

**Bromide, TDS, and  
Radionuclides  
in the Allegheny River:  
A Possible Link with Marcellus Shale Operations**

(2010-2011)

(as of 27 April 2011)

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# Disinfection Byproduct Formation

Natural Organic Matter + Chlorine + Bromide →  
(NOM)

<u>Trihalomethanes:</u>
Chloroform (CHCl <sub>3</sub> )
Dichlorobromomethane (CHCl <sub>2</sub> Br)
Dibromochloromethane (CHClBr <sub>2</sub> )
Bromoform (CHBr <sub>3</sub> )

# Total THMs and % Bromoform Contribution for PWSA Distribution Sites (Sept 2010)

SAMPLE LOCATION (Date)	TTHM (ppb)	% CONTRIBUTION OF BROMOFORM
Brashear Tank Influent (10 Sept)	132	59
4061 Perrysville Ave (16 Sept)	226	60
2000 Mt. Troy Rd. (16 Sept)	191	46
4620 Evergreen Rd. (17 Sept)	270	60
928 Chartiers Ave. (21 Sept)	225	48
Chestnut St. (21 Sept)	205	50
159 Homestead St. (21 Sept)	145	43

# Total THMs and % Bromoform Contribution for Utilities on Lower Allegheny River (Sept 2010)

UTILITY (Date)	TTHM'S IN TREATMENT PLANT EFFLUENT	% CONTRIBUTION OF BROMOFORM
PWSA (13 Sept)	73	49
Plant A (20 Sept)	33	12
Plant B (20 Sept)	73	19
Plant C (22 Sept)	19	37
Plant D (17 Sept)	82	34
Plant E (22 Sept)	102	32
Plant F (20 Sept)	110	55

# Critical Questions

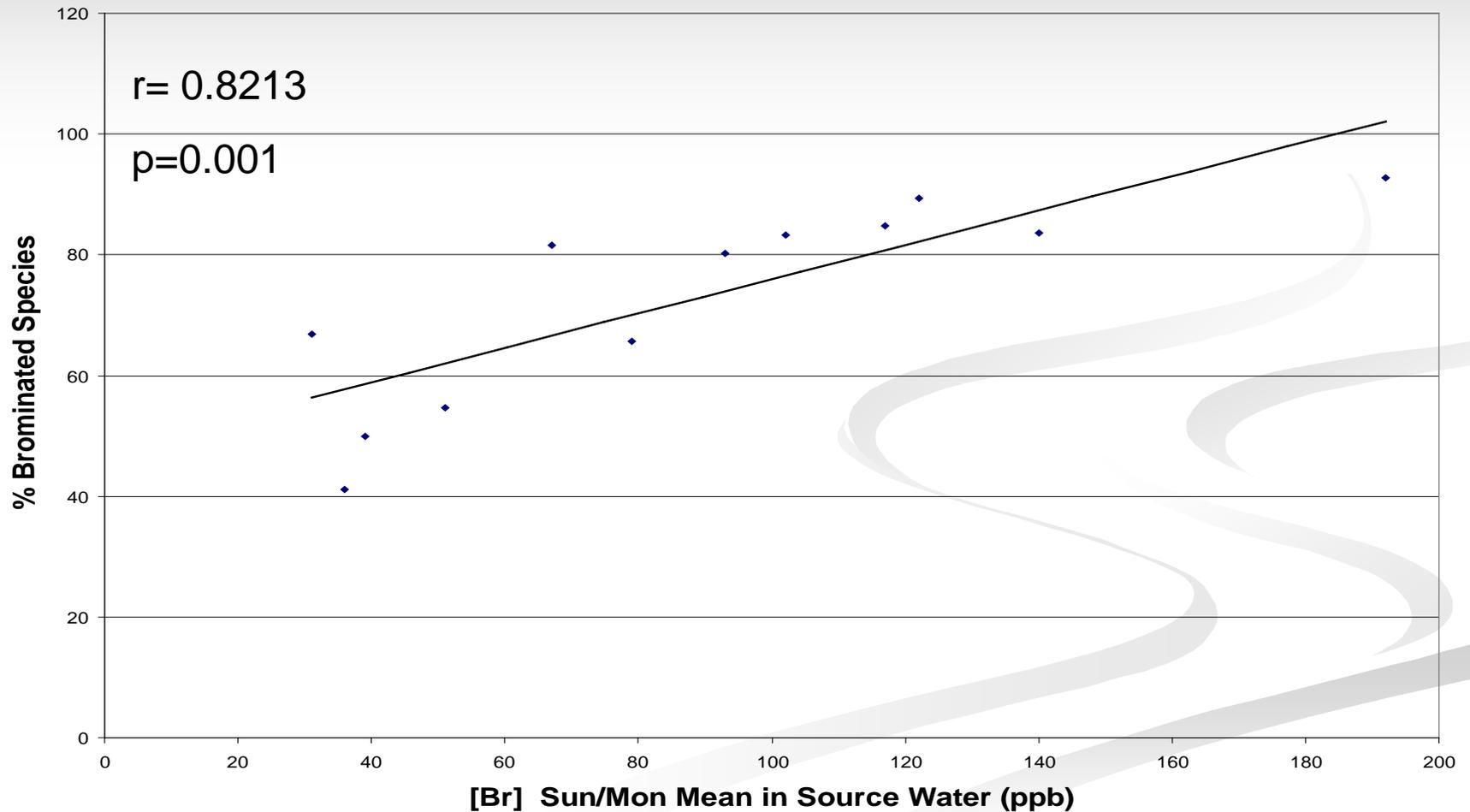
1. What effect does excess bromide in the river have on THM formation in our water system?
  - Total THM concentration
  - % Brominated Species
2. How effective is our treatment plant in removing bromide from source water?
3. What is the source of excess bromide in the Allegheny River?
  - Coal- Fired power Plants
  - Steel Mills
  - POTWs treating Marcellus Shale flowback water
  - Industrial wastewater plants treating Marcellus Shale flowback water

# TTM Formation Potential Study (Effect of Experimental Addition of Bromide)

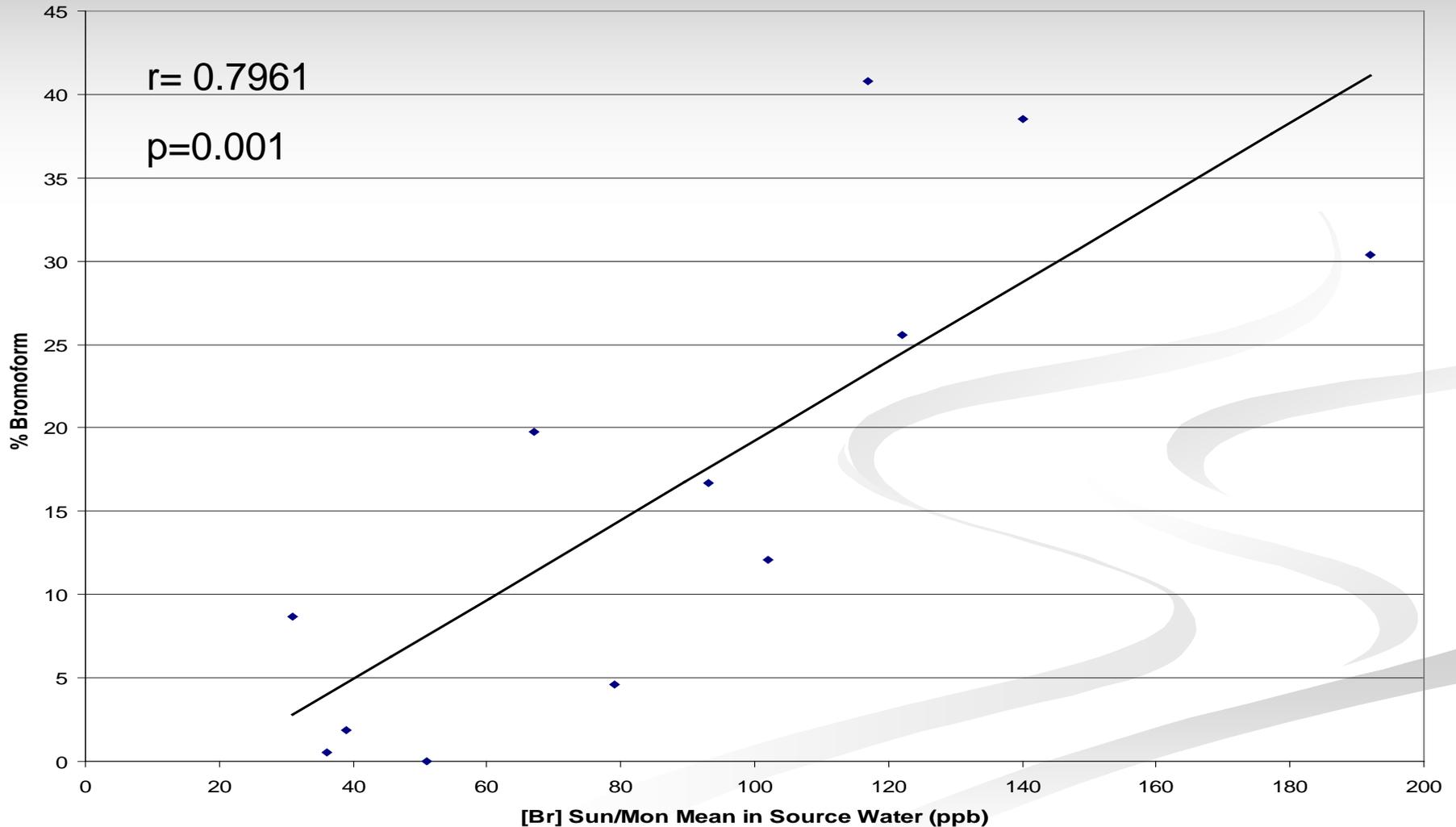
Bromide Supplement (ppb)	Total THMs (ppb)	% Conc. Of Bromoform	% Conc. Brominated Species
0*	55	9	84
100	73	25	93
250	62	43	94
500	65	56	95
750	73	61	96
1000	84	64	95
1500	66	66	94

\*Baseline bromide concentration= 217ppb

# Correlation Between % Brominated THMS in Finished Water Leaving PWSA Treatment Plant and Bromide Concentration in Allegheny River



# Correlation Between % Bromoform in Finished Water Leaving PWSA Treatment Plant and Bromide Concentration in Allegheny River



# Removal of Bromide by PWSA Drinking Water Treatment Plant

<b>SAMPLE SITE</b>	<b>Date -Time</b>	<b>Bromide Conc. (ppb)</b>	<b>Date -Time</b>	<b>Bromide Conc. (ppb)</b>
River Intake	25 Oct - 0730	188	21 Mar- 0720	44
Flume	25 Oct - 1200	158	21 Mar-1230	40
Settled Water	26 Oct - 1210	171	22 Mar- 1300	45
Pre-filtered Water	26 Oct - 1515	192	22 Mar- 1600	<25
Post-filtered Water	26 Oct - 1505	134	22 Mar- 1605	<25
Filtered Water	27 Oct - 0800	<50	23 Mar- 0800	<25

## PWSA INTAKE (Allegheny River)

### Bromide Concentration (ppb)

Day of the Month	Sept 2010	Oct 2010	Nov 2010	Dec 2010	Jan 2011	Feb 2011	March 2011	April 2011
1			136	37 *	85	182	58	48
2			241	42 *	81	147	28	
3			227	39	123	165	36	
4			195	38	97	145	35	
5			216	59	56	135	38	
6			172	44	66	136	43	
7			230	48	71	117	28	
8			170	49	84	114	<25	
9			194	53	85	125	29	
10			124	58	101	126	30	
11			168	64	97	130	32	
12		205	160	68	94	118	30	
13		203		49	82	123	27	
14		188		57	106	110	32	
15		151	170	65	95	141	34	
16			155	57	125	150	37	
17			165	76	82	147	28	
18			143	35	100	136		
19			146	67	147	139	39	
20			158		156	95	28	
21			176	88	123	62	44	
22			140		115	77	31	
23			224		124	42	30	
24	220		204	79	120	38	29	
25		188	180 *	66	128	43	50	
26		142	139 *	106	162	61	61	
27		156	145 *	89	130	46	34	
28		190	117 *	101	165	56	44	
29		241	97 *		159		<25	
30		211	79 *	198	182		42	
31		220		98	202		47	

**Notes:**

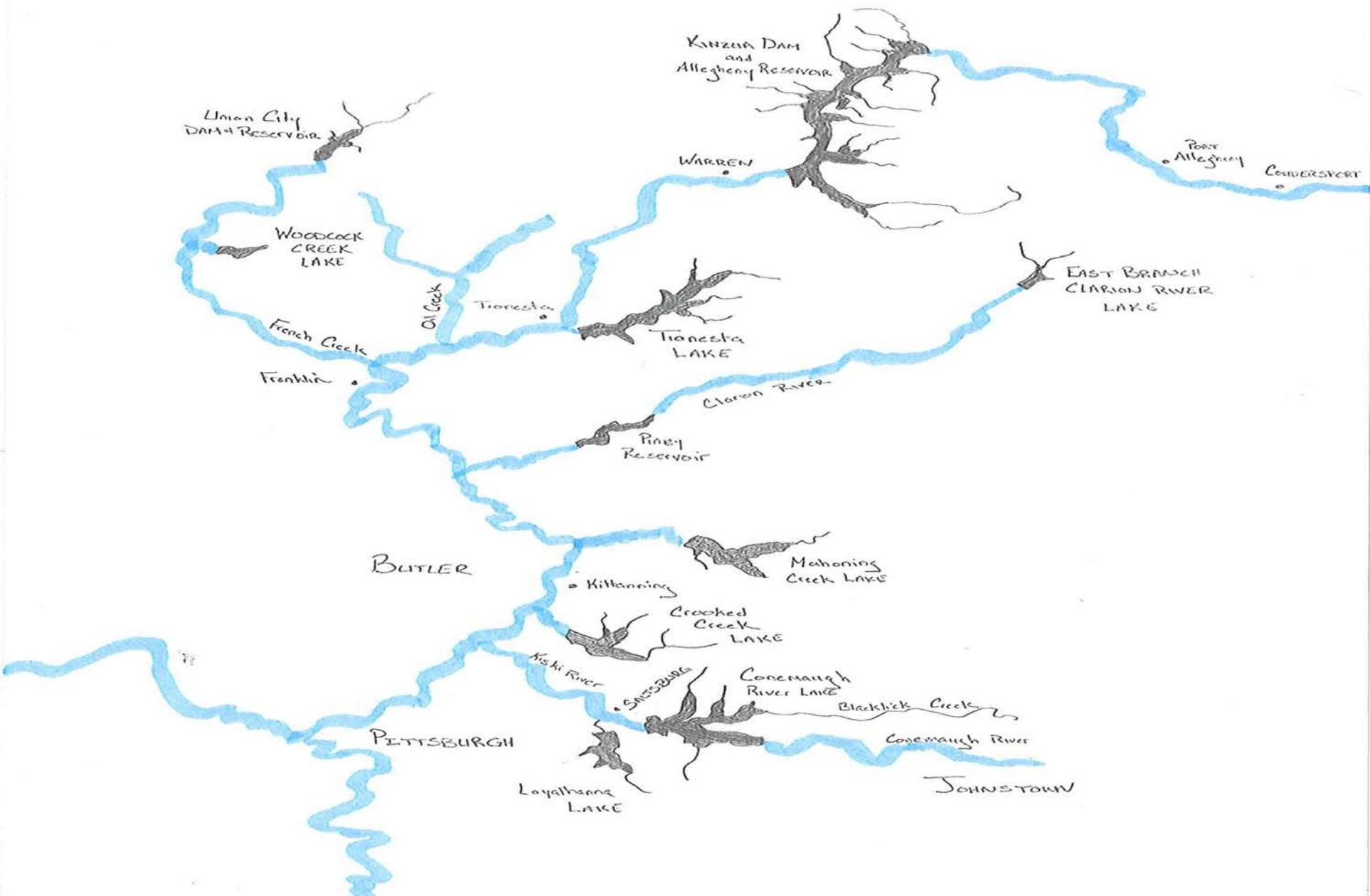
\* Record rainfalls occurred on Nov 25 & 29, 2010

**PWSA INTAKE (Allegheny River)**  
**Total Dissolved Solids from Conductivity (TDS) (ppm)**

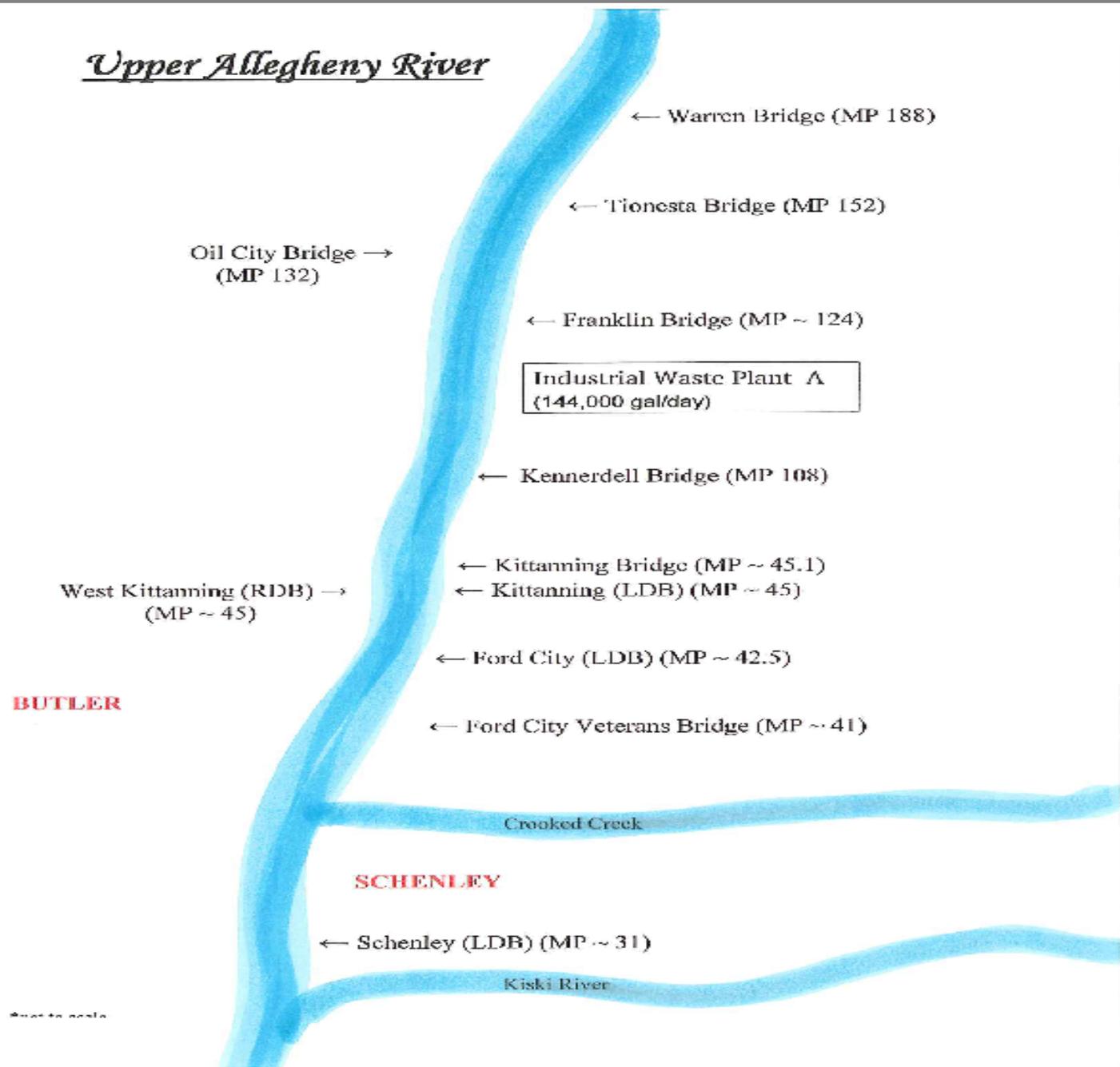
	Sept 2010	Oct 2010	Nov 2010	Dec 2010	Jan 2011	Feb 2011	Mar 2011	April 2011
1						171	110	93
2	225			73	110	221	95	
3		219				208	83	103
4			156			210	79	120
5	212			68		192	98	142
6					82	202	102	139
7		159	143			195	79	108
8					91	195	69	98
9	192			66	91	182	76	75
10					93	194	99	81
11			150		91	187	100	88
12	180				97	196	70	83
13					97	188	71	95
14		292			121	206	88	96
15					122	193	88	93
16	197			77	125	200	113	
17					86	162	98	
18			148		125	192	87	
19				73	138	164	79	
20					137	150	71	
21		178	142		128	129	90	
22					132	120	90	
23	182			78	141	126	89	
24		150			135	166	83	
25			131		163	171	80	
26	191			115	165	118	99	
27					158	112	94	
28	185	174			156	160	79	
29					139		79	
30				98	147		78	
31		157			154		95	

\* Record rainfall occurred on Nov 25 & 29, 2010  
 Note: All results in this table determined using Conductimetric Analysis.

# ALLEGHENY RIVER SYSTEM



# Upper Allegheny River



# UPPER ALLEGHENY RIVER

## Bromide Concentration (ppb)

Sample Site	Sept 2010	Oct 2010	Nov 2010	Dec 2010	Jan 2011	Jan 2011	Feb 2011	March 2011
Warren				<50 (17th)				<25 (7th)
Tionesta				52 (17th)				<25 (7th)
Oil City								
Franklin			85 (19th)			63 (21st)	38 (16th)	<25 (30th)
Industrial Waste Plant A						<b>2 X</b>	<b>3 X</b>	<b>2 X</b>
Kennerdell			83 (19th)			125 (21st)	101 (16th)	51 (30th)
Kittanning Bridge			69 (30th) *	50 (28th)		68 (21st)	118 (16th)	30 (30th)
Kittanning (LDB)		104 (13th)						
West Kittanning (RDB)		105 (13th)						
Ford City Boat Dock (LDB)	150 (24th)	101 (13th)						
Ford City (Vet Bridge)				51 (28th)	57 (12th)		129 (16th)	28 (29th)
Crooked Creek	<b>1.1 X</b>	<b>1.1 X</b>			<b>1.1 X</b>		<b>1.2 X</b>	<b>1.2 X</b>
Schenley (LDB)	170 (24th)	114 (15th)			64 (12th)		146 (16th)	35 (29th)
* Record rainfalls occurred on Nov 25 & 29, 2010								

# UPPER ALLEGHENY RIVER

## Total Dissolved Solids (TDS) (ppm)

Sample Site	Sept 2010	Oct 2010	Nov 2010	Dec 2010	Jan 2011	Feb 2011	March 2011
Warren				63 (17th)			83 (7th)
Tionesta				61 (17th)			80 (7th)
Oil City							
Franklin			84 (17th)		116 (21st)	135 (16th)	83 (30th)
Industrial Waste Plant A			1.2 X				1.2 X
Kennerdell			101 (17th)		116 (21st)	115 (16th)	96 (30th)
Kittanning Bridge			96 (30th)*	97 (28th)	112 (21st)	144 (16th)	94 (30th)
Kittanning (LDB)		147 (13th)					
West Kittanning (RDB)		144 (13th)					
Ford City Boat Dock (LDB)	143 (24th)						
Ford City (Vet Bridge)		148 (13th)		93 (28th)	83 (12th)	138 (17th)	87 (29th)
Crooked Creek					1.1 X	1.1 X	1.2 X
Schenley (LDB)	144 (24th)	154 (15th)			88 (12th)	148 (17th)	104 (29th)

\* Record Rainfalls occurred on Nov 25 & 29, 2010

Note: All results in this table determined using Gravimetric Analysis.

# Crooked Creek & McKee Run

**BUTLER**

**FORD CITY**

**Crooked  
Creek Lake**

**Industrial Waste  
Plant B (45,000 gal/day)**

Bridge Upstream of  
Industrial Waste Plant B (MP 3)

Crooked Creek

↑ Stitt Hill  
Bridge  
(MP 4)

Bridge St. →  
Bridge  
(MP 15)

McKee Run

Blue Spruce Bridge  
(MP 40)

Crooked Creek

**SCHENLEY**

\* not to scale

# CROOKED CREEK & McKEE RUN

## Bromide Concentration (ppb)

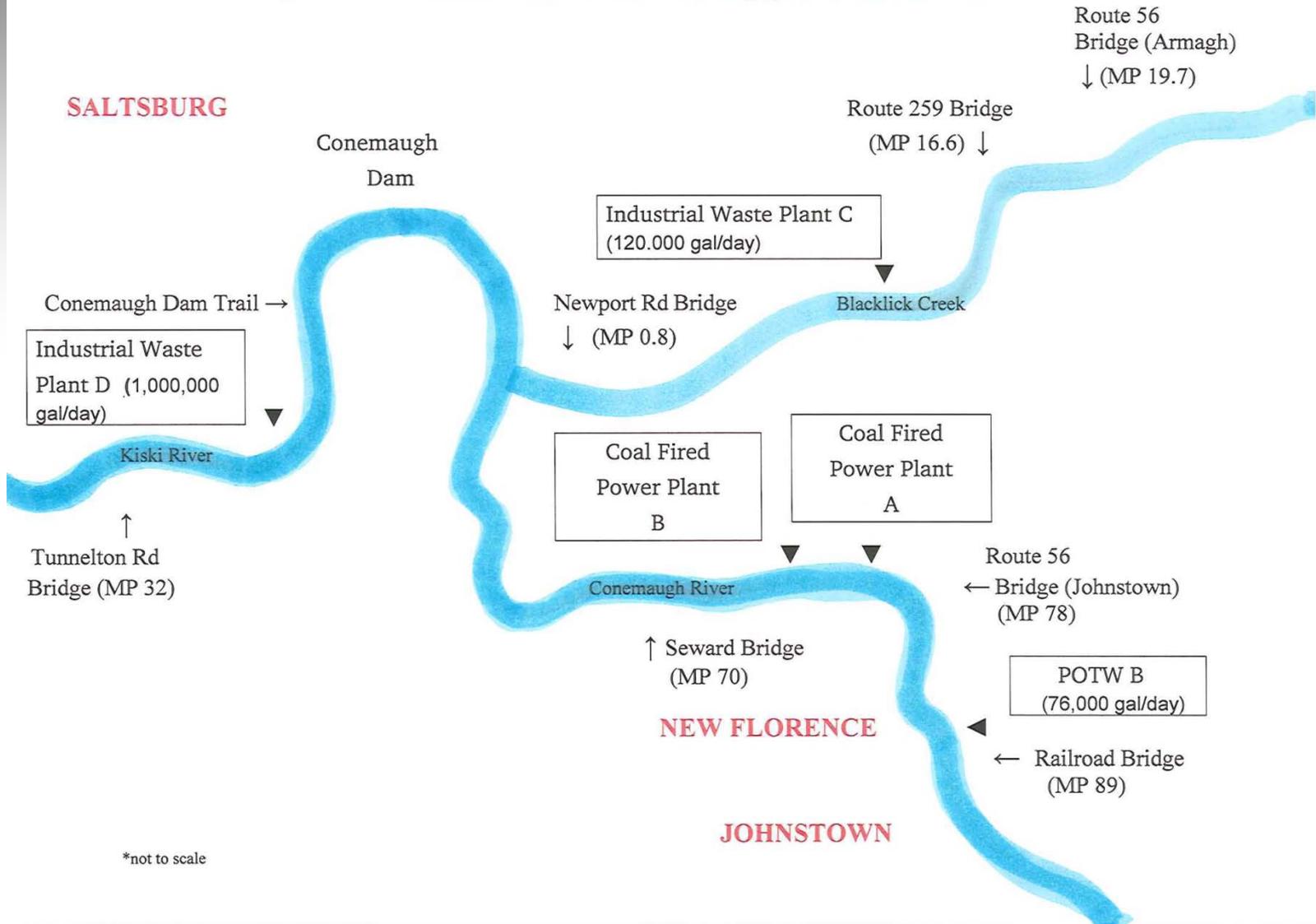
Sample Site		Sept 2010	Oct 2010	Nov 2010	Dec 2010	Jan 2011	Feb 2011	March 2011
McKee Run	Bridge upstream of Industrial Waste Plant B			29 (29th) *	79 (14th)	61 (12th)	36 (17th)	27 (29th)
	Industrial Waste Plant B							
Crooked Creek	Blue Spruce Bridge		57 (29th)	39 (29th) *	64 (14th)	87 (12th)	37 (17th)	38 (29th)
McKee Run			<b>20 X</b>	<b>10 X</b>	<b>9 X</b>	<b>10 X</b>	<b>1.1 X</b>	<b>3 X</b>
Crooked Creek	Bridge St. Bridge		1130 (29th)	345 (29th) *	639 (14th)	774 (12th)	42 (17th)	111 (29th)
	Stitt Hill Rd. Bridge			280 (29th) *	467 (28th)	396 (12th)	173 (17th)	74 (29th)
* Record rainfalls occurred on Nov 25 & 29, 2010								

# CROOKED CREEK & McKEE RUN

## Total Dissolved Solids (TDS) (ppm)

Sample Site		Sept 2010	Oct 2010	Nov 2010	Dec 2010	Jan 2011	Feb 2011	March 2011
McKee Run	Bridge upstream of Industrial Waste Plant B			121 (29th)*	95 (14th)	136 (12th)	129 (17th)	118 (29th)
	Industrial Waste Plant B							
Crooked Creek	Blue Spruce Bridge		269 (29th)	147 (29th)*	139 (14th)	274 (12th)	141 (17th)	215 (29th)
McKee Run			1.7X	1.3X	1.8X	1.5X	1.1X	
Crooked Creek	Bridge St. Bridge		448 (29th)	190 (29th)*	251 (14th)	413 (12th)	150 (17th)	206 (29th)
	Stitt Hill Rd. Bridge			249 (29th)*	324 (28th)	318 (12th)	205 (17th)	170 (29th)
* Record rainfalls occurred on Nov 25 & 29, 2010								
Note: All results in this table determined using Gravimetric Analysis.								

# Conemaugh River, Blacklick Creek & Upper Kiski River



# CONEMAUGH RIVER, BLACKLICK CREEK & UPPER KISKI RIVER

## Bromide Concentration (ppb)

Sample Site	Sept 2010	Oct 2010	Nov 2010	Dec 2010	Dec 2010	Jan 2011	Jan 2011	Feb 2011	Feb 2011	March 2011	
Blacklick Creek	Route 56 Bridge Armagh						86 (28th)		<25 (24th)	28 (17th)	
	Route 259 Bridge		46 (29th)								
	Industrial Waste Plant C						11 X		8 X	4 X	
	Newport Rd. Bridge						961 (28th)		203 (24th)	115 (17th)	
Conemaugh River	Johnstown Railroad Bridge		<50 (25th)			94 (29th)	52 (28th)		<25 (24th)	<25 (17th)	
	POTW B										
	Route 56 Bridge Johnstown		<50 (25th)			52 (29th)	57 (28th)		<25 (24th)	<25 (17th)	
	Coal Fired Power Plant A & B					2 X					
	Seward Bridge		<50 (25th)			115 (29th)	60 (28th)		<25 (24th)	<25 (17th)	
	Blacklick Creek					4 X ?			3 X	2 X	
	Conemaugh Dam Trail								82 (24th)	48 (17th)	
	Industrial Waste Plant D						4 X ?			1.2 X	
Kiski River	Tunnelton Rd. Bridge					431 (29th)	190 (5th)	237 (28th)	119 (4th)	77 (24th)	60 (17th)
	Washington St. Bridge (Saltsburg)		<50 (25th)	460 (24th)	470 (23rd)	378 (29th)	179 (5th)	320 (28th)	141 (4th)	106 (24th)	55 (17th)
* Record rainfalls occurred on Nov 25 & 29, 2010											

# CONEMAUGH RIVER, BLACKLICK CREEK & UPPER KISKI RIVER

## Total Dissolved Solids(TDS) (ppm)

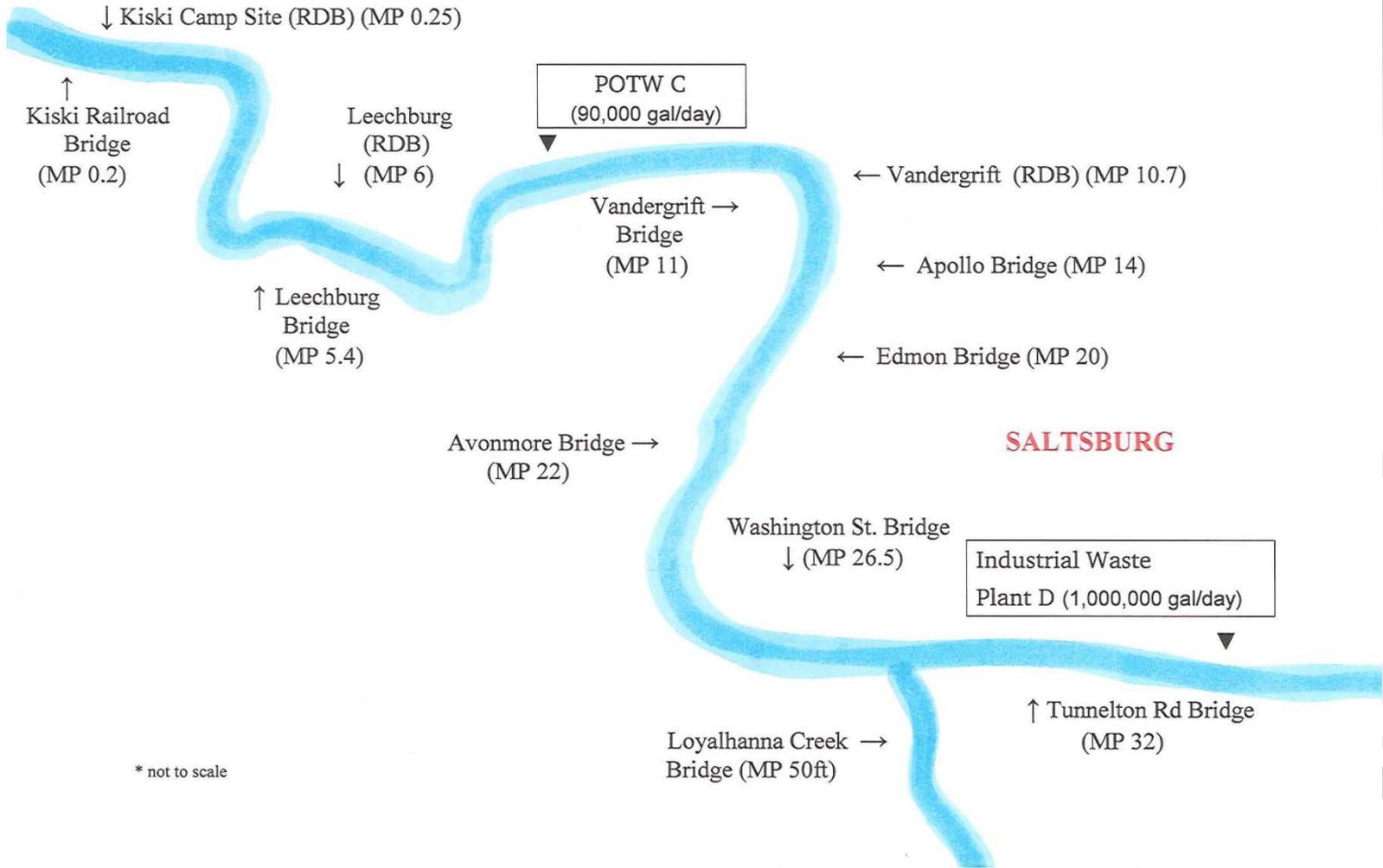
Sample Site	Oct 2010	Nov 2010	Dec 2010	Dec 2010	Jan 2011	Jan 2011	Feb 2011	Feb 2011	March 2011	March 2011	
Blacklick Creek	Route 56 Bridge Armagh					362 (28th)		143 (24th)	163 (17th)		
	Route 259 Bridge	226 (29th)									
	Industrial Waste Plant C					1.5 X		1.4 X			
	Newport Rd. Bridge					532 (28th)		201 (24th)	143 (17th)		
Conemaugh River	Johnstown Railroad Bridge	381 (25th)			302 (29th)	363 (28th)		181 (24th)	206 (17th)		
	POTW B										
	Route 56 Bridge Johnstown	384 (25th)			282 (29th)	358 (28th)		186 (24th)	203 (17th)		
	Coal Fired Power Plant A & B	1.2 X			1.1 X	1.1 X					
	Seward Bridge	470 (25th)			304 (29th)	402 (28th)		170 (24th)	199 (17th)		
	Conemaugh Dam Trail							156 (24th)	141 (17th)		
	Industrial Waste Plant D								1.1 X		
Tunnelton Rd. Bridge				332 (29th)	243 (5th)	353 (28th)	371 (4th)	157 (24th)	150 (17th)	173 (25th)	
Kiski River	Washington St. Bridge (Saltsburg)	454 (25th)	335 (24th)	297 (23rd)	319 (29th)		381 (28th)	380 (4th)	165 (24th)	143 (17th)	163 (25th)

\* Record rainfalls occurred on Nov 25 & 29, 2010

Note: All results in this table determined using Gravimetric Analysis.

# Kiski River

## SCHENLEY



\* not to scale

# KISKI RIVER

## Bromide Concentration (ppb)

Sample Site	Sept 2010	Oct 2010	Nov 2010	Dec 2010	Dec 2010	Jan 2011	Jan 2011	Feb 2011	Feb 2011	March 2011
Loyalhanna Creek Bridge @ Saltsburg (Bridge on Loyalhanna Creek)			33 (24th)	<50 (23rd)		51 (5th)		45 (4th)		<25 (25th)
Washington St. Bridge (Saltsburg)		<50 (25th)	460 (24th)	470 (23rd)	378 (29th)	179 (5th)	320 (28th)	141 (4th)	106 (24th)	70 (25th)
Avonmore (Railroad Ave Bridge)			390 (24th)	376 (23rd)		147 (5th)		145 (4th)		65 (25th)
Edmon (Bridge)			380 (24th)	358 (23rd)		137 (5th)				62 (25th)
Apollo (1st St Bridge)			160 (24th)	234 (23rd)		144 (5th)		125 (4th)		70 (25th)
Vandergrift (Dime Rd. Bridge)			340 (24th)	317 (23rd)		175 (5th)		108 (4th)		73 (25th)
Vandergrift (RDB)		498 (14th)								
POTW C										1.2X
Leechburg (RDB)		489 (14th)								
Leechburg Bridge				177 (23rd)		143 (5th)		108 (4th)		84 (25th)
Kiski Camp Site (RDB)	850 (24th)	500 (14th)								
Kiski Railroad Bridge			109 (30th) *	181 (23rd)		219 (5th)				
* Record rainfalls occurred on Nov 25 & 29, 2010										

# KISKI RIVER

## Total Dissolved Solids (ppm)

Sample Site	Sept 2010	Oct 2010	Nov 2010	Dec 2010	Dec 2010	Jan 2011	Feb 2011	Feb 2011	March 2011	March 2011
Loyalhanna creek Bridge @ Saltsburg (Bridge on Loyalhanna Creek)			190 (24th)	236 (23rd)		230 (5th)	329 (4th)			159 (25th)
Washington St. Bridge ( Saltsburg)		454 (25th)	335 (24th)	297 (23rd)	319 (29th)	239 (5th)	380 (4th)	165 (24th)	143 (17th)	163 (25th)
Avonmore (Railroad Ave Bridge)			326 (24th)	295 (23rd)		251 (5th)	365 (4th)			170 (25th)
Edmon (Bridge)			309 (24th)	292 (23rd)		246 (5th)				170 (25th)
Apollo (1st St Bridge)			310 (24th)	286 (23rd)		267 (5th)	375 (4th)			178 (25th)
Vandergrift (Dime Rd. Bridge)			304 (24th)	269 (23rd)		282 (5th)	363 (4th)			195 (25th)
Vandergrift (RDB)		496 (14th)								
POTW C										
Leechburg (RDB)		459 (14th)								
Leechburg Bridge					265 (29th)	297 (5th)	367 (4th)			195 (25th)
Kiski Camp Site (RDB)	711 (24th)	430 (15th)								
Kiski Railroad Bridge			162 (30th)*		263 (29th)	308 (5th)				206 (25th)

\* Record rainfalls occurred on Nov 25 & 29, 2010

Note: All results in this table determined using Gravimetric Analysis.

# Lower Allegheny River

**SCHENLEY**

**FREEPORT**

Kiski River

Buffalo TWP Water Plant Intake (MP 29) →

← River Forest Yacht Club (LDB)  
(MP 27)

Freeport (RDB)(MP 28) →

Tarentum (RDB) (MP 22) →

New Kensington Bridge (MP 19) →

Coal Fired Power Plant  
C

Coal Fired Power Plant  
D

Cheswick Marina (RDB) (MP 16) →

Harmar Marina (RDB) (MP 13) →

POTW D  
(25,000 gal/day)

Hulton Bridge (MP 12) →

PWSA Intake (RDB) (MP 8) →

← Lock & Dam #2 (LDB) (MP 6)

**PITTSBURGH**

\*not to scale

# LOWER ALLEGHENY RIVER

## Bromide Concentration (ppb)

Sample Site	Sept 2010	Oct 2010	Oct 2010	Nov 2010	Dec 2010	Jan 2011	Feb 2011	March 2011
Freeport Buffalo Twp Water Plant Intake (RDB)				72 (30th)	76 (28th)		137 (4th)	30 (25th)
Freeport Boat Dock (RDB)	170 (24th)	115 (14th)						
River Forest Yacht Club (LDB)		155 (14th)		96 (30th) *	134 (28th)			60 (25th)
Tarentum (RDB)	220 (24th)	158 (15th)					62 (25th)	34 (16th)
New Kensington Bridge		165 (19th)		158 (24th)				
Coal Fired Power Plant C & D				1.2X				
Rachel Carson Park							48 (25th)	34 (16th)
Cheswick Marina (RDB)		167 (19th)						
Harmar Marina (RDB)	230 (24th)	149 (15th)	220 (29th)	190 (24th)	65 (23rd)	122 (27th)		35 (8th)
POTW D								
Hulton Bridge (CTR)	220 (24th)	139 (15th)	205 (29th)	191 (24th)	51 (23rd)	128 (27th)		<25 (8th)
Hulton Bridge (LDB)		127 (15th)						
Hulton Bridge (RDB)	210 (24th)		221 (29th)	202 (24th)	63 (23rd)	133 (27th)		<25 (8th)
PWSA Intake	220 (24th)	151 (15th)	241 (29th)	204 (24th)	79 (24th)	130 (27th)		<25 (8th)
Lock & Dam #2 (LDB)	230 (24th)	147 (15th)	263 (29th)	213 (24th)	62 (23rd)	141 (27th)		<25 (8th)
* Record rainfalls occurred on Nov 25 & 29, 2010								

# LOWER ALLEGHENY RIVER

## Total dissolved Solids (TDS) (ppm)

Sample Site	Sept 2010	Oct 2010	Oct 2010	Nov 2010	Dec 2010	Jan 2011	Feb 2011	March 2011	April 2011
Freeport Buffalo Twp Water Plant Intake (RDB)				104 (30th)	101 (28th)		227 (4th)		
Freeport Boat Dock (RDB)	149 (24th)	119 (14th)							
River Forest Yacht Club (LDB)		166 (14th)		140 (30th)	146 (28th)			139 (25th)	
Tarentum (RDB)	184 (24th)	163 (15th)					176 (25th)	100 (16th)	
New Kensington Bridge		190 (19th)		142 (24th)					
Coal Fired Power Plant C & D									
Rachel Carson Park							148 (25th)	104 (16th)	
Cheswick Marina (RDB)		188 (19th)							
Harmar Marina (RDB)	206 (24th)	165 (15th)	212 (29th)	160 (24th)	117 (23rd)	208 (27th)	223 (17th)	138 (8th)	181 (7th)
POTW D									
Hulton Bridge (CTR)	198 (24th)	156 (15th)	198 (29th)	148 (24th)	90 (23rd)	171 (27th)	183 (17th)	130 (8th)	132 (7th)
Hulton Bridge (LDB)	217 (24th)								
Hulton Bridge (RDB)		150 (15th)	215 (29th)	172 (24th)	105 (23rd)	181 (27th)	198 (17th)	133 (8th)	146 (7th)
Lock & Dam #2 (LDB)	221 (24th)	166 (15th)	204 (29th)	158 (24th)	101 (23rd)	182 (27th)	163 (17th)	135 (8th)	136 (7th)

\* Record rainfalls occurred on Nov 25 & 29, 2010

Note: All results in this table determined using Gravimetric Analysis.

# Radiological Survey (2011)

## (PWSA Intake and Finished Water)

Radiological units: pCi/L	Combined Radium 226 and Radium 228 (MCL= 5 pCi/L)	Gross Alpha (MCL= 15 pCi/L)	Gross Beta (MCL= 50 pCi/L)	Uranium (MCL= 30 pCi/L)
March 4 (Raw Water)	1.42	2.5	3.6	0.03
March 4 (Treated Water)	0.86	0.65	3.0	0.00
April 1 (Raw Water)	0.69	0.48	0.69	0.02
April 1 (Treated Water)	0.00	2.9	2.0	0.00

# Radiological Survey (March 2011)

(Allegheny River Upstream)

Radiological units: pCi/L	Combined Radium 226 and Radium 228 (MCL= 5 pCi/L)	Gross Alpha (MCL= 15 pCi/L)	Gross Beta (MCL= 50 pCi/L)	Uranium (MCL= 30 pCi/L)
Allegheny River @ Warren, PA	.54	3.9	3.8	.02
Industrial wastewater Site A (Upstream)	.23	0	0	.03
Industrial Wastewater Site A (Downstream)	.74	2.3	1.2	.02
Industrial wastewater Site B (Upstream)	.31	0	6.1	.03
Industrial Wastewater Site B (Downstream)	.25	.02	1.2	.01
Industrial wastewater Site C (Upstream)	.59	.06	2.6	.02
Industrial Wastewater Site C (Downstream)	.54	1.5	2.3	.01
Industrial wastewater Site D (Upstream)	.46	1.3	2.2	.02
Industrial Wastewater Site D (Downstream)	.19	2.1	5.9	.02
POTW D (Upstream)				
POTW D (Downstream)				30

## PWSA INTAKE (Allegheny River)

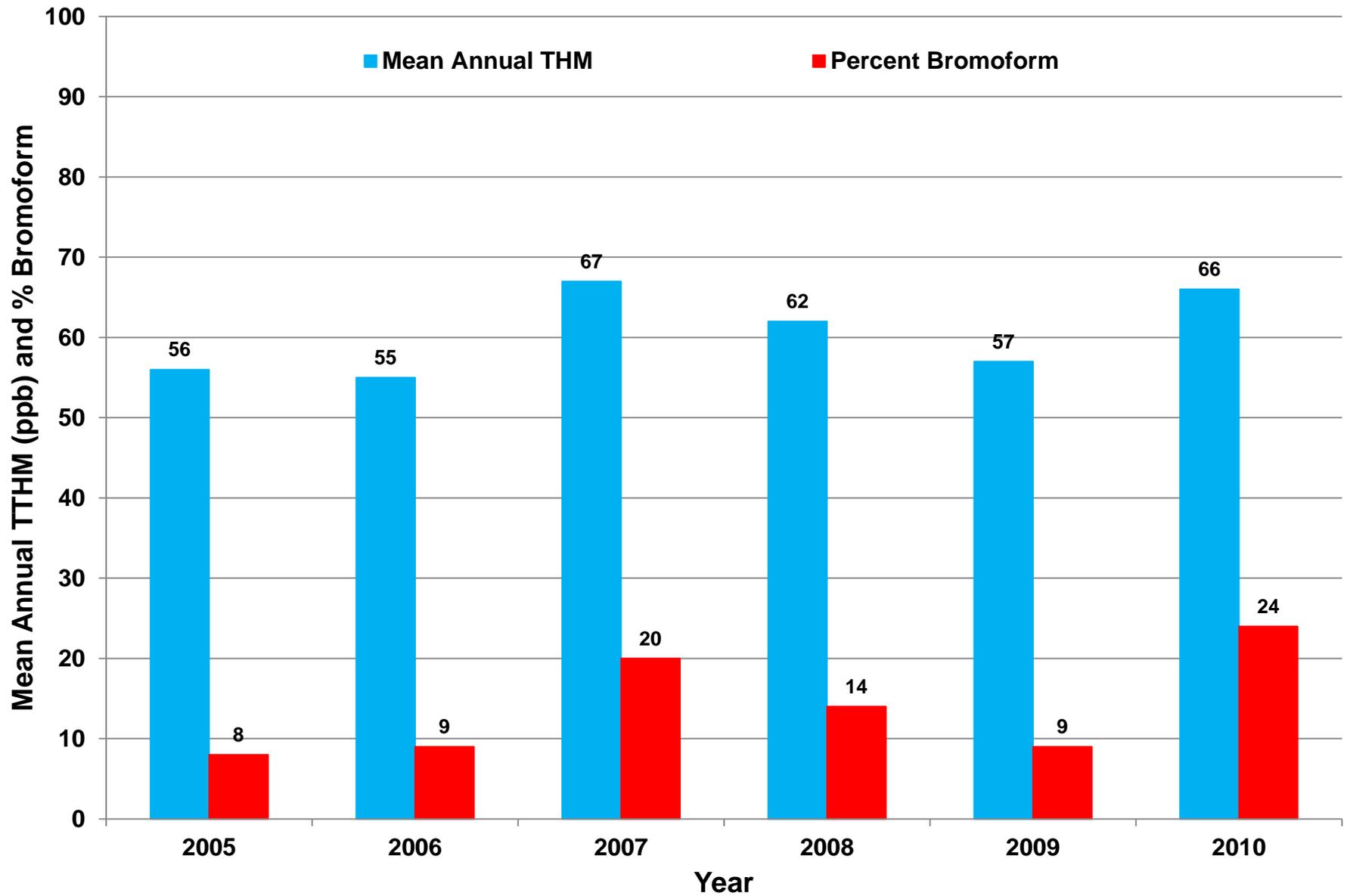
### Bromide Concentration (ppb)

Day of the Month	Sept 2010	Oct 2010	Nov 2010	Dec 2010	Jan 2011	Feb 2011	March 2011	April 2011
1			136	37 *	85	182	58	48
2			241	42 *	81	147	28	
3			227	39	123	165	36	
4			195	38	97	145	35	
5			216	59	56	135	38	
6			172	44	66	136	43	
7			230	48	71	117	28	
8			170	49	84	114	<25	
9			194	53	85	125	29	
10			124	58	101	126	30	
11			168	64	97	130	32	
12		205	160	68	94	118	30	
13		203		49	82	123	27	
14		188		57	106	110	32	
15		151	170	65	95	141	34	
16			155	57	125	150	37	
17			165	76	82	147	28	
18			143	35	100	136		
19			146	67	147	139	39	
20			158		156	95	28	
21			176	88	123	62	44	
22			140		115	77	31	
23			224		124	42	30	
24	220		204	79	120	38	29	
25		188	180 *	66	128	43	50	
26		142	139 *	106	162	61	61	
27		156	145 *	89	130	46	34	
28		190	117 *	101	165	56	44	
29		241	97 *		159		<25	
30		211	79 *	198	182		42	
31		220		98	202		47	

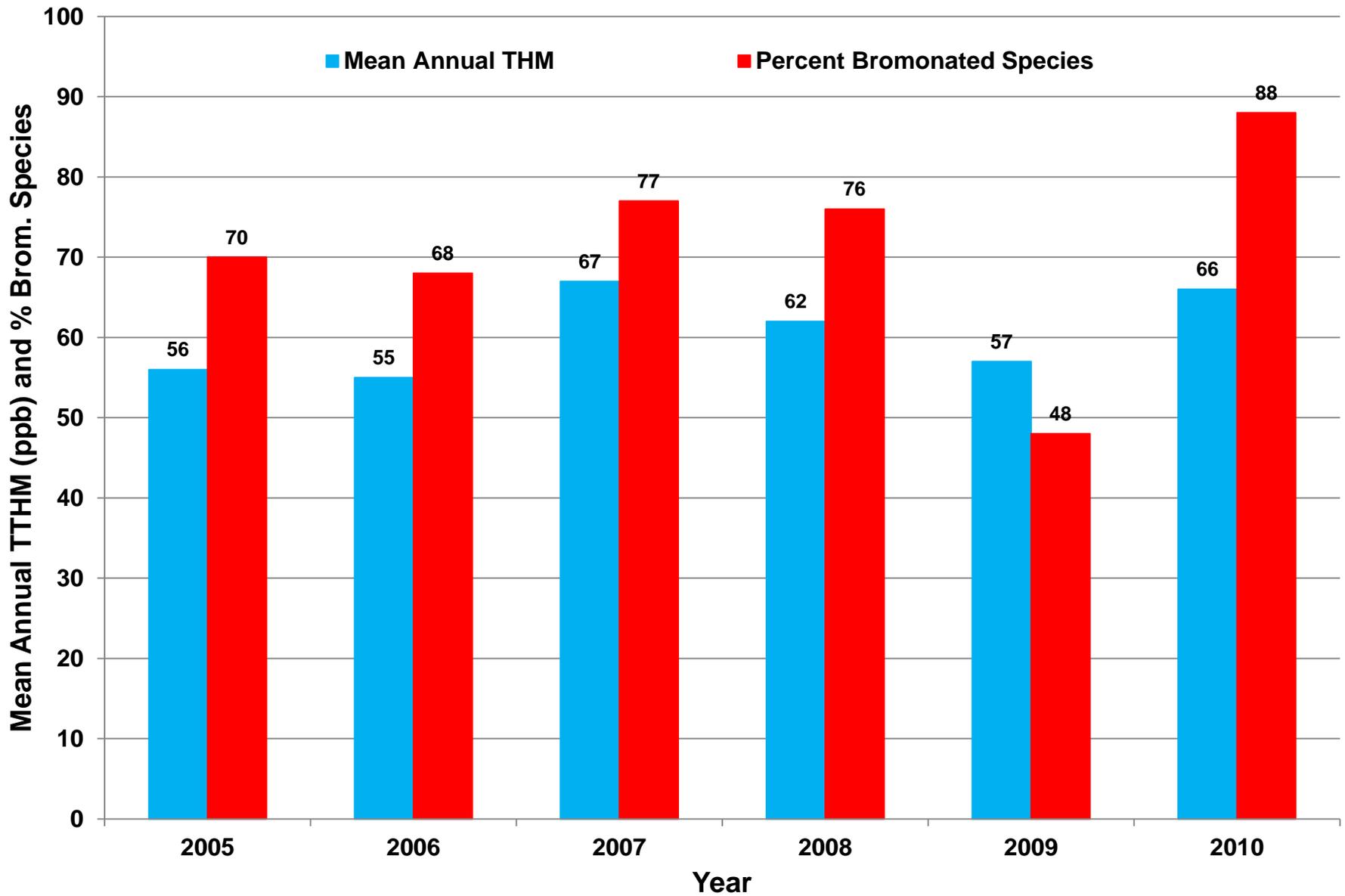
Notes:

\* Record rainfalls occurred on Nov 25 & 29, 2010

# Mean Annual THM Concentrations and Percent Bromoform



# Mean Annual THM Concentrations and % Brominated Sp.



# Preliminary Conclusions

- Increased bromide concentrations in source water cause elevated TTHM concentrations and an increase in % contribution of brominated THMs
- Conventional drinking water treatment does not effectively remove bromide from the raw water
- Radionuclides do not appear to be elevated in the Allegheny River or its tributaries
- Bromide concentrations throughout the Allegheny River system vary from <25- 1130 ppb
- Bromide concentrations in the Allegheny River at PWSA intake vary from <25- 241 ppb

- Bromide concentrations tend to increase as the water flows downstream
- Bromide concentrations are significantly affected by river volume (e.g. snow melt, heavy rains)
- Potential bromide problems for PWSA are more acute during low river flow conditions than during high river flow conditions
- TDS is not a good indicator/surrogate for bromide concentrations in the Allegheny River
- Bromide concentrations increase downstream of industrial wastewater treatment sites treating Marcellus Shale wastewater
- Bromide concentrations do not appear to increase downstream of POTWs treating Marcellus Shale wastewater nor downstream of coal-fired powerplants