING FIELD RECORDS

Information pertinent to confirmation sampling will be recorded in a bound field log book with consecutively numbered pages or on site-specific field log forms. Entries in log books and on sample documentation forms will be made in waterproof black ink. Corrections will consist of single line-out deletions that are initialed and dated. Entries will include the following, as applicable:

- Name and title of author, date and time of entry and physical/environmental conditions during field activity;
- Names and addresses of field contacts;
- Names and responsibilities of field crew members;
- Names and titles of site visitors;
- Location, description and log of photographs of sampling points, as needed;
- References for maps and photographs of sampling points;
- Information concerning sampling changes, scheduling modifications and change orders;
- Details of sampling location (sketches of sampling locations may be appropriate);
- Date and time of sample collection;
- Field observations;
- Field measurements, e.g., groundwater pH, specific conductance, temperature, depth to water and measuring point;
- Calibration and maintenance information concerning field analytical and monitoring equipment
- Sample identification number(s);
- Sample distribution and transportation (e.g., name of laboratory and overnight delivery service);
- Sample documentation, such as chain-of-custody form numbers and shipment airbill numbers;
- Decontamination procedures;
- Summary of daily tasks;
- Documentation for cost or scope of work changes required by field conditions; and
- Signature of personnel responsible for observations and date.

Sampling situations vary widely; therefore, the exact information that must be entered in the logbook and field log forms will vary from site to site. However, the logbook and field log forms should contain enough information to allow anyone to reconstruct the sampling activity without relying on the collector's memory. During the remedial action activities, field records will be kept in the possession of a BMCD

field team member or in a secure place on-site. Following the remedial actions, field records will become part of the final project file.

6.2 PHOTOGRAPHS

Digital photographs will be downloaded from the camera each day or as soon after the sampling event as reasonably possible to the field office computer or BMcD office computer. Photograph file names will provide enough information to identify files by date and activity type.

When photographing soil samples, an informational sign will be prepared and photographed with each sample. This sign will have the site name, initials of photographer, date and a brief description of the sample photographed.

Example: Mendota MGP Site
01/01/2017
Confirmation sample MEN-CA005-F-001
XYZ (sampler's initials)

When photographing sampling locations, a nearby structure or other reference point will be included in the photograph frame to establish orientation and scale whenever possible.

6.3 SAMPLE NUMBERING SYSTEM

A sample numbering system will be used to identify each confirmation sample collected for chemical and physical analysis. The numbering system provides accurate sample tracking and facilitates retrieval of sample data. Sample identification numbers will be used on sample labels, chain-of-custody forms and other applicable sampling activity documentation. A list of sample identification numbers will be maintained in field records. Each sample collected will be assigned a unique sample number. Sample numbers will not change because different analyses are requested.

Soil sample identification numbers consist of a minimum of five components: a three-character alpha site identification code; a two-character alpha sample identification code; an alpha-numeric excavation area identification code; a one-character alpha sample position code; and a three-digit sample number code. The following is an example of a completely numbered sample, with each component identified:

Example: MEN-CS-D3-F-001

Where: MEN – Mendota MGP–Black Brothers Company Site
CS – Confirmation Sample
D3 – Sampling grid location D3
F0 – Floor sample
001 – Soil sample number 1

The site identification code will remain the same for all samples collected at the site.

The following sample position codes will be used:

- F0 – Sample taken from the excavation floor
- N1 – Sample taken from the excavation north sidewall
- S1 – Sample taken from the excavation south sidewall
- E1 – Sample taken from the excavation east sidewall
- W1 – Sample taken from the excavation west sidewall

The numerical portion of the sample position code represents the sample depth range within the grid cell.

The following codes will be used:

- 0 – Sample collected from the excavation floor
- 1 – Sidewall sample collected from depth range 0-3 feet bgs
- 2 – Sidewall sample collected from depth range 3-10 feet bgs
- 3 – Sidewall sample collected from depth range 10+ feet bgs

The sample number code will sequentially number samples taken from the same sampling point when multiple confirmation samples are collected due to additional excavation (i.e., confirmation grid D3, floor samples 001, 002, 003, etc.).

The groundwater sample numbering system will be used to identify each groundwater sample collected for analysis. Sample identification numbers consist of four components: a three-character alpha Site identification code; a five-character alpha-numeric location code; a three-digit sample number; and a six-digit sample date code. The following is an example of a completely numbered sample, with each component identified:

Example: MEN-SMW01-001-020115

Where: MEN – Mendota MGP–Black Brothers Company Site
SMW01 – Groundwater Shallow Monitoring Well number 1
001 – Groundwater sample number 1
013117 – Sample collection date of February 1, 2017

6.4 SAMPLE DOCUMENTATION AND CUSTODY

The following subsections describe sample documents and procedures for completing these documents for each confirmation sample collected.

6.4.1 Sample Containers

Sample containers for soil confirmation samples will be obtained in sealed cartons from the laboratory. Each carton will contain a cleanliness certification appropriate to the analyses to be performed on samples collected in the container. Since some groundwater sample containers require the addition of field preservatives at the laboratory prior to shipment, sample containers for groundwater samples will be sent

from the laboratory in sealed coolers with cleanliness certificates enclosed in the cooler for each type of container sent. A record will be kept in the field office of sampling containers used for individual samples and the corresponding certification lots.

6.4.2 Sample Labels

The following information will be included on each sample label: site name/client, sample number, initials of sampler, sample collection date and time, depth of sample (soil), analysis requested and preservatives added.

Information known before field activities (site name, sample numbers, etc.) can be preprinted on sample labels. Duplicate sample labels can be prepared when multiple sample aliquots must be submitted in separate containers for individual analyses, e.g., three EnCore samplers or three glass vials for each VOC analysis.

6.4.3 Chain-of-Custody Forms

A separate chain-of-custody form will be completed for the samples contained in each sample shipment container. After completion of the chain-of-custody form, the original signature (top) copy will be enclosed in a plastic bag and secured to the inside of the cooler lid. A copy of the original custody form will be retained for BMcD files.

6.4.4 Custody Seals

Custody seals will be used to ensure the integrity of samples from the time they are relinquished to a delivery service or the laboratory by the sampling team until they are opened in the laboratory. Samples will be shipped in coolers. Each cooler will be sealed with at least two custody seals. Seals must be attached to each cooler so that it is necessary to break them to open the cooler.

6.4.5 Receipt for Samples Form

A receipt-for-samples form will be completed when split samples are requested. After completion of this form, the original copy, which is to be signed by both BMcD and the receiving party, will be retained for BMcD files; a photocopy will be given to the sample recipient.

6.4.6 Airbill

If samples are to be shipped, an airbill will be completed for each different laboratory address to which samples are to be shipped. More than one cooler may be shipped to the same address under one airbill. A copy of the airbill will be given to the BMcD representative and will be retained for the BMcD project file. A Portable Document File (PDF) copy of airbills prepared electronically will be retained in the project electronic files. For each shipment of samples, the appropriate airbill numbers will be recorded on chain-of-custody forms or maintained in a list cross-referenced to the chain-of-custody form numbers, either in a field log book or electronically to assist in tracking laboratory shipments.

6.4.7 Sample Documentation Procedures

The following itemized list will be used as a general reference for completion of sample documentation:

- Make or obtain a list of samples to be packaged and shipped that day.
- Determine the number of coolers required to accommodate the day's shipment based on number of samples to be shipped, number of containers per sample and number of sample containers that will fit in each cooler.
- If samples are shipped by Federal Express, complete an airbill.
- Assign a chain-of-custody form to each cooler and determine which sample containers will be shipped in each cooler. (Note: More than one chain-of-custody form may be needed to accommodate number of samples to be shipped in one cooler).
- Determine which samples will be shipped under each chain-of-custody form. Each day that samples are shipped, record chain-of-custody form numbers and airbill numbers (if used) in field logbook. Cross-reference airbill and chain-of-custody numbers.
- Assign custody seals to each cooler and temporarily clip seals to each chain-of-custody form.
- Group all paperwork associated with each cooler with a separate clip.
- Obtain necessary field team members' full signatures or initials on appropriate paperwork.
- Package samples for shipment.

6.5 CORRECTIONS TO DOCUMENTATION

Original information will be recorded with black waterproof ink. If an error is made on a document, corrections will be made by making a single line through the error and entering the correct information. Erroneous information should not be obliterated. Any error discovered on a document should be corrected by the person who identified the error. Corrections must be initialed and dated.

6.6 DOCUMENT CONTROL

The goal of document control is to ensure all documents for a group of samples will be accounted for when the project is complete. Project file audits may be scheduled. The document control audit consists of checking each document submitted for accountability. Written explanations must be made for missing documents.

6.7 PROJECT FILES

At the completion of the project, individual files will be assembled, organized and stored as final evidence for the project. Hard copies and PDFs of analytical data will be stored with project files. In addition, all analytical data results will be submitted electronically by the laboratory and stored in a BMcD database.

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7.0 CALIBRATION PROCEDURES AND FREQUENCY

This section describes procedures for maintaining the accuracy of instruments and measuring equipment used to perform field data measurements and laboratory analyses.

7.1 FIELD INSTRUMENTS/EQUIPMENT

Instruments and equipment used to gather, generate or measure environmental data will be calibrated daily before each use according to manufacturer's specifications. Equipment and field instruments will also be examined daily to verify proper operating conditions. The manufacturer's operating instructions and manuals for each instrument will be read and understood to ensure maintenance requirements are being observed. If the equipment or instruments were used in a previous investigation, field notes will be checked or the equipment manager will be contacted to verify that prior equipment problems were not overlooked and necessary equipment repairs have been performed

7.2 LABORATORY INSTRUMENTS

Laboratory personnel will be responsible for calibration procedures and frequency of calibration for laboratory instruments. Calibration procedures and frequencies will comply with appropriate instrument specifications and the laboratory's standard operating procedures (SOPs).

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8.0 SAMPLE TRANSPORT AND ANALYTICAL PROCEDURES

In general, samples collected during remedial action activities will be delivered to the laboratory within 48 hours of collection. Volatile EnCore soil samples must be sent to the lab within 24 hours to ensure preservation within the 48-hour holding time for preservation. The preferred method of transporting samples is to have the laboratory pick up samples at the site. If this is not possible, BMcD will hand deliver or ship the samples by overnight carrier (overnight priority). Laboratory pickups and sample shipment deliveries will occur daily. BMcD will contact the laboratory to coordinate weekend deliveries no later than 3 p.m. on the Friday preceding the weekend delivery.

The laboratory will perform sample analyses by the specified methods in accordance with its SOP for each method.

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9.0 INTERNAL QUALITY CONTROL CHECKS

9.1 FIELD SAMPLE COLLECTION

The project manager/review team leader will check that field sampling QC is being maintained by verifying that sample collection frequencies and procedures outlined in the Revised SI/ROR/RAP and other sections of this QAPP are maintained.

9.2 FIELD MEASUREMENTS

Field measurement QC procedures will be checked by obtaining multiple instrument readings and by calibrating field instruments daily according to manufacturer's specifications. Field personnel will read and understand applicable sections in manufacturer's literature and operations manuals before field instrument usage. Additionally, field personnel will be trained in proper instrument calibration and handling procedures before using field instruments. The project manager/review team leader will perform field measurement data QC checks by reviewing field data collection and calibration entries in the log book or field forms.

9.3 LABORATORY ANALYSES

The laboratory's quality control manager will verify that analyses are being performed in compliance with laboratory QC procedures provided in method SOPs and the laboratory's quality assurance manual (QAM).

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10.0 DATA REDUCTION, VALIDATION AND REPORTING

10.1 FIELD MEASUREMENTS AND SAMPLE COLLECTION

Field measurement and sample collection activities will be documented in a field logbook or on field data sheets. Data used in project reports will be reduced, validated (to the extent possible) and summarized consistent with other sampling data.

10.2 LABORATORY SERVICES

Data reduction includes processes that change either the form of expression, quantity of data values or number of data items. If data reduction is required, methods used for data reduction will be described in the final remedial action completion report (RACR).

BMCD personnel will perform data assessment evaluations (determine whether analytical work is of acceptable quality). Analytical work will be performed in accordance with approved protocols and procedures capable of meeting DQOs specified in Section 2.2 of this QAPP. Data will be validated using the general validation procedures and sample qualification coding system provided in the United States Environmental Protection Agency (USEPA) Contract Laboratory Program (CLP) National Functional Guidelines for organic and inorganic data review, information contained in SW-846 analytical methods documents, and information provided by the laboratory in the analytical reports. Professional judgment will be applied to validation where discrepancies exist between CLP analytical methods and USEPA SW-846 analytical methods. A data validation memorandum will be produced, detailing validation procedures and results of the validation. Validated data will be tabulated and reported in the RACR.

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11.0 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits of field and laboratory activities will be conducted to verify that sampling and analysis are performed in accordance with procedures established in this QAPP and the Revised SI/ROR/RAP. The following sections describe field and laboratory activity audits.

11.1 FIELD AUDITS

The project manager/review team leader will periodically conduct field activity audits during field sampling activities. Each audit will include examination of field sampling records, verification of sample collection procedures, compliance with sample handling and packaging procedures and maintenance of QA documents (chain-of-custody forms, log books and forms, sampling tracking forms, etc.). Following the audit, a brief report will be prepared summarizing the audit results. Deviations from this QAPP or the Revised SI/ROR/RAP noted during the audit will be remedied immediately.

11.2 LABORATORY AUDITS

Once the laboratory is selected, a laboratory audit will be performed by BMcD personnel prior to the start of remedial action activities if one has not been conducted within the past two years. Additional laboratory audits may be conducted during the course of the remedial action activities. The selected laboratory will also be accredited through IL ELAP for soil and groundwater analyses to be performed as required by the Illinois Environmental Protection Agency.

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12.0 PREVENTATIVE MAINTENANCE PROCEDURES

12.1 FIELD EQUIPMENT/INSTRUMENTS

Field equipment to be used during the soil and groundwater sampling may include a photoionization detector (PID), thermometer, pH meter, conductivity meter or dissolved oxygen meter. The manufacturer's specifications for preventative maintenance and calibration will be followed while using field equipment. Field instruments will be checked and calibrated before being taken to the field. Instruments will be checked and calibrated daily before use. Calibration checks will be performed periodically and documented in a field logbook or on calibration log sheets. Critical spare parts and backup equipment for field instruments will be available for delivery within one day to avoid delays in field activities.

12.2 LABORATORY INSTRUMENTS

Preventative maintenance of laboratory instruments is the responsibility of the laboratory. Laboratory instruments are maintained in accordance with the manufacturer's specifications and requirements of the specific method employed. Maintenance of each instrument used is carried out and documented on a regularly scheduled basis in accordance with laboratory SOPs, QAM and manufacturer's instructions. Emergency repair or scheduled manufacturer's maintenance may be provided by trained laboratory personnel, manufacturer's contracted service providers, or manufacturer's employees.

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13.0 PROCEDURES TO ASSESS DATA PRECISION, ACCURACY AND COMPLETENESS

13.1 FIELD MEASUREMENTS

The field team leader will assess field measurements daily. The field team leader will review field results for compliance with established QA/QC criteria specified in this QAPP or the site-specific Revised SI/ROR/RAP. Accuracy of field measurements will be assessed by calibrating or field checking field instruments daily and, when necessary, by performing field instrument performance checks (testing solutions or gases of known concentrations). Precision will be assessed by obtaining multiple instrument readings. Completeness will be evaluated by checking field notes to verify that appropriate measurements and frequency of measurements are performed and obtained.

13.2 LABORATORY ANALYSES

The laboratory will conduct all analyses using QC requirements for precision, accuracy, representativeness, and completeness as established in its method SOPs and QAM. Evaluation of laboratory QC results will be conducted by BMcD as discussed in Section 4.0 and 10.0.

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14.0 CORRECTIVE ACTIONS

The following subsections describe corrective actions for field measurements, sample collection and laboratory analyses. Nonconformance with established QC procedures outlined in this QAPP or the site-specific Revised SI/ROR/RAP will be identified and corrected.

The project manager/review team leader will be notified immediately of any nonconformance issue. The project manager/review team leader will promptly report nonconformance to the senior project manager, who will discuss major problems, if any, with Nicor Gas representatives.

14.1 FIELD MEASUREMENTS AND SAMPLE COLLECTION

Technical staff and project personnel will be responsible for reporting all nonconformance issues to the project manager/review team leader. The project manager/review team leader will be responsible for assessing suspected problem(s), and deciding whether the problem(s) will affect data quality.

The project manager/review team leader is responsible for controlling, tracking and implementing corrective actions. The project manager/review team leader will inform the senior project manager of field changes. Nonconformance issues and corrective actions taken will be recorded in the field log book.

14.2 LABORATORY ANALYSES

If audits or data reviews result in detection of unacceptable data, the senior project manager will be responsible for developing and initiating corrective action, which may include the following measures:

- Re-analyzing soil samples if holding time criteria permit and adequate sample volumes exist.
- Collecting new samples from the same sampling location or monitoring well for analysis.
- Evaluating and amending sampling and analytical procedures.

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15.0 QUALITY ASSURANCE REPORTS

Separate quality assurance reports will not be submitted. The final site-specific RACR will summarize data quality information for data collected during field activities. Memoranda that address field activity results may be submitted to Nicor Gas.

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