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Ohio Environmental Protection Agency

Division of Surface Water

Biological and Water Quality Study of the Upper Scioto River Watershed 2009 & 2011

John Kasich, Governor
Mary Taylor, Lt. Governor
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Biological and Water Quality Study of the Upper Scioto River Watershed 2009 & 2011

Auglaize, Crawford, Hardin, Logan, Marion, Union, and Delaware Counties, Ohio

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prepared by

State of Ohio Environmental Protection Agency

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Executive Summary

Rivers and streams in Ohio support a variety of uses related to recreation, water supply, and aquatic life. As part of the biological and water quality survey process, Ohio EPA annually evaluates selected streams from selected watersheds to determine the appropriate Aquatic Life Use (ALU) designation and to verify the use is meeting the goals of the federal Clean Water Act. In 2009, 23 streams in the upper Scioto River watershed, located in Auglaize, Crawford, Delaware, Hardin, Logan, Marion, and Union counties, were assessed (Figure 3 & Table 1). The results of that sampling are summarized below.

In 2011, nine sampling stations were resampled for fish and five sites were resampled for macroinvertebrates to evaluate recovery trends following spills and fish kills during 2009. This included six sites on the Scioto River main stem and one site each on Taylor Creek, Fulton Creek, and Elliot Run (Table 2).

Based on analysis of fish community IBI trends (1995 vs. 2009), fish kills were a suspected but unsubstantiated source of impairment on the Scioto River main stem, downstream from Taylor Creek (Figure 1). However, the fish community fully recovered by 2011 (Figure 1). The series of fish kills on lower Taylor Creek resulted from the discharge of untreated wastes at the Durez Corporation permitted outfall (RM 1.57). On July 21, 2010, in response to the notice of violation issued by the Ohio EPA DSW in September 2009, Durez Corporation commenced an action to remove contaminated Taylor Creek sediment. Additional 2009 fish kills on Fulton Creek and Elliot Run resulted from a fertilizer spill (See Spills and Kills section, pg. 58).

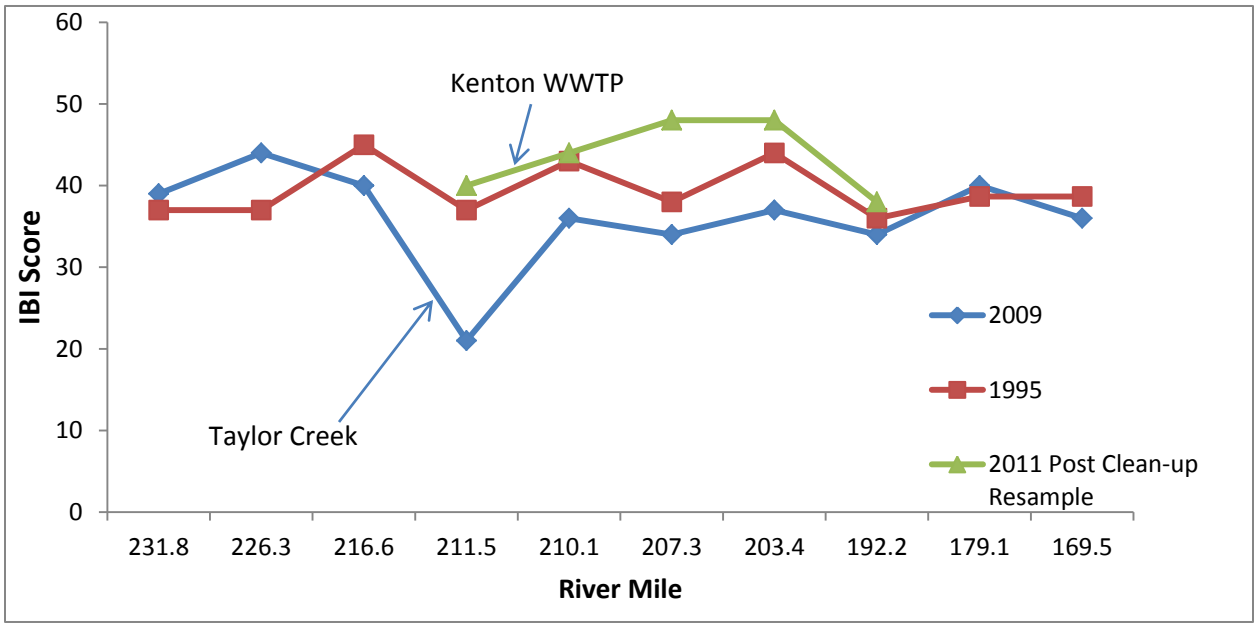

Figure 1. Upper Scioto River and IBI trends (1995-2011) by river mile for selected main stem sites which outline the magnitude of the pollution effects emanating from Taylor Creek.

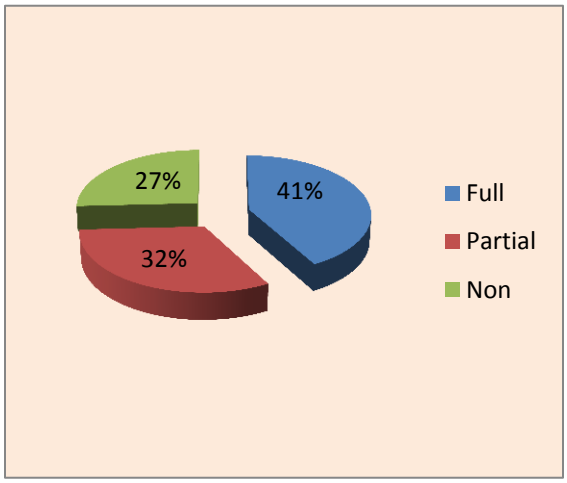

Figure 2. Percent ALU attainment of biological sampling stations in the Upper Scioto River watershed, 2009 & 2011.

Of the 62 biological stations sampled, 26 (41%) were fully meeting the designated or recommended ALU, 20 (32%) were in partial attainment and (27%) were in non-attainment (Figure 3 & Figure 3). In the Scioto River, three sites upstream from Kenton at Madory Road (RM 231.86), County Road 65 (RM 224.20), and Downstream County Road 110 (RM 223.05) and one well downstream at the Big Island Wildlife Area southeast of New Bloomington (RM 186.00) partially attained the existing WWH use; impairment was attributed to physical habitat modification from channelization and fine silt and sediment runoff from the adjacent agricultural landscape (Table 2). At tributary sites, 16 (33%) fully attained their designated ALU, 14 (29%) partially attained and 18 (38%) were in non-attainment (Table 2).

The most common cause of impairment in tributaries was also habitat alteration (channelization) and sediment runoff from agriculture (59% of impaired tributary sites). Stream channelization often exacerbated other, related causes of pollution such as excessive nutrient runoff and silt deposition.

Similar to the widespread biological impairment encountered in the upper Scioto basin, high quality communities were rarely found. Exceptional fish collections were restricted to one main stem site in the extreme headwaters (RM 236.40) and were absent from all tributaries. Exceptional macroinvertebrate performance was limited to the Scioto River main stem and a single tributary site in upper Rush Creek at RM 26.26 (Table 12 & Appendix C-1). As mentioned above, marginal biological quality was largely attributed to the pervasive influences of siltation, nutrient enrichment and channelization associated with the extensive agricultural landscape (see Figure 5).

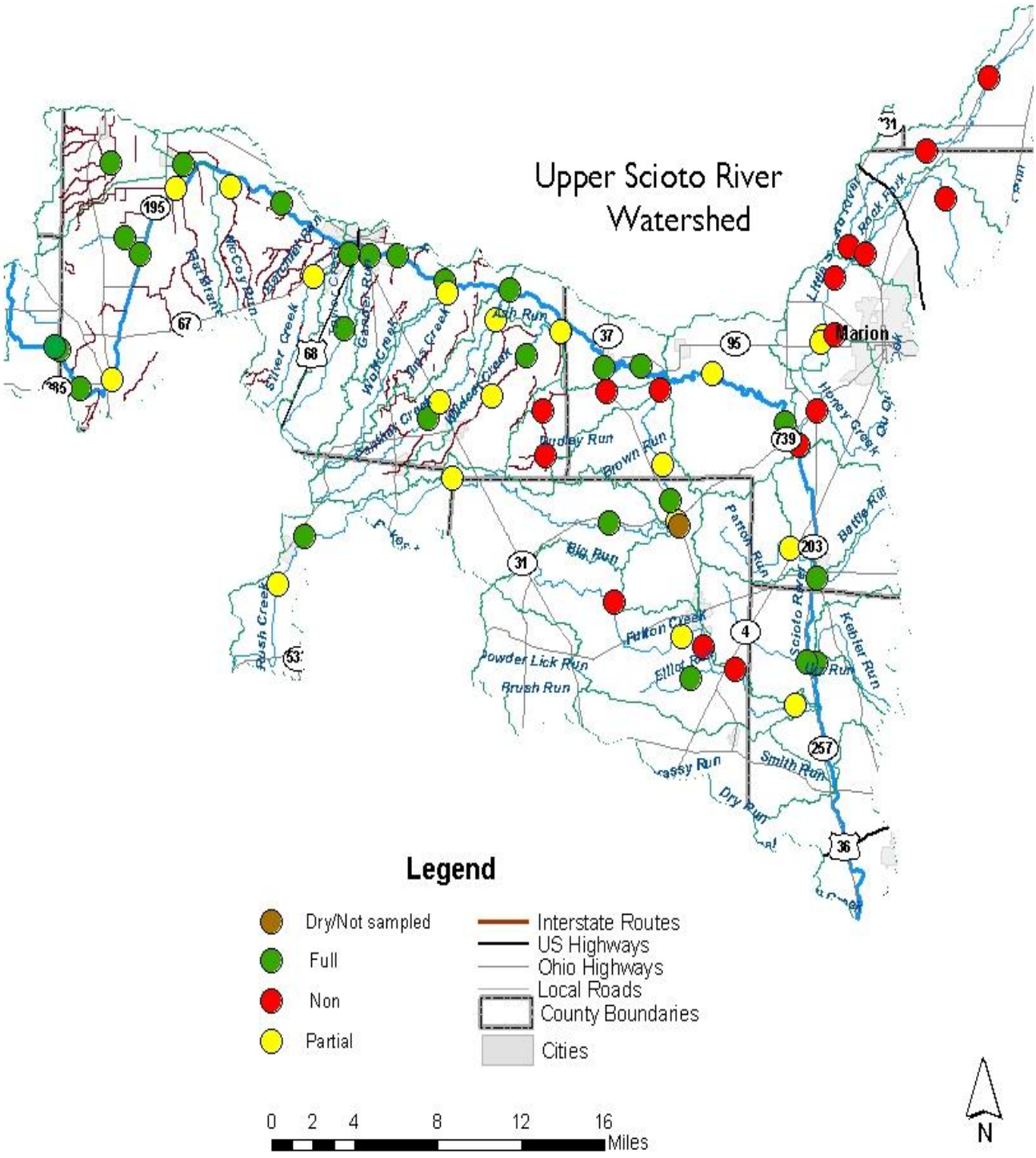

Figure 3. Aquatic life use attainment map for biological stations sampled in the upper Scioto River watershed, 2009 & 2011.

Table 1. Sampling stations for the upper Scioto River watershed, 2009 and 2011.

Rivercode	Stream	Location	RM	Lat	Long	DA	Fish	Bugs	Chem	Bac-T	Sonde	Storet
02-001-000	Scioto R.	Dst. Wallace Fork and Co. Rd. 311	236.4	40.5796080	-83.8826940	13.0	X					301236
02-001-000	Scioto R.	Arbogast Rd.	234.39	40.5547000	-83.8611000	18.3	X	X	X	X	X	VO1W18
02-001-000	Scioto R.	Madory Rd.	231.86	40.5606000	-83.8325000	28.0	2X	X[Qnt]	X	X		VO1W19
02-001-000	Scioto R.	Co. Rd. 130	226.30	40.6358000	-83.8078000	49.0	2X	X[Qnt]	X	X		201834
02-001-000	Scioto R.	Co. Rd. 65	224.2	40.6633000	-83.7925000	62.0	2X	X[Qnt]	X	X		V01P06
02-001-000	Scioto R.	Dst. Co. Rd. 110 (* use ALP # 1)	222.8*	40.6747000	-83.7761000	67.0	2X	X[Qnt]	X	X		V01W20
02-001-000	Scioto R.	Co. Rd. 106	216.67	40.6667000	-83.6792000	117.0	2X	X[Qnt]	X	X		610770
02-001-000	Scioto R.	Dst. Leighton St.	211.50	40.6369000	-83.5986000	162.0	2X	X[Qnt]				V01S04
02-001-000	Scioto R.	Co. Rd. 175	210.07	40.6372000	-83.5733000	170.0	2X	X[Qnt]	X	X		610760
02-001-000	Scioto R.	Twp. Rd. 199	207.26	40.6219000	-83.5303000	178.0	2X	X[Qnt]	X	X		V01W23
02-001-000	Scioto R.	Co. Rd. 227 @ Hepburn	203.36	40.6172000	-83.4703000	223.0	2X	X[Qnt]	X	X		V01S11
02-001-000	Scioto R.	St. Rt. 37 @ Larue	196.12	40.5717970	-83.3840420	258.0	2X	X[Qnt]	X	X	X	V01S23
02-001-000	Scioto R.	Schotte Rd.	192.21	40.5728000	-83.3503000	262.0	2X	X[Qnt]	X	X		V01W24
02-001-000	Scioto R.	Wildlife Refuge SE New Bloomington	186.00	40.5694000	-83.2844000	379.0	2X	X[Qnt]	X	X		201831
02-001-000	Scioto R.	Adj. Green Camp River Rd.	179.05	40.5399000	-83.2176000	407.0	2X	X[Qnt]	X	X		V01W15
02-145-000	Fulton Creek	Miller Rd.	16.30	40.4324280	-83.3727560	12.5	X	X	X			300700
02-145-000	Fulton Creek	Ust. Richwood @ Kinney Pike	10.35	40.4131000	-83.3103000	24.9	2X	X[Qnt]	X		XX	V02S07
02-145-000	Fulton Creek	Dst. Richwood @ Farm Bridge	8.70	40.4067000	-83.2906000	29.0	2X	X[Qnt]	X		XX	V02S05
02-145-000	Fulton Creek	Dst. Richwood , Adj. Fulton Creek Rd.	6.44	40.3936000	-83.2614000	40.0	2X	X[Qnt]	X			V02S04
02-145-000	Fulton Creek	Fulton Creek Rd.(upper)	1.20	40.3728000	-83.2075000	46.4	2X	X[Qnt]				V02S02
02-145-001	Elliot Run	Kinney Pike	1.25	40.3881880	-83.3027920	2.5	X	X	X			300701
02-148-000	Kebler Run	River Rd.	0.87	40.3974000	-83.1874000	14.3	X	X	X	X	X	V02G05
02-149-000	Ottawa Creek	St. Rt. 257	0.08	40.3987000	-83.1968000	8.0	X	X	X		XX	V02G06
02-154-000	Battle Run	At Prospect @ Elm St.	0.25	40.4482000	-83.1875000	9.4	X	X	X			V02G07
02-155-000	Patton Run	Boundary Rd.	2.25	40.4660350	-83.2124220	14.4	X	X	X	X		300699
02-158-000	L. Scioto R.	Caldwell Rd.	25.59	40.7464000	-83.0334000	12.8	X	X	X			V02G02
02-158-000	L. Scioto R.	Crawford-Marion Line Rd.	19.70	40.7026000	-83.0908000	33.0	2X	X[Qnt]	X		XX	V02G01
02-158-000	L. Scioto R.	Kenton-Galion Rd.	11.11	40.6450000	-83.1614000	47.0	2X	X[Qnt]	X	X		V02S01
02-158-000	L. Scioto R.	Hillman Ford Rd.	9.24	40.6267000	-83.1736000	73.0	2X	X[Qnt]	X	X		V02S13
02-158-000	L. Scioto R.	Dst. Holland Rd.	6.50	40.5923530	-83.1836190	86.0	2X	X[Qnt]	X	X		300624

Rivercode	Stream	Location	RM	Lat	Long	DA	Fish	Bugs	Chem	Bac-T	Sonde	Storet
02-158-000	L. Scioto R.	T-97-A	6.24	40.5881000	-83.1863000	86.0	2X	X[Qnt]	X	X	XX	VO2W16
02-158-000	L. Scioto R.	Owens-Green Camp Rd	0.39	40.5275000	-83.2053000	113.0	2X	X[Qnt]	X	X	X	VO2PO7
02-158-004	N Rock Swale Ditch	Holland Rd.	0.55	40.5928000	-83.1733000	10.0	X	X	X			V02W15
02-159-000	Honey Creek	At Mouth	0.10	40.5478000	-83.1889000	7.3	X	X	X			VO2P11
02-162-000	Rocky Fork	Marseilles-Gallion Rd.	8.13	40.6738000	-83.0727000	7.6	X	X	X			V02G03
02-162-000	Rock Fork	@ St. Rt. 423	1.10	40.6411000	-83.1453000	23.1	2X	X[Qnt]	X	X	X	V02P09
02-165-000	Rush Creek	Twp. Rd. 118	39.45	40.4408350	-83.6789050	11.8	X	X	X			300693
02-165-000	Rush Creek	Twp. Rd. 110	36.15	40.4695230	-83.6558180	14.8	X	X	X		XX	300694
02-165-000	Rush Creek	West Mansfield Mt. Victory Rd.	26.26	40.5051050	-83.5204720	25.7	2X	X[Qnt]	X			300695
02-165-000	Rush Creek	Winnimac Rd.	14.50	40.4799520	-83.3778400	50.0	2X	X[Qnt]	X	X		300696
02-165-000	Rush Creek	Ust. SR 739	8.8	40.4808500	-83.3166250	72.7	2X	X[Qnt]				300808
02-165-000	Rush Creek	Sanders Rd.	7.55	40.4938860	-83.3222060	73.9	2X	X[Qnt]				300807
02-165-000	Rush Creek	Mt. Olive-Green Camp Rd.	5.39	40.5150000	-83.3297000	77.0	2X	X[Qnt]	X	X	X	V01S01
02-165-000	Rush Creek	Larue-Green Camp Rd.	0.55	40.5594000	-83.3322000	105.0	2X	X[Qnt]	X		XX	V01K04
02-166-000	McDonald Creek	Co. Rd. 245	9.17	40.5189000	-83.4363000	2.6	X	X	X			V01K01
02-166-000	McDonald Creek	Co. Rd. 245	6.82	40.5456000	-83.4392000	6.3	X	X	X			V01W34
02-166-000	McDonald Creek	St. Rt. 37	2.70	40.5581000	-83.3808000	12.3	X	X	X	X	XX	203089
02-172-000	Wildcat Creek	Twp. Rd. 217 nr. Mt. Victory	6.72	40.5544000	-83.4856000	4.3	X	X	X			V01W31
02-172-000	Wildcat Creek	Twp. Rd. 245 nr. Mt. Victory	4.00	40.5787230	-83.4540970	8.4	X	X	X		XX	300692
02-172-000	Wildcat Creek	Larue-Kenton Rd. nr. Larue	0.49	40.5933000	-83.4233000	22.2	2X	X[Qnt]	X	X	XX	V01W32
02-175-000	Panther Creek	Twp. Rd. 197 nr. Mt. Victory	8.91	40.5406000	-83.5436000	7.1	X	X	X			V01W28
02-175-000	Panther Creek	St. Rt. 31 Roadside Park	7.80	40.5500000	-83.5330000	11	X	X	X			V01W29
02-175-000	Panther Creek	Co. Rd. 219 nr. Hepburn	1.80	40.5997000	-83.4831000	22.3	2X	X[Qnt]	X	X	XX	V01W30
02-177-000	Wolf Creek	Twp. Rd. 199	0.51	40.6151240	-83.5278010	12	X	X	X	X		300691
02-181-000	Taylor Creek	Twp. Rd. 180	4.43	40.5933000	-83.6214000	12.7	X	X	X			V01S07
02-181-000	Taylor Creek	St. Rt. 67	0.76	40.6378000	-83.6172000	16.3	X	X	X	X	X	V01P01
02-182-000	Silver Creek	St. Rt. 67	2.32	40.6242000	-83.6492000	11.3	X	X	X	X	XX	V01W27
02-186-000	McCoy Run	Rodgers Rd.	0.55	40.6758770	-83.7265630	8.0	X	X	X			300690
02-188-000	Cottonwood Ditch	Adj. Twp. Rd 100	4.1	40.6894000	-83.8361000	11.3	X	X	X			VO1S20
02-188-000	Cottonwood Ditch	Dst. McGuffey @ RR Bridge	0.68	40.6893880	-83.7690350	19.3	2X	X[Qnt]	X	X	X	VO1SO8
02-190-000	Dunlap Creek	St. Rt. 195	0.10	40.6448130	-83.8228560	8.9	X	X	X			300689
02-193-000	Wallace Fork	Adj. gravel road @ mouth	0.20	40.5796000	-83.8846000	4.8	X	X	X			300688

Sample site list key:

- (X), (2X) = 1 or 2 pass fish
- (X), ($X^{QNT)}$ =qualitative or quantitative macroinvertebrate sampling
- (X) = water column chemistry, bacterial, or water quality modeling sampling
- DA = Drainage Area in $Miles^2$

Table 2. Aquatic life use attainment status for sampling locations in the upper Scioto River watershed, 2009 and 2011. The Index of Biotic Integrity (IBI), Modified Index of well-being (MIwb), and Invertebrate Community Index (ICI) scores are based on the performance of the biological community. Stream habitat reflects the ability to support a biological community. The upper Scioto River watershed is located in the Eastern Corn Belt Plains (ECBP) ecoregion. If biological impairment has occurred, the cause(s) and source(s) of the impairment are noted.

RM	Stream Name	Station ID	Current Aquatic Life Use	IBI	MIwb[a]	ICI[b]	Macro Narrative	QHEI	Attainment Status	Cause	Source
Basin & Stream Code:		**02-001-000**									
236.40[H]	Scioto R. Dst. Wallace Fk. Dst Hardin County Line Rd (Co Rd 311)	301236	WWH	54	NA	-	-	61.5	Full		
234.39[H]	Scioto R. W Of Roundhead @ Arbogast Rd.	V01W18	WWH	44	NA	-	G	77.5	Full		
231.86[W]	Scioto R. At Roundhead @ Madory Rd.	V01W19	WWH	39[ns]	7.49*	46		79.5	Partial	Sedimentation/ siltation	Upstream Channelization
226.30[W]	Scioto R. Se Of Mcguffey, Upst. Co. Rd. 130	201834	WWH	44	8.50	40		38.5	Full		
224.20[W]	Scioto R. S Of Mcguffey @ Co. Rd. 65	V01P06	WWH	37[ns]	7.59*	44		32.5	Partial	Sedimentation/ siltation, Habitat alteration	Channelization, Agriculture
223.05[W]	Scioto R. Se Of Mcguffey @ Co. Rd. 110	V01W20	WWH	43	7.57*	54		37.5	Partial	Sedimentation/ siltation, Habitat alteration	Channelization, Agriculture
216.67[W]	Scioto R. W Of Kenton @ Co. Rd. 106	610770	WWH	40	8.36	34[ns]		46	Full		
211.50[W]	Scioto R. Just Upst. Kenton WWTP	V01S04	WWH	40	8.10[ns]	44		59	Full		
210.07[W]	Scioto R. At Kenton @ Co. Rd. 175	610760	WWH	44	9.90	40		67	Full		
207.26[W]	Scioto R. Dst. Kenton @ Twp. Rd. 199	V01W23	WWH	48	10.00	42		74	Full		
203.36[W]	Scioto R. At Hepburn @ Co. Rd. 227	V01S11	WWH	48	8.70	48		74.5	Full		
196.12[B]	Scioto R. At Larue @ St. Rt. 37	V01S23	WWH	38[ns]	9.40	52		53	Full		

RM	Stream Name	Station ID	Current Aquatic Life Use	IBI	Mlwb[a]	ICI[b]	Macro Narrative	QHEI	Attainment Status	Cause	Source
192.21[W]	Scioto R. SW Of New Bloomington @ Schotte Rd.	V01W24	WWH	38[ns]	8.20[ns]	48		61	Full		
186.00[W]	Scioto R. Se Of New Bloomington @ WTP At Refuge	201831	WWH	32*	7.14*	46	-	67	Partial	Sedimentation/ siltation	Agriculture
179.05[W]	Scioto R. Adj. Green Camp River Rd.	V01W15	WWH	40	8.51	-	G	71.5	Full		
Basin & Stream Code:		**02-145-000**									
16.3[H]	Fulton Creek Upst. Richwood @ Miller Rd.		WWH	32*	NA	-	P*	27	Non	Habitat alteration, Nutrient enrichment, D.O., Phosphorus	Channelization, Agriculture
10.35[W]	Fulton Creek Upst. Richwood @ Kinney Pike	V02S07	WWH	33*	7.70*	38	-	76.5	Partial	Habitat alteration, Nutrient enrichment, D.O.	Channelization, Agriculture
8.70[W]	Fulton Creek Dst. Richwood @ Farm Bridge	V02S05	WWH	41	5.41*	32[ns]	-	42.5	Non	Habitat alteration, Nutrient enrichment, D.O., Organic enrichment	Channelization, Agriculture, Richwood WWTP
6.44[W]	Fulton Creek Dst. Richwood, Adj. Fulton Creek Rd.	V02S04	WWH	16*	4.6*	38	-	50.5	Non	Habitat alteration, Nutrient enrichment, D.O., Organic enrichment	Channelization, Agriculture, Richwood WWTP
1.20[W]	Fulton Creek Se Of Richwood @ Fulton Creek Rd. (upper)	V02S02	WWH	39[ns]	7.60*	-	MG[ns]	74	Partial	Nutrient enrichment, D.O.	Agriculture
Basin & Stream Code:		**02-145-001**									
1.25[H]	Elliot Run S Of Richwood @ Kinney Pike	300701	Recommended MWH	28	NA	-	F	42	Full		
Basin & Stream Code:		**02-148-000**									

RM	Stream Name	Station ID	Current Aquatic Life Use	IBI	Mlwb[a]	ICI[b]	Macro Narrative	QHEI	Attainment Status	Cause	Source
0.87[H]	Kebler Run S Of Prospect @ River Rd.	V02G05	WWH	42	NA	-	G	83.5	Full		
Basin & Stream Code:		**02-149-000**									
0.08[H]	Ottawa Creek @ St. Rt. 257	V02G06	WWH	42	NA	-	G	79.5	Full		
Basin & Stream Code:		**02-154-000**									
0.25[H]	Battle Run At Prospect @ Elm St.	V02G07	WWH	36[ns]	NA	-	MG[ns]	70.5	Full		
Basin & Stream Code:		**02-155-000**									
2.25[H]	Patton Run @ Boundary Rd.	300699	WWH	32*	NA	-	MG[ns]	56	Partial	Sedimentation/ siltation	Agriculture
Basin & Stream Code:		**02-158-000**									
25.59[H]	L. Scioto R. @ Caldwell Rd.	V02G02	WWH	30*	NA	-	F*	40.5	Non	Habitat alteration	Channelization
19.70[W]	L. Scioto R. @ Crawford-Marion County Line Rd.	V02G01	WWH	27*	5.82*	-	F*	69.5	Non	Sedimentation/ siltation	Agriculture
11.10[W]	L. Scioto R. N Of Marion @ Kenton-Galion Rd.	V02S01	WWH	29*	4.34*	-	MG[ns]	49	Non	Sedimentation/ siltation	Agriculture
9.24[W]	L. Scioto R. NW Of Marion @ Hillman Ford Rd.	V02S13	WWH	27*	6.26*	32[ns]	-	73.5	Non	Sedimentation/ siltation	Agriculture
6.50[B]	L Scioto R At Marion, Upst Marion WWTP/Dst N Rockswale Ditch	300624	MWH-C	26	5.81	10	-	31	Partial	Organic enrichment/D.O. Habitat Alt.	CSOs, Channelization
6.24[B]	L. Scioto R. @ Landfill/Twp. Rd. 97-A	V02W16	MWH-C	29	6.72	12	-	34.5	Partial	Organic enrichment/D.O. Habitat Alt.	CSOs, Channelization
0.39[W]	L. Scioto R. At Green Camp @ Owens-Green Camp Rd. (Cr 104)	V02P07	MWH-C	28	3.98*		LF* [(d)]	45.5	Non	Sediment contamination, Chronic ammonia	CSOs, Creosote
Basin & Stream Code:		**02-158-004**									
0.55[H]	N. Rock Swale Ditch W Of Marion @ Holland Rd.	V02W15	MWH-C	22*	NA	-	VP*	49	Non	Organic enrichment/D.O.	CSO

RM	Stream Name	Station ID	Current Aquatic Life Use	IBI	Mlwb[a]	ICI[b]	Macro Narrative	QHEI	Attainment Status	Cause	Source
Basin & Stream Code:		**02-159-000**									
0.01[H]	Honey Creek SW Of Marion @ Mouth	V02P11	WWH	24*	NA	-	F*	58.5	Non	Habitat, Nutrient enrichment	Agriculture
Basin & Stream Code:		**02-162-000**									
8.13[H]	Rock Fork @ Marseilles-Galion Rd.	V02G03	WWH	34*	NA	-	F*	35.5	Non	Habitat, Nutrient enrichment, Fish kills	Channelization, Agriculture, manure
1.10[W]	Rock Fork N Of Marion @ St. Rt. 423	V02P09	WWH	25*	6.26*	44	-	74	Non	Habitat, Nutrient enrichment, Fish kills	Upstream Channelization, Agriculture, manure
Basin & Stream Code:		**02-165-000**									
39.45[H]	Rush Creek Upst. Rushville @ Twp. Rd. 118	300693	WWH	32*	NA	-	G	82.5	Partial	Ground water, low D.O.	Natural
36.15[H]	Rush Creek Dst. Rushville @ Twp. Rd. 110	300694	WWH	48	NA	-	VG	82	Full		
26.26[W]	Rush Creek @ West Mansfield-Mt. Victory Rd. (Co. Rd. 139)	300695	WWH	43	7.39*	48	-	65.5	Partial	Silt/Sediment	Agriculture
14.50[W]	Rush Creek @ Winnemac Rd.	300696	WWH	42	8.12[ns]	-	MG[ns]	79	Full		
8.80[W]	Rush Creek At Essex, Upst St. Rt. 739	300808	WWH	37[ns]	6.26*	26*	-	61	Partial	Habitat and flow alteration	Logjams, natural
7.55[W]	Rush Creek N Of Essex @ Sanders Rd.	300807	WWH	45	8.48	34[ns]	-	60.5	Full		
5.39[W]	Rush Creek S Of New Bloomington @ Mt. Olive-Green Camp Rd.	V01S01	WWH	36[ns]	6.67*	38	Normal flow 8-19	62.5	Partial	Natural	Low Flow
0.55[W]	Rush Creek @ Larue-Green Camp Rd.	V01K04	WWH	28*	5.16*	28*	-	60	Non	Natural	Low Flow
Basin & Stream Code:		**02-166-000**									
9.17[H]	McDonald Creek Upst. Buckeye Egg Farm @ Co. Rd. 240	V01K05	WWH	32*	NA	-	P	38	Non	Habitat, Organic enrichment/ D.O.	Channelization, On-site septic

RM	Stream Name	Station ID	Current Aquatic Life Use	IBI	Mlwb[a]	ICI[b]	Macro Narrative	QHEI	Attainment Status	Cause	Source
6.82[H]	McDonald Creek SW Of Larue @ Co. Rd. 245	V01W34	WWH	30*	NA	-	P*	43	Non	Habitat, nutrient enrichment, D.O.	Channelization, Agriculture
2.70[H]	McDonald Creek S Of Larue @ St. Rt. 37	203089	WWH	32*	NA	-	P*	44.5	Non	Habitat, nutrient enrichment, D.O.	Channelization, Agriculture
Basin & Stream Code:		**02-172-000**									
6.72[H]	Wildcat Creek Ne Of Mt. Victory @ Twp. Rd. 217	V01W31	WWH	38[ns]	NA	-	F*	43.5	Partial	Habitat, nutrient enrichment, D.O.	Channelization, Agriculture
4.00[H]	Wildcat Creek @ Twp. Rd. 245	300692	WWH	38[ns]	NA	-	MG[ns]	49.5	Full	-	-
0.49[W]	Wildcat Creek NW Of Larue @ Larue-Kenton Rd.	V01W32	WWH	31*	7.72*	40	-	84.5	Partial	Nutrient enrichment	Agriculture
Basin & Stream Code:											
8.91[H]	Panther Creek W Of Mt. Victory @ Twp. Rd. 197	V01W28	WWH	40	NA	-	MG[ns]	82.5	Full		
7.80[H]	Panther Creek @ St. Rt. 31 Roadside Park	300704	WWH	30*	NA	-	MG[ns]	75	Partial	Nutrient enrichment	Agriculture
1.80[W]	Panther Creek SW Of Hepburn @ Co. Rd. 219	V01W30	WWH	37[ns]	6.86*	-	F*	71.5	Partial	Nutrient enrichment	Agriculture
Basin & Stream Code:		**02-177-000**									
0.51[H]	Wolf Creek @ Twp. Rd. 199	300691	WWH	40	NA	-	F*	59	Partial	Low flow	Natural
Basin & Stream Code:		**02-181-000**									
4.43[H]	Taylor Creek S Of Kenton @ Tr. 180	V01S07	WWH	42	NA	-	G	80	Full		
0.76[H]	Taylor Creek At Kenton @ St. Rt. 67	V01P01	WWH	42	NA	48	-	65	Full		
Basin & Stream Code:		**02-182-000**									
2.32[H]	Silver Creek @ St. Rt. 67	V01W27	WWH	40	NA	-	F*	74.5	Partial	Low flow	Natural
Basin & Stream Code:		**02-186-000**									
0.55[H]	McCoy Run @ Rodgers Rd.	300690	WWH	46 upst	NA	-	F* /dnst sample	53.5	Partial	Organic enrichment/D.O.	On-site septic

RM	Stream Name	Station ID	Current Aquatic Life Use	IBI	MIwb[a]	ICI[b]	Macro Narrative	QHEI	Attainment Status	Cause	Source
Basin & Stream Code:		**02-188-000**									
4.10[H]	Cottonwood Ditch Dst. Alger, Adj. Twp. Rd. 100, Dst C.R. 35	V01S20	MWH-C	26*	NA	-	HF [(e)]	24	Full		
0.68[H]	Cottonwood Ditch Dst. Mcguffy WWTP @ RR Bridge	V01S08	MWH-C	34	NA	32[ns]	-	18	Full		
Basin & Stream Code:		**02-190-000**									
1.01[H]	Dunlap Creek Near Mouth @ End Of Lane, N Off Co. Rd. 130	300689	Recommended MWH-C	36[ns]	NA	-	HF [(e)]	20.5	Full		
Basin & Stream Code:		**02-193-000**									
0.20[H]	Wallace Fork @ Mouth	300688	Recommended **MWH-C**	32	NA	-	F	39	Full		

Resampled for fish in 2011 due to fish kills during the 2009 sampling season with 2011 scores shown and 2009 scores in trends section.

Resampled for fish and macroinvertebrates (Qual. only) during 2011 due to fish kills during the 2009 season with 2011 scores shown and 2009 scores in trends section.

Biological Criteria

Eastern Corn Belt Plains			
Index – Site Type	**EWH**	**WWH**	**MWH**
IBI – Headwaters	50	40	24
IBI – Wading	50	40	24
IBI – Boat	48	42	24
MIwb – Wading	9.4	8.3	6.2
MIwb – Boat	9.6	8.5	5.8
ICI	46	36	22

H - Headwater site

W - Wading site.

B - Boat site.

a - MIwb is not applicable to headwater streams with drainage areas $\leq$ 20 mi^2.

b - A narrative evaluation of the qualitative sample based on attributes such as EPT taxa richness, number of sensitive taxa, and community composition was used when quantitative data was not available or considered unreliable due to current velocities less than 0.3 fps flowing over the artificial substrates. VP=Very Poor, P=Poor, LF=Low Fair, F=Fair, MG=Marginally Good, G=Good, VG=Very Good, E=Exceptional

c - Attainment status is given for the existing or if a change is proposed then the proposed use designations.

NA - Not applicable

ns - Nonsignificant departure from biocriteria ($\leq$4 IBI or ICI units, or $\leq$0.5 MIwb units).

* - Indicates significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.

d - LF = Low Fair range. Performance does not meet MWH.

e - HF = High Fair range. Performance meets MWH.

Water Quality Use Designations and Recommendations

The streams in the upper Scioto River watershed study area currently listed in the Ohio Water Quality Standards (WQS) are assigned one or more of the following aquatic life use designations: Warmwater Habitat (WWH) and Modified Warmwater Habitat (MWH). The aquatic life use designations of the streams in this survey have been previously verified using biological data with the exception of Rush Creek, Wolf Creek, McCoy Run, Dunlap Creek, Wallace Fork, Fulton Creek, Big Run, Kebler Run, Ottawa Creek (from Mooney road to the mouth), Battle Run, and Patton Run. These streams were originally designated for WWH aquatic life use in the 1978 Ohio WQS but the techniques used then did not include standardized approaches to the collection of instream biological data or numerical biological criteria. This study used biological data to evaluate and establish aquatic life uses for streams in the upper Scioto River study area.

Twenty-three streams in the upper Scioto River study area were evaluated for aquatic life and recreational use potential in 2009 and 2011 (Table 1). Significant findings include the following**:**

- Seventeen streams with an existing WWH use designation should maintain the WWH use. These streams include the: Scioto River, Fulton Creek, Kebler Run, Ottawa Creek, Patton Run, Little Scioto River (Headwaters to RM 9.0, Honey Creek, Rock Fork, Rush Creek, McDonald Creek, Wildcat Creek, Panther Creek, Wolf Creek, Taylor Creek, Silver Creek, and McCoy Run.

- Three stream segments (i.e., Little Scioto River (RM 9.0 to the mouth), North Rock Swale Ditch, and Cottonwood Ditch) are currently under County maintenance and designated MWH. The existing designation for these reaches is appropriate and should be maintained.

- Elliot Run, Dunlap Creek, and Wallace Fork are also under County maintenance in perpetuity but were assigned an unverified WWH designation based on the 1978 water quality standards. In 2009, both the fish and macroinvertebrate scores met MWH, but not WWH, biological criteria. All three streams are channelized and do not have sufficient energy as low-gradient headwater streams to form natural channels without direct restoration efforts and are therefore not capable of attaining WWH at this time It is therefore recommended that these three streams be assigned the MWH aquatic life use.

Twenty-one streams in this study should retain the Primary Contact Recreation (PCR) use, along with the Agricultural Water Supply (AWS) and Industrial Water Supply (IWS) uses. A Secondary Contact Recreation use (SCR) has been issued to Rock Swale and North Rock Swale ditches which have also been listed as acceptable AWS and IWS streams. The Scioto River (RM 180.04) and Little Scioto River (RM 7.1) should also retain their Public Water Supply (PWS) use designations.

General Recommendations

Once a watershed's condition has been studied and any impairments identified, it is useful to examine ways to correct the problems. In this section, general recommendations for the upper Scioto River watershed are discussed. More specific, quantified recommendations may result from the Total Maximum Daily Load project (TMDL).

Managing Storm Water

The upper Scioto River watershed and the overall water quality downstream are directly affected by storm water and a lack of buffering between receiving streams and the agricultural landscape. Unrestricted agricultural drainage was responsible for storm water pollution and biological impairment at many of the sites. This resulted in several streams not attaining their respective ALU in the watershed (Table 2). Reduction of sediment, nutrients, fertilizers/chemicals, erosion, and hydrologic modifications can be accomplished through proper storm water management and result in improved stream quality.

Positive mechanisms to reduce storm water pollution include re-establishing natural riparian buffers (wetland and wooded riparian corridors) in the watershed to help slow storm water and filter pollutants before they reach the surface waters. In addition, efforts should be made to incorporate the stream's natural assimilative capacities to reduce storm water impacts. Natural development of stream channels provides an array of beneficial services including settling fine sediments into adjacent floodplains, processing of nutrients into productive biomass instead of nuisance algae, improved water quality, creation of natural instream habitats to increase carrying capacity of biomass, and ultimately and most importantly evolution into a stable channel and the slowing of erosion.

Providing out of stream watering areas for livestock and fencing livestock out of streams and riparian corridors will allow the natural vegetative riparian zone to re-establish and help buffer the stream banks from storm water erosion. Another benefit of fencing out livestock is to protect the chemical water quality from elevated bacteria and nitrate levels associated with livestock wastes.

Nutrient Enrichment and Bacteria

Nutrient enrichment was a significant problem in the upper Scioto River watershed. Methodologies describing ways to reduce nonpoint nutrient contributions (livestock, agricultural drainage, and urban storm water) are described above. Wastewater treatment plants (WWTPs) also contributed to nutrient enrichment but, unlike nonpoint source pollution, should be addressed through the NPDES permitting process. Since the sources of nutrient enrichment varied between subwatersheds, the resolution to these problems should be tailored to benefit the specific drainages.

Improve Habitat Quality

Many streams in the upper Scioto River watershed have been physically altered. Small watercourses, generally < 20 $mi.^2$ in drainage area, have been legally petitioned under the provisions of the Ohio County Ditch Law to facilitate drainage. They will be maintained in this condition in perpetuity or until their petitions are revoked. Other streams were altered by

individual landowners or under provisions of older ditch laws. Regardless, channelization has lowered habitat quality in the affected streams.

To remedy these problems an effort should be made to restore the modified streams to their natural morphological state. Many of the current causes and sources of stress within this watershed could be reduced by allowing riparian vegetation to re-establish and the stream channel to evolve. Removing the remaining dams, restoring manmade cutoff channels, restoring wetlands and moving dikes and levees away from the active stream channel will foster this process.

Table 3. Waterbody use designation recommendations for the upper Scioto River watershed. Designations based on the 1978 and 1985 water quality standards appear as asterisks (*). A plus sign (+) indicates a confirmation of an existing use and a triangle (▲) denotes a new recommended use based on the findings of this report.

Water Body Segment	Use Designations												Comments
		Aquatic Life Habitat						Water Supply			Recreation			
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR	
Scioto river - at RM 33.6		+						o	+	+		+		PWS intake - U.S. Enrichment (emergency intake)
- Greenlawn dam (RM 129.8) to the mouth		+							+	+		+		
- Olentangy river (RM 132.3) to Greenlawn dam				+					+	+		+		ECBP ecoregion - impounded
- Dublin rd. WTP dam (RM 133.4) to the Olentangy river (RM 132.3)		+							+	+		+		
- O'Shaughnessy dam (RM 148.8) to the Dublin rd. WTP dam		+						+	+	+		+		PWS intake - Columbus
- at RM 180.04		*						o	*	*		*		PWS intake - Marion
- all other segments		*							*	*		*		
Fulton creek		+							*	*		*		
Big run		*							*	*		*		
Richwood tributary (Fulton creek RM 9.4)							+		+	+			+	Small drainageway maintenance
Elliot Run		*		▲										ECBP ecoregion - channel modification
Utz run		*							*	*		*		
Kebler run		+							*	*		*		
Ottawa creek - headwaters to Mooney rd. (RM 1.6)							+		*	*			+	Small drainageway maintenance
- Mooney rd. to the mouth		+							*	*		*		

Water Body Segment	Use Designations												Comments
		Aquatic Life Habitat						Water Supply			Recreation		
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR	
Battle run		+							*	*		*		
Patton run		+							*	*		*		
Beaver run		*							*	*		*		
Davids run		*							*	*		*		
Little Scioto river - RM 9.0 (0.2 miles downstream of Hillman Ford rd.) to the mouth				+					+	+		+		ECBP ecoregion - channel modification
- at RM 7.1				+				o	+	+		+		PWS intake - Marion
- all other segments		+							+	+		+		
Honey creek		+							+	+			+	
Rider ditch (Honey creek RM 1.75)							+		*	*			+	Small drainageway maintenance
Cusic ditch (little Scioto river RM 2.55)		+							*	*			+	
Rock Swale ditch							+		+	+			+	Small drainageway maintenance
Columbia ditch - Sawyer lake outlet (RM 2.2) to the mouth				+					+	+		+		ECBP ecoregion - channel modification
North Rockswale ditch - RM 4.4 to the mouth				+					+	+			+	ECBP ecoregion - channel modification
- all other segments		+							+	+			+	
Rock fork		+							+	+		+		
Long branch		*							*	*		*		
Zeig ditch		*							*	*		*		
Rush creek		+							+	+		+		

Water Body Segment	Use Designations													Comments
		Aquatic Life Habitat						Water Supply			Recreation			
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR	
McDonald creek		+							+	+		+		
Dudley run		*							*	*		*		
Big swale							+		*	*			+	Small drainageway maintenance
Rocky fork		*							*	*		*		
Wildcat creek		+							+	+		+		
Ash run		*							*	*		*		
South Wildcat creek		*							*	*		*		
Panther creek		+							+	+		+		
Jims creek		*							*	*		*		
Wolf creek		+							+	+		+		
Garwood run		*							*	*		*		
Gander run		*							*	*		*		
Manlove run		*							*	*		*		
Taylor creek		+							+	+		+		
Silver creek		+							+	+		+		
Jordan run		*							*	*		*		
Batchlet run		*							*	*		*		
Payden run		*							*	*		*		
McCoy run		+							+	+		+		
Cooney ditch		*							*	*		*		

Water Body Segment	Use Designations													Comments
		Aquatic Life Habitat						Water Supply			Recreation			
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR	
| | | | | | | |														
Cottonwood ditch - Hardin county rd. 35 (RM 4.5) to the mouth				+					+	+		+		ECBP ecoregion - channel modification
- all other segments		*							*	*		*		
Twin branches		*							*	*		*		
Dunlap creek		*		▲					*	*		*		ECBP ecoregion - channel modification
Elder creek		*							*	*		*		
Poe ditch		*							*	*		*		
Wallace fork		*		▲					*	*		*		ECBP ecoregion - channel modification

SRW = state resource water; WWH = warmwater habitat; EWH = exceptional warmwater habitat; MWH = modified warmwater habitat; SSH = seasonal salmonid habitat;

CWH = coldwater habitat; LRW = limited resource water; PWS = public water supply; AWS = agricultural water supply; IWS = industrial water supply; BW = bathing water;

PCR = primary contact recreation; SCR = secondary contact recreation.

INTRODUCTION

Figure 4. Map of the upper Scioto River watershed.

Sixty-three stream sampling locations were evaluated in the upper Scioto River watershed in Auglaize, Crawford, Hardin, Logan, Marion, Union, and Delaware Counties in 2009 and 2011 (Table 1). Fifteen sites on the main stem of the upper Scioto River were sampled as well as 46 locations on 23 major tributaries (≥ 8.0 miles^2) including: Fulton Creek, Elliot Run, Kebler Run, Ottawa Creek, Battle Run, Patton Run, Little Scioto River, North Rock Swale Ditch, Honey Creek, Rock Fork, Rush Creek, McDonald Creek, Wildcat Creek, Panther Creek, Wolf Creek, Taylor Creek, Silver Creek, McCoy Run, Cottonwood Ditch, Dunlap Creek, and Wallace Fork. Thirty-seven National Pollutant Discharge Elimination System (NPDES) permitted facilities discharge sanitary wastewater, industrial process water, and/or industrial storm water into the upper Scioto River watershed within Hardin, Marion, Logan and Union Counties.

A total of 62 biological, 58 water chemistry, 18 fish tissue, and 30 bacterial stations were sampled in 2009 to assess biological, surface water and recreation (bacterial) conditions and the results can be downloaded from the Ohio EPA GIS interactive maps at: http://www.epa.state.oh.us/dsw/gis/index.aspx. In 2011, nine sites were resampled for fish and five for macroinvertebrates due to spills and fish kills during the 2009 sampling season (Table 2).

Specific objectives of the evaluation were to:

- ascertain the present biological conditions in the upper Scioto River watershed by evaluating fish and macroinvertebrate communities,
- identify the relative levels of organic, inorganic, and nutrient parameters in the sediments and surface water,
- evaluate influences from NPDES point source discharges and nonpoint sources of pollution,
- assess physical habitat influences on stream biotic integrity,
- determine recreation water quality,
- compare present results with historical conditions, and
- determine aquatic life use attainment status and recommend changes if appropriate.

The findings of this evaluation may factor into regulatory actions taken by the Ohio EPA (e.g. NPDES permits, Director's Orders, or the Ohio Water Quality Standards [OAC 3745-1], and may eventually be incorporated into State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, Total Maximum Daily Loads (TMDLs) and the biennial Integrated Water Quality Monitoring and Assessment Report (305[b] and 303[d] report).

STUDY AREA DESCRIPTION

The upper Scioto River watershed is in the Eastern Corn Belt Plains (ECBP) ecoregion and is predominated by agricultural land (Figure 5). The cities of Kenton and Marion and the Village of Richwood are the largest developed areas in the watershed. The main stem of the Scioto River is over 236 miles long and drains 6,517 mi^2 and has an average gradient of 2.3 feet per mile (ODNR, 2001). However, for the purposes of this project the upper Scioto River watershed study area consisted of the Scioto River main stem from its source near Roundhead (RM 236.4) to the confluence with the Little Scioto River (RM 179.05).

Glacial activity from the Wisconsin Ice Age left this area with a gently rolling to nearly flat topography. Bedrock geology of the upper Scioto watershed consists mainly of dolomites and limestones. There are two main soil types in the study area based on glacial history. Soils in the upland areas of Marion and Hardin counties are formed predominantly in the Blount-Pewamo and Blount-Glynwood associations. These are level to gently sloping soils which are lightly colored, fertile, and poorly drained. Near Roundhead and McGuffey in Hardin County, the soils were formed on the broad flats of glacial lake plains. This soil is characterized as muck which is subject to wind erosion and is both poorly drained and highly fertile. The muck soils are found in the Scioto Marsh area along the channelized and steeply leveed sections of the main stem Scioto River and Cottonwood Ditch in Western Hardin County (Figure 6). A 1989 Ohio Historical Society Marker from the area reads: "*Scioto Marsh, the largest of three extensive marsh areas in western Hardin County, was formed in low basins left by the last retreating glacier 10,000 years ago. It covered more than 16,000 acres and was thought to be a source of malaria by the early settlers. A drainage project was begun in 1859, and the remaining peat-ladened soil helped make this a rich agricultural area.*"

Most streams in the upper watershed are designated WWH with the exception of: Little Scioto River (RM 9.0 to mouth), Elliot Run, North Rock Swale Ditch, Cottonwood Ditch (RM 4.5 to mouth), Dunlap Creek, and Wallace Fork, which are MWH (Table 3). Dunlap Creek, Wallace Fork, and Elliot Run were originally designated WWH in the original 1978 Ohio WQS. The techniques used then did not include standardized approaches to the collection of in-stream biological data or numerical biological criteria. This study used biological data to evaluate and establish aquatic life uses for these streams.

Most designated streams in the upper watershed are currently listed as Primary Contact Recreation (PCR) with the exception of Big Swale, North Rock Swale, and Honey and Ottawa (headwaters to RM 1.6) Creeks which are assigned a Secondary Contact Recreation use (SCR). However, all streams in the study area are assigned as Agricultural Water Supply (AWS) and Industrial Water Supply (IWS). Within the study area, the Scioto River at RM 180.0 and Little Scioto River RM 7.1 are also assigned Public Water Supply (PWS) designations.

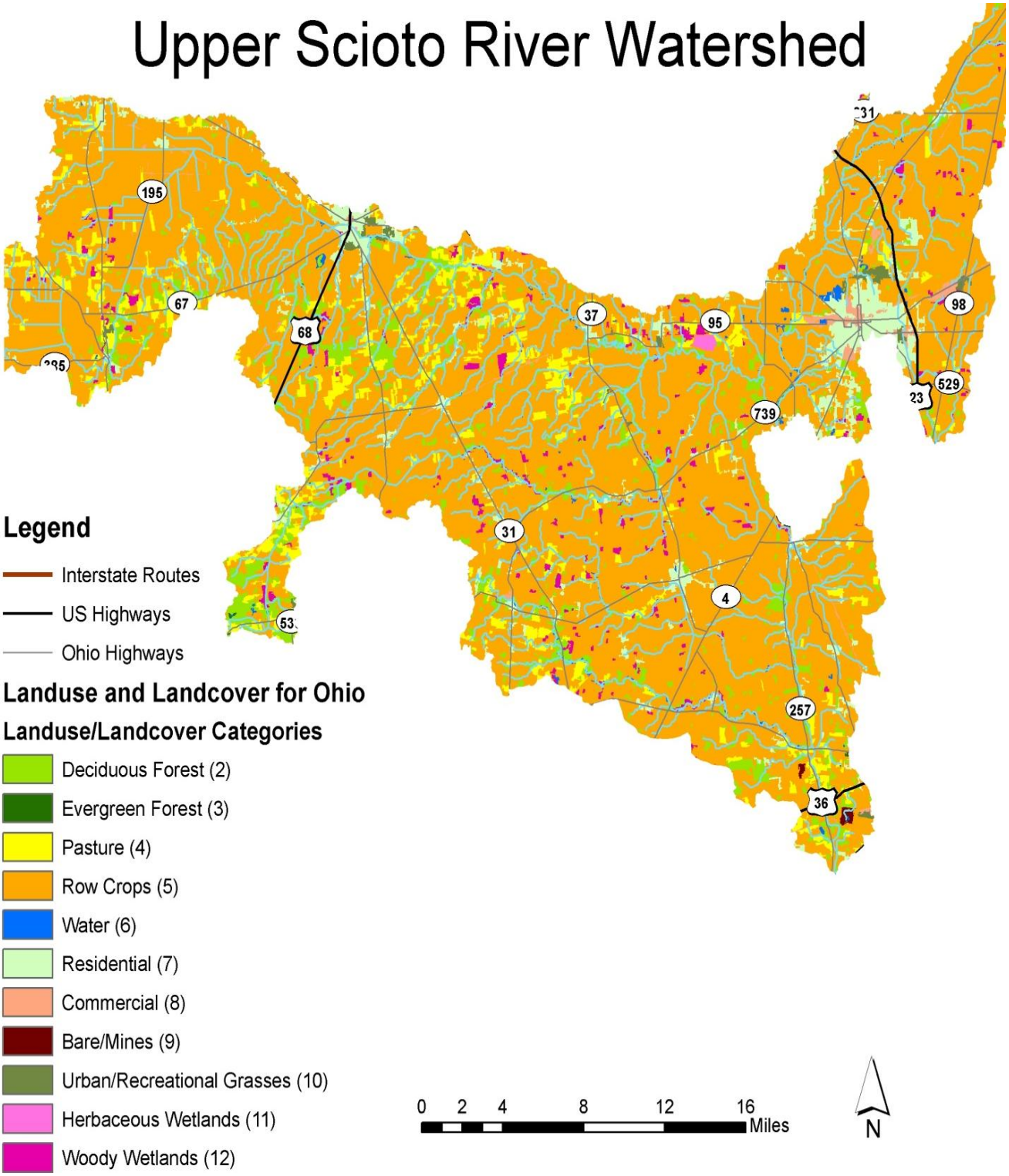

Figure 5. Landuse coverage map within the upper Scioto River watershed.

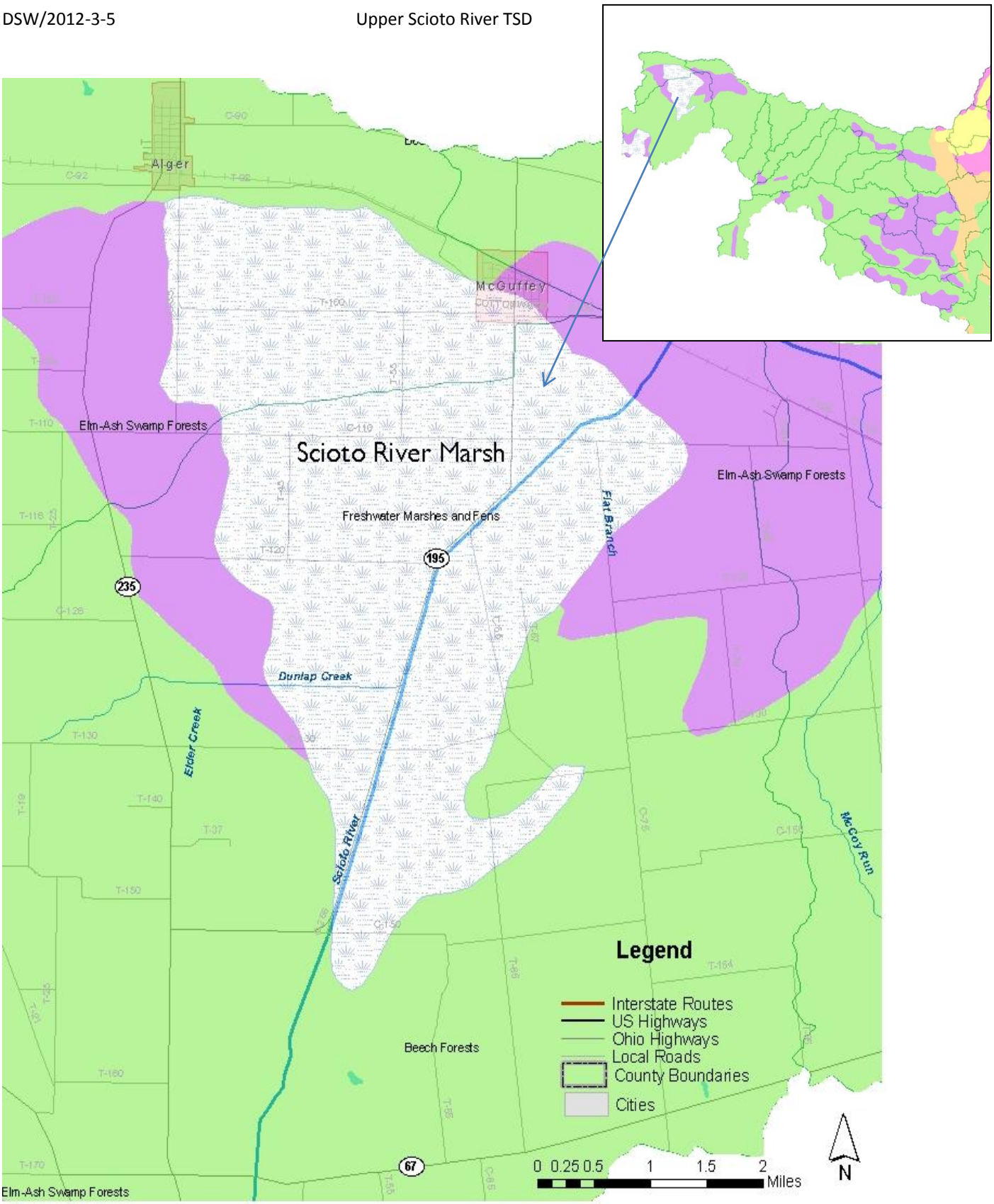

Figure 6. Map of the Scioto River Marsh area outlined by the Ohio original vegetation map.

Recreation Use

Water quality criterion for determining attainment of the recreation use are established in the Ohio Water Quality Standards (Table 7-13 in OAC 3745-1-07) based upon the quantities of bacteria indicators (*Escherichia coli*) present in the water column.

Escherichia coli (*E. coli*) bacteria are microscopic organisms that are normally present in large numbers in the feces and intestinal tracts of humans and other warm-blooded animals. *E. coli* typically comprises approximately 97 percent of the organisms found in the fecal coliform bacteria of human feces (Dufour 1977). There is currently no simple way to differentiate between human and animal sources of coliform bacteria in surface waters, although methodologies for this type of analysis are becoming more feasible. These microorganisms can enter water bodies where there is a direct discharge of human and animal wastes, or may enter water bodies along with runoff from soils where these wastes have been deposited.

Pathogenic (disease-causing) organisms are typically present in the environment in such small amounts that it is impractical to monitor every type of pathogen. Fecal indicator bacteria by themselves, including *E. coli*, are usually not pathogenic. However, some strains of *E. coli* can be pathogenic, capable of causing serious illness. Although not necessarily agents of disease, fecal indicator bacteria such as *E. coli* may indicate the potential presence of pathogenic organisms that enter the environment through the same pathways. When *E. coli* are present in high numbers in a water sample, it invariably means that the water has received fecal matter from one or multiple sources. Swimming or other recreation-based contact with water having a high *E. coli* count may result in ear, nose, and throat infections, as well as stomach upsets, skin rashes, and diarrhea. Young children, the elderly, and those with depressed immune systems are most susceptible to infection.

Streams in the upper Scioto River watershed are designated as primary contact recreation (PCR) and secondary contact recreation (SCR) use in OAC Rule 3745-1-09. Water bodies with a designated recreation use of PCR "...are suitable for one or more full-body contact recreation activities such as, but not limited to, wading, swimming, boating, water skiing, canoeing, kayaking, and scuba diving" [OAC 3745-1-07 (B)(4)(b)]. There are three classes of PCR use to reflect differences in the potential frequency and intensity of use. Streams designated PCR class A support, or potentially support, frequent primary contact recreation activities. Streams designated PCR class B support, or potentially support, occasional primary contact recreation activities. Streams designated as PCR class C support, or potentially support, infrequent primary contact recreation activities. Streams designated as SCR use are rarely used for water-based recreation.

In addition, some waters that are used heavily for swimming can be designated as bathing waters. The geometric mean criterion for bathing waters is ≤126 colony forming units per 100 ml. There are no waters designated as bathing waters in the study area.

The *E. coli* criterion that applies to PCR class A streams is a geometric mean of ≤126 colony forming units (cfu)/100 ml. The *E. coli* criterion that applies to PCR class B streams is a geometric mean of ≤161 cfu/100 ml. The criterion that applies to PCR

class C streams is a geometric mean of ≤206 cfu/100 ml. The criterion that applies to SCR streams is ≤1,030 cfu/100 ml. The geometric mean is based on two or more samples and is used as the basis for determining the attainment status of the recreation use.

Summarized bacteria results are listed in Table 4 and the complete dataset is reported in Appendix F-1. Downloadable bacteria results are also available from the Ohio EPA geographic information systems (GIS) interactive maps at the following link: http://www.epa.ohio.gov/dsw/gis/index.aspx.

Twenty-eight (28) locations in the watershed were tested for *E. coli* levels four to twelve times between May and October 2009. Evaluation of *E. coli* results revealed that 24 of the 28 locations sampled failed to attain the applicable geometric mean criterion, indicating an impairment of the recreation use at these locations (Figure 7). Sources of elevated bacteria concentrations were ubiquitous and most likely due to a variety of inputs including agriculture (livestock, manure application), unsewered areas and home sewage treatment systems (HSTS) and municipal wastewater treatment plants (WWTP). Some of the highest bacteria concentrations were found in the Wildcat Creek watershed where agricultural production (including livestock) dominates the landscape. In the Marion urbanized area, combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs) are documented sources of bacterial contamination to the Little Scioto River.

Bacterial contamination in most streams was present during both wet and dry weather events. This indicates that strategies to reduce bacteria levels in streams should include both nonpoint source and point source measures. Summarized *E.coli* bacteria results are presented in the Table 4. Some of the sources of bacterial contamination throughout the study area are indicated in the Table 4. At the time of this study, the sources listed have not necessarily been confirmed as a source of impairment nor are they exclusive of other possible sources.

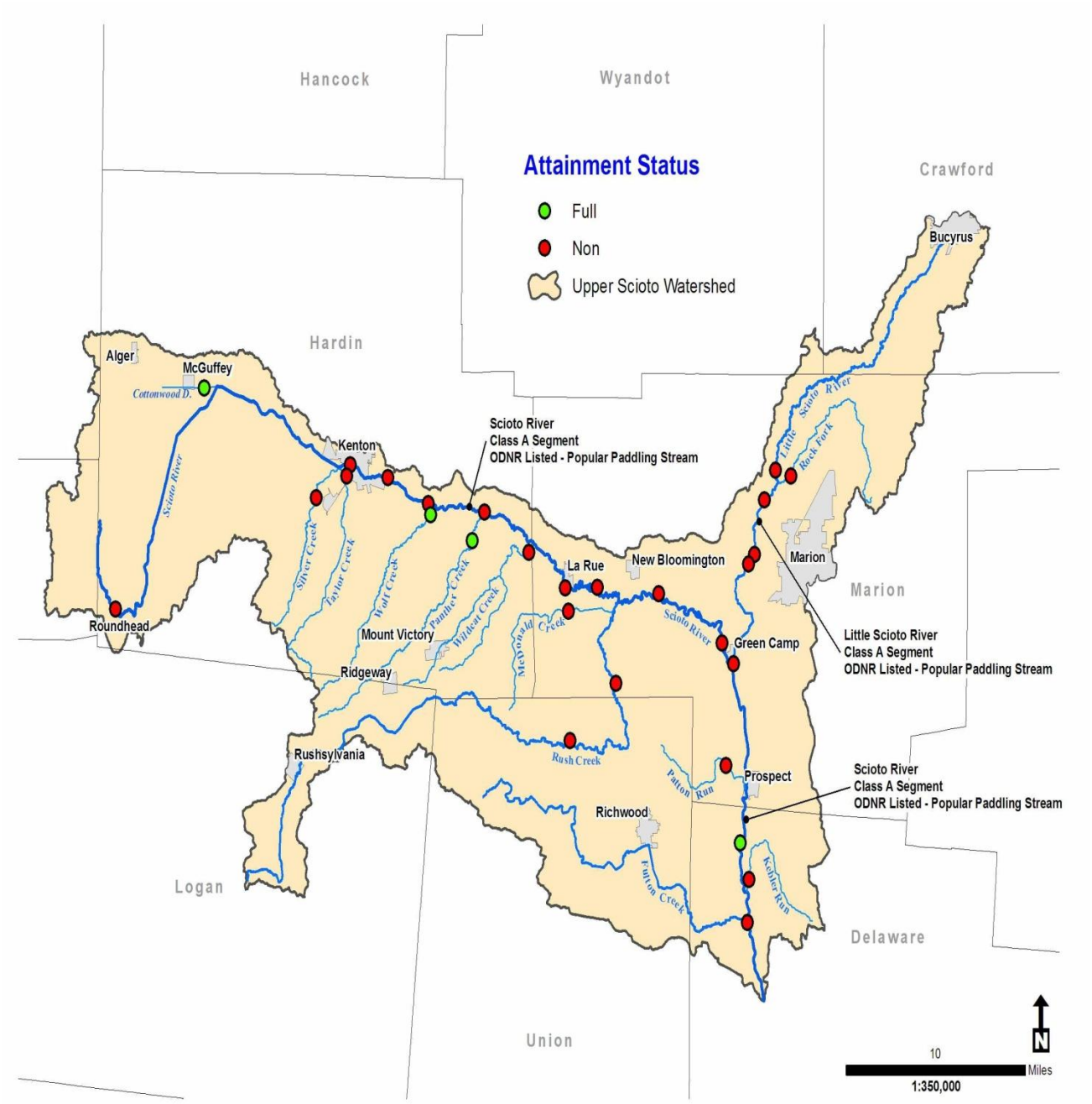

Figure 7. Map of the recreation use attainment status for 28 stations sampled in the upper Scioto River watershed, 2009.

Table 4. *A summary of E. coli data for the 28 locations in the upper Scioto River Watershed, May 1 through October 31, 2009. recreation use attainment based on comparing the geometric mean to Primary Contact Recreation (PCR) criteria of the proposed standard (OAC 3745-1-07). All values expressed in colony forming units (cfu) per 100 ml of water. For Class A streams E. coli geometric mean < 126. For Class B streams E. coli geometric mean < 161. For Class C streams E. coli geometric mean < 206. For Secondary Contact Recreation (SCR) geometric mean < 1030. Highlighted scores do not attain the respective recreation use geometric mean criterion.*

Location	River Mile	# Samples	Class	Geometric Mean	Maximum Value	Recreation Use Attainment Status	Possible Source(s) of Bacteria
Cottonwood Ditch HUC 05060001 01 01							
Cottonwood Ditch	0.68	12	PCR	387	1600	**FULL**	
Headwaters Scioto R. HUC 05060001 01 02							
Scioto R.	234.4	11	B	324	1100	**NON**	AG-runoff
Taylor Creek HUC 05060001 01 03							
Taylor Cr. @ SR 67	0.76	12	B	228	1600	**NON**	HSTS, unsewered area (home septic), WWTP (Durez, Sypris), AG-runoff
Silver Creek HUC 05060001 01 04							
Silver Cr. @ SR 67	2.32	4	B	358	2400	**NON**	AG-runoff, AG-livestock
Headwaters Rush Creek HUC 05060001 02 01							
Rush Cr. @ Winnimac	14.5	5	B	728	2400	**NON**	AG-runoff, HSTS
McDonald Creek HUC 05060001 02 02							
McDonald Cr. @ SR 37	2.70	5	B	208	820	**NON**	AG-runoff, AG-livestock
Dudley Run-Rush Creek HUC 05060001 02 03							
Rush Cr. @ Mt.Olive	5.39	12	B	172	2400	**NON**	AG-runoff
Rock Fork HUC 05060001 03 01							
Rock Fork	1.10	12	B	262	2400	**NON**	AG-runoff, AG-livestock

Location	River Mile	# Samples	Class	Geometric Mean	Maximum Value	Attainment Status	Possible Source(s) of Bacteria
Headwaters L. Scioto HUC 05060001 03 02							
L. Scioto R.	11.11	12	A	423	2400	**NON**	AG-runoff, WWTP (Ridgedale Elem.)
City of Marion L. Scioto HUC 05060001 03 03							
L. Scioto R. @ Hill.Ford	9.24	5	A	320	980	**NON**	AG-runoff, WWTP
L. Scioto R. ust WWTP	6.5	5	A	680	2400	**NON**	CSOs, Urban (Marion), AG-runoff
L. Scioto R. dst WWTP	6.0	5	A	916	2400	**NON**	WWTP, CSOs, Urban (Marion), AG-runoff
Honey Creek L. Scioto HUC 05060001 03 04							
L. Scioto R. nr. G.Camp	0.4	10	A	270	2400	**NON**	AG-runoff, AG-livestock, WWTP (Harmony Sub.)
Gander Run Scioto R. HUC 05060001 04 01							
Scioto R. @ Kenton	212.5	10	A	322	660	**NON**	AG-runoff, Urban (Kenton)
Scioto R. @ CR 175	210.1	4	A	187	980	**NON**	AG-runoff, WWTP (Kenton)
Panther C. Scioto R. HUC 05060001 04 02							
Panther Cr.	1.80	5	B	155	1000	**FULL**	
Wolf C. Scioto R. HUC 05060001 04 03							
Scioto R. @ TR 199	207.3	5	A	170	690	**NON**	AG-runoff, AG-livestock
Wolf Cr.	0.51	5	B	152	720	**FULL**	
Wildcat C. Scioto R. HUC 05060001 04 04							
Wildcat Cr.	0.49	5	B	1209	1600	**NON**	AG-runoff, AG-livestock

Location	River Mile	# Samples	Class	Geometric Mean	Maximum Value	Attainment Status	Possible Source(s) of Bacteria
Town of Larue Scioto R. HUC 05060001 04 05							
Scioto R. @ CR 227	203.4	5	A	335	650	**NON**	AG-runoff, WWTP (Eldrige Sta.) unsewered area (Hepburn)
Scioto R. @ SR 37	196.1	11	A	238	600	**NON**	AG-runoff, AG-livestock
Scioto R. @ Schotte	192.2	5	A	335	870	**NON**	AG-runoff, AG-livestock WWTP (LaRue)
Glade Run Scioto R. HUC 05060001 04 06							
Scioto R. @ Refuge	186.0	5	A	209	610	**NON**	AG-runoff, WWTP (New Bloom.)
Scioto R. nr G.Camp	179.1	5	A	223	400	**NON**	AG-runoff
Patton Run Scioto R. HUC 05060001 05 01							
Patton Run	2.25	5	B	380	1800	**NON**	AG-runoff, AG-livestock, HSTS
Kebler Run Scioto R. HUC 05060001 05 03							
Kebler Run	0.87	11	B	191	600	**NON**	AG-runoff, HSTS
Fulton Creek Scioto R. HUC 05060001 05 04							
Fulton Cr.	0.22	11	B	181	1200	**NON**	AG-runoff, AG-livestock, HSTS
Ottawa Creek Scioto R. HUC 05060001 05 05							
Scioto R. @ Hoskins	169.2	12	A	85	400	FULL	

NPDES - Point Source Pollutant Loadings

Facilities within the study areas that are regulated by an individual NPDES permit are listed in (Table 5).

Facilities regulated by an individual NPDES permit are required to conduct routine self-monitoring of effluent quality and quantity. Results are reported monthly to Ohio EPA as discharge monitoring report (DMR) data. Each permit includes a detailed list of each parameter to be monitored and the specific limits for both concentration and loading rate. They also include monthly average limits and daily or weekly maximum limits, depending on the monitoring requirements. This DMR data can be used to track compliance as well as to evaluate historical trends.

The Ohio EPA conducts 48-hr acute screening bioassays to evaluate toxicity during the permit compliance and renewal process for Major NPDES permitted facilities (discharge >1.0 MGD) and occasionally for minor facilities if time permits. Grab and composite samples of the effluents are collected along with samples of the receiving stream upstream and in the near field mixing zone. The fathead minnow, *Pimephales promelas,* and daphnid, *Ceriodaphnia dubia,* are used as test organisms.

Below are descriptions and annual pollutant loadings of select NPDES facilities that were included as part of the 2009 study.

Durez Corporation (formerly Occidental Chemical) – Kenton Facility (2IF00002)

A major discharger, Durez Corporation manufactures phenolic-based resins used in a variety of industrial and commercial applications, ranging from automotive brake pistons to frying pan handles. Phenolic resins are formed as the result of a condensation reaction which takes place in a batch reactor. Raw materials used in the production process are phenol and formaldehyde, which are reacted together in the presence of an acid catalyst. After the reaction, the resulting resin product is further processed by vacuum distillation. Resin from the batch reactors is passed through flaking rolls where it is reduced in size, and then packaged. This plant is classified under the Standard Industrial Classification Code (SIC) 2821 which is identified as “Phenolic Resin and Molding Compounds.” The process waste streams generated by this facility are regulated by Chapter 40 of the Code of Federal Regulations, Part 414, “Organic Chemicals, Plastics, and Synthetic Fibers,” Subparts E and I.

Durez Corporation operates one external outfall which flows to Taylor Creek. Outfall 001 discharges treated process wastewater, non-contact cooling water, boiler blowdown, storm water, and sanitary wastewater. Approximately half of the flow through this outfall is non-contact cooling water, with the remainder being discharged through internal station 601.

The sanitary wastewater is treated with a trickling filter prior to combining with process wastewater in a storage basin. Wastewater flows from the storage basin to a mix tank, and then to an aeration basin where it flows into a clarifier. Discharge from the clarifier flows through a sand filter and then combines with flow from a storm water pond prior to being treated in carbon adsorption filters. The discharge from the carbon adsorption

filters flows through internal outfall 601, then combines with non-contact cooling water before final discharge to Taylor Creek at outfall 001. Process wastewater plus storm water contributes approximately 86 percent of the total flow recorded at outfall 601. Sludge from the clarifier is pumped to an aerobic digester and then dewatered with a filter press. Dewatered sludge is hauled off-site to a municipal solid waste landfill.

During 2009, monthly DMR data submitted by the Durez documented 7 permit violations: 3 for ammonia, 3 for dissolved oxygen (D.O.) and 1 for total suspended solids (TSS). In 2008 there were 6 permit violations: 3 for TSS, 2 for Oil & Grease, and 1 for the pH minimum.

In the last ten years, Ohio EPA conducted 48-hour acute screening bioassays at Durez in August and September of 2004, and in October and November of 1999. The results of the bioassays conducted in 1999 showed no acute toxicity in the Durez effluent. However, both bioassays conducted in 2004 were acutely toxic to both *P. promelas* and *C. dubia.* In August 2004 the magnitude of the composite toxicity was expressed as a *P. promelas* 96-hour LC50 of 3.99% and EC50 of 3.57%, which convert respectively to acute toxic units (TUa) of 25.1 and 28.0. The composite effluent toxicity was also expressed as a *C. dubia* 48-hour LC50 of <6.25%, which converts to TUa >16. In September 2004 the toxicity was expressed as a *P. promelas* 96-hour LC50 of 7.4% and EC50 of 5.2%, which convert respectively to acute toxic units (TUa) of 13.5 and 19.2. The *C. dubia* 48-hour LC50 was 48.3%, which converts to 2.1 TUa.

Recent acute screening bioassays in March and April 2010 also showed no acute toxicity. However, using the EC50 of 3.57% (and TUa of 28.0) from 2004, a potential for chronic toxicity exists. The results suggest chronic tests may be required to better assess the toxicity in the discharge.

During the 2009 survey, major fish kills were investigated at the Durez Corporation discharge and downstream in Taylor Creek and the Scioto River. Additional details are provided throughout this report.

Annual pollutant loadings and flow information for Durez Corporation is presented in Figure 8.

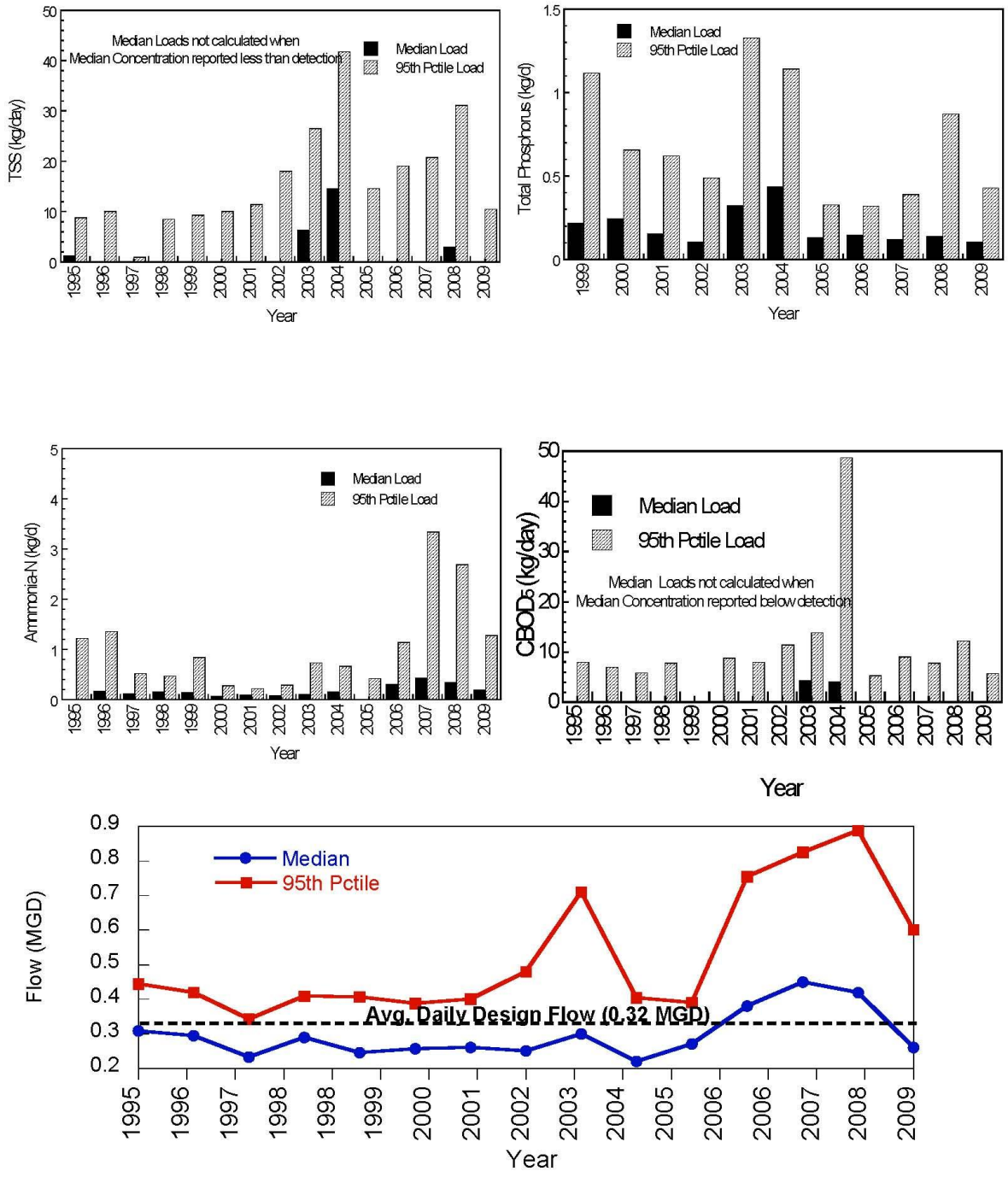

Figure 8. Annual pollutant loading and flow graphs for Durez Corporation listed by pollutant, 1995 to 2009.

City of Kenton WWTP (2PD00020)

A major discharger, the Kenton WWTP was originally constructed in 1955 with the most recent upgrade occurring in 2000. Treatment processes include influent pumping, bar screening, grit removal, comminution, pre-aeration, oxidation ditch, secondary clarification, ultraviolet disinfection, post aeration and storm flow storage. The Kenton WWTP has an average design flow of 2.4 million gallons per day (MGD) and is capable of treating flows up to 12 MGD. Influent wastewater is treated biologically in the oxidation ditch. By adjusting the amount of oxygen supplied, a single-stage suspended growth process operates with a solids retention time of 15 to 25 days. The oxidation ditch handles flows from 1 to 12 MGD. Two large final clarifiers are sized to treat wet weather flows of 12 MGD. The storm tank is designed to handle flows from 13 to 24 MGD, and provides the storage to capture flow volumes produced by rain events. The contents of the storm tank are routed through the UV disinfection unit and post aeration prior to being discharged at outfall 001. Sludge is stabilized and reduced in aerobic digesters, dewatered by belt filter press, then land applied at agronomic rates in accordance with Kenton's sludge management plan which was approved on August 22, 2001.

The City of Kenton's collection system is over 90% separate sanitary sewers. There are eight lift stations in the collection system and no overflows or bypasses. All overflows from combined sewers in Kenton's collection system were eliminated in 2000.

During 2009, monthly DMR data submitted by the Kenton WWTP documented 4 permit violations: all for TSS. In 2008 there were 22 permit violations: 15 for TSS, 6 for $cBOD_5$ and 1 for Oil & Grease.

During the 2009 study, five (5) grab samples were collected from the Kenton WWTP effluent for analysis. The median concentrations for dissolved oxygen and total suspended solids were 9.9 mg/l and 5.0 mg/l respectively. For nutrients, the median results were 15.3 mg/l for nitrate+nitrite and 1.87 mg/l for total phosphorus.

In the last ten years, Ohio EPA conducted 48-hour acute screening bioassays at the Kenton WWTP in March 2010, July and August of 2004, and in June and July 2000. The results of all four bioassays showed no acute toxicity in the Kenton WWTP effluent.

Annual pollutant loadings and flow information for City of Kenton WWTP is presented in Figure 9.

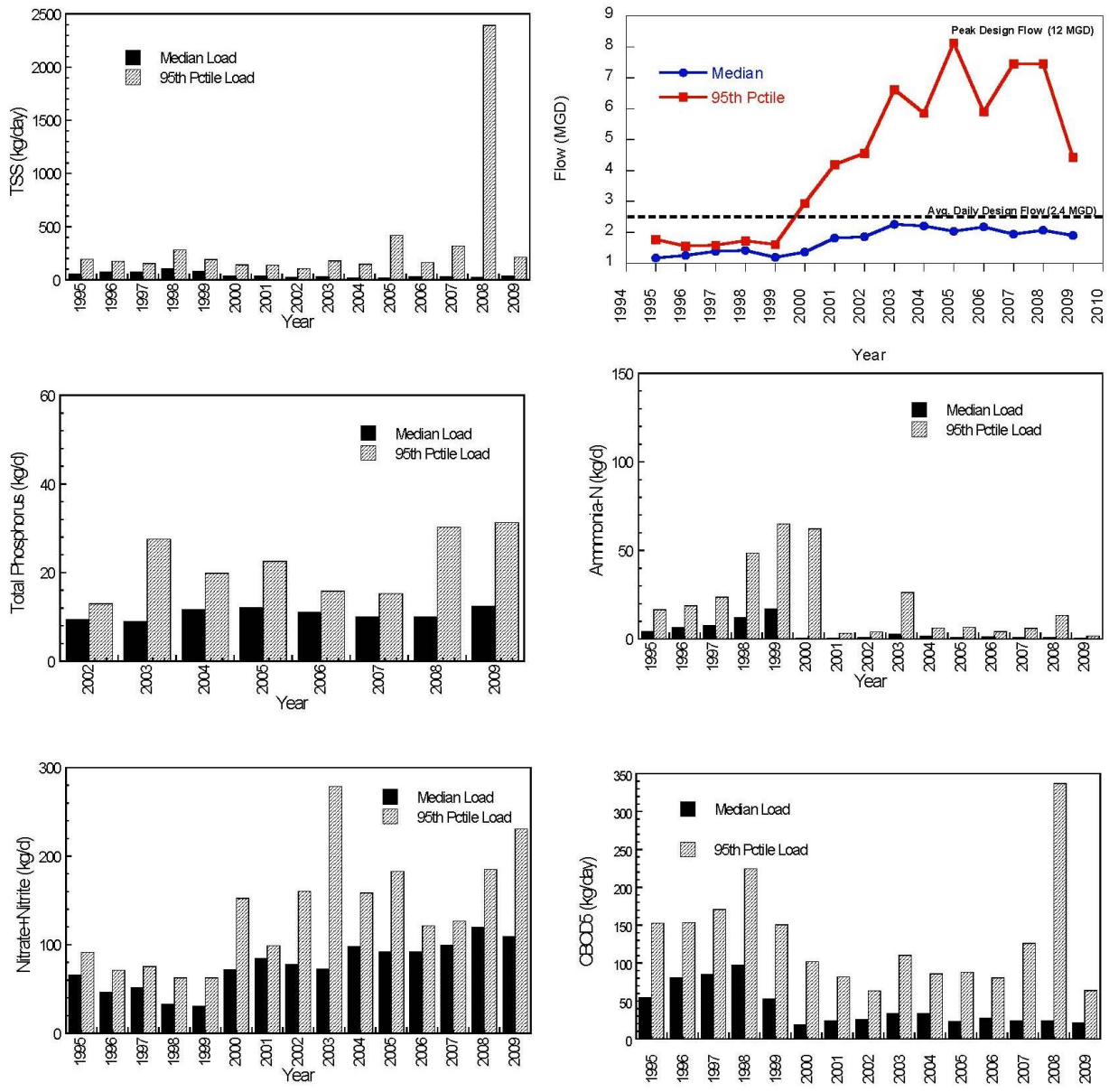

Figure 9. Pollutant loadings and flow graphs for the City of Kenton WWTP.

City of Marion WWTP (2PD00011)

A major discharger, the plant was originally built in 1924 and expanded in 1953 and 1972. Plant modifications were made in 1978, 1992, and 1994, with the last major modification in 2003. The Marion WWTP is a tertiary treatment facility utilizing screening, primary settling, activated sludge aeration, secondary clarification, chemical addition, tertiary clarification, chlorination, and dechlorination. Sludge processes include thickening, sludge holding, dewatering using belt filter presses, lime stabilization, sludge storage, and land application. The Marion WWTP has an average design flow of 10.5 MGD and a hydraulic flow of 21 MGD, serving a population of 34,075 in Marion and 400 in the Village of Green Camp. Effluent is discharged at RM 6.4 of the Little Scioto River. Average flow through the plant is about 10.85 MGD, including 10% from industry. Marion implements an approved pre-treatment plan with 6 non-categorical significant industrial users and 2 categorical industrial users discharging to the system.

Before the 2003 upgrade, the Marion WWTP was designed to treat peak flows up to 21 MGD through secondary treatment, but flows in excess of 17 MGD bypassed secondary and tertiary treatment and recombined with fully treated effluent prior to disinfection. After the 2003 upgrade, average design flow did not change, but the plant's ability to provide secondary treatment to flows of 21 MGD was restored.

The collection system is 50% combined and 50% separated with 3 CSOs: Outfall 003 discharges to Rock Swale Ditch, Outfall 004 discharges to Columbia Ditch, and Outfall 004 discharges to Qu Qua Ditch. A Long Term Control Plan (LTCP) was submitted on December 1, 2000 and a revised LTCP on August 25, 2004. The Marion LTCP recommends sewer separation. The CSO LTCP implementation schedule is 15 years and Ohio EPA is still reviewing the revised LTCP. A compliance schedule of the early projects that will begin during the term of the permit will be included in the draft permit. A copy of the permit fact sheet can be viewed at: http://wwwapp.epa.ohio.gov/dsw/permits/doc/2PD00011.fs.pdf . From January to November 2009, there were nine (9) reported plant bypasses of partially treated sewage during wet weather conditions. There were also 158 CSO release occurrences reported.

Also during 2009, monthly DMR data submitted by the Marion WWTP documented 5 permit violations: 4 for dissolved oxygen (D.O.) and 1 for total residual chlorine. However, during 2008 there were 39 documented permit violations: 27 for D.O., 7 for ammonia, 2 for total suspended solids (TSS), 2 for mercury, and 1 of the pH minimum.

During the 2009 study, five (5) grab samples were collected from the Marion WWTP effluent for analysis. The median concentrations for dissolved oxygen and total suspended solids were 7.36 mg/l and 5.0 mg/l respectively. For nutrients, the median results were 3.64 mg/l for nitrate+nitrite and 1.87 for total phosphorus.

In the last ten years, Ohio EPA conducted 48-hour acute screening bioassays at the Marion WWTP in April 2011, July and August of 2004, and in October and November of 1999. The results of all four bioassays showed no acute toxicity in the Marion WWTP

effluent. Additional acute screening bioassays will be scheduled for the spring of 2010.Annual pollutant loadings and flow information for City of Marion WWTP is presented in Figure 10.

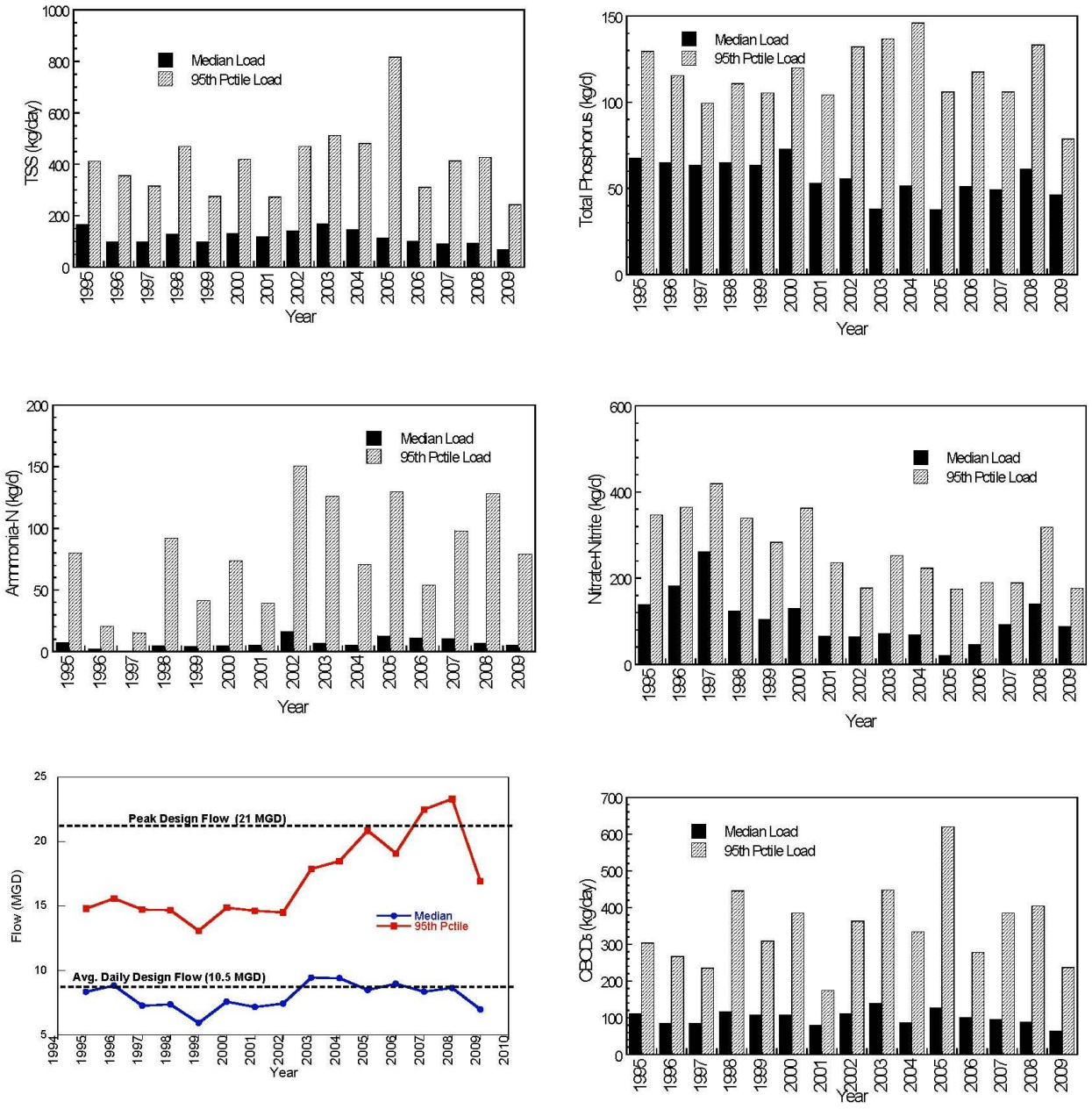

Figure 10. Average annual pollutant loadings and flow (MGD) for the City of Marion WWTP.

Village of Richwood WWTP (4PB00018)

The Richwood WWTP has a design treatment capacity of 0.38 MGD with a discharge to Fulton Creek at RM 9.60. Wet stream processes provided at the plant include influent screening, aerated grit removal, 2 sequencing batch reactors, chlorination, dechlorination, and post aeration. Solids handling consists of aerobic digestion, dewatering on sand beds followed by disposal at a landfill. The average daily flow at outfall 001, for the time period between January and December 2009, was 0.28 MGD. The maximum daily flow during this period was 1.72 MGD.

June grab sampling revealed an anomalous discharge from the Richwood WWTP that contained high concentrations of ammonia (9.57 mg/l) and TKN (11.1 mg/l) along with elevated concentrations of bacteria. Organic nitrogen constituents comprised about 14% of the total TKN load with the balance being ammonia (86%). Investigation into the discharge results was inconclusive. Highly elevated concentrations of ammonia and TKN were also noted 0.8 mile downstream in Fulton Creek only a little later on the same day (Appendix F-1). Samples obtained during the rest of the survey indicated compliance with NPDES permit limits.

Only one violation of the dissolved oxygen concentration limit was reported for January 2009 and only 2 reporting frequency violations were noted for total suspended solids in September 2009, both noted in self-monitoring monthly operating reports. An inspection in June of 2009 revealed good progress in remedying past deficiencies in operations and maintenance which has consequently resulted in much improved compliance with the NPDES permit.

Annual pollutant loadings and flow information for Richwood WWTP is presented in Figure 11.

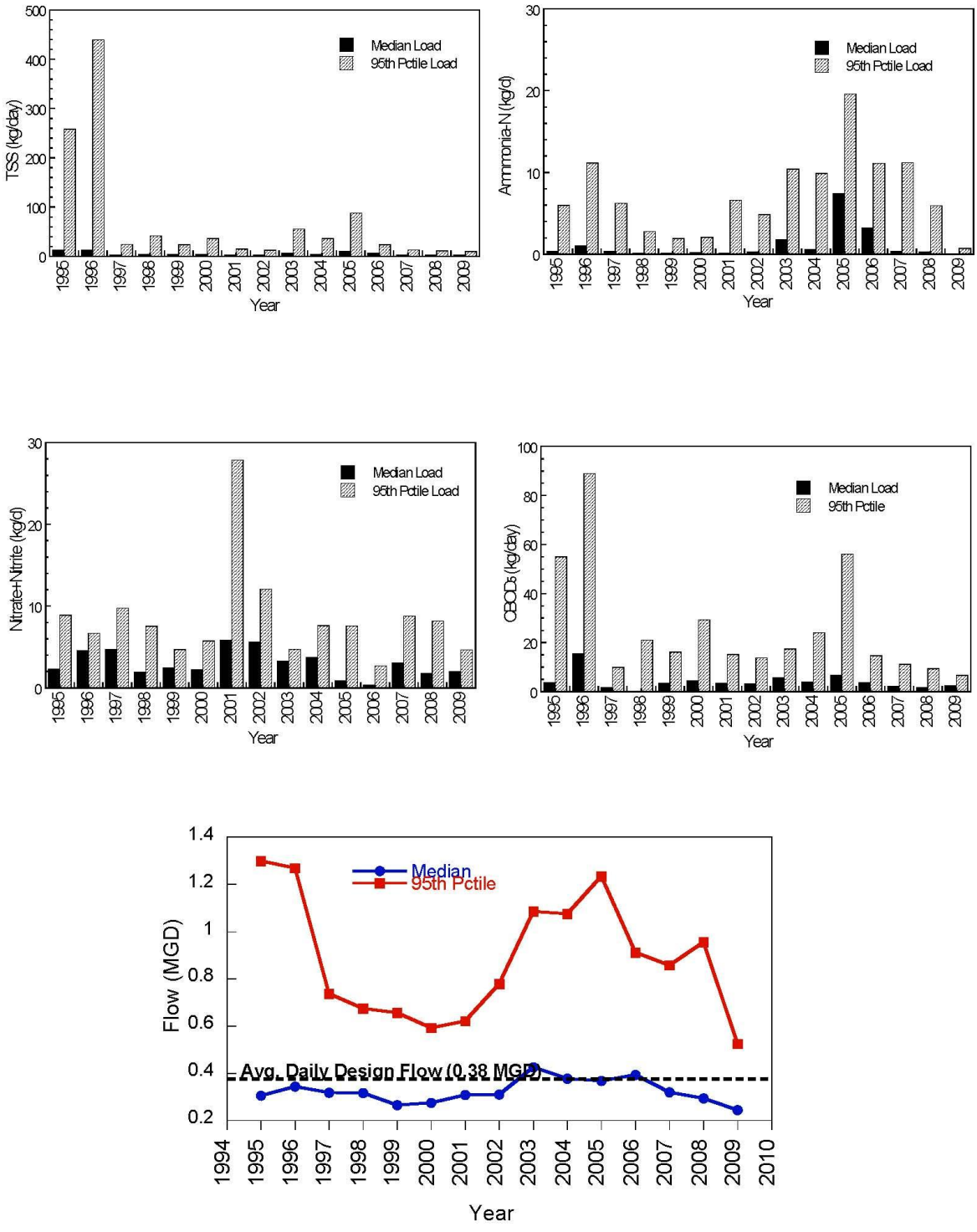

Figure 11. Average annual pollutant loadings and flows for the City of Richwood WWTP.

Table 5. NPDES permitted facilities by county in the upper Scioto River watershed.

Facility Name	Type	NPDES Number	Receiving Stream
Hardin County			
Alger WWTP	Minor	2PB00064	Cottonwood Ditch Trib
BP Amoco Oil Corp Bulk Plant Kenton	Minor	2IN00168	Scioto R Trib
Durez Corporation	Major	2IF00002	Taylor Ck
Eldridge Station Hills WWTP	Minor	2PG00005	Scioto R
Fairwayview STP	Minor	2PG00012	Scioto R Trib
Green Hills Coach Park Ltd	Minor	2PY00041	Taylor Ck
Jumpin Jim's	Minor	2IN00215	Scioto R Trib
Kenton WWTP	Major	2PD00020	Scioto R
McGuffey STP	Minor	2PA00006	Cottonwood Ditch
Morton Buildings Inc	Minor	2PR00233	Gander Run Trib
Mt Victory WWTP	Minor	2PA00046	Wildcat Ck
Reed Road WWTP	Minor	2PG00004	Scioto R
Sypris Tech Kenton Inc	Minor	2IS00000	Taylor Ck
Marion County			
Asphalt Materials Inc Marion Plant	Minor	2IN00163	Blum Ditch
BP Amoco Oil Corp Bulk Plant Marion	Minor	2IN00170	Rock Swale Ditch
Elgin High School	Minor	2PT00052	Glade Run
Grandview Estates SD 2A	Minor	2PG00036	Rock Fork
Harmony Subdiv SD 5B	Minor	2PG00072	Honey Creek Run
LaRue WWTP	Minor	2PA00051	Scioto R
Marion Ethanol LLC	Minor	2IF00025	Rock Swale Ditch
Marion WPC	Major	2PD00011	L Scioto R
Morning View Care Center	Minor	2PR00240	Honey Creek
National Lime & Stone Co Marion Plant	Minor	2IJ00027	Harvey Ditch
New Bloomington WWTP	Minor	2PA00065	Scioto R
North Quarry Subdivision	Minor	2PW00004	Honey Creek
Nucor Steel Marion LLC	Minor	2ID00017	L Scioto R Tribs
Pleasant Acres MH Community LLC	Minor	2PR00040	Honey Creek
Pleasant Local Schools	Minor	2PT00048	L Scioto R
Prospect WWTP	Minor	2PA00041	Scioto R

Facility Name	Type	NPDES Number	Receiving Stream
Ridgedale Elementary School	Minor	2PT00049	L Scioto R
Sims Brothers Inc	Minor	2IN00052	Sawyer Lake Trib
Sypris Technologies Marion Plt	Minor	2II00104	Rock Swale Ditch
Whirlpool Corp Marion Division	Minor	2IC00009	Rock Swale Ditch
Logan County			
Rushsylvania WWTP	Minor	1PB00025	Rush Creek
Union County			
Richwood WWTP	Minor	4PB00018	Fulton Creek
Richwood WTP	Minor	4IW00121	Fulton Creek
Tawa Estates WWTP	Minor	4PB00018	Ottawa Creek Trib

Sediment Quality

Sediment samples were collected from twelve (12) sites in the upper Scioto River watershed study area by the Ohio EPA in September 2009 and are summarized in Table 6 Samples were analyzed for metals, organics, nutrients, total organic carbon (TOC) and particle size. Sediment sample results were evaluated using published guidelines discussed below.

Sediment samples were collected by focusing on depositional areas of fine grain material (silts and clays). These areas are typically represented by higher contaminant levels, compared to sands and gravels. All sediment sampling occurred in areas along the stream bank, which were represented by sparse deposits of fine grained material. These near bank areas comprised only a small fraction of the bottom substrates of the streams surveyed. Bottom substrates at some sites surveyed (e.g. Fulton Creek), were dominated by cobble, gravel and sand.

At each sample location, one hundred and thirty (130) organic parameters were tested for including polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and pesticides. Sediment sample results for organics were evaluated using guidelines established in *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems* (McDonald et. al. 2000).

The consensus-based sediment guidelines define two levels of ecotoxic effects. A *Threshold Effect Concentration* (TEC) is a level of sediment chemical quality below which harmful effects are unlikely to be observed, and is comparable to background conditions. A *Probable Effect Concentration* (PEC) indicates a level above which harmful effects are likely to be observed.

At eight of the twelve sites (67%) no organic parameters were detected. Where organic detections occurred, no results exceeded the PEC. Not surprisingly, the highest number of organic detections occurred at the Little Scioto River near Green Camp (RM 0.4) downstream from Marion. This site is downstream from the Little Scioto River historic sediment PAH contamination and remediation section. Here, several PAHs and PCBs were detected. Only PCB (total) was above the TEC at 140.3 ug/kg (TEC = 59.8 ug/kg). This MWH site was in non-attainment of aquatic life use partially due to the historic contaminated sediments. Additional information regarding assessment of the historic sediment PAH contamination section can be found in the Biological and Water Quality Study of the Little Scioto River (Ohio EPA 2008c).

At most sites studied in 2009, concentrations of metals in sediment were below Ohio EPA *Sediment Reference Values* (SRV) for metals (Ohio EPA 2008c). The Ohio SRVs represent ecoregion background conditions based on data collected at Ohio reference sites.

Strontium was the most frequently detected metal found above the SRV. This occurred at three sites (Taylor Creek, Kebler Run and Cottonwood Ditch) and may be partially attributed to groundwater influences. Mercury concentrations were generally less than or near the reporting limit (RL) and below any effect concentration. Overall, metal concentrations were minimal and not expected to impact benthic communities.

Nutrient sediment sampling included Total Organic Carbon (TOC) at all sites and Total Phosphorus (4 sites only) in the study area. These results were evaluated using guidelines established by Persuad et.al. (1993). This includes the Lowest Effect Level (LEL) and the Severe Effect Level (SEL). The LEL is a level of sediment concentration that can be tolerated by a majority of benthic organisms. The SEL is a concentration considered harmful to most benthic organisms. For sample sites in this study, most results for TOC and Total Phosphorus were above the LEL but less than the SEL.

Cottonwood Ditch, a MWH stream, showed the highest concentration of Total Phosphorus at 1230 mg/kg. This was above the LEL of 600 mg/kg but below the SEL of 2000 mg/kg. For TOC, most sites studied were less than 5.0% which is above the LEL of 1%. At the Futon Creek site, the TOC value of 10% was the highest in the study and at the SEL (10%). Based on the dearth of fine-grained materials found in the wetted channel, sediment contamination effects on the benthic community were considered negligible for this site.

Table 6. Summary of selected sediment sampling results in the upper Scioto River watershed, 2009.

Site	Summary
Scioto R. – RM 234 (Arborgast Rd.)	**Organics:** 0 of 130 organics (0%) detected. **Metals:** 0 of 18 metals (0%) above SRV. Arsenic (11.4) above TEC. Mercury < RL. **Nutrients:** TOC (4.8 %) above LEL. Total Phosphorus (581) less than LEL.
Scioto R. – RM 212 (at Kenton)	**Organics:** 0 of 130 organics (0%) detected. **Metals:** 0 of 18 metals (0%) above SRV. Arsenic (13.7) above TEC. Mercury < RL. **Nutrients:** TOC (5.1%) above LEL (< SEL). Total Phosphorus not tested at this site.
Scioto R. – RM 196 (at LaRue)	**Organics:** 0 of 130 organics (0%) detected. **Metals:** 0 of 18 metals (0%) above SRV. Mercury detected (0.038 , RL=0.037). **Nutrients:** TOC (4.2%) above LEL (<SEL). Total Phosphorus (938) above LEL (<SEL).
Scioto R. – RM 169 (Hoskins Rd.)	**Organics:** 5 of 130 organics (3%) detected. Benzo[a]pyrene (0.69), Benzo[b]fluoranthene (0.67), chrysene (0.88), fluoranthene (0.88) and Pyrene (0.68). All just above RL and well below TEC. **Metals:** 0 of 18 metals (0%) above SRV. Mercury detected (0.046, RL = 0.034). **Nutrients:** TOC (3.8%) above LEL (<SEL). Total Phosphorus not tested at this site.
L. Scioto R. – RM 11 (Ust. Marion)	**Organics:** 1 of 130 organics (<1%) detected. Dieldrin (9.4) just above RL and below TEC. **Metals:** 0 of 18 metals (0%) above SRV. Mercury < RL. **Nutrients:** TOC (3.1%) above LEL (<SEL). Total Phosphorus (940) above LEL (<SEL).
L. Scioto R. – RM 0.4 (at Green Camp)	**Organics:** 15 of 130 organics (11%) detected. PCB (Total) at 140.3 is above TEC (<PEC). Includes PCB-1242 (60.6) and PCB 1260 (79.7). No other organics above TEC. Other organics detected: alpha-Chlordane (8.8), gamma-Chlordane (11.6), Anthracene (0.80); Benz[a]anthracene (2.44); Benzo[b]fluoranthene (3.28); Benzo[a]pyrene (3.54); Benzo[g,h]perylene (3.01); Benzo[k]fluoranthene (2.46); Chrysene (3.67); Fluoranthene (5.30); Indeno[1,2,3-cd]pyrene (2.80); Phenanthrene (0.90); Pyrene (3.95). **Metals:** 1 of 18 metals (5%) above SRV. Zn (163) above SRV and TEC. Mercury detected near SRV (0.117). **Nutrients:** TOC (2.6%) above LEL. Total Phosphorus not tested at this site.
Rock Fk. – RM 1.35 (Ust. Marion)	**Organics:** 0 of 130 organics (0%) detected. **Metals:** 0 of 18 metals (0%) detected above SRV. Mercury < RL. **Nutrients:** TOC (2.6%) above LEL (<SEL). Total Phosphorus not tested at this site.
Taylor C. – RM 0.8 (near Kenton)	**Organics:** 0 of 130 organics (0%) detected. **Metals:** 1 of 18 metals (5%) above SRV. Strontium (807) above SRV. Mercury < RL. **Nutrients:** TOC (4.0%) above LEL (<SEL). Total Phosphorus not tested at this site.
Rush C. – RM 5.39 (Mt. Olive-GC Rd.)	**Organics:** 0 of 130 organics (0%) detected. **Metals:** 0 of 18 metals (0%) detected above SRV. Zinc (124) above TEC. Mercury below detection. **Nutrients:** TOC (2.6%) above LEL (<SEL). Total Phosphorus not tested at this site.
Fulton C. – RM 0.22 (SR 257)	**Organics:** 0 of 130 organics (0%) detected. **Metals:** 0 of 18 metals (0%) detected above SRV. Mercury detected (0.044, RL = 0.043). **Nutrients:** TOC (10%) above LEL and at SEL (10%). Total Phosphorus (871) above LEL (<SEL).
Kebler Run – RM 0.9 (Kebler Run Rd.)	**Organics:** 0 of 130 organics (0%) detected. **Metals:** 1 of 18 metals (5%) detected above SRV. Strontium (520) above SRV. Mercury < RL. **Nutrients:** TOC (5.0%) above LEL (<SEL). Total Phosphorus (914) above LEL (<SEL).
Cottonwood D. (dst. McGuffey)	**Organics:** 3 of 130 organics (2%) detected. 4,4'-DDD (25), 4,4'-DDE (29.1), 4,4'-DDT (17.4) all above TEC (<PEC). **Metals:** 1 of 18 metals above SRV (Strontium 559). Nickel (28.3) above TEC. Mercury detected (0.041). **Nutrients:** TOC (5.1%) above LEL (<SEL). Total Phosphorus (1230) above LEL (<SEL).

TEC, PEC = Threshold Effect Concentration, Probable Effect Concentration (MacDonald et. al., 2000). TEC is a level of sediment chemical quality below which harmful effects are unlikely to be observed. PEC is indicates a level above which harmful effects are likely to be observed. Used for sediment organics and sediment metals evaluation.
SRV = Sediment Reference Value (Ohio EPA, 2003). SRV is a statewide (Pb, Hg) or ecoregion (all others) background sediment value. Used for sediment metals evaluation.
LEL, SEL = Lowest Effect Level, Severe Effect Level (Persaud et. al., 1993). LEL is a level of sediment concentration that can be tolerated by a majority of benthic organisms. SEL is a level that would be detrimental to a majority of benthic organisms. Used for Total Organic Carbon (TOC) and Total Phosphorus evaluation.
RL = Report Limit.

Upper Scioto River Basin Physical Habitat

Stream habitat was evaluated at 62 fish sampling locations in 2009. Main stem habitat quality was highly variable and ranged from very poor to excellent (Table 7). In tributaries, good to excellent stream habitat was recorded at 36 sites (58%) which included: Patton Run, Honey Creek, Wolf Creek, Rush Creek, Fulton Creek, Scioto River, Taylor Creek, Little Scioto River, Panther Creek, Rock Fork, Silver Creek, Battle Run, Ottawa Creek, Kebler Run, and Wildcat Creek. The average QHEI score for the upper Scioto River main stem was 59.6 which reflected the overall good habitat quality in the Scioto River main stem (Appendix A-1). However, for more than sixteen miles the Scioto River main stem is severely modified from channelization scoring an average QHEI of 43 (poor to fair quality habitats) within this section southeast of McGuffy (RM 226.30) downstream to Kenton (RM 210.07) (Figure 12 & Figure 13). Excellent physical habitat was scored outside of this reach, near Roundhead and downstream from Kenton with an average QHEI score of 70.7. This helped increase the diversity and biological recruitment potential in the fish communities within the channelized sections which had only fair or poor habitat. Southeast of McGuffey to Kenton habitat restoration activities could help achieve greater assimilation of nonpoint source nutrients and runoff coming from the upstream and adjacent agricultural land uses.

Fair to poor habitat was noted at 21(34%) stream sampling sites (Table 7). This included the main stem from McGuffey to Kenton, McCoy Run, Wildcat Creek, five sites on the L. Scioto River, North Rock Swale Ditch, McDonald Creek, and Rock Fork. All the sites were channelized with related, negative attributes such as substrates comprised of silt, lack of riparian buffer and sinuosity (Appendix A-1). Four sites (1.6%) were characterized by very poor habitat within the upper Scioto River watershed. These included one site each on Fulton and Dunlap Creek and all of Cottonwood Ditch. Habitat at these locations was also characterized by channelization with substrates covered in silt and row crops planted close to the edge of the steeply leveed stream banks (Figure 14). All four of these sites appeared to have flashy flow regimes, likely having sustained flow only during and immediately following storm events. There was no apparent ground water connection in these streams to aid in the flow or buffer temperature. These otherwise stagnant streams lacked sufficient canopy cover due to a lack of riparian vegetation and were susceptible to elevated water temperatures creating nuisance algae blooms and dissolved oxygen swings.

Figure 12. Pictured above is a channelized portion of the upper Scioto River main stem southeast of McGuffy at RM 226.3.

Figure 13. Pictured above is a channelized portion the Scioto River main stem south of McGuffy at RM 224.2.

Figure 14. Pictured above are four upper Scioto River tributaries which were not attaining their respective aquatic life use designations in part due to habitat impairment from channelization.

Table 7. Summarized results of QHEI scores for the upper Scioto River study area, 2009.

RM	Stream Name	QHEI	DA(mi^2)
	Excellent		
0.49	WILDCAT CREEK NW OF LARUE @ LARUE-KENTON RD.	84.5	22.2
0.87	KEBLER RUN S OF PROSPECT @ RIVER RD.	83.5	14.3
8.91	PANTHER CREEK W OF MT. VICTORY @ TWP. RD. 197	82.5	7.1
39.45	RUSH CREEK UPST. RUSHVILLE @ TWP. RD. 118	82.5	11.8
36.15	RUSH CREEK DST. RUSHVILLE @ TWP. RD. 110	82.0	14.8
4.43	TAYLOR CREEK S OF KENTON @ TWP. RD. 180	80.0	12.7
231.86	SCIOTO R. AT ROUNDHEAD @ MADORY RD.	79.5	28.0
0.08	OTTAWA CREEK @ ST. RT. 257	79.5	8.0
14.50	RUSH CREEK @ WINNEMAC RD.	79.0	50.0
234.39	SCIOTO R. W OF ROUNDHEAD @ ARBOGAST RD.	77.5	18.3
10.35	FULTON CREEK UPST. RICHWOOD @ KINNEY PIKE	76.5	24.9
7.80	PANTHER CREEK @ ST. RT. 31 ROADSIDE PARK	75.0	11.0
2.32	SILVER CREEK @ ST. RT. 67	74.5	11.3
0.25	BATTLE RUN AT PROSPECT @ ELM ST.	70.5	9.4
	Good		
203.36	SCIOTO R. AT HEPBURN @ CO. RD. 227	74.5	223.0
207.26	SCIOTO R. DST. KENTON @ TWP. RD. 199	74.0	178.0
1.20	FULTON CREEK SE OF RICHWOOD @ FULTON CREEK RD. (UPPER)	74.0	46.4
1.10	ROCK FORK N OF MARION @ ST. RT. 423	74.0	23.1
9.24	L. SCIOTO R. NW OF MARION @ HILLMAN FORD RD.	73.5	73.0
179.05	SCIOTO R. ADJ. GREEN CAMP RIVER RD.	71.5	407.0
1.80	PANTHER CREEK SW OF HEPBURN @ CO. RD. 219	71.5	22.3
192.21	SCIOTO R. SW OF NEW BLOOMINGTON @ SCHOTTE RD.	71.0	223.0
19.70	L. SCIOTO R. @ CRAWFORD-MARION COUNTY LINE RD.	69.5	33.0
186.00	SCIOTO R. SE OF NEW BLOOMINGTON @ WTP AT REFUGE	67.0	379.0
0.76	TAYLOR CREEK AT KENTON @ ST. RT. 67	66.5	16.3
26.26	RUSH CREEK @ WEST MANSFIELD-MT. VICTORY RD. (CO. RD. 139)	65.5	25.7
5.39	RUSH CREEK S OF NEW BLOOMINGTON @ MT. OLIVE-GREEN CAMP RD.	62.5	77.0
236.40	SCIOTO R. DST. WALLACE FK. DST HARDIN COUNTY LINE RD (CO RD 311)	61.5	13.0
8.80	RUSH CREEK AT ESSEX, UPST ST. RT. 739	61.0	72.7
196.12	SCIOTO R. AT LARUE @ ST. RT. 37	60.5	258.0
6.44	FULTON CREEK DST. RICHWOOD, ADJ. FULTON CREEK RD.	60.5	40.0
7.55	RUSH CREEK N OF ESSEX @ SANDERS RD.	60.5	73.9
0.55	RUSH CREEK @ LARUE-GREEN CAMP RD.	60.0	105.0
0.51	WOLF CREEK @ TWP. RD. 199	59.0	12.0
0.01	HONEY CREEK SW OF MARION @ MOUTH	58.5	7.3
2.25	PATTON RUN @ BOUNDARY RD.	56.0	14.4

RM	Stream Name	QHEI	DA(mi^2)
	Fair		
210.07	SCIOTO R. AT KENTON @ CO. RD. 175	57.0	170.0
0.55	MCCOY RUN @ RODGERS RD.	53.5	8.0
4.00	WILDCAT CREEK @ TWP. RD. 245	49.5	8.4
11.10	L. SCIOTO R. N OF MARION @ KENTON-GALION RD.	49.0	47.0
0.55	N. ROCK SWALE DITCH W OF MARION @ HOLLAND RD.	49.0	10.0
211.50	SCIOTO R. JUST UPST. KENTON WWTP	46.5	162.0
216.67	SCIOTO R. W OF KENTON @ CO. RD. 106	46.0	117.0
0.39	L. SCIOTO R. AT GREEN CAMP @ OWENS-GREEN CAMP RD. (CR 104)	45.5	113.0
2.70	MCDONALD CREEK S OF LARUE @ ST. RT. 37	44.5	12.3
6.72	WILDCAT CREEK NE OF MT. VICTORY @ TWP. RD. 217	43.5	4.3
6.82	MCDONALD CREEK SW OF LARUE @ CO. RD. 245	43.0	6.3
	Poor		
8.70	FULTON CREEK DST. RICHWOOD @ FARM BRIDGE	42.5	29.0
25.59	L. SCIOTO R. @ CALDWELL RD.	40.5	12.8
0.20	WALLACE FORK @ MOUTH	39	4.8
226.30	SCIOTO R. SE OF MCGUFFEY, UPST. CO. RD. 130	38.5	49.0
1.25	ELLIOT RUN S OF RICHWOOD @ KINNEY PIKE	38.0	2.5
9.17	MCDONALD CREEK UPST. BUCKEYE EGG FARM @ CO. RD. 240	38.0	2.6
223.05	SCIOTO R. SE OF MCGUFFEY @ CO. RD. 110	37.5	67.0
8.13	ROCK FORK @ MARSEILLES-GALION RD.	35.5	7.6
6.24	L. SCIOTO R. @ LANDFILL/TWP. RD. 97-A	34.5	86.0
224.20	SCIOTO R. S OF MCGUFFEY @ CO. RD. 65	32.5	62.0
6.50	L SCIOTO R AT MARION, UPST MARION WWTP/DST N ROCKSWALE DITCH	31.0	86.0
	Very Poor		
16.30	FULTON CREEK UPST. RICHWOOD @ MILLER RD.	27.0	12.5
4.10	COTTONWOOD DITCH DST. ALGER, ADJ. TWP. RD. 100, DST C.R. 35	24.0	11.3
1.01	DUNLAP CREEK NEAR MOUTH @ END OF LANE, N OFF CO. RD. 130	20.5	8.9
0.68	COTTONWOOD DITCH DST. MCGUFFY WWTP @ RR BRIDGE	18.0	19.3

General narrative ranges assigned to QHEI scores.

Narrative Rating		QHEI Range	
		Headwaters (≤20 sq. mi)	Larger Streams
Excellent		≥70	≥75
Good		55 to 69	60 to 74
Fair		43 to 54	45 to 59
Poor		30 to 42	30 to 44
Very Poor		<30	<30

Physical Habitat Trends (1995-2008)

Upper Scioto River Main Stem

Main stem physical stream habitat displayed five significant changes from 1995 to 2009 (Figure 15). Narrative physical habitat quality improved from good to excellent at 4 locations (RM 231.8, 207.3, 192.2, and 169.5) and at RM 226.3 the habitat improved from very poor (QHEI = 23) to poor (QHEI = 38.5) quality. Improvements resulted from reductions in MWH attribute scores in the QHEIs reflecting gradual channel recovery over time (Appendix A-2). Riffles were recorded as present in 2009 at two of the locations which had no riffles during the 1995 assessment. These sections will never form stable channels while constrained by the very steeply leveed banks but slight recovery was evident over the last 15 years. One exception to this was at RM 226.3 where the score improved because of an artificial riffle created by riprap near the bridge.

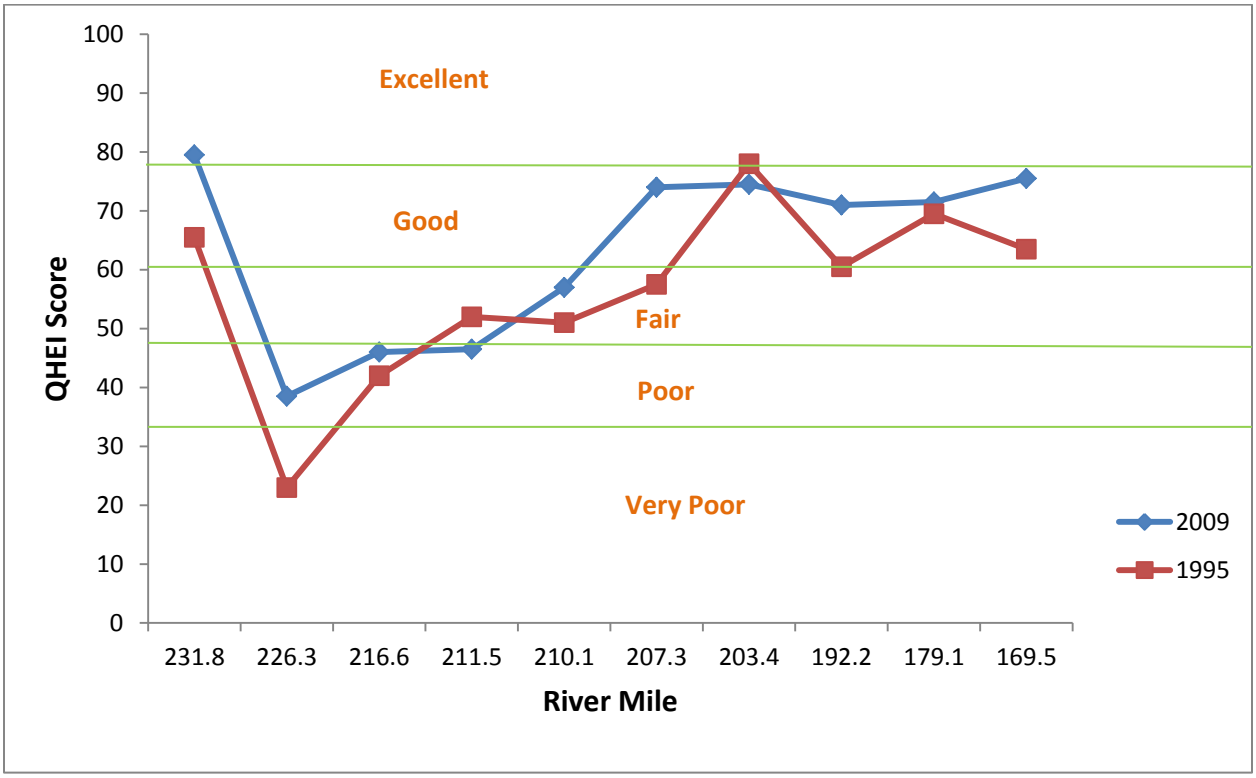

Figure 15. Comparison of QHEI trends in the upper Scioto River main stem, 1995 - 2009.

Upper Scioto River basin Tributaries

Comparisons between historical physical habitat scores from upper Scioto River tributaries and 2009 scores showed overall improvement in Wildcat Creek (Figure 16). Wildcat Creek displayed significant improvement in QHEI score and habitat at both of the historically sampled sites from 1995. Two of the other previously sampled tributaries (Panther Creek, Taylor Creek, and McDonald Creek) showed only partial improvement in 2009 compared to historical data. The Little Scioto River was more recently sampled during 2007 and displayed negligible differences in QHEI score in 2009. QHEI scores at the lower two sites on McDonald Creek decreased compared to the 1995 scores.

Regarding the improvements in Wildcat Creek, recovery from channelization and silt reduction yielded higher QHEI scores at both RM 6.7 and 0.5 (Table 2). Based on field sheet notations for these two sites, Wildcat Creek habitat improved from being channelized to showing signs of recovery by forming a more stable channel between 1995 and 2009 (Appendix A-1).

Panther Creek and Taylor Creek both displayed minor improvements in QHEI score and habitat in 2009 (Figure 16). The upstream and downstream sites on Panther Creek were inversely proportional. While the upstream site (RM 8.9) showed improvements the downstream location (RM 1.8) scored lower or decreased in habitat quality when compared to the 1995 data.

Stream habitat quality declined in McDonald Creek at RM 6.8 and RM 2.7 between 1995 and 2009, with QHEI scores dropping from 60 to 43 and 64.5-44.5, respectively (Figure 16). Analysis of the QHEI attributes suggests that McDonald Creek was physically modified by channelization between 1995 and 2009. The WWH attributes and substrate quality declined and signs of recovery from channelization were noted during 2009.

Many of these positive successional changes noted in physical habitat at several survey sites can be attributed to the process of recovery from channelization into more stable and natural stream channels. Many upper Scioto headwater streams (>20 $mi.^2$ in drainage area) have been physically altered. Some small water courses are legally petitioned under the provisions of the Ohio County Ditch Law to facilitate drainage. They will be maintained in this condition in perpetuity or until their petitions are revoked. Other streams were altered by individual landowners or under provisions of older ditch laws. Regardless, channelization has lowered habitat quality in large portions of the watershed.

To remedy observed habitat problems, efforts should be made to restore modified streams to their natural morphological state. Natural stream channels have a greater capacity to assimilate nutrients and fine sediments by flushing them into adjacent floodplains, process nutrients into productive biomass rather than nuisance algae, improve water quality, create diverse instream habitats, and ultimately (and most important for adjacent landowners) evolve into a stable channel. Many current causes

and sources of stress within the watershed could be reduced or eliminated by allowing altered stream channels and riparian vegetation to recover naturally. Wherever possible, previous physical modifications should be undone (e.g., restore cutoff channels, restore wetlands, move dikes and levees away from stream banks).

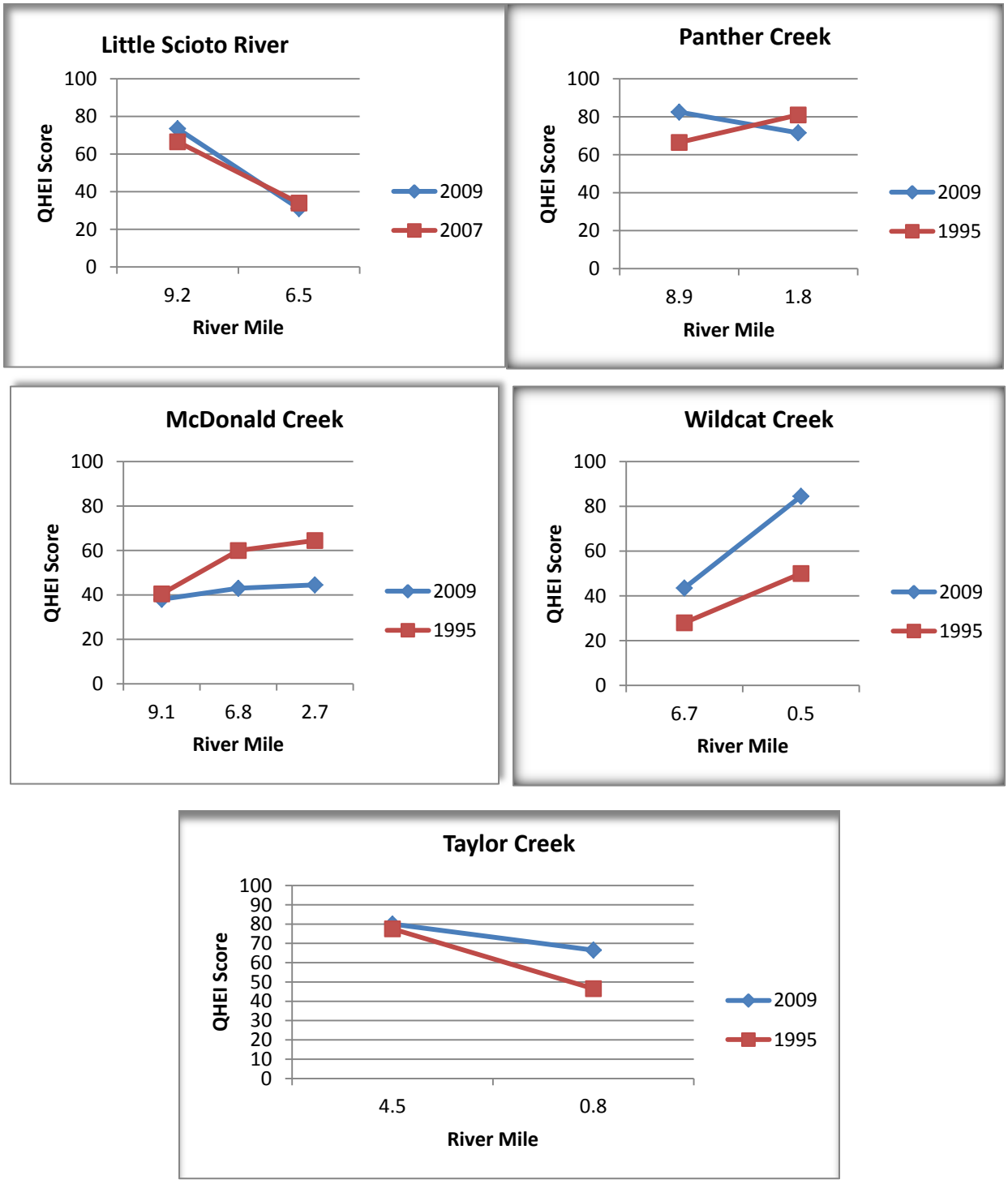

Figure 16. Comparison of QHEI trends for upper Scioto River tributaries, 1995-2009.

Spills and Fish Kills

A total of 5 spills which resulted in 3 fish kills were reported in the upper Scioto River watershed during 2009 (Table 8). Two of the fish kills occurred at RM 1.57 on Taylor Creek and originated from the same source, Durez Corporation. On June 18 and July 29 2009 untreated or poorly treated effluent from the Durez outfall into Taylor Creek caused fish kills. There was another incident which occurred on November 18, 2009 in which the effluent from Durez was polluting Taylor Creek, but did not result in any known fish kills. On July 21, 2010, in response to the notice of violation issued by the Ohio EPA DSW in September 2009, Durez Corporation commenced an action to remove contaminated Taylor Creek sediment. Ohio EPA conducted an inspection of the removal activity on July 23, 2010. Starting in August 2010, the facility removed the top 16-48 inches of sediment in Taylor Creek beginning 10 feet upstream from their discharge point to a point roughly 1500 feet downstream (Figure 17). The company restored the stream to its natural condition following removal of the contaminated sediment which was completed on September 17, 2010. To view the full Taylor Creek chronology of events, remediation summary and cleanup pictures, see Appendix G-1.

Spills without documented fish kills associated with them occurred at Rush Creek (RM 31.2) and Elliot Run (RM 1.25). In Rush Creek a truck crashed on April 16, 2009 spilling 36,000 gallons of ammonium thiosulfate (liquid fertilizer) though no dead fish were found immediately following the spill or the next day. On May 21, 2009 73 dead fish were found in Elliot Run as a result of an over-application of an unknown agricultural chemical to the adjacent 213 acre field by an unknown farmer. In addition to these verified fish kills, there was also suspicion that fish kills had occurred on the Scioto River main stem downstream from Taylor Creek after analyzing fish community IBI and MIwb trends (Figure 1).

On July 24, 2008, 42,000 gallons of manure spilled into Rock Fork in the headwaters killing a total of 5,250 fish throughout the entire length of the stream. Effects of this spill were still apparent in the poor quality fish community sampled in 2009 (Appendix C-1 and Table 12).

Table 8. Documented spills and fish kills in the upper Scioto River watershed, 2008 & 2009.

Stream	Date	RM	Length Affected	# Killed	Operation	Pollutant	Source
Rush Creek	16-Apr-09	31.2	0.2	0	transportation	ammonium thiosulfate (fertilizer)	overturned truck
Elliot Run	21-May-09	1.25	0.63	73	agriculture	unknown land applied chemical spray	unknown (farmer)
Taylor Creek	18-Jun-09	1.57	1.57	519	chemical industries	unknown	Durez
Taylor Creek	29-Jul-09	1.57	1.57	2,705	chemical industries	unknown	Durez
Taylor Creek	18-Nov-09	1.57	0.25	0	chemical industries	chemicals	Durez
Rock Fork	24-Jul-08	11.6	8.65	5,250	Livestock	Manure	Farm field tile

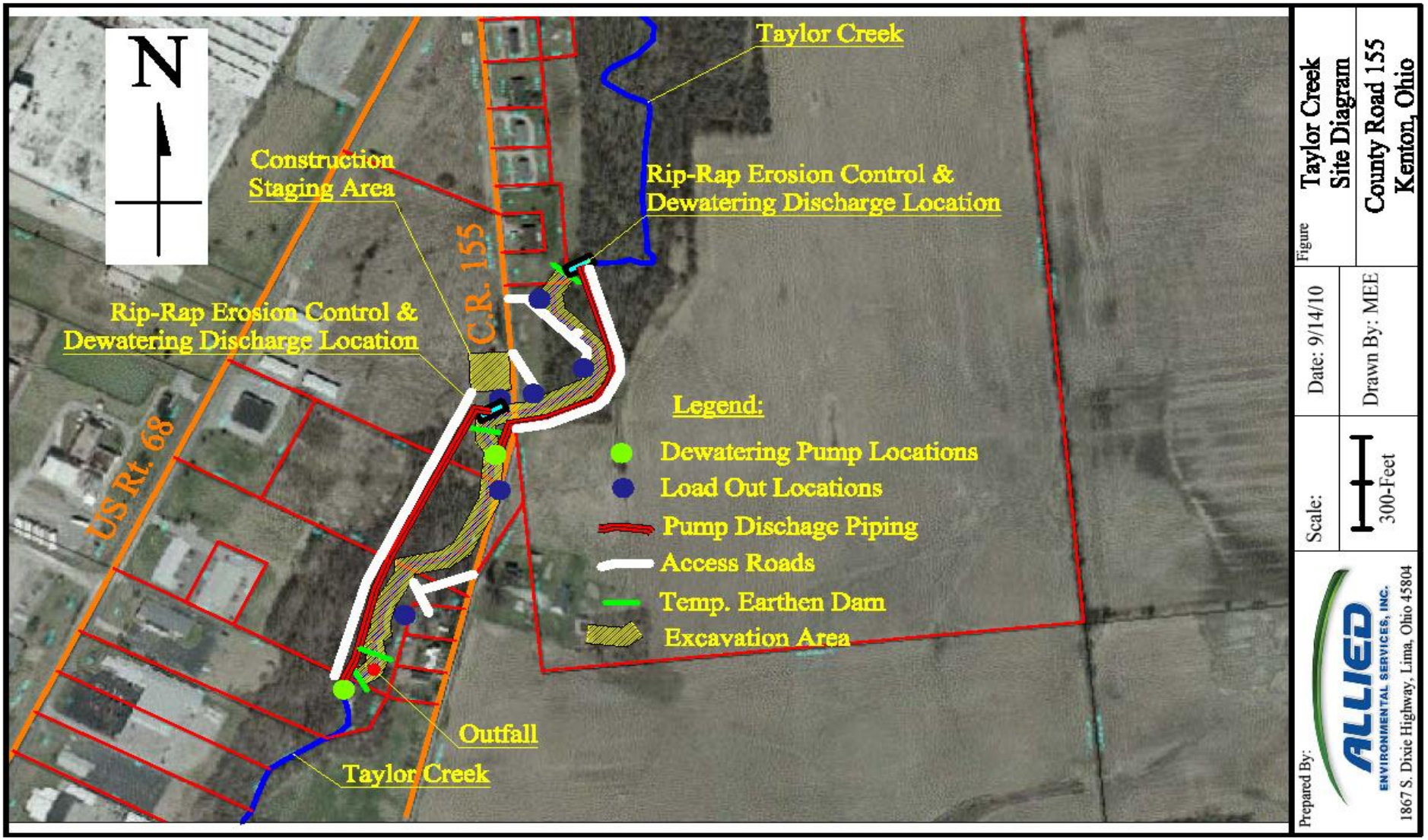

Figure 17. Taylor Creek contaminated sediment removal action project map, courtesy of Allied Environmental Services, INC, 2011.

Fish Tissue Contamination

Ohio has been sampling streams annually for sport fish contamination since 1993. Fish are analyzed for contaminants that bioaccumulate in fish and that could pose a threat to human health if consumed in excessive amounts. Contaminants analyzed in Ohio sport fish include mercury, PCBs, DDT, mirex, hexachlorobenzene, lead, selenium, and several other metals and pesticides. Other contaminants are sometimes analyzed if indicated by site-specific current or historic sources. For more information about chemicals analyzed, how fish are collected, or the history of the fish contaminant program, see State of Ohio Cooperative Fish Tissue Monitoring Program Sport Fish Tissue Consumption Advisory Program, Ohio EPA, January 2010 (http://www.epa.state.oh.us/portals/35/fishadvisory/FishAdvisoryProcedure10.pdf).

Fish contaminant data are primarily used for three purposes: 1) to determine fish advisories; 2) to determine attainment with the water quality standards; and 3) to examine trends in fish contaminants over time.

Fish advisories

Fish contaminant data are used to determine a meal frequency that is safe for people to consume (e.g., two meals a week, one meal a month, do not eat), and a fish advisory is issued for applicable species and locations. Because mercury mostly comes from nonpoint sources, primarily aerial deposition, Ohio has had a statewide one meal a week mercury advisory for most fish since 2001. Most fish are assumed to be safe to eat once a week unless specified otherwise in the fish advisory, which can be viewed at http://www.epa.state.oh.us/dsw/fishadvisory/index.aspx.

The minimum data requirement for issuing a fish advisory is three samples of a single species. For the upper Scioto River in 2009, common carp, channel catfish, and rock bass met the requirement. Channel catfish and rock bass are in the one meal a month advisory category due to mercury contamination. Common carp are in the one meal a week category due to mercury contamination, as well as PCB contamination. In the Little Scioto River in 2009, only common carp met the requirement. Common carp are in the one meal a week advisory category for mercury contamination.

For a listing of fish tissue data collected from the upper Scioto River in support of the advisory program, see Table 10. The advisory information for the upper Scioto River and Little Scioto River presented in this section differs from the information given in Ohio's fish consumption advisory because of a difference in years of data and sites included in the analysis. The segment of the upper Scioto River referred to in the Ohio fish consumption advisory includes from US 68 in Kenton to Ostrander Road in Warrensburg, and uses data from 2003 through 2009; for this document, only data taken in 2009 from adjacent the Kenton wastewater treatment plant downstream to

Green Camp were used. For the Little Scioto River, all fish have a "Do Not Eat" advisory in Marion due to historic polycyclic aromatic hydrocarbon (PAH) contamination, which is not monitored under the fish contaminant monitoring program.

Fish tissue/human health use attainment

In addition to determining safe meal frequencies, fish contaminant data are also used to determine attainment with the human health water quality criteria pursuant to OAC Rules 3745-1-33 and 3745-1-34. The human health water quality criteria are presented in water column concentrations of µg/Liter, and are then translated into fish tissue concentrations in mg/kg. [See Ohio's 2012 Integrated Report, Section E (http://www.epa.ohio.gov/portals/35/tmdl/2012IntReport/IR2012_SectionE.pdf) for further details of this conversion.]

In order to be considered in attainment of the water quality standards, the sport fish caught within a HUC12 in the Ohio River basin must have a weighted average concentration of the geometric means for all species below 1.0 mg/kg for mercury, and below 0.054 mg/kg for PCBs.

Fish tissue data were adequate to determine attainment status for one of seventeen HUC12s in this survey. At least two samples from each trophic level, three and four, are needed, and of the 17 upper Scioto watershed HUC12s, 0506000101 04 05 met that data requirement. Insufficient data or no data were available for the other HUC12s in the survey.

Table 9. Attainment status of HUC 12s for fish tissue/human health use.

HUC 12	Mercury (mg/kg)	PCBs (mg/kg)	Attainment
0506000101 04 05	0.281	0.045	In Attainment

The evaluated HUC12 was in attainment for mercury, below both Ohio's 1.0 mg/kg attainment threshold, and U.S. EPA's 0.3 mg/kg criterion for mercury in fish tissue. For PCBs, The HUC12 is below the 0.054 mg/kg PCB in fish tissue attainment threshold, and is therefore in attainment.

Fish contaminant trends

Fish contaminant levels can be used as an indicator of pollution in the water column at levels lower than laboratory reporting limits for water concentrations but high enough to pose a threat to human health from eating fish. Most bioaccumulative contaminant concentrations are decreasing in the environment because of bans on certain types of chemicals like PCBs, and because of stricter permitting limits on dischargers for other chemicals. However, data show that PCBs continue to pose a risk to humans who

consume fish, and mercury concentrations have been increasing in some locations because of increases in certain types of industries for which mercury is a byproduct that is released to air and/or surface water.

For this reason, it is useful to compare the results from the survey presented in this TSD with the results of the previous survey(s) done in the study area. Recent data can be compared against historical data to determine whether contaminant concentrations in fish tissue appear to be increasing, decreasing, or staying the same in a water body or watershed.

Fish tissue had previously been collected in the upper Scioto River in 1990, 1993, 2003, and 2004. Fish were collected along approximately the same stretch of river as in 2009, from downstream of the Kenton waste water treatment plant at river mile 211.2 to downstream of the Little Scioto River at river mile 177. Sampling in 1990 and 1993 was very limited and will not be included in the context of this discussion. Mercury levels in fish appear to have risen in the upper Scioto River since 2003-2004, from a weighted average of 0.126 mg/kg in 2003-2004 to 0.282 mg/kg in 2009. A small part of the change in mercury concentrations may be attributable to an increase in the size of the average fish caught in the upper Scioto River, from 348 mm in 2003-2004, to 363 mm in 2009, since mercury concentration tends to increase in fish with increasing length. However, overall the mercury concentration in fish has on average more than doubled between the study periods. PCBs had been very rarely detected in the past in the upper Scioto River, only having been found in two common carp samples taken near Green Camp in 2003. In 2009, five samples, three channel catfish and two common carp, all taken from the LaRue area, had detections of PCBs. The reason for the additional detections of PCBs is not known, since there are no known sources in the area, and detection limits were the same in both studies.

Table 10. Select Fish Tissue Data from 2009 upper Scioto River Sampling (mg/kg)

Year Collected	Location	River Mile	Species	Mercury	PCBs
2009	Scioto River at LaRue	196.12	Black Crappie	0.165	<0.05
2009	Scioto River at LaRue	196.12	Channel Catfish	0.266	0.117
2009	Scioto River downstream LaRue	192.21	Channel Catfish	0.526	0.132
2009	Scioto River downstream LaRue	192.21	Channel Catfish	0.139	0.226
2009	Scioto River at Green Camp	179.5	Channel Catfish	0.339	<0.075
	Averages			**0.318**	**0.137**
2009	Scioto River downstream Creosote Farm	200.5	Common Carp	0.083	<0.075
2009	Scioto River at LaRue	196.12	Common Carp	0.189	0.105
2009	Scioto River downstream LaRue	192.21	Common Carp	0.207	0.102
2009	Scioto River at Green Camp	179.5	Common Carp	0.231	<0.075
	Averages			**0.178**	**0.089**
2009	Scioto River at LaRue	196.12	Northern Pike	0.684	<0.05
2009	Scioto River downstream Kenton WWTP	211.1	Rock Bass	0.081	<0.050
2009	Scioto River at LaRue	196.12	Rock Bass	0.258	<0.050
2009	Scioto River downstream LaRue	192.21	Rock Bass	0.332	<0.050
2009	Scioto River at Green Camp	179.5	Rock Bass	0.308	<0.050
	Averages			**0.245**	<0.050
2009	Scioto River downstream LaRue	192.21	Smallmouth Bass	0.207	<0.050
2009	Scioto River at LaRue	196.12	White Crappie	0.148	<0.050
2009	Scioto River downstream Creosote Farm	200.5	Yellow Bullhead	0.074	<0.050

The shading indicates the advisory category that applies. Green = two meals per week, yellow = one meal per week, orange = one meal per month, red = one meal every two months. Unshaded cells had reporting limits above the one meal per week threshold, and so could not be determined.

Upper Scioto River Watershed Fish Community

Fish sampling was conducted at 62 sites during the upper Scioto River watershed study, 2009 (Table 1). Nine sites were resampled in 2011 as a result of fish kills (Table 2). Multiple fish kills before and during the 2009 sampling season devastated Taylor Creek and seemed to have affected approximately twenty miles [upstream of Kenton WWTP (RM 211.5) to southwest of New Bloomington at Schotte Rd. (RM 192.21)] of the Scioto River main stem. The pollutant source was poorly treated effluent coming from Durez Corporation discharging to Taylor Creek upstream from Hardin County Road 155, less than two miles before Taylor Creek drains into the Scioto River main stem.

Twenty-six of the fish sites attained the designated aquatic life use (ALU). The average IBI score on the main stem of the upper Scioto River was 42 while tributary sites scored an average IBI of 34 (Table 2). Relative numbers of fish species collected per location are presented in Appendix C-1. IBI and MIwb scores are presented in Table 2 and Table 12 and the IBI metric breakdowns can be found in Appendix B-1. Sampling locations were evaluated using either Warmwater Habitat (WWH), Modified Warmwater Habitat (MWH), Coldwater Habitat (CWH) or Exceptional Warmwater Habitat (EWH) biocriteria. A summary of the fish data are presented in Table 12.

Scioto River watershed sites sampled during 2009 and 2011 achieved the applicable fish biocriterion at 26 of the 62 sites evaluated (41.9%). Twenty sites were partially achieving the biocriterion. Sixteen sites were not achieving the applicable biocriterion, representing 25.8% of the watershed sites. Historical trends in fish community results, represented by average IBI and MIwb scores, are presented in Table 11. The 2011 fish community not only fully recovered from the 2009 fish kills, but showed a slight improvement over the 1995 historical sampling (Table 11).

Year	IBI	MIwb
2011	44	8.98
2009	32	6.46
1995	40	8.60

Table 11. Upper Scioto River IBI and MIwb averages for five main stem sites affected by the 2009 fish kills downstream of the Durez Co. toxic discharge.

Upper Scioto River Main Stem

The entire upper Scioto River main stem is designated WWH from the headwaters to RM 179.05. The fish community was in full attainment at 11 of the 15 sites that were sampled between RM 236.40 to RM 179.05. This included all six sites affected by fish kills that did not attain the WWH aquatic life use in 2009 which were found to be fully attaining when resampled in 2011 (Table 2). The Scioto River at RM 231.86, 224.20,

223.05, and 186.00 were partially attaining their respective WWH designated use due to physical habitat impairment of the stream substrates from silts and fine sediments running off the adjacent agricultural landscape which impaired the fish community (Table 2). Three of the four sites in partial attainment were entirely within a section of river that was channelized. The fourth site was upstream from a section where a side channel was created to accommodate a water treatment plant southeast of New Bloomington. With the exception of the side channel necessary for the water treatment plant, it is recommended to not perform channel maintenance and allow the river to return to a more natural ecological condition within the channel modified reaches.

Upper Scioto River Tributaries

Fish communities at thirty-two Scioto River tributaries were not fully meeting their designated aquatic life use. Sixteen of the sites partially attained the designated aquatic life use and sixteen sites were not attaining their designated aquatic life use (Table 2). The most common cause for impairment among 21 of the 32 impaired tributary sites was habitat alteration (channelization) and sediment runoff from agriculture. Stream segments which were channelized exacerbated other causes for pollution associated with these locations such as: nutrient loading, silt, and phosphorus runoff.

Two sites on Fulton Creek (RM 8.70 and 6.44) impaired by channelization were also polluted from improperly treated sewage coming from the Richwood WWTP. Raw sewage flowing from Marion CSOs was also a reason for non-attainment at two sites on the Little Scioto River (RM 6.24 and 6.50) and North Rock Swale Ditch (RM 0.55). Four sites on Rush Creek (RM 39.45, 8.8, and 5.39) were determined to be impaired due to natural conditions, low dissolved oxygen from ground water, log jams and low flow, respectively.

Narrative Evaluations

Narrative fish community evaluations, based on IBI and MIwb scores, are provided in Table 12. Descriptive evaluations allow for the comparison of fish communities from site to site. The upper Scioto River headwater site at RM 236.40 was the only biologically exceptional fish community sampled and had five darter species in the community (Appendix C-1). The Scioto River (RM 207.26) downstream of Kenton scored very good while 6 (40%) main stem sites scored good and the other 7 (47%) were found to have only marginally good or fair quality fish communities.

Thirty-two percent of fish communities at tributary sites scored within the narrative very good to marginally good range (Table 2 and Table 12). Sites that scored within the very

good, good and marginally good categories met WWH biocriterion for fish. Seventy-four percent of tributaries were found to have only fair to poor fish communities which were degraded predominately from habitat alterations, such as channelization, or contained poor quality silty substrates from agricultural runoff. Downstream of the Richwood WWTP, Fulton Creek (RM 6.44) was found capable of supporting only a very poor fish community as a result of the poorly treated effluent from the WWTP and upstream non-point source (NPS) runoff from agriculture

Table 12. Fish community status for stations sampled in the upper Scioto River basin based on data collected in 2009 and 2011. The Index of Biotic Integrity (IBI) and Modified Index of well-being (MIwb) are scores based on the performance of the fish community. The narrative fish evaluations (Exceptional, Very Good, etc.) were based upon the corresponding IBI and MIwb relative to the drainage area, ecoregion, and the assigned ALU. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support a biotic community.

RM	Stream Name	Total Species	Relative Number	Relative Weight	IBI	MIwb	QHEI
Exceptional							
236.40[H]	SCIOTO R. DST. WALLACE FK. DST HARDIN COUNTY LINE RD (CO RD 311)	25	5672	NA	54	H	61.5
Very Good							
207.26[W]	SCIOTO R. DST. KENTON @ TWP. RD. 199	27	1003.5	46.87	48	10.00	74
36.15[H]	RUSH CREEK DST. RUSHVILLE @ TWP. RD. 110	18	1030	NA	48	H	82
0.55[H]	MCCOY RUN @ RODGERS RD.	20	1874	NA	46	H	53.5
Good							
203.36[W]	SCIOTO R. AT HEPBURN @ CO. RD. 227	24	589.5	28.6	48	8.70	74.5
7.55[W]	RUSH CREEK N OF ESSEX @ SANDERS RD.	29	556	27.01	45	8.48	60.5
226.30[W]	SCIOTO R. SE OF MCGUFFEY, UPST. CO. RD. 130	32	897	40.14	44	8.50	38.5
210.07[W]	SCIOTO R. AT KENTON @ CO. RD. 175	27	1938	24.91	44	9.90	67
234.39[H]	SCIOTO R. W OF ROUNDHEAD @ ARBOGAST RD.	25	1148	NA	44	H	77.5
14.50[W]	RUSH CREEK @ WINNEMAC RD.	24	423	13.51	42	8.12[ns]	79
0.87[H]	KEBLER RUN S OF PROSPECT @ RIVER RD.	20	1004	NA	42	H	83.5
0.08[H]	OTTAWA CREEK @ ST. RT. 257	14	860.77	NA	42	H	79.5
4.43[H]	TAYLOR CREEK S OF KENTON @ TWP. RD. 180	17	962	NA	42	H	80
0.76[H]	TAYLOR CREEK AT KENTON @ ST. RT. 67	21	1906	NA	42	H	65
179.05[W]	SCIOTO R. ADJ. GREEN CAMP RIVER RD.	32	424.25	46.6	40	8.51	71.5
216.67[W]	SCIOTO R. W OF KENTON @ CO. RD. 106	27	306.75	31.66	40	8.36	46
0.51[H]	WOLF CREEK @ TWP. RD. 199	15	408	NA	40	H	59
2.32[H]	SILVER CREEK @ ST. RT. 67	21	882	NA	40	H	74.5
8.91[H]	PANTHER CREEK W OF MT. VICTORY @ TWP. RD. 197	14	1278	NA	40	H	82.5
Marginally Good							
211.50[W]	SCIOTO R. JUST UPST. KENTON WWTP	25	558	6.05	40	8.10[ns]	59
196.12[B]	SCIOTO R. AT LARUE @ ST. RT. 37	23	284	82.49	38[ns]	9.40	53

RM	Stream Name	Total Species	Relative Number	Relative Weight	IBI	MIwb	QHEI
192.21[W]	SCIOTO R. SW OF NEW BLOOMINGTON @ SCHOTTE RD.	24	201.75	16.66	38[ns]	8.20[ns]	61
6.72[H]	WILDCAT CREEK NE OF MT. VICTORY @ TWP. RD. 217	13	664	NA	38[ns]	H	43.5
4.00[H]	WILDCAT CREEK @ TWP. RD. 245	14	936	NA	38[ns]	H	49.5
1.01[H]	DUNLAP CREEK NEAR MOUTH @ END OF LANE, N OFF CO. RD. 130	16	326	NA	36[ns]	H	20.5
0.25[H]	BATTLE RUN AT PROSPECT @ ELM ST.	11	296	NA	36[ns]	H	70.5
Fair							
223.05[W]	SCIOTO R. SE OF MCGUFFEY @ CO. RD. 110	31	490	18.26	43	7.57*	37.5
26.26[W]	RUSH CREEK @ WEST MANSFIELD-MT. VICTORY RD. (CO. RD. 139)	23	860	5.3	43	7.39*	65.5
231.86[W]	SCIOTO R. AT ROUNDHEAD @ MADORY RD.	24	634	15.64	39[ns]	7.49*	79.5
1.20[W]	FULTON CREEK SE OF RICHWOOD @ FULTON CREEK RD. (UPPER)	27	642.25	8.67	39[ns]	7.60*	74
224.20[W]	SCIOTO R. S OF MCGUFFEY @ CO. RD. 65	27	900	11.18	37[ns]	7.59*	32.5
1.80[W]	PANTHER CREEK SW OF HEPBURN @ CO. RD. 219	16	466	1.28	37[ns]	6.86*	71.5
8.80[W]	RUSH CREEK AT ESSEX, UPST ST. RT. 739	20	516.75	74.08	37[ns]	6.26*	61
5.39[W]	RUSH CREEK S OF NEW BLOOMINGTON @ MT. OLIVE-GREEN CAMP RD.	24	302.25	16.69	36[ns]	6.67*	62.5
0.68[H]	COTTONWOOD DITCH DST. MCGUFFY WWTP @ RR BRIDGE	13	396	NA	34	H	18
8.13[H]	ROCK FORK @ MARSEILLES-GALION RD.	10	206	NA	34*	H	35.5
10.35[W]	FULTON CREEK UPST. RICHWOOD @ KINNEY PIKE	19	775	4.01	33*	7.70*	76.5
186.00[W]	SCIOTO R. SE OF NEW BLOOMINGTON @ WTP AT REFUGE	24	235	76.94	32*	7.14*	67
16.3[H]	Fulton Creek upst. Richwood @Miller Rd	13	246	NA	32*	H	27
2.25[H]	PATTON RUN @ BOUNDARY RD.	11	808	NA	32*	H	56
9.17[H]	MCDONALD CREEK UPST. BUCKEYE EGG FARM @ CO. RD. 240	5	216	NA	32*	H	38
0.20[H]	WALLACE FORK @ MOUTH	10	140	NA	32	H	39
2.70[H]	MCDONALD CREEK S OF LARUE @ ST. RT. 37	12	780	NA	32*	H	44.5
39.45[H]	RUSH CREEK UPST. RUSHVILLE @ TWP. RD. 118	14	1126	NA	32*	H	82.5
0.49[W]	WILDCAT CREEK NW OF LARUE @ LARUE-KENTON RD.	23	2212	8.14	31*	7.72*	84.5
7.80[H]	PANTHER CREEK @ ST. RT. 31 ROADSIDE PARK	11	468	NA	30*	H	75
25.59[H]	L. SCIOTO R. @ CALDWELL RD.	14	516	NA	30*	H	40.5
6.82[H]	MCDONALD CREEK SW OF LARUE @ CO. RD. 245	10	1818	NA	30*	H	43
6.24[B]	L. SCIOTO R. @ LANDFILL/TWP. RD. 97-A	18	444	123.93	29	6.72	34.5
Poor							

RM	Stream Name	Total Species	Relative Number	Relative Weight	IBI	MIwb	QHEI
8.70[W]	FULTON CREEK DST. RICHWOOD @ FARM BRIDGE	13	94	0.94	41	5.41*	42.5
11.10[W]	L. SCIOTO R. N OF MARION @ KENTON-GALION RD.	22	200.25	25.01	29*	4.34*	49
0.39[W]	L. SCIOTO R. AT GREEN CAMP @ OWENS-GREEN CAMP RD. (CR 104)	15	154.5	9.32	28	3.98*	45.5
1.25[H]	ELLIOT RUN S OF RICHWOOD @ KINNEY PIKE	6	50	NA	28	H	42
0.55[W]	RUSH CREEK @ LARUE-GREEN CAMP RD.	16	155.25	2.25	28*	5.16*	60
19.70[W]	L. SCIOTO R. @ CRAWFORD-MARION COUNTY LINE RD.	18	414	8.77	27*	5.82*	69.5
9.24[W]	L. SCIOTO R. NW OF MARION @ HILLMAN FORD RD.	15	419.5	3.47	27*	6.26*	73.5
6.50[B]	L SCIOTO R AT MARION, UPST MARION WWTP/DST N ROCKSWALE DITCH	14	371	83.2	26	5.81	31
4.10[H]	COTTONWOOD DITCH DST. ALGER, ADJ. TWP. RD. 100, DST C.R. 35	14	530	NA	26	H	24
1.10[W]	ROCK FORK N OF MARION @ ST. RT. 423	16	786	7.74	25*	6.26*	74
0.01[H]	HONEY CREEK SW OF MARION @ MOUTH	16	327	8.15	24*	H	58.5
0.55[H]	N. ROCK SWALE DITCH W OF MARION @ HOLLAND RD.	6	80	NA	22	H	49
Very Poor							
6.44[W]	FULTON CREEK DST. RICHWOOD, ADJ. FULTON CREEK RD.	8	48	0.65	16*	4.6*	50.5

Narrative ranges and WWH biocriteria (bold) for ECBP ecoregion. Exceptional (EWH biocriteria), very good (EWH nonsignificant departure), poor and very poor evaluations are common statewide. For WWH, the ranges of marginally good and nonsignificant departure are the same.

IBI			MIwb		ICI	Narrative Evaluation
Headwater	Wading	Boat	Wading	Boat	All	
50-60	50-60	48-60	≥9.4	≥9.6	46-60	Exceptional
46-49	46-49	44-47	8.9-9.3	9.1-9.5	42-44	Very Good
Eastern Corn Belt Plains						
40-45	**40**-45	**42**-43	**8.3**-8.8	**8.5**-9.0	**36**-40	Good
36-39	36-39	38-41	7.8-8.2	8.0-8.4	32-34	Marginally Good
28-35	28-35	26-37	5.9-7.7	6.4-7.9	14-30	Fair
18-27	18-27	16-25	4.5-5.8	5.0-6.3	8-12	Poor
12-17	12-17	12-15	0-4.4	0-4.9	≤6	Very Poor

H - Headwater site, MIwb is not applicable.
W - Wading site.
B - Boat site.
a - MIwb is not applicable to headwater streams with drainage areas ≤ 20 mi^2.
c - Attainment status is given for the existing or if a change is proposed then the proposed use designations.
NA - Not applicable
ns - Nonsignificant departure from biocriteria (≤4 IBI or ≤0.5 MIwb units).
* - Indicates significant departure from applicable biocriteria (>4 IBI units, or >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.

Fish Community Trends

Upper Scioto River Main Stem

In 2009, main stem fish communities performed much worse compared to 1995. All IBI scores decreased downstream of Taylor Creek (RM 211.5) in Kenton to Schotte Road (RM 192.21) as a result of the multiple documented fish kills before and during the sampling index period (Table 8). After Durez resumed proper treatment and the spilled solids were removed from Taylor Creek, the downstream fish communities were given two years to recover before follow-up sampling was conducted in the main stem (RM 211.5 – 192.2) and lower Taylor Creek (RM 0.76) in 2011. Significant increases in IBI scores occurred at each follow-up site and the fish fully met WWH biocriteria (Figure 1). After recovery in 2011, improvements made to the Kenton WWTP were evident in the fish community immediately downstream at RM 207.26; IBI scores increased from 38 (Marginally Good) in 1995 to 48 (Very Good) in 2011.

Upper Scioto River Tributaries

Eleven sites on five upper Scioto River tributaries were historically sampled prior to 2009. Linear comparisons of the historical IBI scores and the 2009 IBI scores have been plotted in Figure 18. One of the five tributaries, McDonald Creek, displayed overall improvements from historical IBI scores and fish community performance. Overall, fewer numbers of tolerant fish were caught at all three sites on McDonald Creek, suggesting improved water quality conditions throughout McDonald Creek (Appendix B-1). Three tributaries, Little Scioto River, Wildcat Creek and Panther Creek, showed IBI decreases at one site each.

The upper sample site on the Little Scioto River (RM 9.2) decreased in fish community quality and IBI score in just two years going from 32 to 27. The lower site performed the same between 2007 and 2009, scoring an IBI of 25 both years. Similarly, both Wildcat and Panther Creeks showed decreases in fish community performance and IBI score at their respective lowermost sampling sites.

Taylor Creek displayed full recovery from the fish kills between 2009 and 2011at RM 0.8 (Figure 18). The fish community was very poor in 2009 (average IBI=14). Two sampling passes were completed on Taylor Creek during 2009 to see if conditions had improved between July and August. Four species totaling 21 fish were found in the 150m sampling zone on July, 28th (IBI=16). Almost one month later on August 20th only three fish, all blackstripe topminnows *Fundulus notatus*, were caught indicating conditions had not yet improved (IBI=12) (Appendix C-1).

Durez Corporation resumed treatment after the fish kills were investigated in 2009 in compliance with their permit. Follow-up sampling in 2011 resulted in a catch of 20 species and 953 total fish. The 2011 IBI (42) was identical to the historical score from 1995 indicating full recovery.

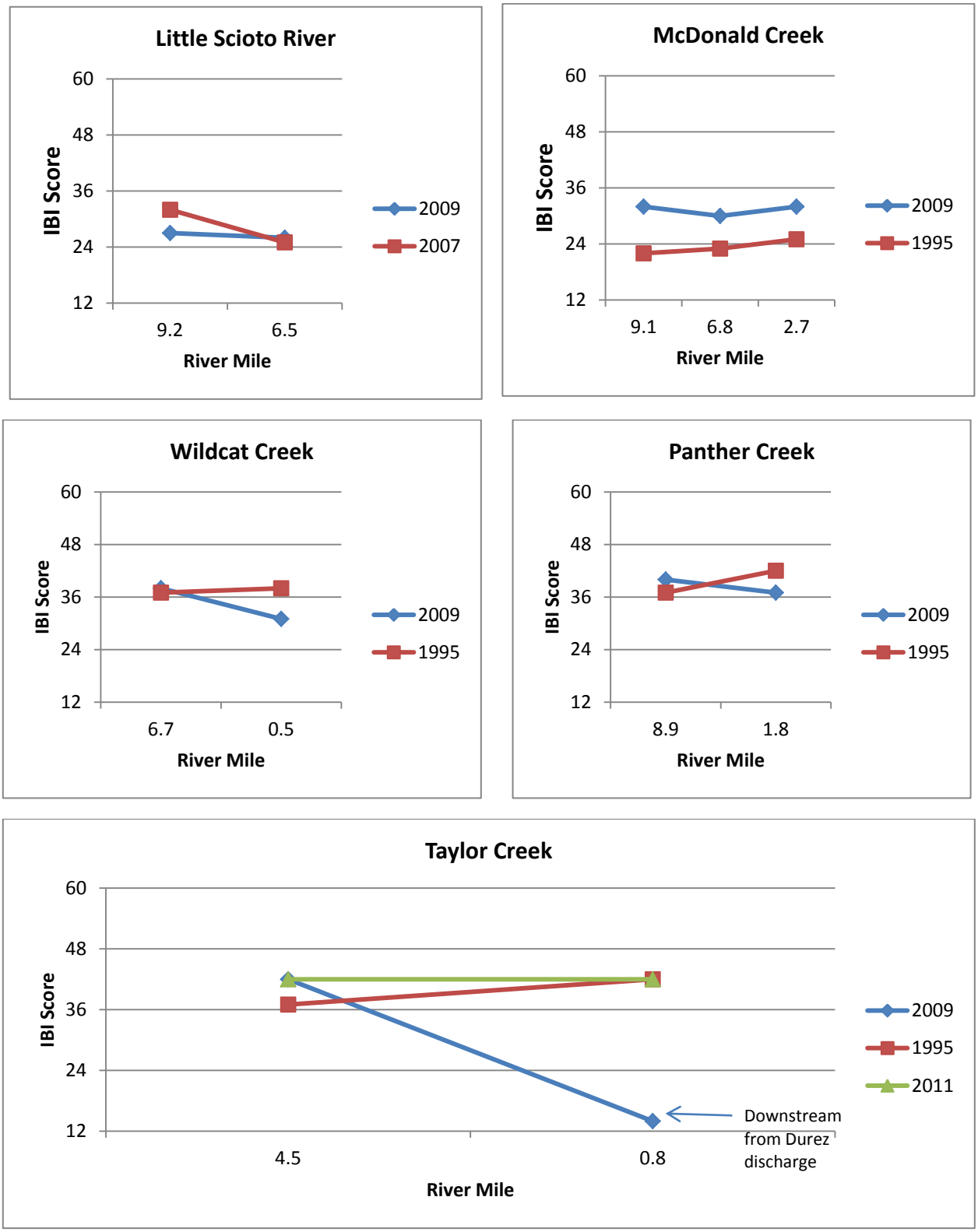

Figure 18. Upper Scioto River tributary IBI trends listed by tributary and river mile, 1995-2009.

Macroinvertebrate Community

Macroinvertebrates were sampled at 14 locations along the upper Scioto River main stem in 2009, from its headwaters in Logan County near Roundhead to the confluence with the Little Scioto River in Marion County (RM 234.39-179.05). In addition, 21 upper Scioto River tributaries were sampled at 48 locations (Table 1 and Figure 3). Big Swale Creek, a tributary to Rush Creek, was visited but not sampled due to stream desiccation. Qualitative sampling was conducted at all sampling sites while quantitative, Hester/Dendy artificial substrate samplers were retrieved from 27 sites along the Scioto River main stem, Fulton Creek, Little Scioto River, Rock Fork, Rush Creek, McDonald Creek, Wildcat Creek, Taylor Creek, and Cottonwood Ditch. Artificial substrate sampling was restricted to sites with drainages greater than 20 $mi.^2$ and regional reference sites. A summary of the macroinvertebrate data are presented in Table 14 while raw macroinvertebrate data are presented in Appendix D-1. Sampling locations were evaluated using Warmwater Habitat or Modified Warmwater Habitat biocriteria based on the current or recommended aquatic life use designation.

During the 2009 survey, a toxic pollutant spill from the Durez Corp. near Kenton impacted biological communities in lower Taylor Creek (fish and macroinvertebrates) and the Scioto River main stem (fish). A fertilizer spill near Rushville also impacted communities in Elliot Run, a tributary to Fulton Creek. As a result, five selected sites in the affected streams were resampled during the summer of 2011 to evaluate trends. These results are highlighted and included in Table 14.

In 2009, Scioto River main stem sites achieved the applicable WWH macroinvertebrate biocriterion at all sites evaluated. The average ICI score (44.8) was generally reflective of good to very good biological quality. The most upstream and downstream main stem sites were sampled using only qualitative methods due to small stream size (upper) and loss of artificial substrate samplers (lower). Narrative descriptions for both sites documented good quality communities.

Main stem sites bracketing Taylor Creek (confluence RM 213.07) and the Durez Corp. spill found no discernible impacts extending downstream into the Scioto River. The nearest upstream "control" site at RM 216.67 was largely pooled and sluggish. As a result, most biological water quality indicators (e.g., ICI score, EPT and sensitive taxa richness) actually increased downstream from Taylor Creek at RM 211.5 (Table 14). Fewer freshwater mussel species were found at RM 211.5 in 2009 and 2011 (3 and 4, respectively) compared to seven in 1995 (Table 15) but this could not be directly linked to the spill. As evidence, numerous live specimens of the pollution sensitive Threeridge mussel (Amblima plicata) were found just weeks after the incident in 2009 and again during 2011 resampling.

Further downstream, macroinvertebrates maintained good quality immediately below the Kenton WWTP (ICI = 40 at RM 210.07), then gradually improved with increased distance downstream, and communities maintained good to exceptional quality from Kenton to the

Little Scioto River confluence at Greencamp (RM 207.6-179.05). Resampling of three Scioto main stem sites in 2011 between Taylor Creek and Hepburn (RM 211.5, 210.07, and 203.36) found conditions similar to 2009 with no additional or lingering influences from the Druez spill.

Scioto River Main Stem Trends

Compared to historical collections from the upper main stem in 1995 (Ohio EPA 1996), 2009 sampling suggest little change in quality over the period (Table 13 & Figure 19). Excluding RM 216.67, ICI scores from seven duplicated main stem sampling sites averaged 46.0 and 48.3 during the 2009 and 1995 surveys, respectively. Both ICI averages fell in the lower exceptional range and both were within the range of acceptable variability (*i.e.,* ±4 ICI points) for the index. A large, 22 point difference in ICI scores was encountered at RM 216.67 (34 in 2009 vs. 56 in 1995), several miles upstream from Kenton. However, the lower score was considered largely a function of pooled habitat conditions and slow current velocity over the artificial substrates, not a significant decline in water quality. A slightly different sampling location in 1995 offered riffle habitats and swifter current velocities that were not reproduced in 2009. Like the ICI trend, slightly fewer total taxa were found at 2009 sites but the difference was not considered significant. Overall, macroinvertebrate community performance throughout the upper main stem was similar between surveys. Both stream studies represented a substantial improvement over the earliest monitoring survey in 1984 (Figure 19).

Table 13. *Average ICI scores and total taxa richness from seven similar upper Scioto River main stem sites in the 1995 and 2009.*

Year	ICI	Total Taxa Per Site
2009	46.0	72.1
1995	48.3	81.6

Upper Scioto River Tributaries

Macroinvertebrates fully achieved biological integrity goals for applicable WWH and MWH uses at 26 of 48 (54.2%) tributary sampling sites. However, out of the 26 attaining sites, only one (upper Rush Creek RM 26.26) reached the exceptional range and most (65.4%) fell in the upper fair or marginally good ranges. Both narrative categories mark the minimum levels of attainment for the MWH and WWH use designations, respectively. Survey results show the large majority of upper basin tributaries were either impaired or reflected performance levels barely exceeding acceptable levels. Higher quality tributary sites were mostly restricted to the upper Rush Creek basin, a localized area with greater relief, rolling topography, and sustained

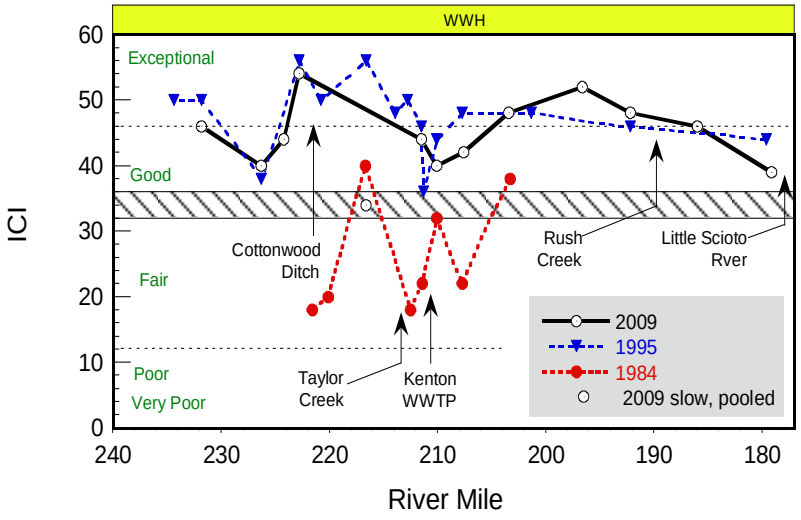

Figure 19. ICI scoring trends in the upper Scioto River, 1984-2009.

groundwater flow. The Rush Creek headwaters abut the Bellefontaine outlier, a small erosional remnant that includes the highest point in Ohio (http://www.dnr.state.oh.us/portals/10/pdf/BG-1_8.5x11.pdf).

High quality tributaries were rarely encountered in the upper Scioto River basin and a majority of samples reflected degraded or marginal quality. Throughout the study area, channelization and nutrient enrichment associated with agriculture were considered the most common and widespread stressors at these lower quality sites. In the macroinvertebrates, the deleterious effects of these activities were manifest in low total taxa, few EPT taxa, and low sensitive taxa richness, and a predominance of facultative, nutrient and silt tolerant populations (Table 14). These mostly facultative populations included a number of flatworms, blackflies, midges and riffle beetles, along with several common varieties of baetid mayflies (e.g., *Baetis intercalaris*) and net-spinning caddisflies (e.g., *Cheumatopsyche* sp*, Hydropsyche depravata* group). Tributaries that were primarily impacted by agricultural stressors included Wildcat Creek, McDonald Creek, Honey Creek, Panther Creek RM 1.8 (also influenced by low flow), and the upper reaches of the Little Scioto River (RMs 25.6-19.7), Fulton Creek (RM 16.3) and Rock Fork (RM 8.13, in part).

Localized, and often more severe impacts, were encountered near discharges of poorly treated or untreated sewage from septic tanks (McCoy Run), and combined sewer overflows [North Rockswale Ditch, Little Scioto River RM 6.50 and 6.24 (Figure 20)], fertilizer or manure spills (Elliot Run, upper Rock Fork), toxic pollutant spills (lower Taylor Creek) and sediment contamination (*i.e.,* residual creosote at Little Scioto River RM 0.39). Little Scioto River samples from RM 6.50 and 6.24 were also influenced, to a lesser degree, by recent channelization and construction activity associated with removal of contaminated sediments. Given the degraded conditions upstream at RM 6.5, no discernible impacts were attributed to the Marion WWTP discharge at RM 6.3. Fulton Creek RM 9.2 sampling reflected an obvious enrichment influence immediately downstream from the Richwood WWTP, including high densities of flatworm and very low EPT and sensitive taxa richness. However, the ICI score of 32 met minimum WWH standards.

Figure 20. The large, Holland Rd. flap gate CSO on North Rockswale Ditch (RM 0.5) in Marion. The periodic discharge impacted the ditch and the Little Scioto R. downstream.

In addition to chemical and sewage impacts, late summer low flows and stream intermittence contributed to impairment in Wolf Creek, Silver Creek, Panther Creek RM 1.8, and portions of lower Rush Creek. As mentioned previously, Big Swale Creek was not sampled because the channel was dry. Impounded flow behind a large log jam at Rush Creek RM 8.8 also contributed to localized macroinvertebrate impairment.

Upper Scioto River Tributary Trends

Historical macroinvertebrate sampling has been conducted in many 2009 upper Scioto River basin tributaries since 1984 and sampling in the Little Scioto River main stem dates back to 1974. Depending on stream size, available resources and other factors, tributary samples were collected using either artificial substrate (quantitative) or natural substrate (qualitative) collections (a qualitative sample was included at every quantitative site). As a result, specific analysis of ICI scoring trends was often complicated by the differences in sampling methodology. In addition, inadequate current velocities over the samplers and differences in stream flows from site to site or year to year contributed to sample variability. These factors were often exacerbated at tributary sites by their smaller drainage, local geology, and the tendency of heavily tiled agricultural streams to dry up during the late summer. For all the reasons above, discussions of trends often stress the qualitative results since this sampling was consistently conducted at each site, regardless of methodology.

Fulton Creek

Fulton Creek macroinvertebrates were sampled in 1985 and 2009 between RM 10.4 and RM 1.2, and at RM 10.4 in 1999. Direct comparisons between the results were complicated by differences in sample methods. Artificial substrate quantitative sampling was collected in 1999 and at most 2009 sites while only qualitative sampling was conducted in 1985.

Upstream from Richwood at RM 10.4, natural substrate communities have improved steadily since 1985, as evidenced by steady increases in EPT and sensitive taxa richness in 1999 and 2009. ICI scores were in the good or marginally good ranges in both 1999 and 2009, despite insufficient current speeds over the artificial substrates.

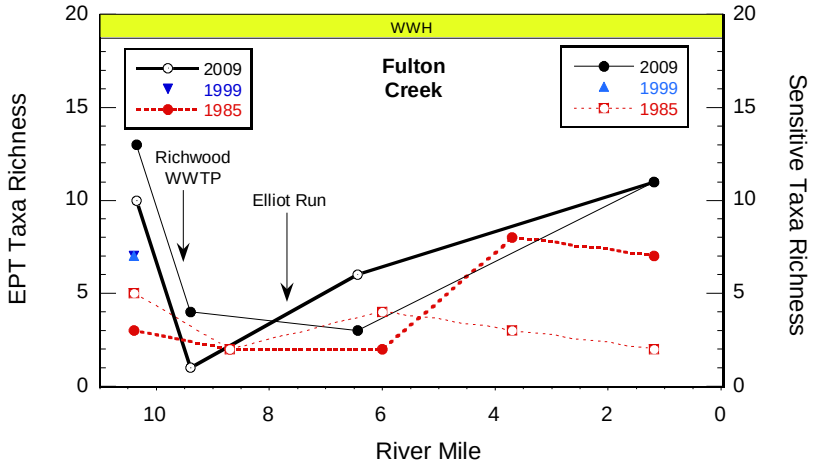

Figure 21. Qualitative EPT and sensitive taxa richness trends in Fulton Creek, 1984-2009.

Downstream from the Richwood WWTP (RM 9.5), Fulton Creek ICI scores maintained at least marginally good quality in 2009. However, aspects of the natural substrate community, particularly EPT and sensitive taxa richness, experienced sharp declines and reflected lower performance. A similar declining trend was also observed in 1985 (Figure 21), with narrative evaluations ranging from fair to marginally good. Given the optimal colonizing surface afforded by the artificial substrate samplers and exposure to adequate current velocities, lower Fulton Creek macroinvertebrates were able to maintain minimum WWH performance levels in 2009. However, natural substrate

communities in the same reach continued to suggest degraded conditions during all sampling years. In addition to channelization, urban runoff, and the Richwood WWTP, a 2009 fertilizer spill in Elliot Run (confluence RM 7.67) may have also influenced Fulton Creek communities at downstream sampling locations.

Little Scioto River

Numerous macroinvertebrate sampling surveys have been conducted in the lower 9.2 miles of the Little Scioto River, originally beginning in the 1970s and continuing between 1987 and 2007 (Ohio EPA 1994, 2008). Historically, the lower stretch of North Rockswale Ditch and the lower 6.55 miles of the Little Scioto were severely contaminated by creosote from the abandoned Baker Wood Preserving Co. property located just east of North Rockswale Ditch. The company likely used creosote, petroleum, and solvents to preserve railroad ties and other wood products between the 1890s and 1960s (http://costperformance.org/monitoring/pdf/3_bakerwo.pdf). This section of the river was already historically channelized but, between 2002 and 2006, additional modification occurred from RM 6.8 to 6.0, as part of a contaminated sediment remediation project. Contaminated sediments in this reach were physically removed and the river channel was backfilled with replacement substrates of clean clay (Ohio EPA, 2008).

Upstream from Marion at Little Scioto River RM 9.2, Ohio EPA has documented consistently good to exceptional macroinvertebrate quality. Downstream, severely degraded communities were consistently encountered in the channelized, creosote contaminated reach between North Rockswale Ditch and the mouth (Ohio EPA 1994, 2008). The most recent, 2009 survey continued to reflect poor performance within the restored, downstream reach (RM 6.5 and 6.24). However, this was largely attributed to the recent re-channelization and a large combined sewer overflow just upstream on North Rockswale Ditch (Figure 20). The restored section of the river has obviously improved aesthetically and chemically, as the enormous volume of creosote and sheens that once welled up from the bottom were eliminated. However, creosote contamination remains a major problem in the lower, un-restored section of the creek, including sampling sites at RM 0.39 in 2009 and RM 5.7, 4.4, and 2.7 in 2007 (Ohio EPA, 2008).

Rush Creek

Historical macroinvertebrate results from Rush Creek were limited to a regional reference site sampled at RM 5.4 in 1985, 2005 (USGS sampling) and 2009 and at RM 4.2 in 1999. ICI scoring trends over the same period were somewhat ambiguous as a result of slow or non-detectable current velocities over the

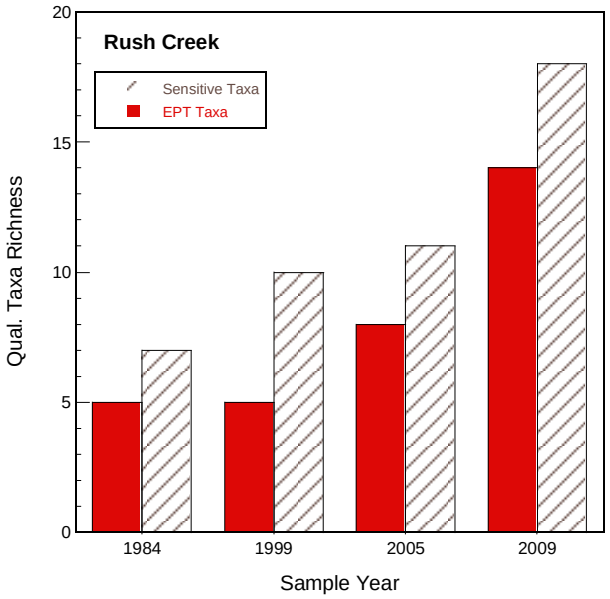

Figure 22. Qual. EPT and sensitive taxa richness in Rush Creek,1984-2009.

artificial substrates, site variability, and stream intermittence. Qualitative sample comparisons were more straight-forward and the steady increases in EPT and sensitive taxa richness reflects improved quality since 1984 (Figure 22).

McDonald Creek

Macroinvertebrates were collected at two to three sites between RM 9.2 and 2.7 in 1995, 1998, 1999 and 2009. The Ohio Fresh Egg farm began production following the 1995 survey.

Excepting one sample in 1995, all McDonald Creek sampling sites were in the lower fair or poor ranges and none met the existing WWH, or even lower, MWH performance standards. Since 1998, all sampling has documented poor quality, enriched conditions and slightly worse quality than first observed in 1995.

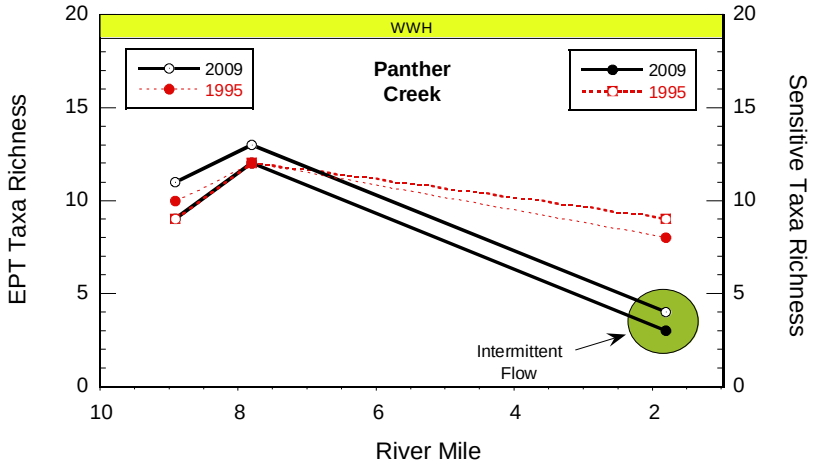

Figure 23. Qualitative EPT and sensitive taxa richness trends in Panther Creek in 1995 and 2009.

Wildcat Creek

Two Wildcat Creek sites were sampled at RM 6.7 and 0.5 in 1995 and 2009. Conditions were virtually identical during each survey with fair quality at RM 6.7 and good quality near the mouth.

Panther Creek

Panther Creek was sampled at three sites between RM 8.9 and 1.8 in both 1995 and 2009. Community composition and water quality conditions at the upstream sites were similar and fell in the good or marginally good ranges. However, communities declined at RM 1.8 from marginally good to fair between surveys **(**Figure 23). The lower quality was primarily attributed to background agricultural stressors and intermittent flow conditions due to a lack of rain.

Taylor Creek

Taylor Creek has been surveyed on three occasions between RM 4.4 and 0.7 in 1984, 1995 and 2009. Station RM 4.4 was upstream from Kenton, the Durez Corp. (RM 2.1; formerly Occidental Chemical Corp.), and the former Rockwell International discharge (RM 1.35 and 1.26). Macroinvertebrate performance ranged

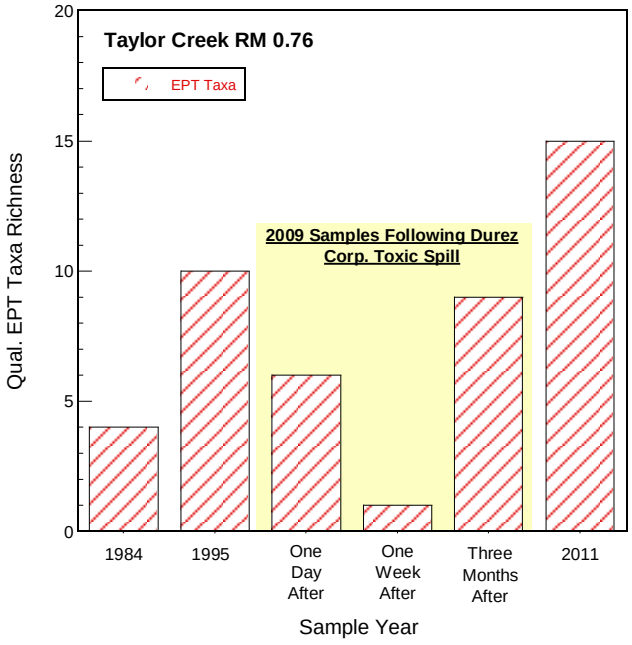

Figure 24. Qual. EPT taxa richness trends at Taylor Creek RM 0.76, 1984-2011. Multiple samples collected in 2009 followed a July 30 toxic spill at Durez Corp (RM 2.1).

from good, to exceptional, to good in 1985, 1995 and 2009, respectively. While all samples met WWH standards, a specific reason for the decline between 1995 and 2009 is unknown. Both sensitive and EPT taxa richness were cut nearly in half, indicating a significant change in quality.

Further downstream, the strong improving trend observed at RM 0.76 between 1984 and 1995 was negated by a toxic industrial spill from Durez Corp in 2009. Sampling conducted in the days immediately following the spill found very poor quality and elimination of most EPT taxa (Figure 24). Dead fish and the remnants of dead or decomposing macroinvertebrates were observed. Resampling at RM 0.76 in October 2009 found improved quality (ICI=22/fair) but incomplete recovery. Additional sampling in 2011 verified full recovery and exceptional quality communities (ICI=48). Freshwater mussels were not found in lower Taylor Creek in 1995 or immediately following the 2009 spill in late July and August (Table 15, pg.82). However, live Fatmucket specimens (*Lampsilis radiata luteola*) were found in October 2009 and again in 2011.

While not considered a significant source of impact, a large grey-water discharge that was first noted at SR 68 (RM 1.4) in 1984, continued to visibly discharge in 2009 and 2011 (Figure 25). A thick layer of sewage solids blanketed the stream bottom immediately downstream from the collective, home septic system discharge.

Figure 25. A grey-water discharge from home septic systems in Kenton at Taylor Creek RM 1.4 (SR 68) in Kenton. The effluent was first observed in 1984 and continued in 2009 and 2011.

Silver Creek

Sampling at the RM 2.3 regional reference site in 1984, 1995 and 2009 revealed variable quality related to stream flow. Between 1984 and 1995, community health improved from fair to good as evidenced by substantial increases in EPT taxa (from 3 to 13) and sensitive taxa (from 2 to 17). However, conditions in 2009 returned to fair with declines in EPT (3) and sensitive taxa (6) richness to near 1984 levels. Late summer intermittent flow conditions in both 2009 and 1984 were the suspected cause of decline. In contrast, 13 EPT and 17 sensitive taxa were found in 1995 under continuous flow conditions.

Cottonwood Ditch

Like Taylor and Silver creeks, Cottonwood Ditch was surveyed in 1984, 1995 and 2009. Two sites bracketing the McGuffey WWTP (RM 1.1) were sampled during each year. Excepting the 1984 sample from RM 0.7, all samples met the existing MWH designation. Increases in EPT and sensitive taxa richness downstream from the WWTP (from 0 in 1985 to 7 and 8, respectively, in 2009, respectively) suggest a significant improvement in effluent quality.

Table 14. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in the upper Scioto River basin study area, July to October, 2009 and July 2011[#].

River	RM[a]	D.A.[b]	Qual[c] Taxa	Sens.[d] Taxa Ql./Total.	EPT Ql./Total	Density[e] Ql. or Qt.	ICI	Predominant Populations on the Natural Substrates (Tolerance Categories = sensitive, facultative, tolerant)[d]
Exceptional								
Scioto River	231.80	28	65	23 / 32	14 /14	949	46	Baetid mayflies, net-spinning caddisflies (facultative)
Scioto River	222.80	67	60	21 / 29	16 / 23	340	54	Snailcase caddisflies, square-gill mayflies (facultative); water boatmen (tolerant)
Scioto River	203.36	223	51	20 / 30	16 /21	1716	48	Tanytarsini midges, riffle beetles (fac.), caddisflies, (sensitive)
Scioto River	203.36	223	50	25	17	Mod.	--	Mayflies (fac.- sens.); net-spinning caddisflies (facultative)
Scioto River	196.60	258	38	13 / 24	13 / 19	2087	52	Mayflies (fac.- sens.), red midges (sens.- tolerant)
Scioto River	192.20	262	38	15 / 22	12 / 15	312	48	Mayflies (fac.- sens.), red midges (sens.- tolerant)
Scioto River	186.00	379	40	10 / 22	11 / 15	167	46	Mayflies (fac.- sens.), riffle beetles (facultative) *[Slow/pooled]*
Rush Creek	26.26	25.7	50	22 / 35	17 / 20	422	48	Baetid mayflies, net-spinning caddisflies (facultative); hemoglobin utilizing midges (facultative-sensitive)
Taylor Creek	0.76	16.3	44	12 / 20	15 / 16	229	48	Baetid mayflies (facultative) *[3 months after toxic spill]*
Very Good								
Scioto River	224.20	62	41	10 / 21	8 / 13	401	44	Net-spinning caddisflies (facultative)
Scioto River	211.50	162	57	23 / 28	21 / 22	330	44	Net-spinning caddisflies (facultative)
Scioto River	211.50	162	57	25	22	Mod.	--	Mayflies (fac.- sens.); net-spinning caddisflies (facultative)
Scioto River	207.60	178	56	23 / 30	18 / 23	1975	42	Baetid mayflies, midges (fac.); aquatic moth larvae (sensitive)
Rock Fork	1.1	23.1	43	13 / 20	16 / 16	Mod.	44	Baetid mayflies (facultative), other mayflies (fac.- sensitive)
Rush Creek	36.15	14.8	49	23	16	High	--	Brush legged mayflies (sensitive); baetid mayflies, net-spinning caddisflies (facultative)
Good								
Scioto River	234.30	18	54	10	13	Mod.	--	Net-spinning caddisflies, baetid mayflies (facultative)
Scioto River	226.30	49	39	10 / 18	10 / 12	368	40	Net-spinning caddisflies (facultative)
Scioto River	210.07	170	58	21 / 28	13 / 16	368	40	Baetid mayflies, flatworm, net-spinning caddisflies (fac.)
Scioto River	210.07	170	43	15	18	Mod.	--	Mayflies (fac.- sens.); water mites (facultative)
Scioto River	179.05	407	46	11	12	Mod.	--	Baetid mayflies, net-spinning caddisflies (fac.) *[Slow/pooled]*
Fulton Creek	10.35	24.9	46	13 / 19	10 / 12	325	38	Baetid mayflies, midges (facultative)
Fulton Creek	6.44	40	21	3 / 9	6 / 8	258	38	Baetid mayflies, scuds (facultative)
Kebler Run	0.87	14.3	61	14	15	High	--	Baetid mayflies, flatworm, riffle beetles (facultative); case building caddisflies (sensitive)
Ottawa Creek	0.08	8.0	47	16	16	High	--	Baetid mayflies, blackflies (fac.); fingernet caddisflies (sens.)
Wildcat Creek	0.49	22.2	40	9 / 21	10 / 13	525	40	Baetid mayflies (facultative); water boatmen (tolerant)
Rush Creek	39.45	11.8	63	23	13	Mod.	--	Net-spinning caddisflies (fac.), baetid mayflies (fac.-sensitive)

River	RM[a]	D.A.[b]	Qual[c] Taxa	Sens.[d] Taxa Ql./Total.	EPT Ql./Total	Density[e] Ql. or Qt.	ICI	Predominant Populations on the Natural Substrates (Tolerance Categories = sensitive, facultative, tolerant)[d]
Good (continued)								
Rush Creek	5.39	77.0	54	18 / 26	14 / 17	198	38	Baetid mayflies (facultative-sensitive)
Taylor Creek	4.43	12.7	45	12 / 23	13 / 16	383	26**	Fingernet caddisflies (sensitive), flatworm (facultative)
Marginally Good								
Scioto River	216.67	117	43	15 / 26	9 / 12	628	34[ns]	Mussels (sensitive), mayflies (facultative-sensitive)
Fulton Creek	9.40	28.2	29	4 / 9	1 / 5	399	32[ns]	Flatworm (facultative)
Fulton Creek	1.20	46.4	41	11	11	Mod.	--	Net-spinning caddisflies, scuds (facultative)
Battle Run	0.08	9.4	36	7	9	Mod.	--	Flatworm, riffle beetles, baetid mayflies (facultative)
Patton Run	2.30	14.4	45	16	12	High	--	Baetid mayflies, riffle beetles (facultative)
Little Scioto River	11.11	47.0	37	11	11	High	--	Baetid mayflies (facultative)
Little Scioto River	9.24	73.0	51	16 / 27	12 / 15	224	32[ns]	Baetid mayflies (facultative); fingernet caddisflies (sensitive)
Rush Creek	14.5	50.0	38	9	8	Mod.	--	Flat-headed mayflies, riffle beetles (facultative); hemoglobin utilizing midges (sensitive- tolerant) *[Intermittent flow]*
Rush Creek	7.55	74.0	45	10 / 14	10 / 10	262	34[ns]	Midges (facultative-sensitive); net-spinning caddisflies, baetid mayflies (facultative)
Wildcat Creek	4.00	8.4	50	12	9	Mod.	--	Baetid mayflies, flatworm (facultative)
Panther Creek	8.91	7.1	45	9	11	Mod.	--	Flatworm, riffle beetles, net-spinning caddisflies (facultative)
Panther Creek	7.80	11.0	40	12	13	Low	--	Net-spinning caddisflies, flatworm (facultative) *[Intermittent]*
Cottonwood Ditch	0.68	19.3	44	8 / 12	7 / 9	816	32[ns]	Flatworm, fingernail clams (facultative)
High Fair Range (exceeds MWH expectations - applied to MWH designated streams)								
Elliot Run	1.25		44	4	9	Mod.	--	Square-gill mayflies, isopods (fac.); water boatmen (tolerant) *[2 years after fertilizer spill]*
Cottonwood Ditch	4.10	11.3	38	4	6	Mod.	--	Baetid mayflies, flatworm (facultative)
Dunlap Creek	0.10	8.9	23	5	4	Mod.	--	Damselflies (tolerant); riffle beetles (facultative)
Wallace Fork	0.20	4.8	35	9	8	High	--	Square-gill mayflies (facultative); physid snails (tolerant)
Fair								
Little Scioto River	25.60	12.8	38	6	9	Mod.	--	Flatworm, riffle beetles (fac.), snailcase caddiflies (sens.),
Little Scioto River	19.70	33	42	10	7	Low	--	Flatworm (facultative), leeches (tolerant)
Honey Creek	0.10	7.3	40	8	7	Mod.	--	Baetid mayflies, blackflies (facultative)
Rock Fork	8.13	7.6	41	1	7	High		Physid snails (tolerant) *[Manure spill 1 year earlier]*
Rush Creek	8.80	74.0	42	10 / 9	11 / 9	450	26*	Midges (fac.-sens.); net-spinning caddisflies (facultative)
Rush Creek	0.55	105	39	8 / 22	9 / 17	329	28*	Baetid mayflies (facultative); water boatmen (tolerant)
Wildcat Creek	6.72	4.3	32	3	7	Mod.	--	Flatworm, baetid mayflies, tanytarsini midges (facultative)
Panther Creek	1.80	22.3	31	3	4	Low	--	Flatworm (facultative), hemoglobin utilizing midges (fac.-tol.)
Wolf Creek	0.51	12.0	30	3	4	Low	--	Hemoglobin utilizing midges (sensitive-tolerant), net-spinning caddisflies (facultative) *[Interstitial flow]*

River	RM[a]	D.A.[b]	Qual[c] Taxa	Sens.[d] Taxa Ql./Total.	EPT Ql./Total	Density[e] Ql. or Qt.	ICI	Predominant Populations on the Natural Substrates (Tolerance Categories = sensitive, facultative, tolerant)[d]
Fair (continued)								
Taylor Creek	0.76	16.3	38	4 / 10	9 / 10	161	22*	Baetid mayflies (facultative) *[3 months after toxic spill]*
Silver Creek	2.32	11.3	33	6	3	Low	--	Net-spinning caddisflies (sensitive), hemoglobin utilizing midges (sensitive-tolerant) *[Interstitial flow]*
McCoy Run	0.55	8.0	41	7	9	Mod.	--	Physid snails (tolerant), flatworm (fac.) [*dst. septic discharge]*
Low Fair Range (does not meet MWH expectations - applied to MWH designated streams)								
Little Scioto River	0.39	113	25	2	4	Low	--	Water boatmen (tolerant)
Poor								
Fulton Creek	16.30	12.5	35	2	3	Mod.	--	Scuds (facultative); water boatmen (tolerant)
Elliot Run	1.25	2.5	33	2	3	Mod.	--	Midges, (facultative- tolerant); damselflies, mayflies (tolerant)
Little Scioto River	6.50	86	30	1 / 1	2 / 2	893	10*	Water boatmen, hemoglobin utilizing midges (tolerant)
Little Scioto River	6.24	86	34	1 / 1	4 / 4	939	12*	Water boatmen, hemoglobin utilizing midges (tolerant))
McDonald Creek	9.17	2.6	26	2	3	Mod.	--	Physid snails, leeches (tolerant)
McDonald Creek	6.82	6.3	28	2	2	High	--	Flatworm (facultative)
McDonald Creek	2.7	12.3	26	0	2	Mod.	--	Flatworm, net-spinning caddisflies, riffle beetles (facultative)
Very Poor								
N. Rockswale Ditch	0.55	6.9	22	0	3	Low	--	Physid snails, leeches, (tolerant) *[dst. CSO]*
Taylor Creek	0.76	16.3	20	3	1	Low	--	Physid snails, diving beetles (tolerant) *[1 wk after toxic spill]*

Selected sites resampled in July 2011 are shaded in tan.

[a] RM = River Mile

[b] D.A. = Drainage Area in mi^2

[c] Ql.: Qualitative sample collected from the natural substrates.

[d] Tolerance descriptors are derived from Ohio EPA macroinvertebrate taxa tolerance categories. "Sensitive" includes *Intolerant* and *Moderately Intolerant* taxa. "Tolerant" includes taxa listed as *Very Tolerant*, *Tolerant*, and *Moderately Tolerant*.

[e] Ql. = Qualitative sample. Qualitative sample relative density: Low, Mod. = Moderate, High;

Qt = Quantitative sample collected on Hester-Dendy artificial substrates; Quantitative density is expressed as organisms collected per square foot of artificial substrate.

ns - Nonsignificant departure from biocriteria (<4 ICI units).

* - Indicates significant departure from applicable biocriteria (>4 ICI units). Underlined scores are in the Poor or Very Poor range.

Table 15. Distribution of freshwater mussel (Unionidae) species collected live or fresh dead in selected reaches of the upper Scioto River main stem (headwaters to Little Scioto River) and Taylor Creek RM 0.76 during the 1995, 2009*, and 2011 sampling efforts.

Scioto River and Taylor Creek:	**Hdwtrs. to Dunlap Cr. RM 234.4-226.3**		**Dunlap Cr. to Taylor Cr. RM 222.8-213.9**		**Taylor Cr. to Kenton WWTP RM 212.8-211.5**		**Kenton WWTP to Rush Cr. RM 211.4-201.3**		**Rush Cr. to L. Scioto R. RM 201.3-179.05**		**Taylor Cr. RM 0.76 Dst. Durez**		
Sample Year:													
Taxa	**1995**	**2009**	**1995**	**2009-11**	**1995**	**2009-11**	**1995**	**2009-11**	**1995**	**2009-11**	**1995**	**July-Aug. 2009**	**Oct. 2009 - July 2011**
Alasmidonta marginata			X	X		X		X-X					
Amblema plicata			X	X-X	X	X-X	X	X					
Anodontoides ferussacianus			X				X						
Elliptio dilatata							X						
Fusconaia flava			X	X	X								
Lampsilis cardium				X				X-X					
Lampsilis radiata luteola			X	X-X	X	X-X	X	X-X	X				X-X
Lampsilis ventricosa			X										
Lasmigona complanata			X	X	X		X	X-X	X				
Lasmigona costata			X	X	X		X	X-X					
Letodea fragilis				- - X		- - X							
Ptychobranchus fasciolaris [a]			X										
Pyganadon grandis			X	- - X	X	- - X	X	- -X	X	X			
Strophitus undulatus			X		X		X	X					
Utterbackia imbecillis								- - X					
Number of Sites	**2**	**3**	**4**	**3**	**2**	**1-1**	**5**	**5-2**	**2**	**2-na**	**1**	**1**	**1-1**
Total	**0**	**0**	**11**	**7-4**	**7**	**3-4**	**8**	**7-6**	**3**	**0-na**	**0**	**0**	**1-1**

* One to four freshwater mussels species were also collected at other 2009 upper Scioto tributary stations including Wildcat Creek RM 4.0 and 0.49, Rush Creek RM 8.8 and 5.39, Rock Fork RM 1.1, and Little Scioto River RM 19.7 and 9.24. The species are listed on the Macroinvertebrate Collection sheets by site in Appendix D-1.

[a] State listed Species of Concern.

Chemical Water Quality

Surface water chemistry samples were collected from 58 sites in the upper Scioto River Watershed (Table 1). All sites were sampled a minimum of five separate occasions, typically at two week intervals, from June 2009 to August 2009. In addition, 12 sentinel sites located throughout the watershed were sampled more frequently (typically monthly) from January 2009 to November 2009. Samples were analyzed for a variety of parameters including bacteria, nutrients and metals. Sites were sampled from free-flowing sections of streams and were primarily collected from bridge crossings. Surface water samples were collected in appropriate containers, preserved and delivered to Ohio EPA's Division of Environmental Services (DES) Laboratory or Alloway (Marion) environmental testing lab for analysis. Sample collection followed the methods as outlined in Parts I and II of the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio EPA, 2009).

For analysis of water chemistry results, many graphs are provided with dotted lines representing Ohio EPA water quality criteria, target values or percentile concentrations from least impacted regional reference sites of similar size (Ohio EPA 1999). Statistical data were segregated by ecoregion and further stratified by three ranges of stream and river sizes for these analysis as follows: headwater streams (0-20 mi^2); wadeable streams (20-200 mi^2); and small rivers (200-1000 mi^2).

Generally, chemistry water quality sampling was conducted to capture a wide variety of stream flow conditions. Data from the United States Geological Survey (USGS) gage station near Prospect, Ohio was examined to show flow trends in the upper Scioto Watershed during the 2009 survey (Figure 26). Dates when surface water chemistry samples were collected during the summer of 2009 are noted on the graph. Samples captured a variety of flow conditions during the study. However, the majority of summer sampling was conducted below the historical median.

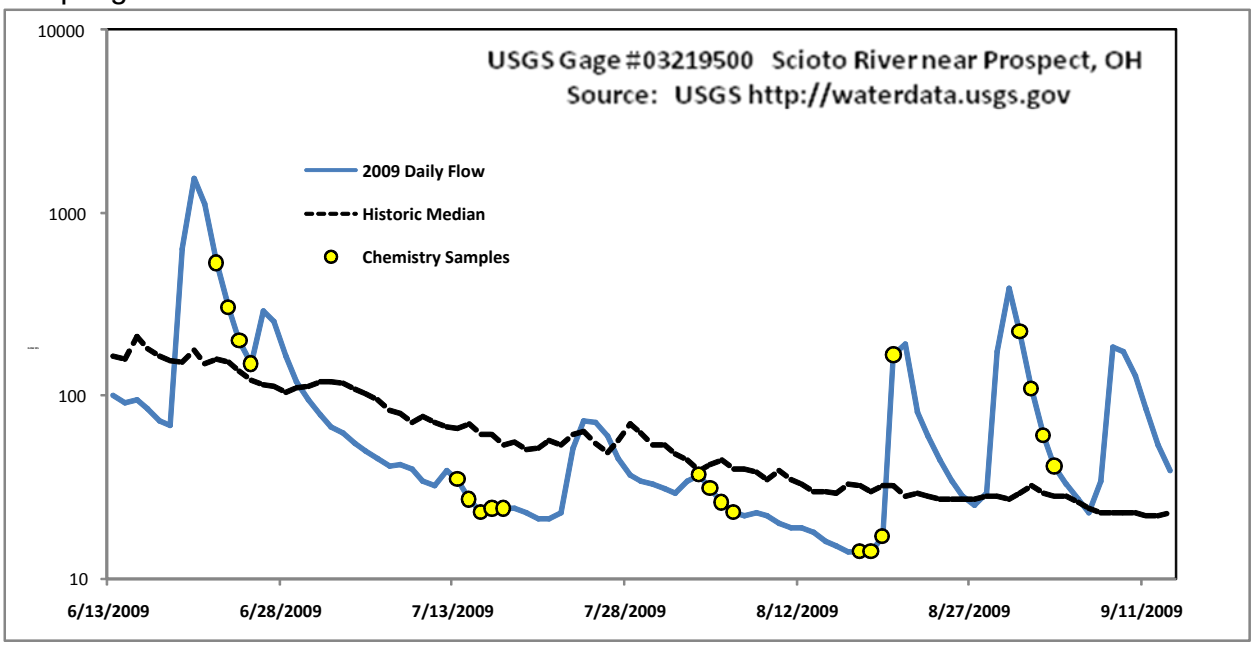

Figure 26. Water chemistry sampling dates plotted on 2009 daily flow values vs. historic median flow values for the upper Scioto River. Flows values were recorded at USGS Gaging station # 03219500 at Prospect, OH.

The single greatest form of pollution found to impact the chemical water quality was nutrient runoff emanating from municipalities and the extensively tiled and channelized agricultural landscape (Figure 27). Thirty-five out of the fifty-eight sites sampled for water column chemistry had both phosphorus and nitrate levels elevated. At these locations nitrate+nitrite exceeded 1.1 mg/l and total phosphorus exceeded 0.1 mg/l.

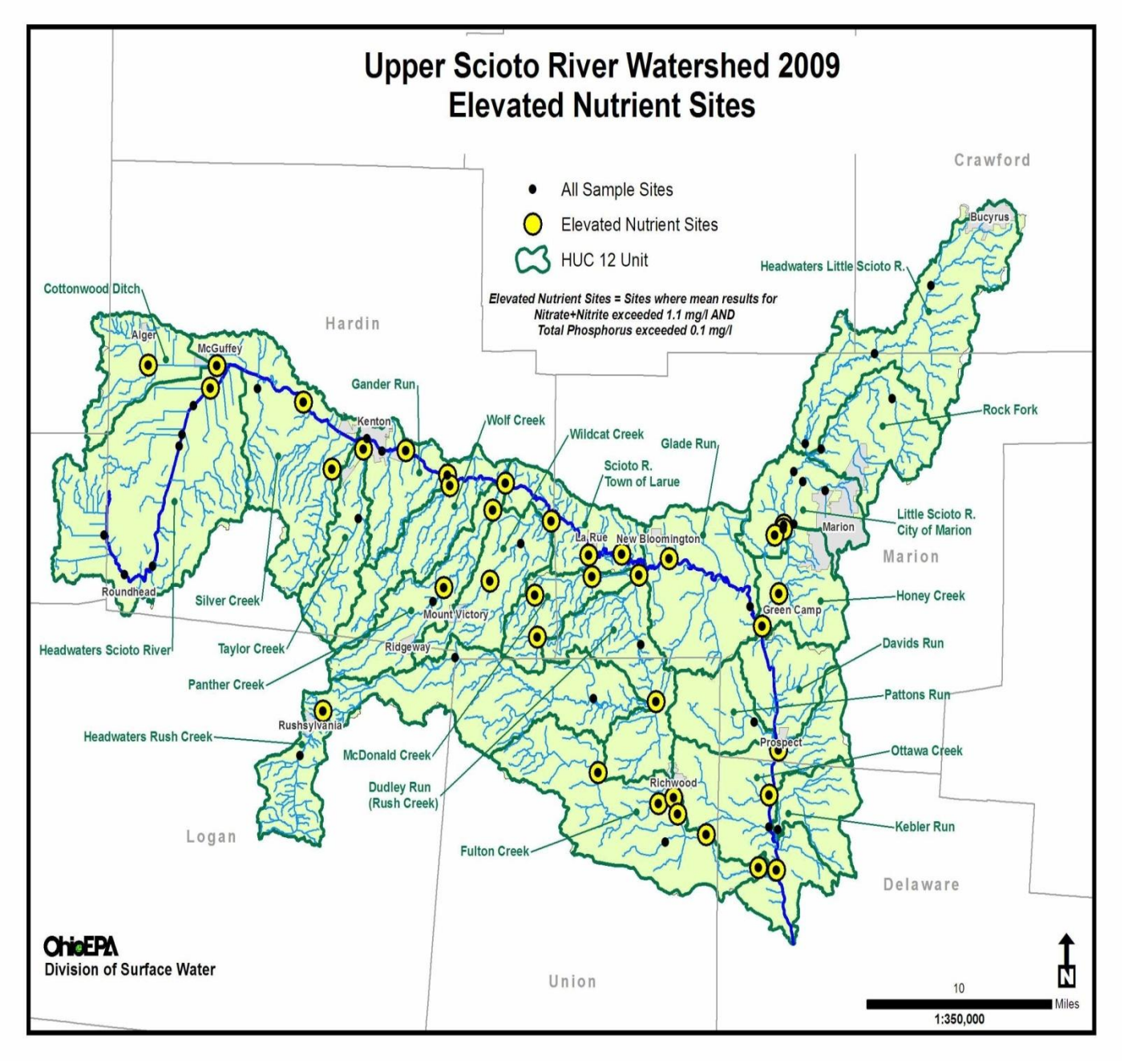

Figure 27. Upper Scioto River watershed map depicting sites which had both nitrate+nitrite exceeding 1.1 mg/l and total phosphorus exceeding 0.1 mg/l, 2009.

Upper Scioto River Headwaters

The Headwaters Scioto River 10-digit Hydrologic Unit Code (05060001 01) encompasses 159 mi^2 of drainage area. This reach includes the Scioto River headwaters in Auglaize County. In this portion of the watershed, the Scioto River initially flows south past the village of Roundhead before turning north and flowing through an historic lake basin (Scioto Marsh) and eventually heading due east past the village of McGuffey to the City of Kenton.

Surface water chemistry samples were collected from seven sites on the Scioto River in this assessment unit. In addition, samples were collected from eight sites on tributary streams. The tributary streams studied include Wallace Fork, Dunlap Creek, Cottonwood Ditch, McCoy Run, Taylor Creek and Silver Creek.

Scioto River Headwaters

This upper main stem segment included seven sampling locations from RM 234.4 (upstream Roundhead) to RM 212.4 (in Kenton). Median concentrations of nutrients were mostly below ecoregion statewide reference targets. Where early spring sampling occurred (RM 234.39 and RM 212.47), high nitrate values were captured with concentrations above 7.0 mg/l common (Appendix F-1). The elevated nitrates were attributed to row crop agricultural production which dominates the landscape. Except for the spring samples, nutrient concentrations fell or remained steady at most sites compared to 1995 data (Figure 28 & Figure 29).

Dissolved oxygen results were satisfactory in this segment with no WQS violations and most concentrations above 6.0 mg/l. These results, however, were mostly lower than those recorded in 1995 which had wide fluctuations due to enriched conditions. This was an indication of improved water quality conditions within this segment (Figure 30).

Turbid stream conditions and elevated total suspended solids (TSS) concentrations were noted in this reach starting at RM 226.3, just north of the village of Roundhead. Main stem concentrations exceeded the 75^{th} percentile ECBP reference target and were particularly high in the RM 228.0 – 222.4 reach that passes through the former Scioto Marsh. Concentrations ranging from 50 – 100 mg/l were common (Appendix F-1) and noticeably higher in 2009 compared to 1995. At RM 222.8, the 2009 TSS median was more than 90 mg/l compared to just above 40 mg/l in 1995 (Figure 12).

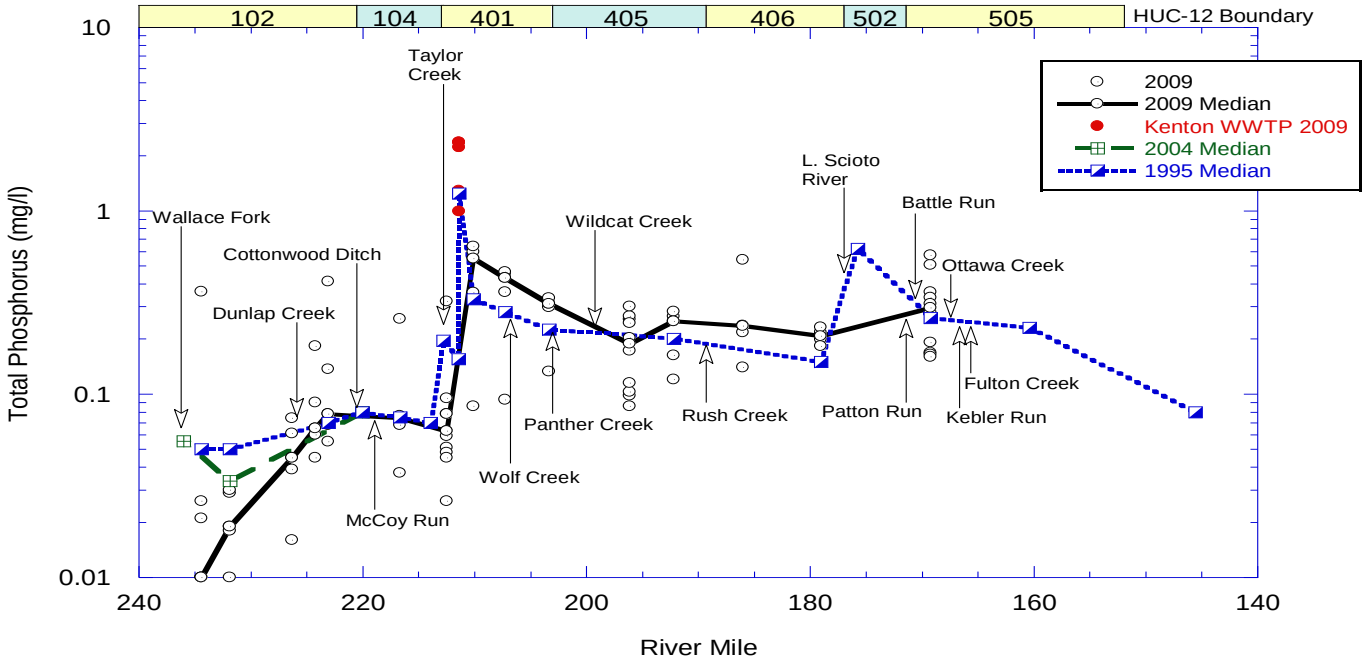

Figure 28. Historical trends for total phosphorus (mg/l) values for the upper Scioto River main stem plotted by river mile,1995, 2004, and 2009.

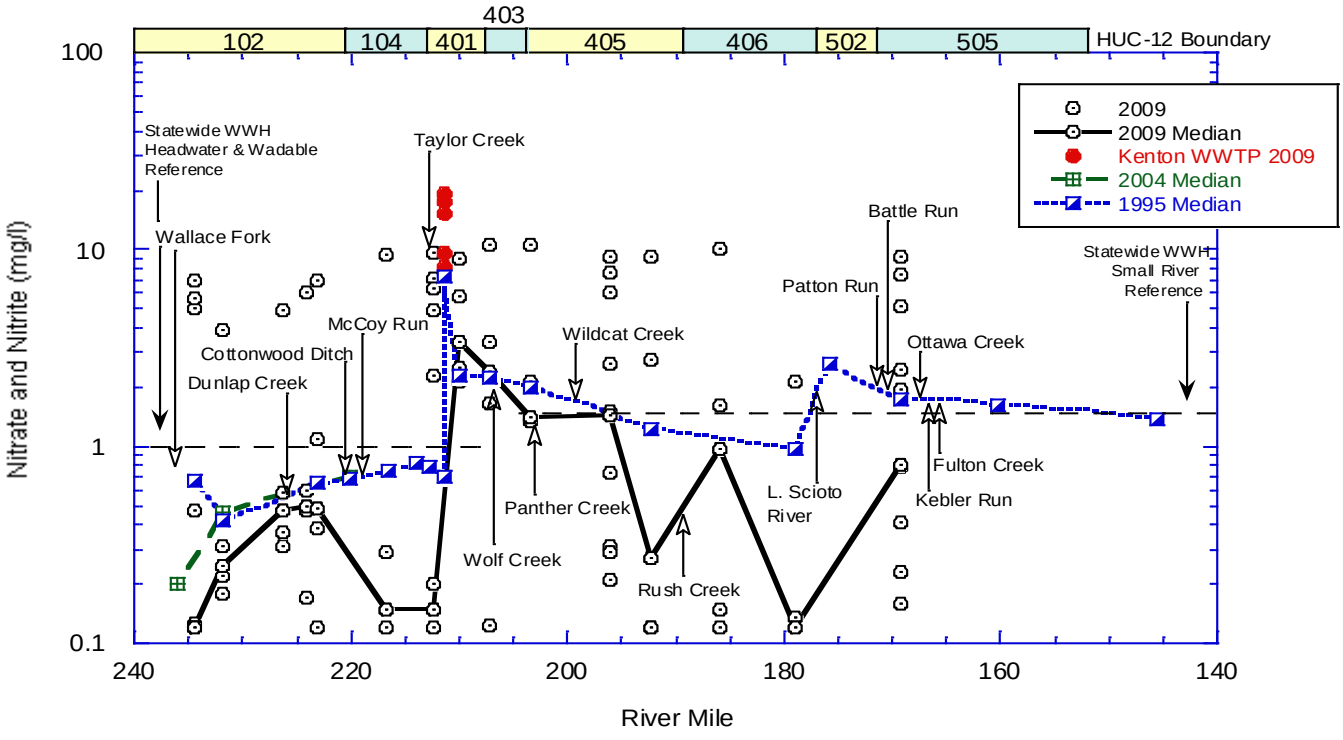

Figure 29. Historical trends for nitrate and nitrite (mg/l) values for the upper Scioto River main stem plotted by river mile, 1995, 2004 and 2009.

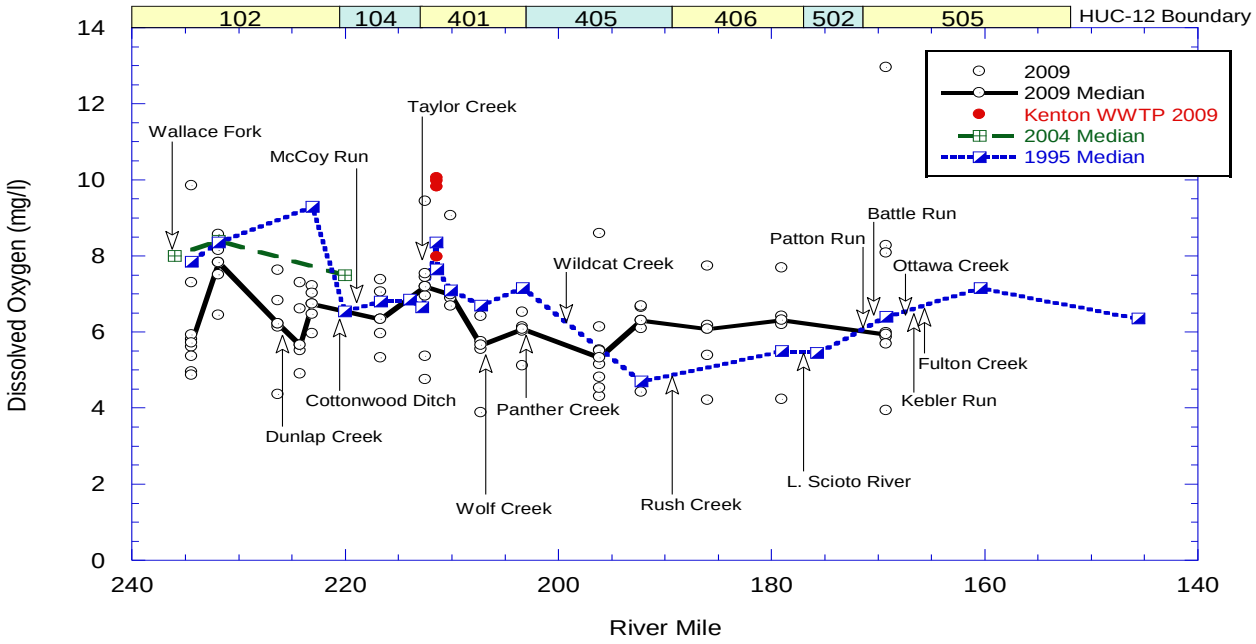

Figure 30. Historical trends for dissolved oxygen (mg/l) values for the upper Scioto River main stem plotted by river mile, 1995, 2004, and 2009.

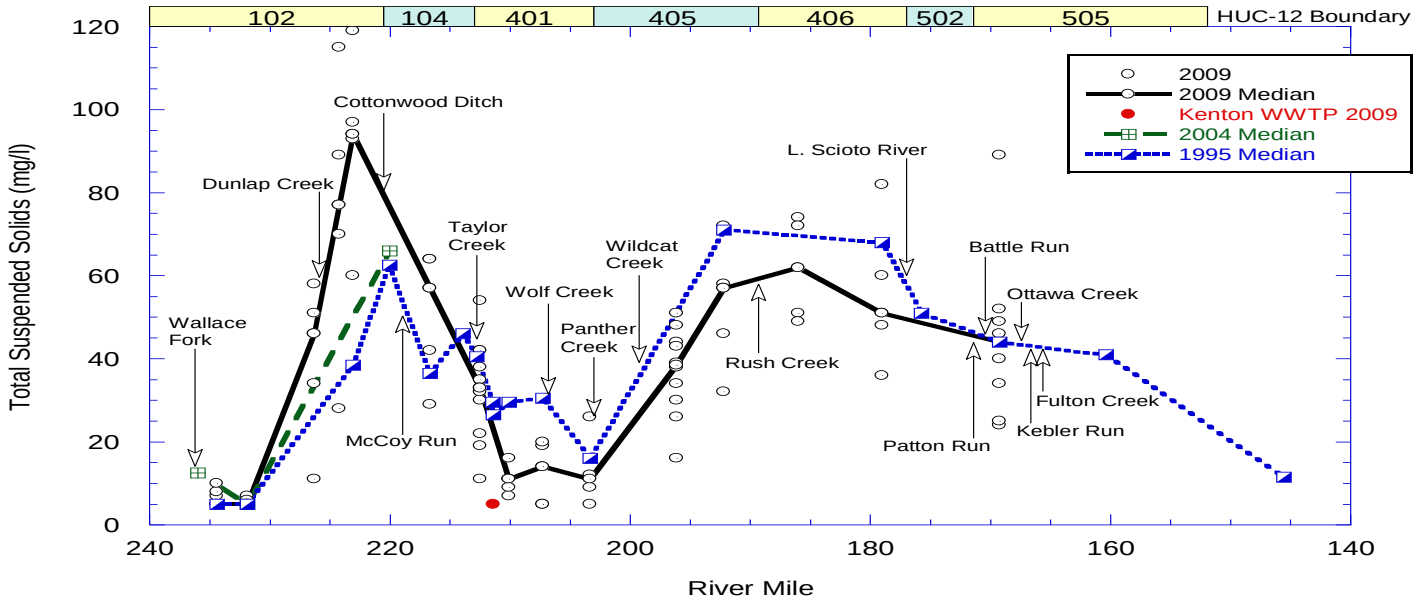

Figure 31. Historical trends for total suspended solids (mg/l) for the upper Scioto River main stem plotted by river mile, 1995, 2004, and 2009.

Cottonwood Ditch Watershed

This channel modified stream is six miles in length and drains 19.5 mi². Two sites were sampled at RM 4.1 and RM 0.68, both located adjacent to Twp. Rd. 100. The upper site is downstream from the village of Alger WWTP and the lower site is downstream from of the village of McGuffey WWTP. Surrounding land use is entirely row crop agriculture in the former, Scioto Marsh glacial lake plain (Figure 5 and Figure 6).

Both sampling sites showed signs of nutrient enrichment with excessive filamentous algae growth and supersaturated dissolved oxygen conditions. At the upper site, four of five total phosphorus sample results exceeded the ecoregion 95th percentile. At the lower site, spring and early summer nitrate + nitrite readings were extremely elevated with most readings above 8.0 mg/l (Appendix F-1). These results are comparable to previous sampling in 1995 (Figure 32 & Figure 33).

Wallace Fork Watershed

Located in Auglaize County, Wallace Fork is under active channel maintenance for agricultural drainage. The fork drains just over 10 mi² forming the Scioto River at its confluence at RM 236.6. Sampling was conducted just upstream from the mouth (RM 0.20) adjacent County Road 15. Nutrients were only slightly elevated despite extensive row crop agriculture. A single violation of the WWH minimum dissolved oxygen criterion was recorded (2.69 mg/l) during a late August trip when stream flow was extremely low (Table 16).

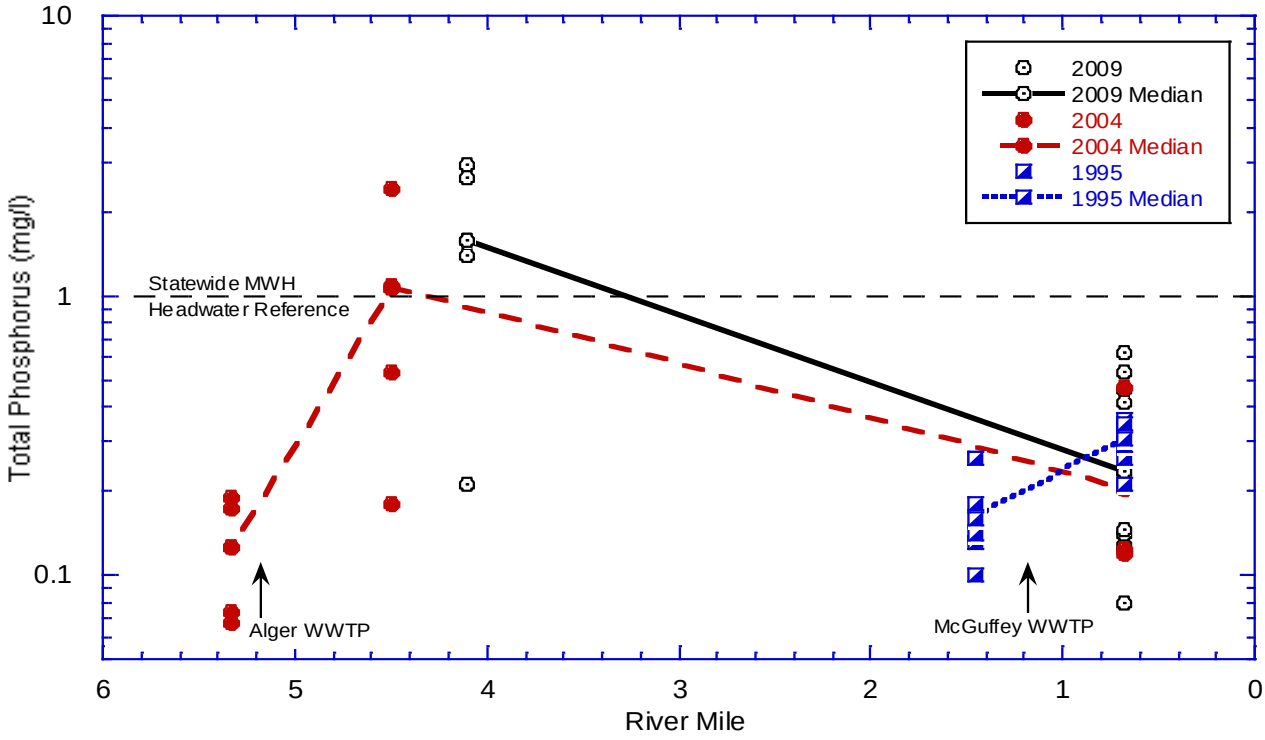

Figure 32. Historical trends for total phosphorus values for Cottonwood Ditch plotted by river mile,1995, 2004, and 2009.

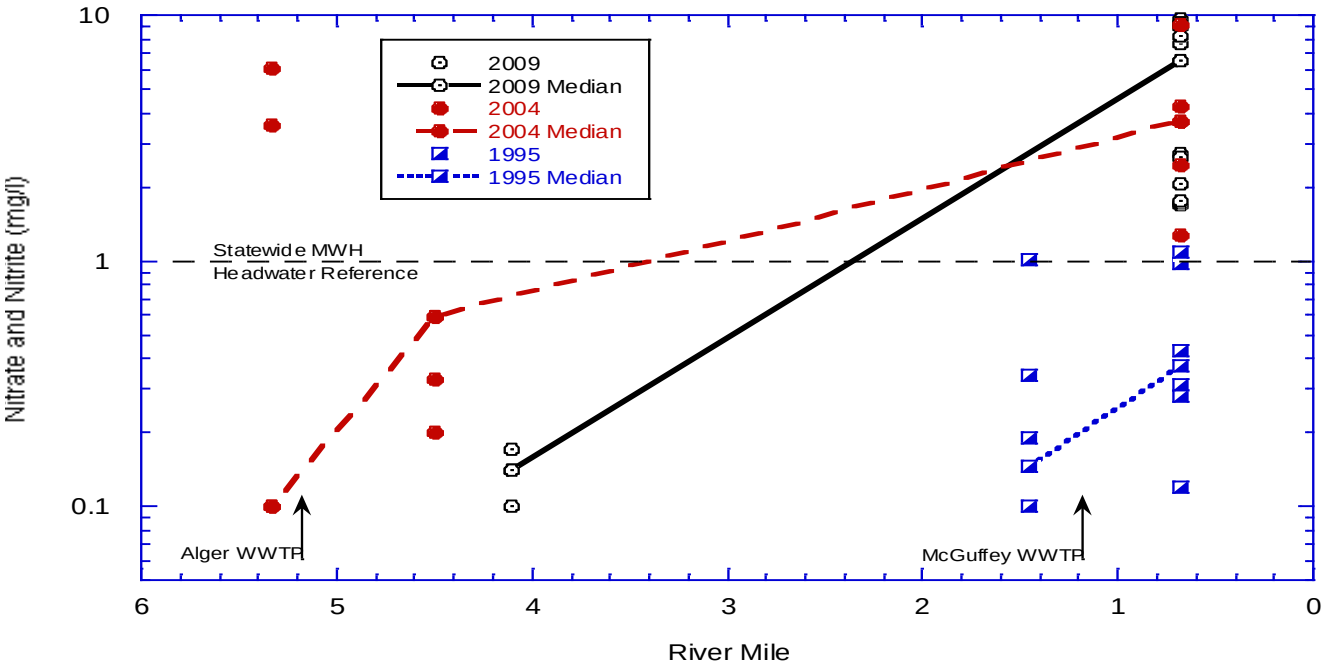

Figure 33. Historical trends for nitrate and nitrite (mg/l) values for Cottonwood Ditch plotted by river mile, 1995, 2004, and 2009.

Table 16. Violations of chemical water quality standards in the upper Scioto River basin (HUC 0506000101) in 2009. Streams labeled U.T. are unnamed tributaries. Wastewater treatment facilities are listed where their discharge points occur. Sites with no entries do not have any violations.

River/Stream (Uses)	River Mile	NPDES Discharge	Parameter	Code
Cottonwood Ditch (HUC 0506000101-01)				
Cottonwood Ditch (MWH_d, AWS, IWS, PCR-B)	4.10			
Cottonwood Ditch	1.0	McGuffy WWTP		
Cottonwood Ditch (MWH_d, AWS, IWS, PCR-B)	0.68			
Scioto River Headwaters (HUC 0506000101-02)				
Wallace Fork (WWH, AWS, IWS, PCR-B)	0.23		Dissolved oxygen	c
Scioto River (WWH, AWS, IWS, PCR-B)	234.39			
Scioto River (WWH, AWS, IWS, PCR-B)	231.86			
Scioto River (WWH, AWS, IWS, PCR-B)	226.30			
Dunlap Creek (WWH, AWS, IWS, PCR-B)	0.10		Dissolved oxygen	c
Scioto River (WWH, AWS, IWS, PCR-B)	224.20			
Scioto River (WWH, AWS, IWS, PCR-B)	223.05			
Taylor Creek (HUC 05060000101-03)				
Taylor Creek (WWH, AWS, IWS, PCR-B)	4.43			
Taylor Creek (WWH, AWS, IWS, PCR-B)	0.76		Dissolved oxygen	c
Silver Creek-Scioto River (HUC 0506000101-04)				
McCoy Run (WWH, AWS, IWS, PCR-B)	0.55		Dissolved oxygen	c
Scioto River (WWH, AWS, IWS, PCR-B)	216.67			
Silver Creek (WWH, AWS, IWS, PCR-B)	2.32		Dissolved oxygen	c

MWH_c—Modified Warmwater Habitat, channel modification
WWH—Warm Water Habitat
AWS—Agricultural Water Supply
IWS—Industrial Water Supply
PCR—Primary Contact Recreation (A=Class A, B=Class B, C=Class C)
SCR—Secondary Contact Recreation
NA—Not Applicable
c—violates the aquatic life protection criterion outside the mixing zone (minimum or maximum)

Dunlap Creek Watershed

Dunlap Creek is extensively modified and drains 8.9 mi². The sample location was just upstream from the mouth (RM 1.0) at County Road 130 in an area of intensive row crop agriculture. A high nitrate + nitrite result of 8.86 mg/l was recorded during a late June sample runoff event. Otherwise, nutrient results were only slightly elevated and generally lower when compared to other headwater streams in the study area (Figure 34). Dissolved oxygen readings of 6.0 to 7.0 mg/l were typical but included a single reading (3.94 mg/l), slightly below the 4.0 mg/l minimum water quality standard.

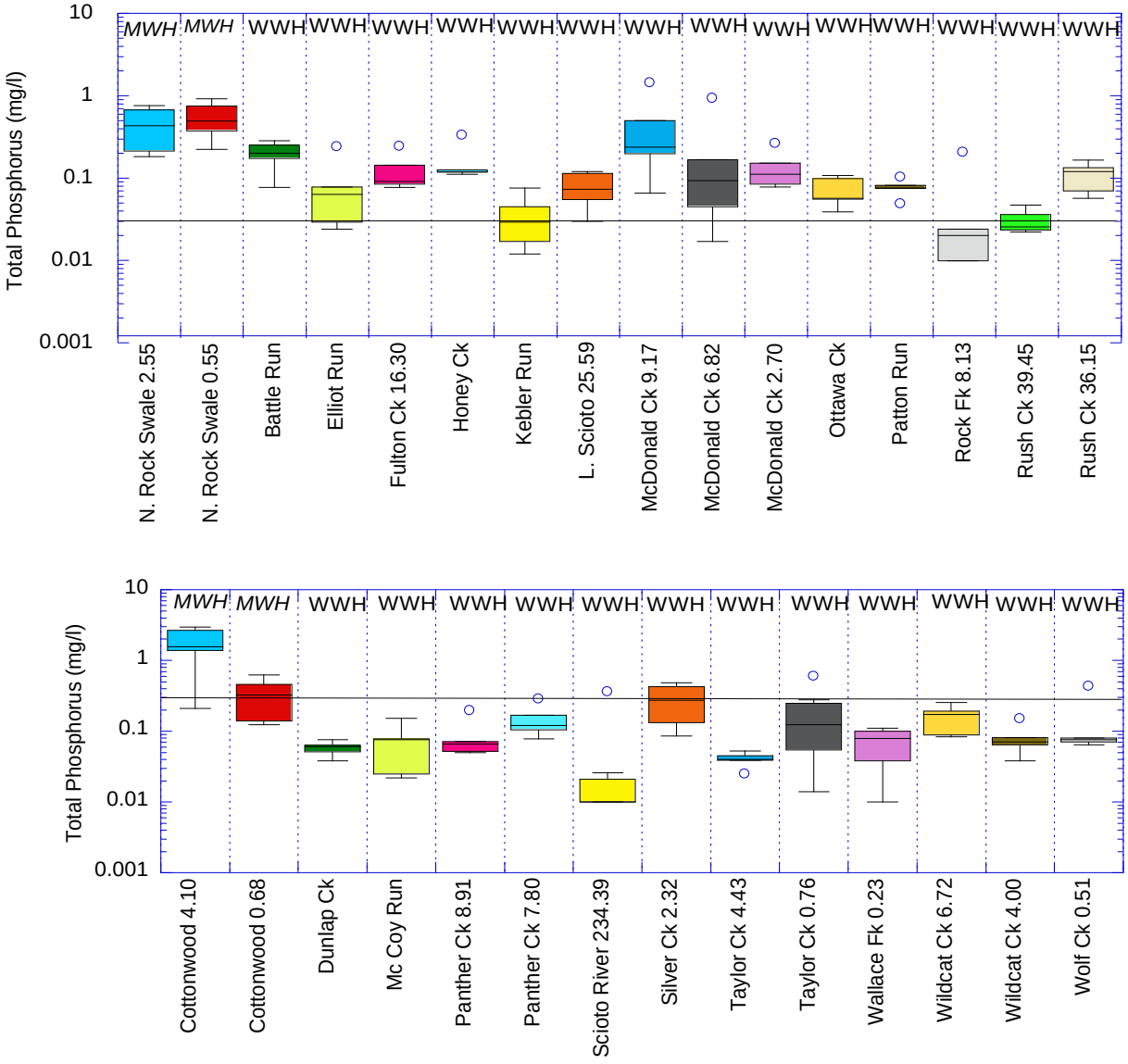

Figure 34. Total Phosphorus (mg/l) for headwater streams in the upper Scioto River study area, 2009. Horizontal lines represent reference values for the Eastern Corn Belt Plains (ECBP) ecoregion.

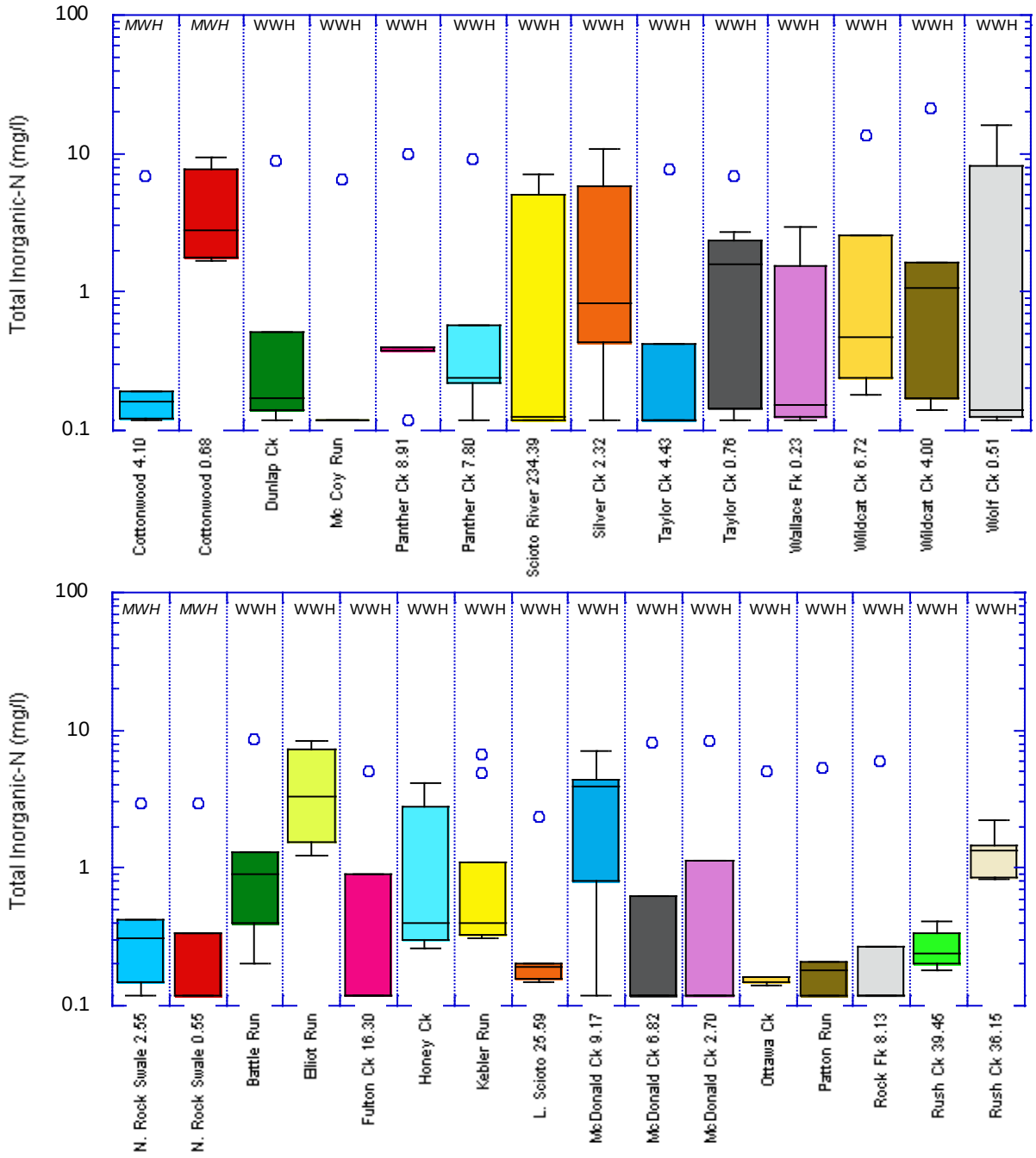

Figure 35. Total inorganic-N (mg/l) for headwater streams in the upper Scioto River study area, 2009.

Taylor Creek Watershed

Taylor Creek drains 29.3 mi² and is the largest tributary in the upper Scioto River subwatershed. Two locations were sampled on this 7.8 mile long stream at RM 4.43 at Twp. Rd. 180 and RM 0.76 at SR 67.

Water quality conditions in Taylor Creek were generally similar to a previous survey in 1995. Dissolved oxygen concentrations were nearly identical at RM 4.43 compared to 1995 but lower at RM 0.76. Several dissolved oxygen violations were recorded at the lower site (Table 16). The Durez Corporation was a suspected source of impact during the most recent survey (Figure 36).

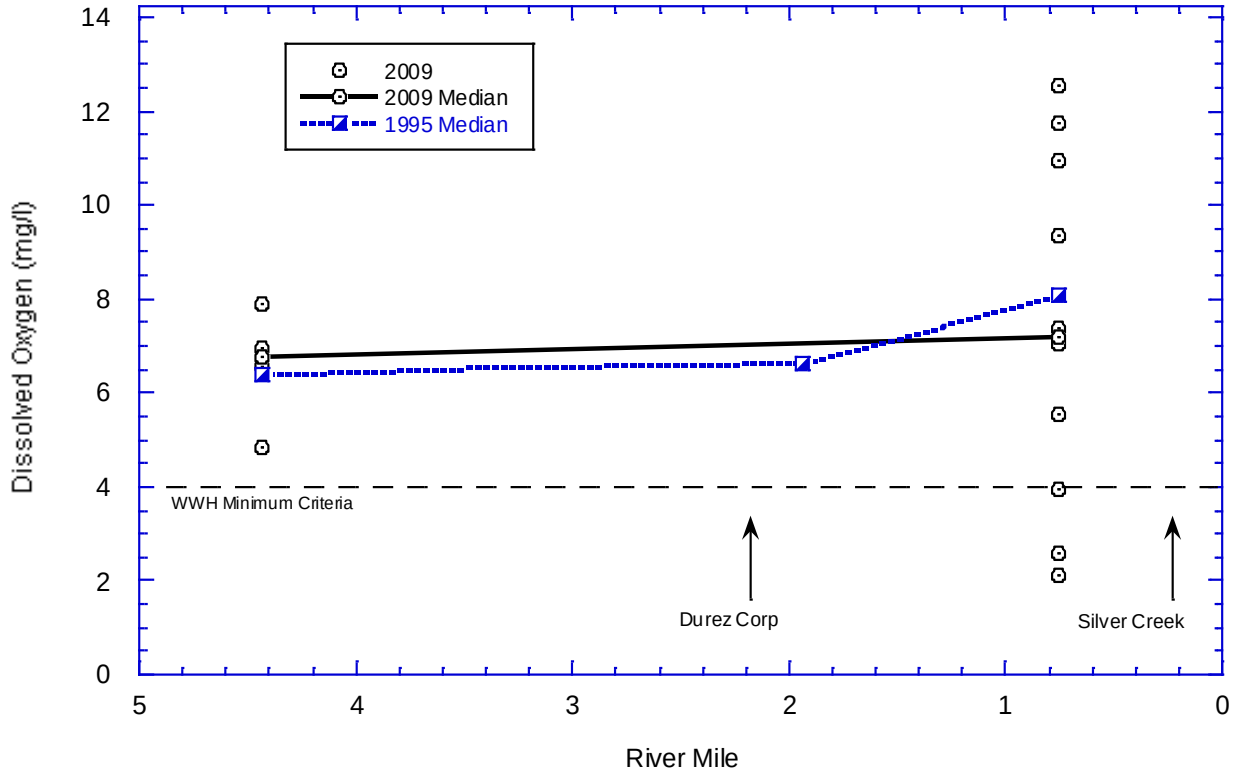

Figure 36. Dissolved oxygen (mg/l) trends for Taylor Creek listed by river mile, 2009 vs. 1995.

Nutrients levels have remained mostly steady in Talyor Creek with results near or above ecoregion target values. Total ammonia concentrations were elevated at the lower site (0.1 mg/l median) compared to the upper site (0.05 mg/l median). Phosphorus and nitrate + nitrite concentrations showed a similar trend with the medians of both above the reference target at RM 0.76 (Figure 37, Figure 38, & Figure 36). Moderate algae growth and a septic discharge were observed. Total dissolved solids (TDS) and conductivity results were also elevated at the lower site (Appendix F-1).

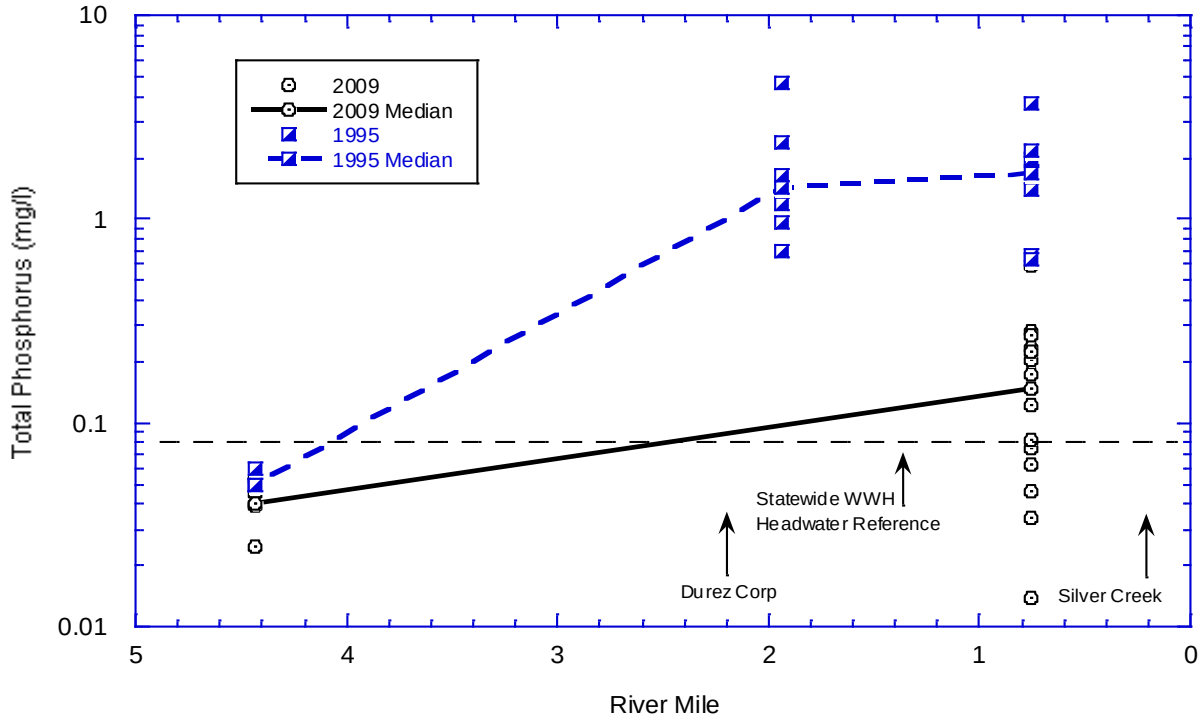

Figure 37. Total phosphorus (mg/l) trends for Taylor Creek listed by river mile, 2009 vs. 1995.

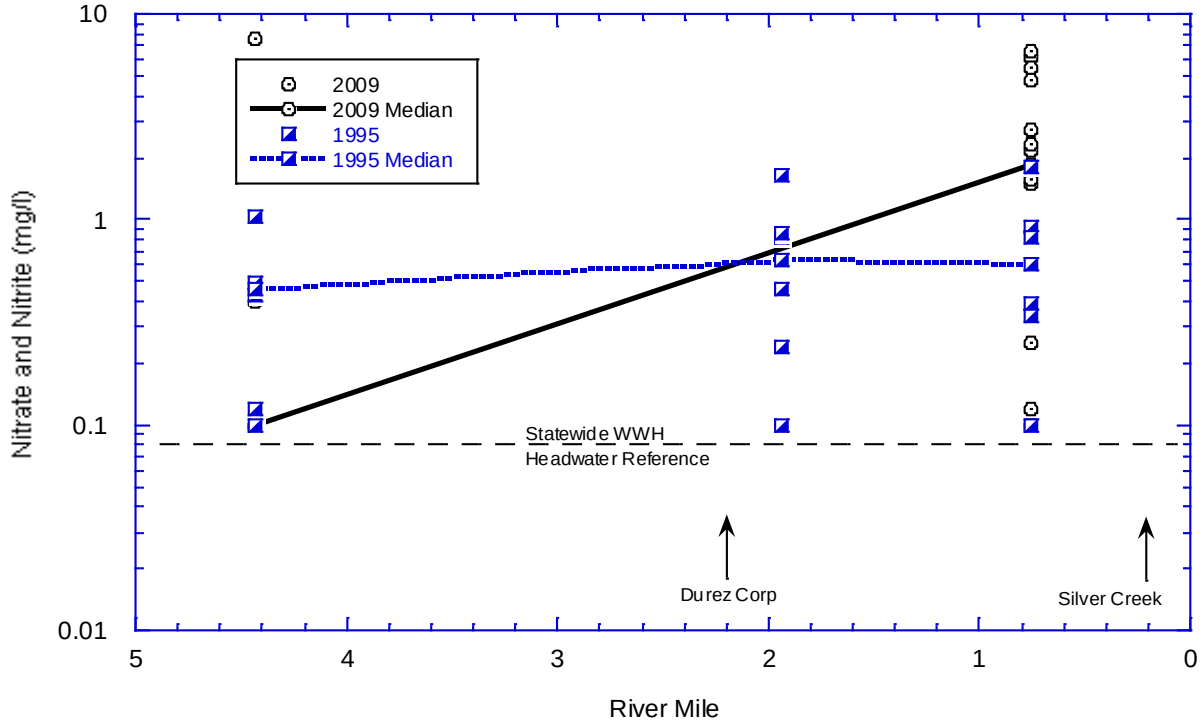

Figure 38. Nitrate and nitrite (mg/l) trends for Taylor Creek listed by river mile, 2009 vs. 1995.

DUREZ CORPORATION

Durez Corporation (NPDES Permit No. 2IF00002), formerly Occidental Chemical, discharges effluent at RM 2.1 on Taylor Creek. During field survey work in July 2009, a fish kill was investigated downstream from Durez Corporation. In addition to dead and dying fish, deposits of black solids (sludge) were observed below the outfall and low D.O. levels were recorded downstream.

In response to the fish kill, sediment sampling was conducted upstream and downstream from Durez (Table 17). Three metals (copper, strontium, and zinc) exceeded Ohio EPA's Sediment Reference Value (SRV) in the downstream sediments, but it is unlikely the levels could cause the acute toxicity which resulted in the fish kill.

Volatile and semi-volatile organic compounds were detected in one or more of the sediment samples from Taylor Creek (Table 18). Compounds that were below the method detection limit (not detected) in any sample are not listed. No organic priority pollutants were detected in the upstream sample. However, there were 13 organic priority pollutants detected in the downstream sample. Of these, 5 of the 6 PAHs exceeded the Consensus Based Sediment Quality Guidelines PEC (probable effect concentration) presented in McDonald, et.al. (2000). In addition, toluene was present at 7.11 mg/kg (ppm), 3&4 methylphenol was very high at 193 mg/kg, and phenol was detected at 61.5 mg/kg. The PAHs and the 3&4 methylphenol (aka p-cresol) concentrations were high enough to be considered likely suspects in the recent fish kill. Their continued presence at this level in the sediments may have been a source of ongoing toxicity. As a result of the notice of violation issued to the Durez Corporation on July 24, 2010, they funded a project to remove all the contaminated sediment which was completed on September 17, 2010 (See pg. 58 for more). None of these priority pollutants were detected in the sediments upstream or downstream from the outfall in 1995.

Table 17. Metal concentrations (mg/kg) in sediment collected from Taylor Creek, upstream and downstream of Durez Corp. Outfall 001. Values in **Bold** were above either the statewide (*) or Eastern Cornbelt Plains ecoregion Sediment Reference Value (SRV).

Parameter (mg/kg)	**Sampling Location, Date and River Mile**				
	ECBP **SRV**	Taylor Ck Upper Scioto River BWQS Survey OEPA Sediment Sampling Oct 4, 1995		Taylor Ck OEPA Sediment Sampling After 2 Fish Kills Aug 17, 2009	
		Upstream Durez† Outfall Buck T.R. 180 (RM 4.43)	Downstream Durez† Outfall Hardin C.R. 155 (RM 1.94)	Just Upstream Durez Outfall 001 (RM 2.12)	Just Downstream Durez Outfall 001 (RM 2.09)
Arsenic	18	8.99	7.88	5.24	11.7
Cadmium	0.90	0.246	0.272	0.256	0.435
Chromium	40	20.1	**42.8**	9.81	22.2
Copper	34	13.6	16.3	10.6	**35.3**
Lead	47 *	ND	**175**	9.13	27.4
Nickel	42	ND	ND	12.8	29.6
Selenium	2.3	NA	NA	ND	ND
Strontium	390	NA	NA	227	**1040**
Zinc	160	65.4	145	53.4	**338**

NA – Not analyzed.
ND – Not detected.

* Statewide SRV

† AKA Occidental Chemical Corp. in 1995

Table 18. Organic compounds detected in sediments collected from Taylor Creek, upstream and downstream of Durez Corporation outfall 001.

METHOD Compound (mg/kg) except where noted	**Sampling Location, Date and River Mile**			
	Taylor Ck Upper Scioto River BWQS Survey OEPA Sediment Sampling Oct 4, 1995		Taylor Ck OEPA Sediment Sampling After 2 Fish Kills Aug 17, 2009	
	Upstream Durez† Outfall 001 at Buck T.R. 180 (RM 4.43)	Downstream Durez† Outfall 001 at Hardin C.R. 155 (RM 1.94)	Just Upstream Durez Outfall 001 (RM 2.12)	Just downstream Durez Outfall 001 (RM 2.09)
USEPA 8260B (volatile)				
Naphthalene	NA	NA	ND	1.06**
Toluene	NA	NA	ND	**7.11**
1,2,4-Trichlorobenzene	NA	NA	ND	0.78
USEPA 8270 (semi-volatile)				
Bis(2-Ethylhexyl)phthalate	ND	ND	ND	1.34
Di-n-butylphthalate	ND	ND	ND	1.72
1,4-Dichlorobenzene	ND	ND	ND	1.07
3&4-Methylphenol	ND	ND	ND	**193**
Phenol	ND	ND	ND	**61.5**
1,2,4-Trichlorobenzene	ND	ND	ND	6.56
PAHs:				
Benz[a]anthracene	ND	ND	ND	1.06**
Chrysene	ND	ND	ND	1.54**
Fluoranthene	ND	ND	ND	2.11*
Naphthalene	ND	ND	ND	1.64**
Phenanthrene	ND	ND	ND	1.86**
Pyrene	ND	ND	ND	1.76**
Total PAHs (mg/kg)	ND	ND	ND	9.97*

NA – Not Analyzed
ND – Not Detected
* above Consensus Based Sediment Quality Guideline TEC (threshold effect concentration), McDonald, et. al.
** above Consensus Based Sediment Quality Guideline PEC (probable effect concentration), McDonald, et. al.

† AKA Occidental Chemical Corp. in 1995

McCoy Run

One site on McCoy Run was assessed at RM 0.55 (Rodgers Road). A septic discharge was noted just upstream from the sample site. This was reflected in stream chemistry results with high total ammonia – nitrogen values recorded in three of the five samples (Appendix F-1). In addition, a dissolved oxygen violation of 2.24 mg/l was recorded indicating possible organic enrichment (Table 16, 90). Adjacent commercial/residential sewage treatment systems and the unsewered village of Foraker are possible sources.

Silver Creek

Silver Creek is a tributary to Taylor Creek and drains just over 12 mi^2. One site at RM 2.32 (SR 67) was sampled in 2009. Elevated nutrients reflective of an agricultural landscape were recorded, including an extremely high nitrate + nitrite result (10.5 mg/l) during early summer (Appendix F-1). Total phosphorus concentrations were also elevated compared to other headwater streams in the study (Figure 34). In addition, a severe dissolved oxygen violation (1.86 mg/l) was recorded in late August under intermittent flow (Table 16).

Rush Creek Watershed

The Rush Creek assessment unit (Hydrologic Unit Code 0506000102) encompasses 105 mi^2 of drainage area. Rush Creek is 40.1 miles in length and flows mostly in an easterly direction across the study area before turning north near the upper central portion of Union County. Rush Creek empties into the Scioto River at RM 189.6 east of the village of Larue in Marion County.

Surface water chemistry samples were collected from six Rush Creek sites from the headwaters above Rushsylvania in Logan County to the mouth in Marion County. Other streams assessed included McDonald Creek (3 sites) and Big Swale (one site) (Table 1).

Rush Creek

Nutrient results were mostly below the 90^{th} percentile ecoregional concentration. No significant stream algae conditions were observed throughout the reach. When compared to other wadeable streams in the study, nutrient concentrations were generally lower (Figure 39 & Figure 40). Dissolved oxygen readings were capable of sustaining WWH communities with most medians above 6.5 mg/l. A single dissolved oxygen violation (1.94 mg/l) was observed at the mouth under late summer interstitial flow conditions and was attributed to a significant groundwater contribution (Table 19). Low stream temperature (13^{o}c) and elevated mineral concentrations (strontium, iron and manganese) support this observation (Appendix F-1).

Turbidity appeared to be a problem for the lower reaches of Rush Creek. TSS concentrations increased moving downstream. Around RM 8.5 near the village of Essex, a significant riparian removal project was undertaken during the survey contributing to stream bank erosion and sediment loss (Figure 41).

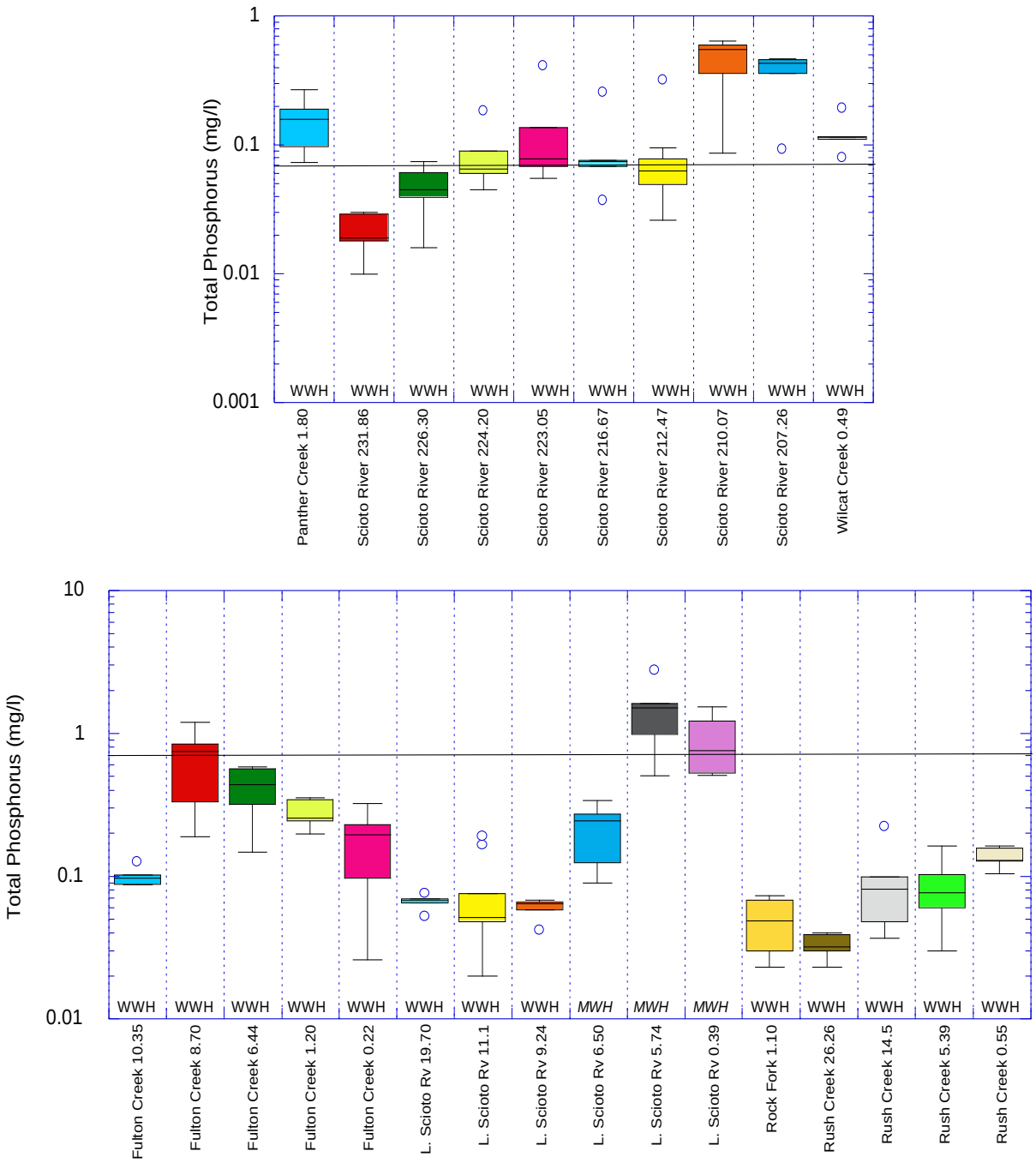

Figure 39. Total phosphorus (mg/l) for wading streams in the upper Scioto River study area, 2009. Horizontal lines represent reference values for the Eastern Corn Belt Plains (ECBP) ecoregion.

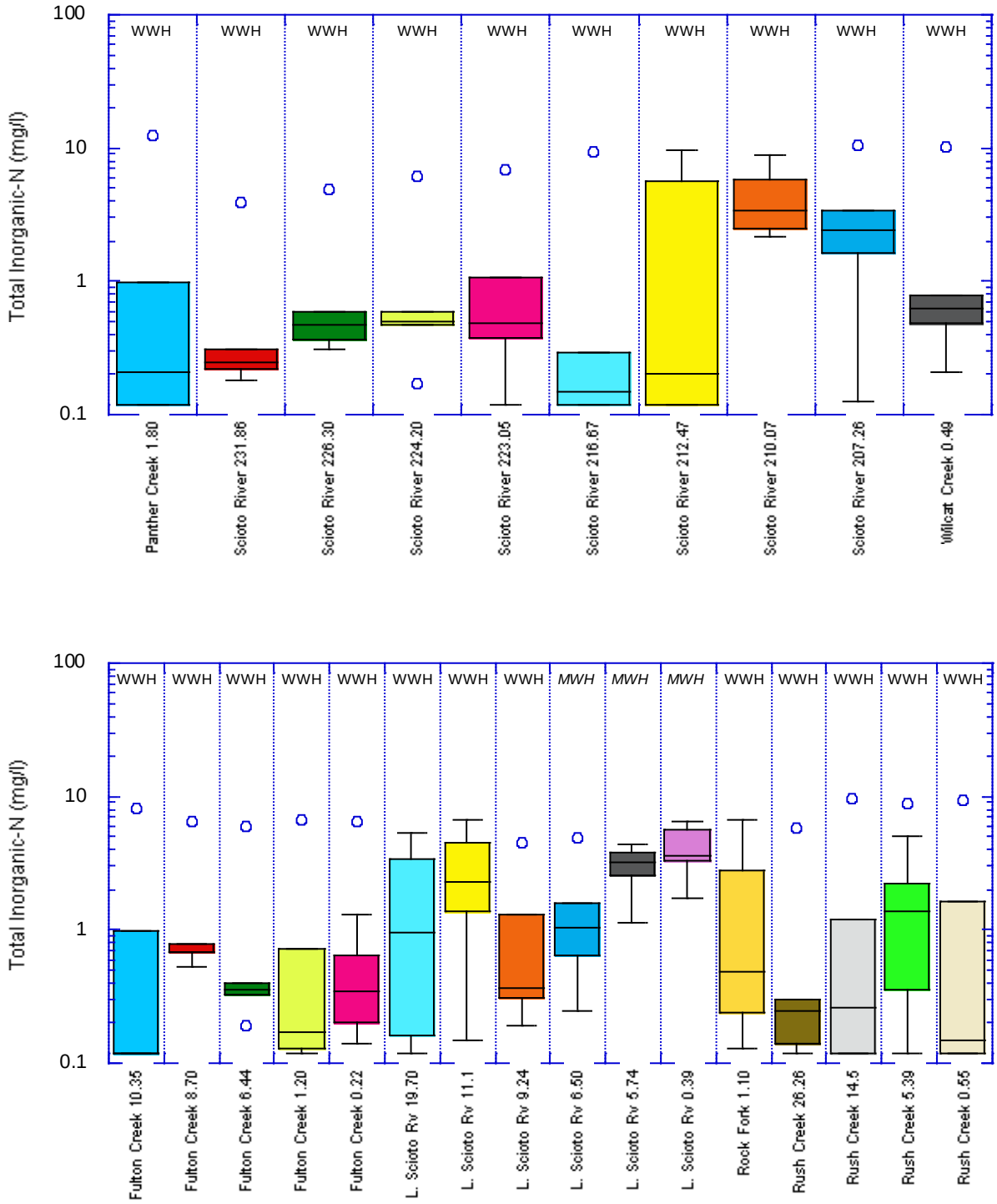

Figure 40. Total inorganic-N (mg/l) for wading streams in the upper Scioto River study area, 2009.

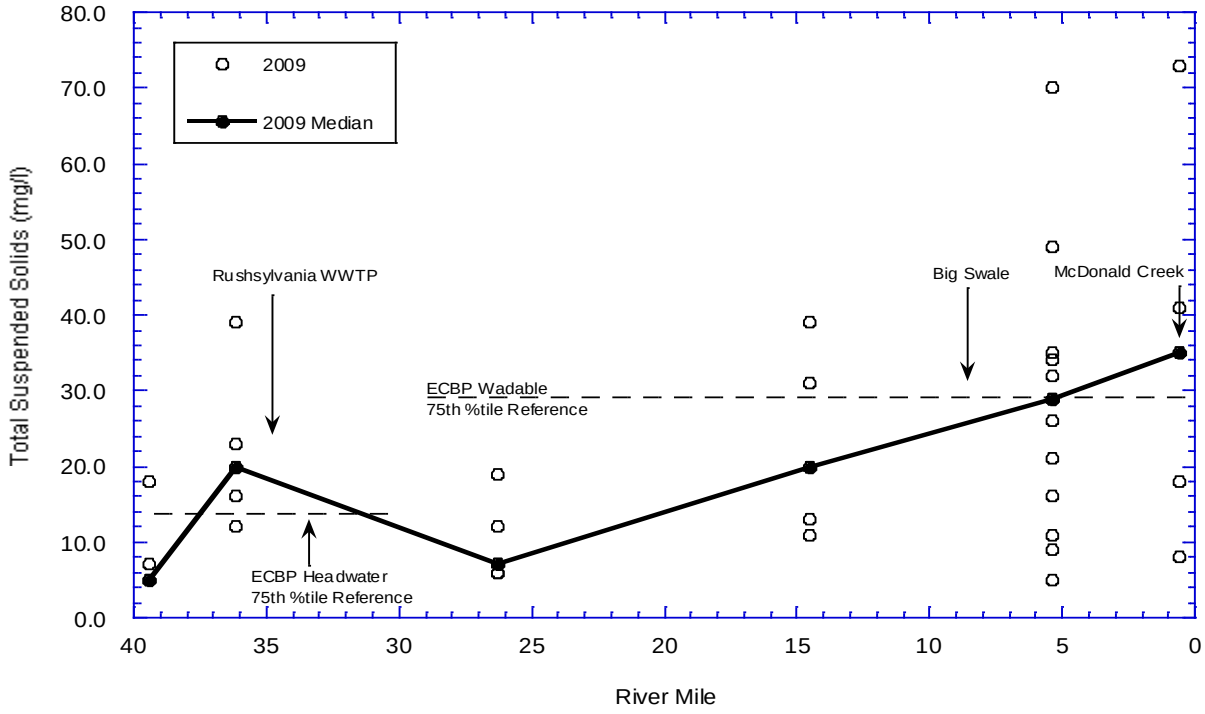

Figure 41. Total suspended solids (mg/l) for Rush Creek listed by river mile, 2009.

McDonald Creek

McDonald Creek has a drainage area of 14.6 mi² including a portion of the Ohio Fresh Eggs complex in Hardin County. Three sites were sampled for stream chemistry from RM 9.17 to RM 2.70. The upper portion of McDonald Creek has been channelized.

Nutrient enrichment was problematic for McDonald Creek. Excessive filamentous algae was observed at the upper sites bracketing Ohio Fresh Eggs. Nitrogen compounds, including TKN and nitrate + nitrite, were elevated with several readings exceeding the 95th percentile of reference sites. Total phosphorus levels were high also, particularly at the upper site where the median was .238 mg/l (Appendix F-1) and elevated compared to other headwater streams (Figure 34).

Limited nutrient sample results from 1995-1998 remain generally comparable to the 2009 survey results. The exception is total ammonia nitrogen where 2009 levels were lower than results observed in historical sampling at RM 6.8 (Figure 42).

Four violations of the dissolved oxygen minimum criterion ere also recorded at sites bracketing Ohio Fresh Eggs (Table 19). Included were readings of 1.58 and 1.01 mg/l in the channelized portion of McDonald Creek at RM 9.17. Below Ohio Fresh Eggs at RM 6.82, a single violation was recorded (2.25 mg/l). Datasonde sampling at RM 6.82 measured supersaturated dissolved oxygen conditions (range 15.68 mg/l) and further indicated excessive enrichment (Appendix F-1). Agricultural land use practices, on-site sewage treatment systems and historic stream channelization impacts are noted sources.

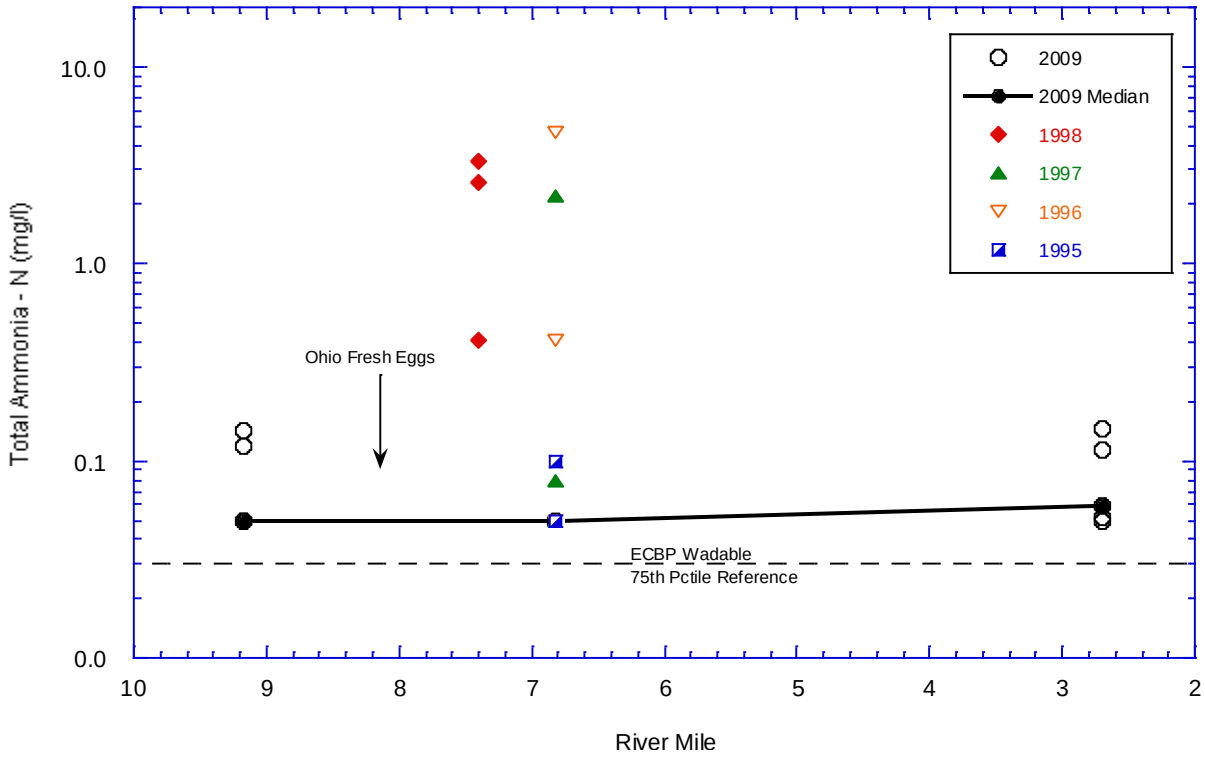

Figure 42. Total ammonia-N (mg/l) for McDonald Creek listed by river mile, 1995 - 2009.

Big Swale

One site on Big Swale at RM 0.20 was sampled. This small intermittent stream went dry during most of the study season. Only two samples were collected and no significant chemical water quality impacts were noted.

Little Scioto River Watershed

The Little Scioto River watershed covers 113 mi² of drainage area. The Little Scioto River is 27.2 miles in length and flows mostly in a southerly direction before emptying into the Scioto River at RM 177.38 just south of the village of Green Camp. This watershed includes the city of Marion.

Surface water chemistry samples were collected from seven sites located on the Little Scioto River. The sites included the headwaters below the city of Bucyrus in Crawford County to the mouth near the Village of Green Camp. Other streams assessed in this unit included Rock Fork (2 sites), North Rock Swale Ditch (one site) and Honey Creek (one site) (Table 1).

Table 19. Violations of chemical water quality standards in the Rush Creek basin (HUC 0506000102) in 2009. Sites with no entries do not have any violations.

River/Stream (Uses)	River Mile	NPDES Discharge	Parameter	Code
Headwaters Rush Creek (HUC 0506000102-01)				
Rush Creek (WWH, AWS, IWS, PCR-B)	39.45			
Rush Creek (WWH, AWS, IWS, PCR-B)	36.15			
Rush Creek (WWH, AWS, IWS, PCR-B)	26.26			
Rush Creek (WWH, AWS, IWS, PCR-B)	14.50			
McDonald Creek (HUC 0506000102-02)				
McDonald Creek (WWH, AWS, IWS, PCR-B)	9.17		Dissolved oxygen	c
McDonald Creek (WWH, AWS, IWS, PCR-B)	6.82		Dissolved oxygen	c
McDonald Creek (WWH, AWS, IWS, PCR-B)	2.70		Dissolved oxygen	c
Dudley Run-Rush Creek (HUC 0506000102-03)				
Big Swale (LRW, AWS, IWS, SCR)	0.20			
Rush Creek (WWH, AWS, IWS, PCR-B)	5.39			
Rush Creek (WWH, AWS, IWS, PCR-B)	0.55		Dissolved oxygen	c

LRW—Limited Resourse Water, small drainage-way, under maintenance
MWH_c—Modified Warmwater Habitat, channel modification
WWH—Warm Water Habitat
AWS—Agricultural Water Supply
IWS—Industrial Water Supply
PCR—Primary Contact Recreation (A=Class A, B=Class B, C=Class C)
SCR—Secondary Contact Recreation
NA—Not Applicable
c—violates the aquatic life protection criterion outside the mixing zone (minimum or maximum)

Little Scioto River

This segment included seven sites from RM 25.9 to RM 0.39 near the mouth. From RM 9.0 (downstream Hillman-Ford Road) to the mouth the stream has been channelized and is designated as MWH. The lower portion of this segment also contains the historic sediment polycyclicaromatic hydrocarbon (PAH) contamination and remediation[1] activities (OEPA report number EAS/2008-1-1 http://www.epa.ohio.gov/dsw/document_index/psdindx.aspx). Dissolved oxygen readings were satisfactory from RM 25.4 to RM 9.24 with medians above 5.0 mg/l. In the modified channel below N. Rock Swale Ditch poor dissolved oxygen conditions were observed at RM 6.50. Four of five instantaneous dissolved oxygen readings did not meet the minimum criterion of 3.0 mg/l (Table 20). CSOs contributed to poor water quality conditions. Dissolved oxygen conditions improved between the Marion WWTP and the mouth.

Elevated nutrients were typical in the lower reach of the Little Scioto River. Total phosphorus and nitrogen compounds were above the 75th percentile for ECBP reference streams. Total ammonia nitrogen was elevated with median results of 0.167 mg/l, 0.227 mg/l and 0.134 mg/l at the three lower sites (Appendix F-1). TKN results were also generally higher when compared to other wadeable streams in the study (Figure 43). WWTP impact (CSOs), historic stream sediment contamination and modified stream conditions are among the factors impacting water quality in this reach.

Turbidity as measured by TSS followed a similar trend as nutrients. The upper portion of the Little Scioto River had low TSS levels with medians below 10 mg/l. Lower reach sample sites had higher TSS levels with several median results above 30 mg/l (Appendix F-1).

Previous sampling conducted in 2004 included the three upper sites sampled in 2009. Both nutrients (phosphorus and nitrate+nitrite) and TSS levels were very similar and relatively low in the upper reach, upstream from Marion. Median dissolved oxygen levels were lower in 2009 compared to 2004 with a wider range of swings indicating more eutrophic conditions (Figure 44 - Figure 47).

Rock Fork Creek

Rock Fork has a drainage area of 23.9 mi^2 and consists predominantly of agricultural land use (row crop production). Two sites on Rock Fork were sampled at RM 8.13 and RM 1.35.

Nutrient enrichment was a problem at the upper site on Rock Fork. A significant growth of filamentous algae was present the entire sampling season. Several violations of the dissolved oxygen minimum criterion were also recorded (Table 20). The channel is modified, open, and was subjected to a large manure spill in July 2008 (ODNR Division of Wildlife, 2008).

[1] The remediation of the Little Scioto River was limited to a short reach near the Marion WWTP, not the entire 8-9 mile reach.

At RM 1.35, Rock Fork water quality conditions improved. There were no significant algae observations made. Dissolved oxygen levels were acceptable for sustaining aquatic life and nutrient concentrations were not excessive for an agricultural area (Appendix F-1).

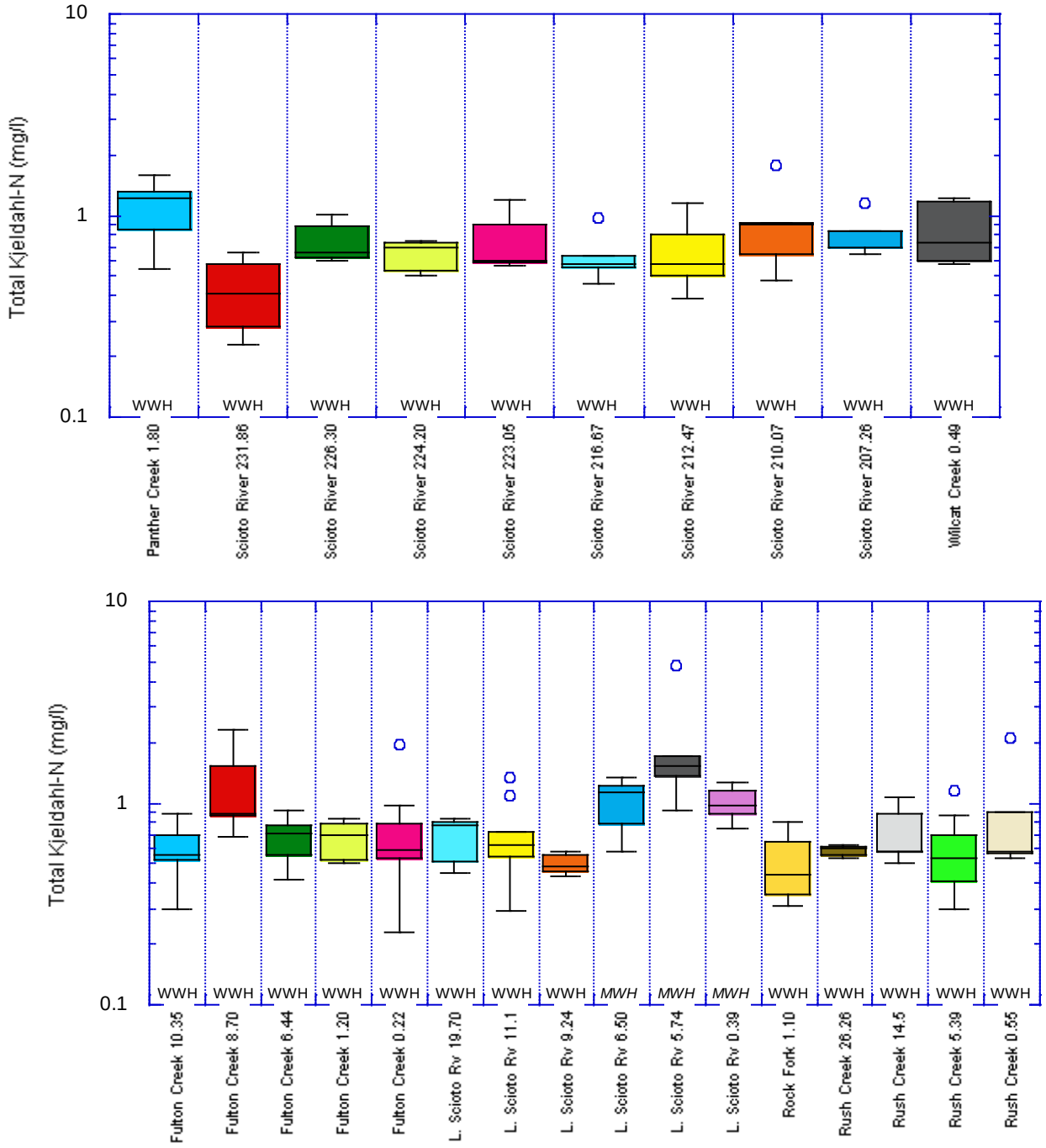

Figure 43. Total Kjeldahl-N (mg/l) for wading sites in the upper Scioto River watershed, 2009.

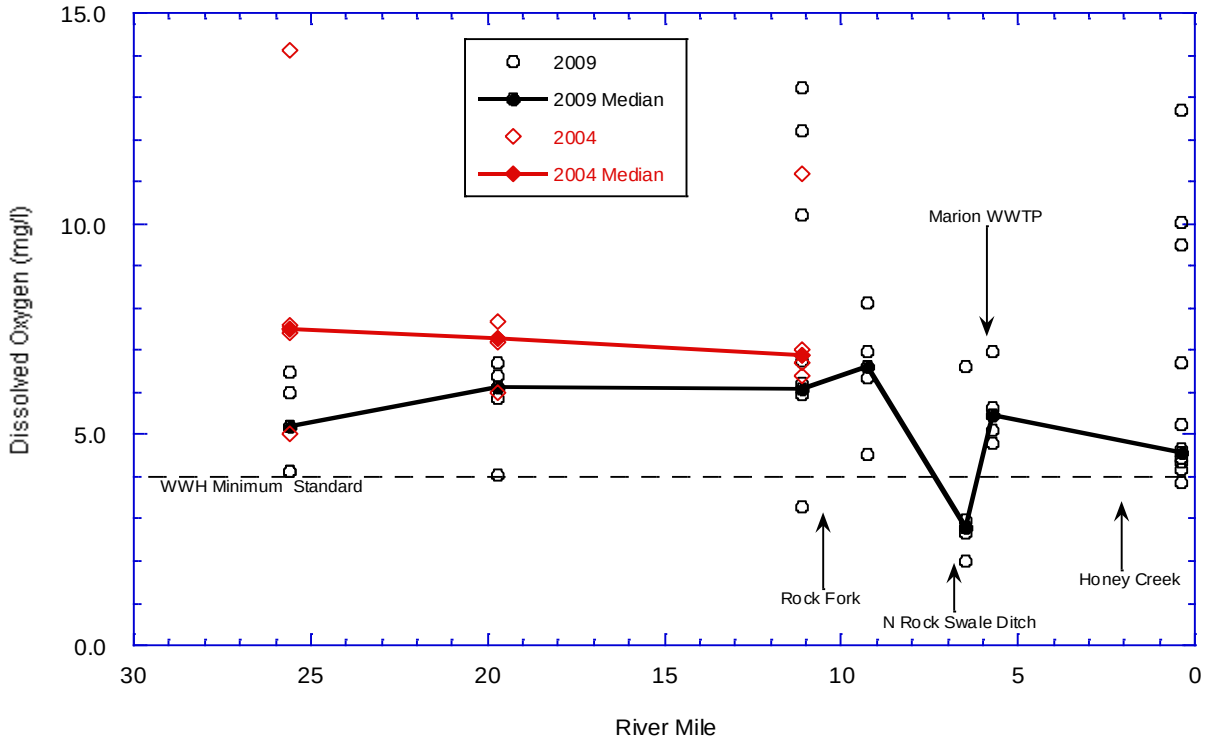

Figure 44. Dissolved oxygen (mg/l) trends for the Little Scioto River listed by river mile, 2004 vs. 2009.

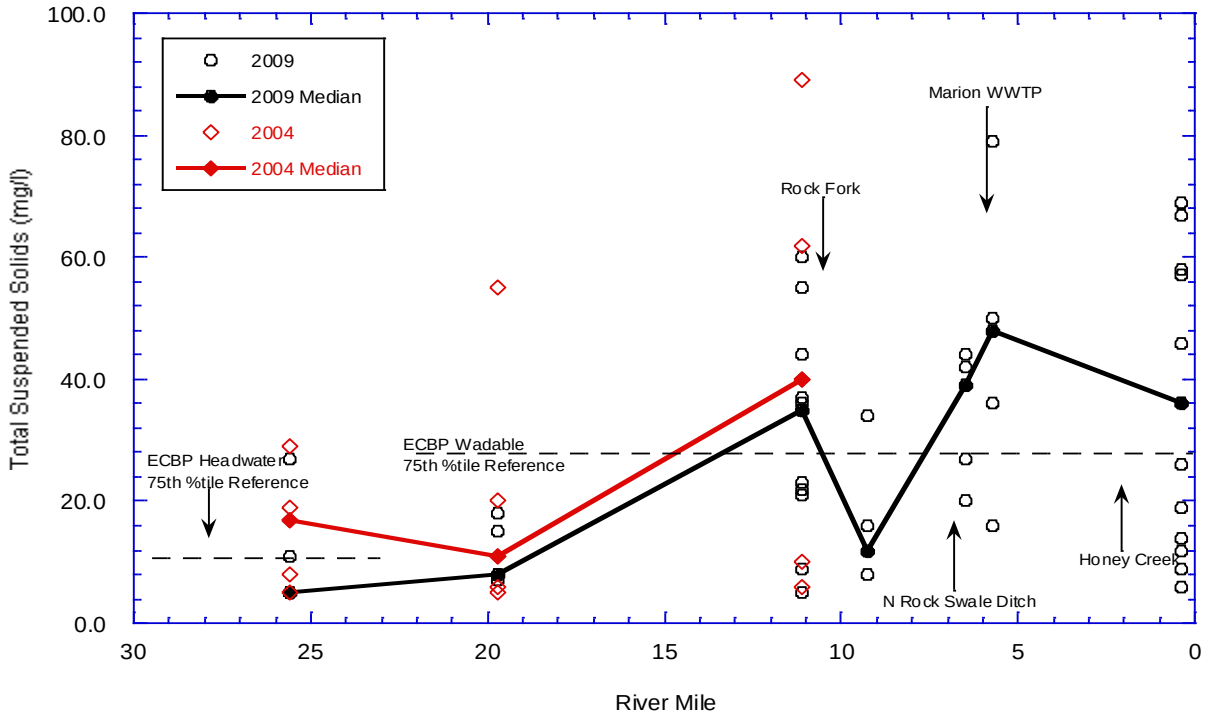

Figure 45. Total suspended solids (mg/l) trends for the Little Scioto River listed by river mile, 2004 vs. 2009.

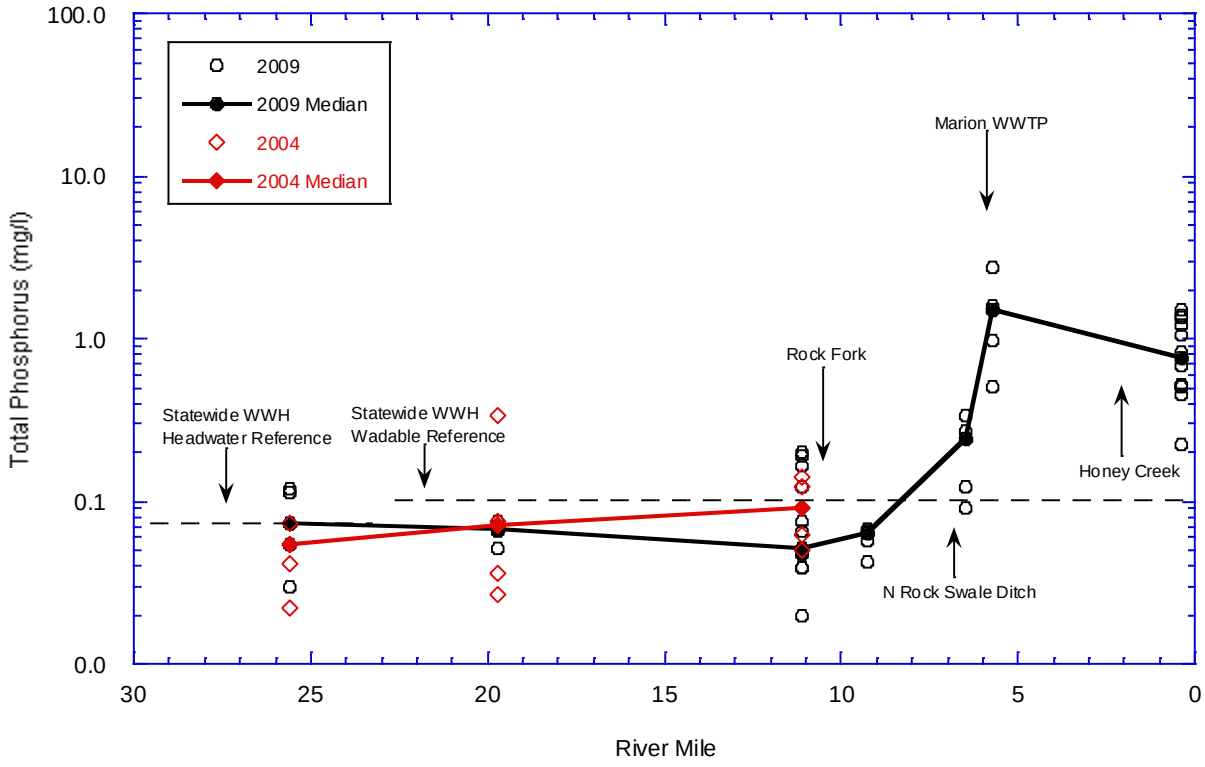

Figure 46. Total phosphorus (mg/l) trends for the Little Scioto River listed by river mile, 2004 vs. 2009.

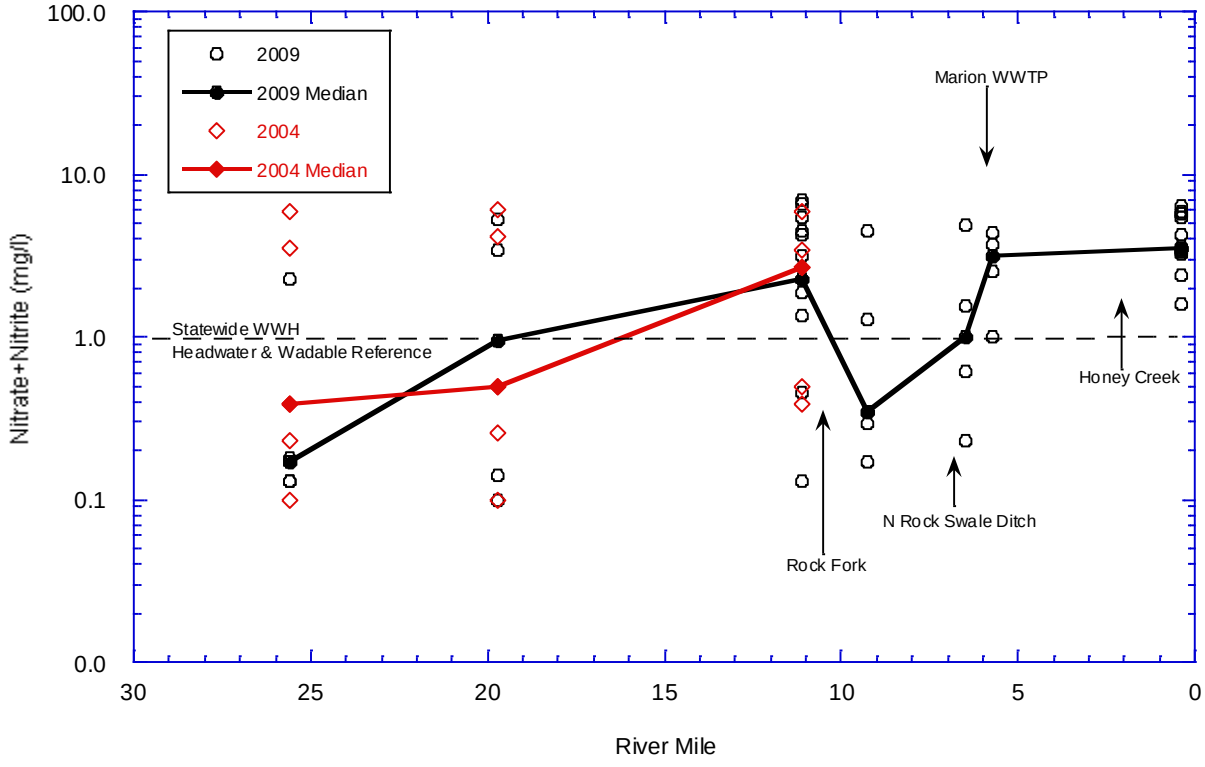

Figure 47. Nitrate+nitrite (mg/l) trends for the Little Scioto River listed by river mile, 2004 vs. 2009.

North Rock Swale Ditch

This 6.32 mile stream has been modified from RM 4.4 to the mouth. Two sites on this stream were sampled for water chemistry. Both sites were located in the modified portion of the stream reach.

Total phosphorus was elevated with median concentrations at both sites above 0.43 mg/l. In addition, total ammonia nitrogen results were significantly elevated with several results above 0.2 mg/l due to Marion's CSO (Appendix F-1 and Table 2).

During one late season sampling event at the upper site (RM 0.55), stream discoloration was noted after a minor rainfall event. This site is just below the Poet Ethanol refining facility stormwater runoff and NPDES discharge. At the lower site (RM 0.55) additional water quality concerns included two violations of the WWH minimum dissolved oxygen criterion (Table 20) and high concentrations of TDS.

Honey Creek

Honey Creek is a headwater stream near the village of Green Camp and drains 7.38 mi^2 and was sampled at RM 0.1. No violations of dissolved oxygen criterion were observed. During one late season runoff event, a high total ammonia nitrogen value (0.657 mg/l) and TSS result (52 mg/l) was recorded (Appendix F-1). Otherwise, water quality conditions appeared mostly satisfactory with conditions comparable to other agricultural headwater streams in the watershed (Figure 34, Figure 35, and Figure 48).

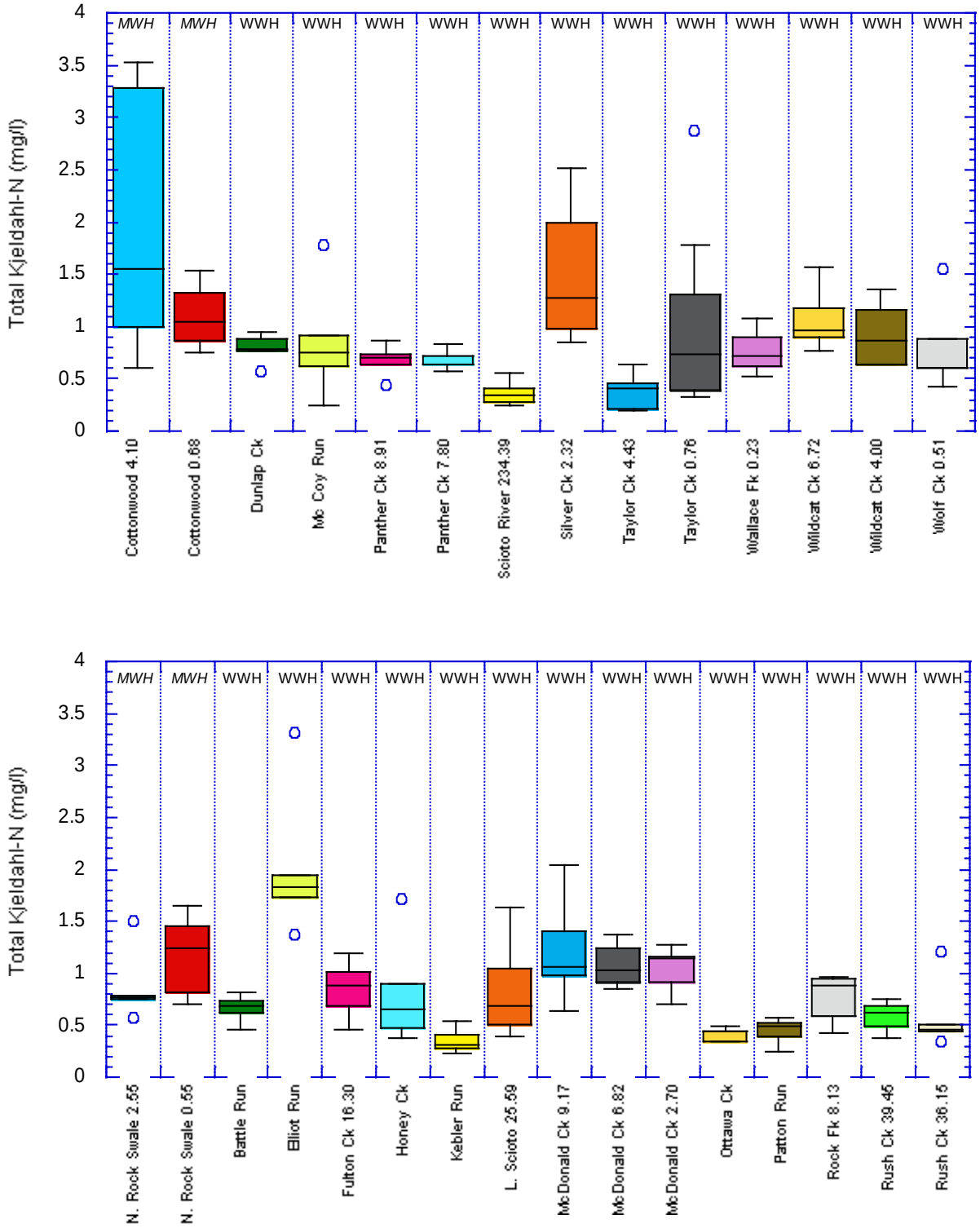

Figure 48. Total Kjeldahl-N (mg/l) for headwater streams in the upper Scioto River watershed, 2009.

Table 20. Violations of chemical water quality standards in the Little Scioto River basin (HUC 0506000103) in 2009. Streams labeled U.T. are unnamed tributaries. Wastewater treatment facilities are listed where their discharge points occur. Sites with no entries do not have any violations.

River/Stream (Uses)	River Mile	QHEI	Biological Use Attainment	NPDES Discharge	Parameter	Code
Rock Fork (HUC 0506000103-01)						
Rock Fork (WWH, AWS, IWS, PCR-B)	8.13				Dissolved oxygen	c
Rock Fork (WWH, AWS, IWS, PCR-B)	1.10					
Headwaters Little Scioto River (HUC 0506000103-02)						
Little Scioto River (WWH, AWS, IWS, PCR-B)	25.59					
Little Scioto River (WWH, AWS, IWS, PCR-B)	19.70					
Little Scioto River (WWH, AWS, IWS, PCR-B)	11.10					
City of Marion-Little Scioto River (HUC 0506000103-03)						
N. Rock Swale Ditch (MWH, AWS, IWS, SCR)	2.55					
N. Rock Swale Ditch (MWH, AWS, IWS, SCR)	0.55				Dissolved oxygen	c
Little Scioto River (WWH, AWS, IWS, PCR-B)	9.24					
Little Scioto River (MWH, AWS, IWS, PCR)	6.50				Dissolved oxygen	c
Little Scioto River	6.39			Marion WWTP		
Little Scioto River (MWH, AWS, IWS, PCR)	5.74					
Honey Creek-Little Scioto River (HUC 0506000103-04)						
Honey Creek (WWH, AWS, IWS, SCR)	0.10					
Little Scioto River (MWH, AWS, IWS, PCR)	0.39					

MWH_c—Modified Warmwater Habitat, channel modification
WWH—Warm Water Habitat
AWS—Agricultural Water Supply
IWS—Industrial Water Supply
PCR—Primary Contact Recreation (A=, B=, C=)
SCR—Secondary Contact Recreation
NA—Not Applicable
a—violates an NPDES permit limit
c—violates the aquatic life protection criterion outside the mixing zone (minimum or maximum)

Panther Creek-Scioto River Watershed

This particular HUC grouping encompasses much of the Scioto River main stem and tributaries from Taylor Creek in Kenton to Green Camp, just upstream from the Little Scioto River. This watershed is divided into 6 smaller drainages including Gander Run-Scioto River, Wolf Creek-Scioto River, Panther Creek, Wildcat Creek, La Rue-Scioto River, and Glade Run-Scioto River. Sixteen main stem and tributary sites were sampled in this area during 2009.

Scioto River

Two main stem sites bracketing the Kenton WWTP were evaluated along with effluent sampling. The Kenton discharge exhibited an obvious influence on the Scioto River main stem during the summer months. Total inorganic nitrogen (TIN) and total phosphorus concentrations rose precipitously downstream of the WWTP discharge. Trend analysis of these same nutrients showed little change from 1995 sample results (Figure 29 & Figure 28). Additionally, chloride concentrations were also elevated downstream due to the WWTP discharge (Figure 50). Median ammonia concentrations downstream of Kenton were lower in 2009 compared to 1995, but were still above the ecoregional reference value of 0.025 mg/l (Figure 1).

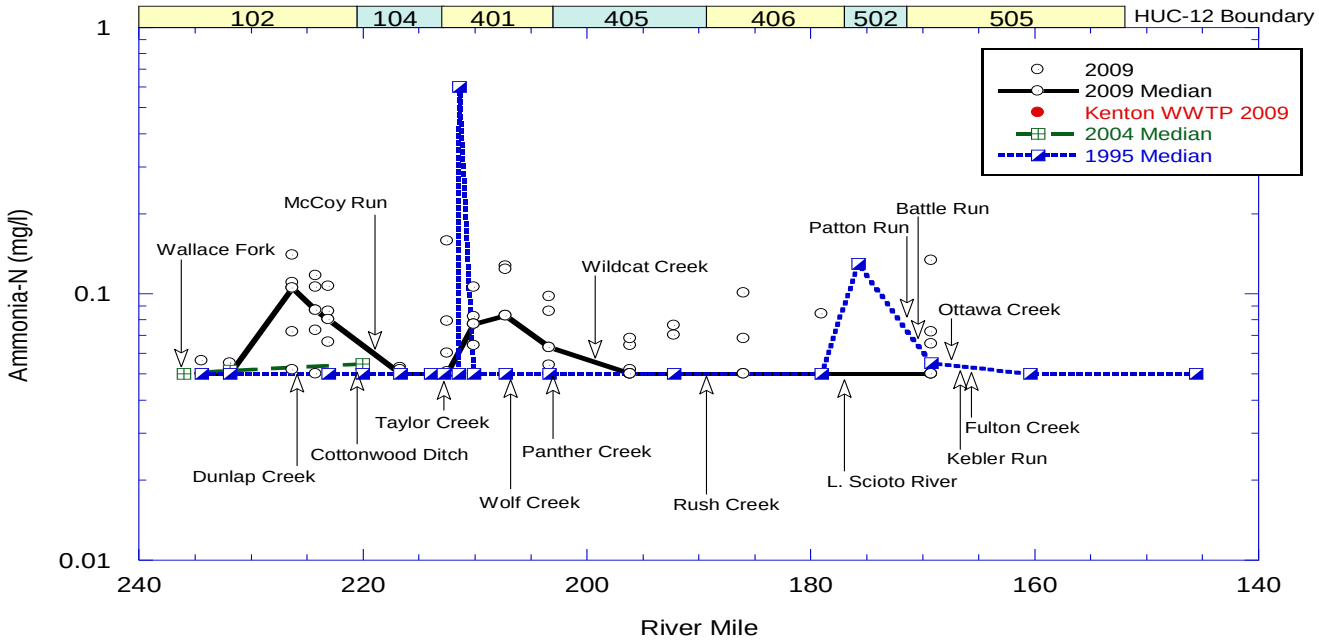

Figure 49. Ammonia-N (mg/l) trends for the upper Scioto River main stem by river mile, 1995- 2009.

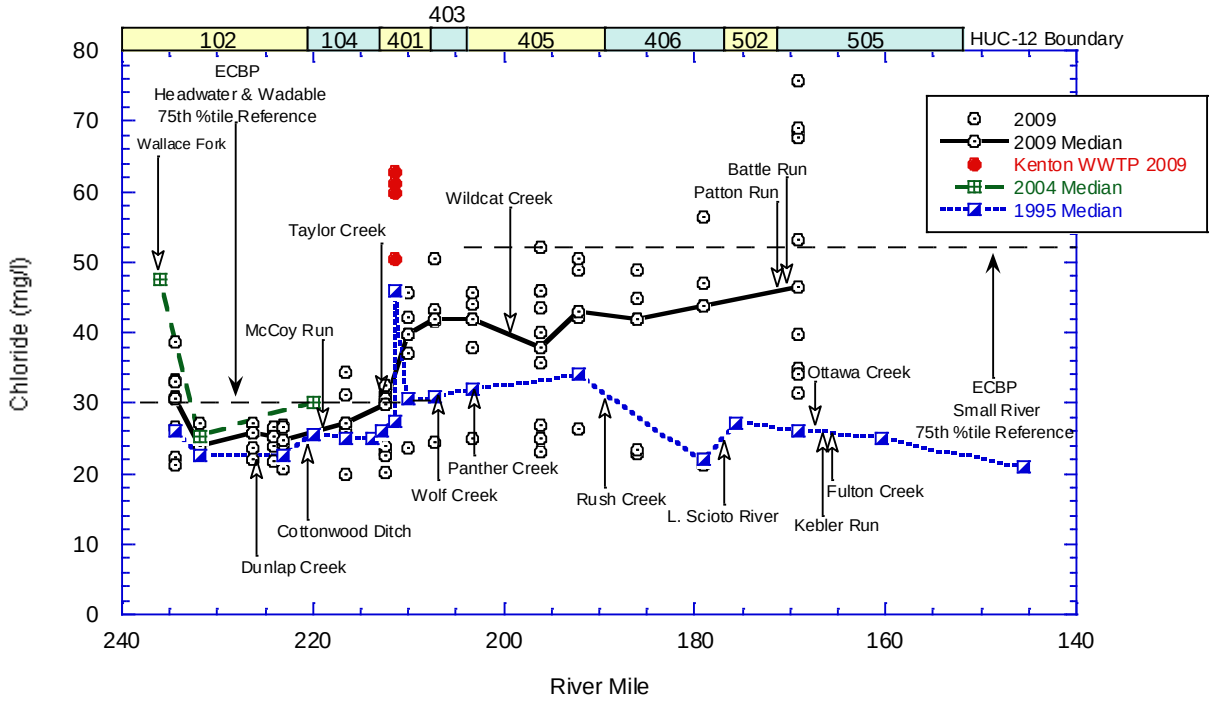

Figure 50. Chloride (mg/l) trends for the upper Scioto River main stem, 1995-2009.

Panther Creek

Three sites were evaluated on Panther Creek. Samples taken in mid-August revealed violations of WWH minimum dissolved oxygen concentrations at each of the 3 locations (Table 21). Nutrient concentrations were moderately elevated at all locales but in line with values seen in similarly sized streams in the upper Scioto study area (Figure 34 & Figure 39). Also, two mid-summer sampling events revealed highly elevated concentrations of dissolved solids and chloride (Appendix F-1, Figure 51, and Figure 52) that were atypical of area streams. There are no obvious causes or sources of these salt constituents.

Trends analysis revealed some differences between 1995 and 2009 results. At the mouth, median phosphorus and TKN concentrations double in 2009 and suspended solids quadrupled (Figure 53 - Figure 55). Median dissolved oxygen concentrations in 2009 were very similar to those in 1995 over the length of the stream.

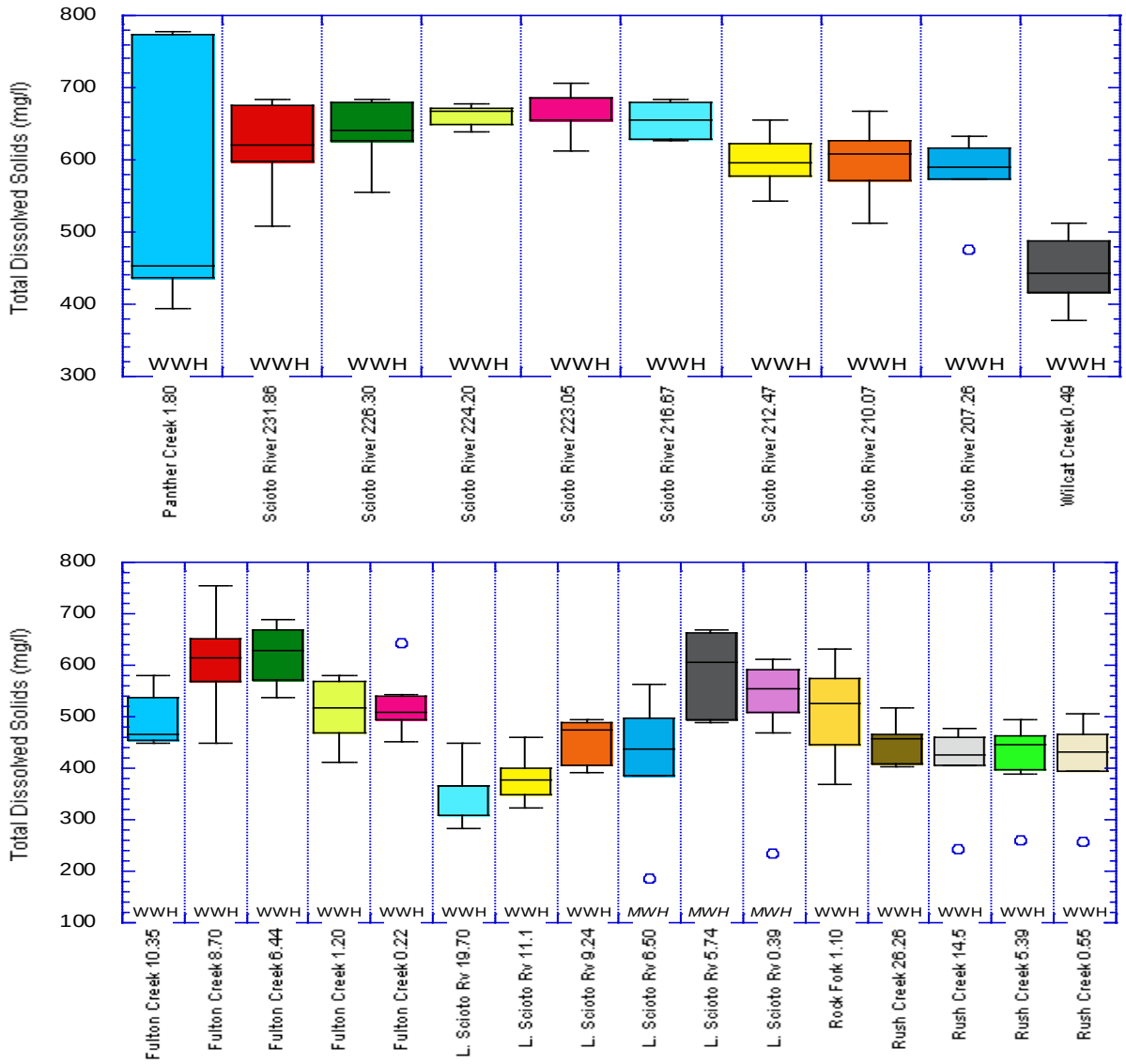

Figure 51. Total dissolved solids (mg/l) values for wading sites in the upper Scioto River watershed, 2009.

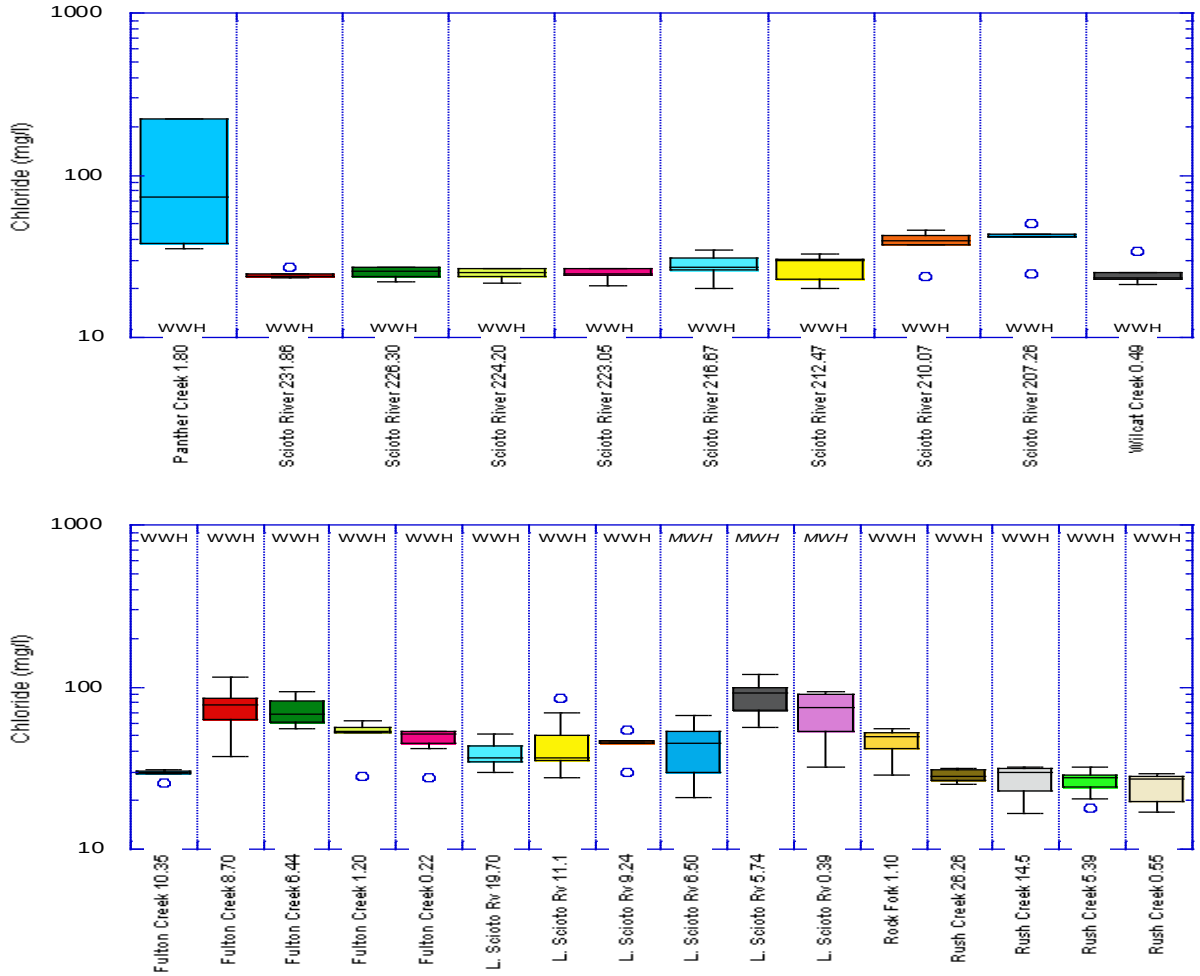

Figure 52. Chloride (mg/l) values for wading sites in the upper Scioto River watershed, 2009.

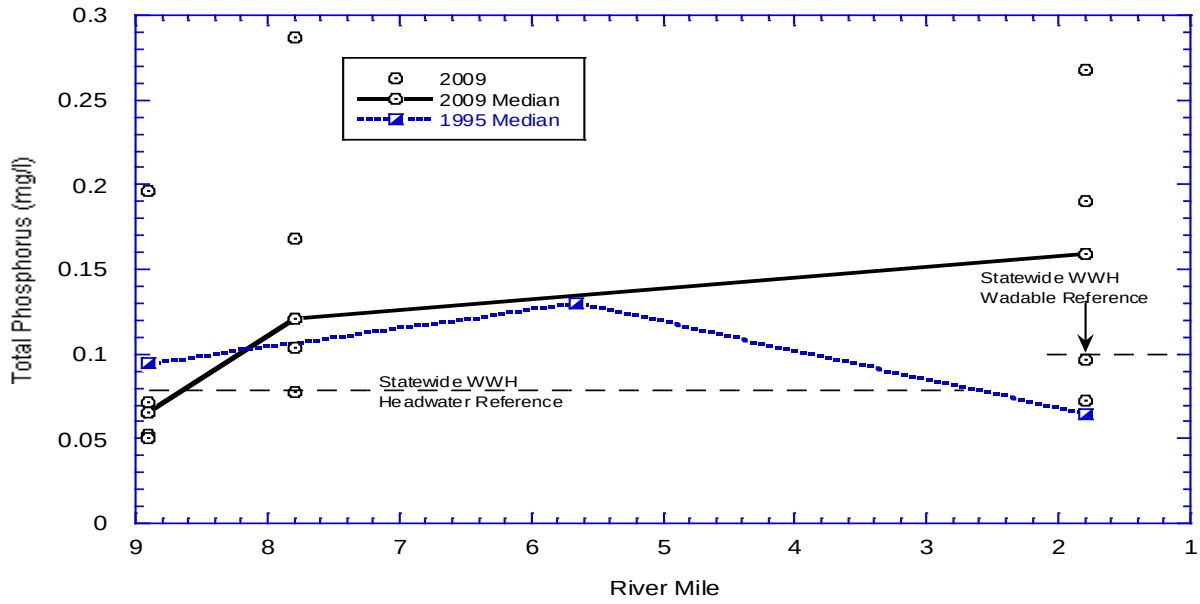

Figure 53. Total Phosphorus (mg/l) trends for Panther Creek, 1995 vs. 2009.

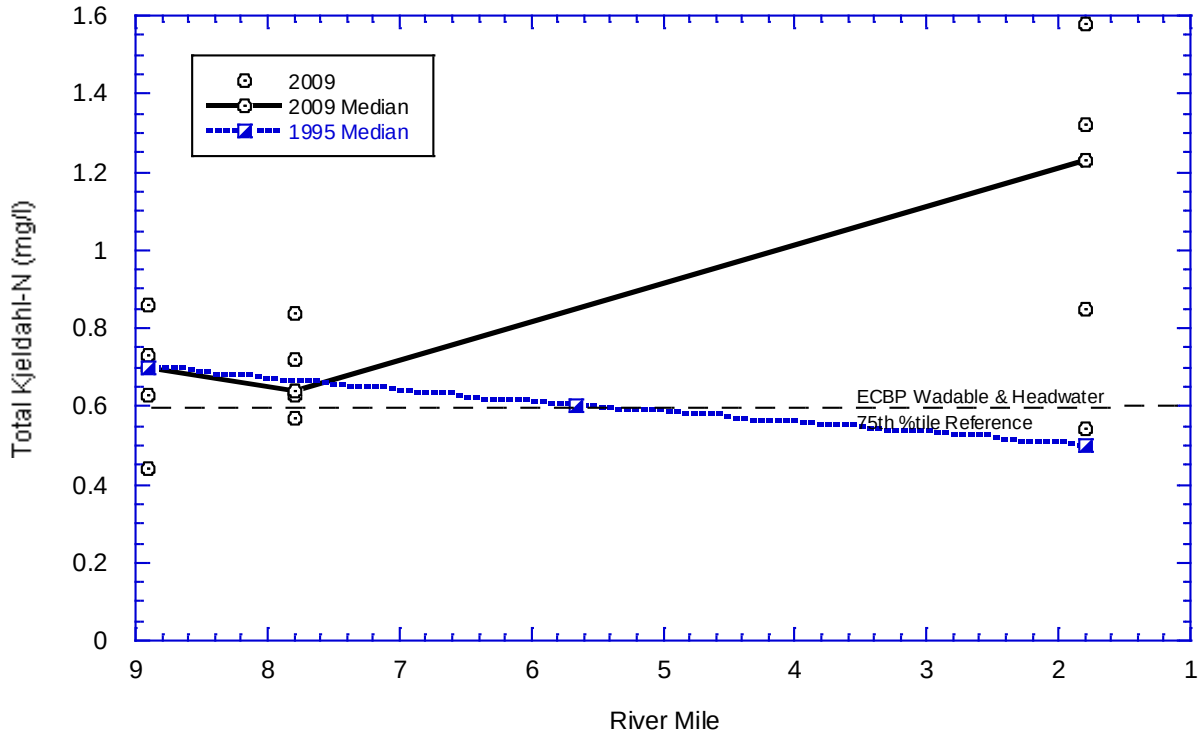

Figure 54. Total Kjeldahl-N (mg/l) trends for Panther Creek, 1995 vs. 2009.

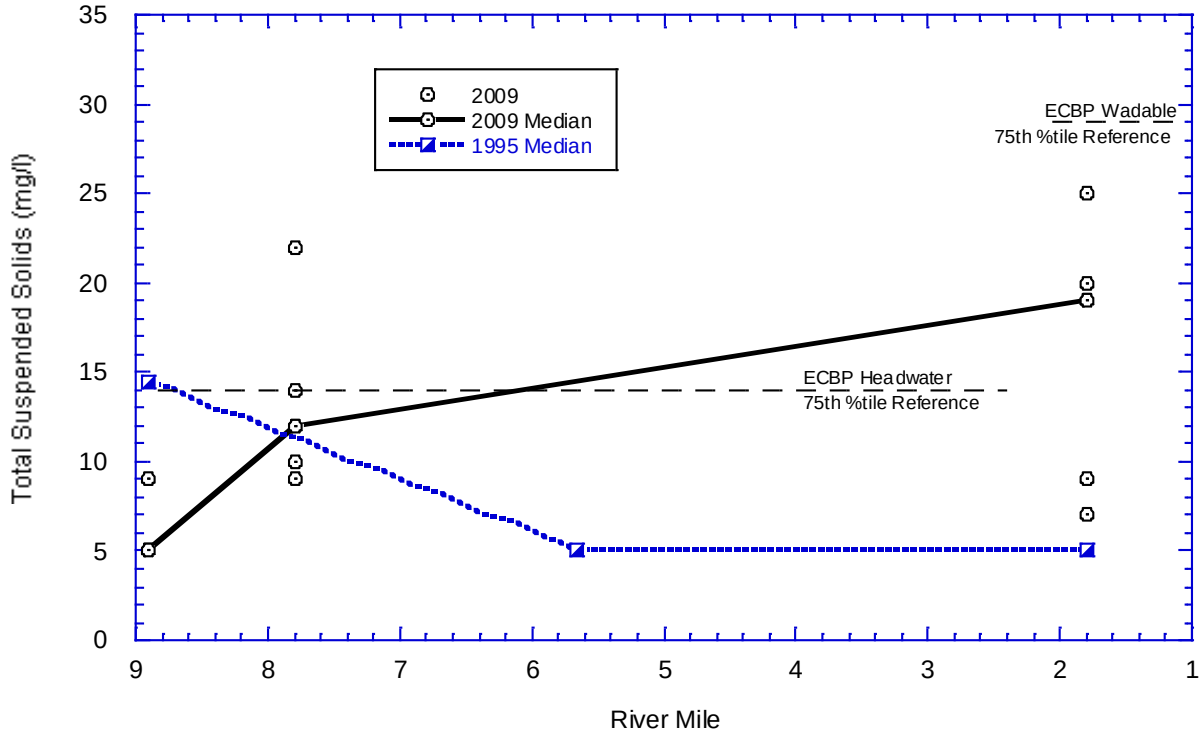

Figure 55. Total suspended solids (mg/l) trends for Panther Creek, 1995 vs. 2009.

Wolf Creek-Scioto River

Two sites were evaluated in this hydrologic unit, one on the Scioto River main stem and one at the mouth of Wolf Creek. The site on the Scioto River at RM 207.26 exhibited one violation of the WWH dissolved oxygen minimum criterion with a reading of 3.88 mg/l on August 17, 2009 (Table 21). Nutrient enrichment was also evident with highly elevated concentrations of total phosphorus and elevated concentrations of TIN (Appendix F-1). Water chemistry trends for this site showed little change between median values from 1995 and 2009 (Figure 29).

Sporadic low dissolved oxygen concentrations in Wolf Creek appeared the result of nutrient enrichment and low flow. Nutrient concentrations were similar to other agricultural headwater streams in the area with elevated concentrations of total phosphorus, ammonia, and TKN (Figure 34, Figure 57, Figure 48). The channel was wetted throughout the summer but flow was often very low, possibly interstitial. This combination of low flow and background enrichment likely accounted for the depressed dissolved oxygen regime.

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Trend analysis for the single site on the Scioto River did not reveal much change comparing 2009 data with 1995 data. Slight increases in median nutrient concentrations were evident as was increased chloride (Figure 56, Figure 28, and Figure 50).

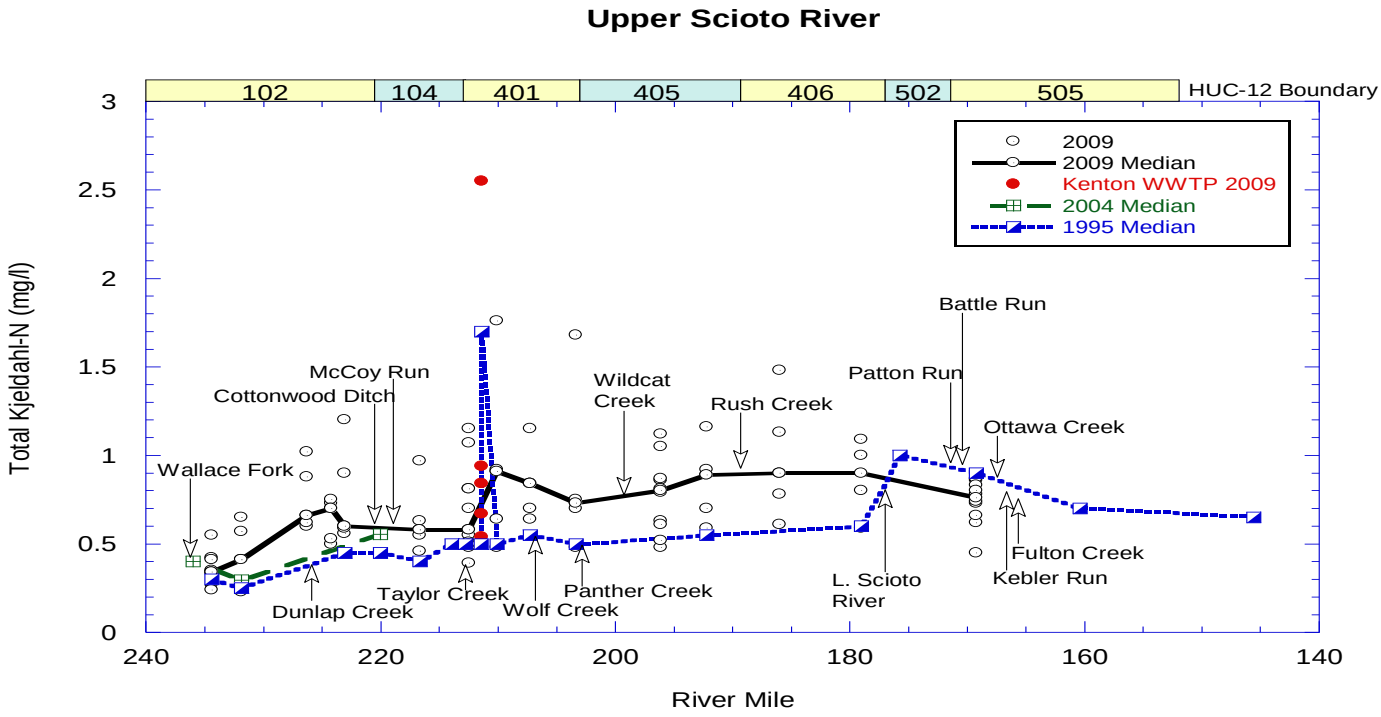

Figure 56. Total Kjeldahl-N (mg/l) trends for the upper Scioto River main stem, 1995 vs. 2009.

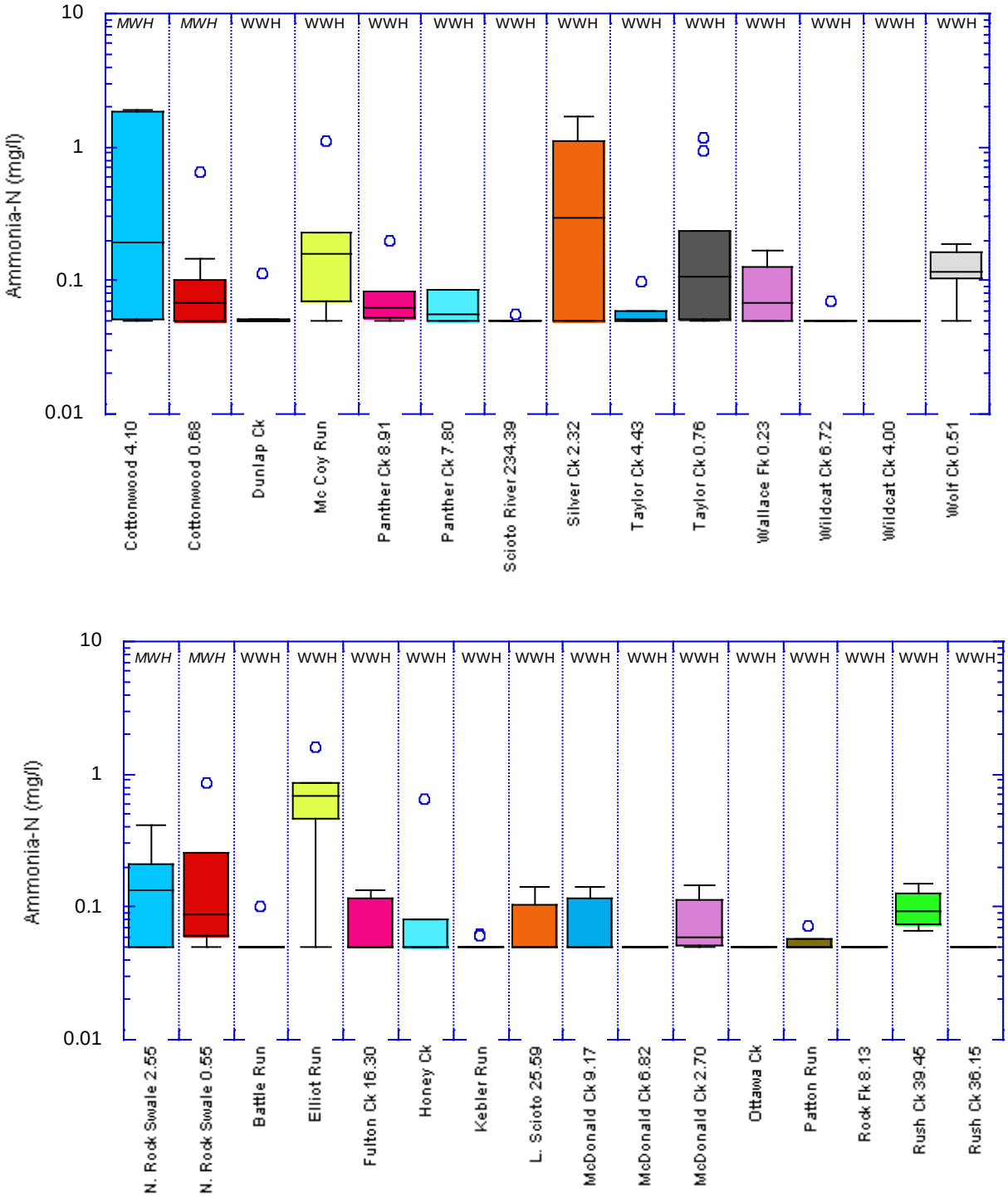

Figure 57. Ammonia-N (mg/l) values for headwater sites in the upper Scioto River watershed, 2009.

Wildcat Creek

As with Panther Creek, 3 sites were evaluated in Wildcat Creek. No WQS violations were recorded but the results did reveal moderate nutrient enrichment from organic nitrogen (TKN) and total phosphorus (Appendix F-1) which persisted throughout the summer. Total inorganic nitrogen concentrations were typically wide ranging with highly elevated values found in June and much reduced results observed during the remainder of the summer (Appendix F-1). These trends were fairly typical of other area streams similar to Wildcat Creek (Figure 32, Figure 34, Figure 48, Figure 40, Figure 39, and Figure 43). Like other area streams, agricultural production is the likely source for nutrients in this sub-watershed.

Trends analysis showed significant declines in median chloride concentrations from 1995 to 2009 with increases in total phosphorus and TKN over the same period (Figure 58) indicating intensified nutrient enrichment.

La Rue-Scioto River

Three Scioto River main stem sites were sampled in this drainage to determine chemical water quality. No violations of chemical water quality standards were noted in the grab samples. At this point in the Scioto River watershed, the main stem drainage area begins exceeding 200 mi^2 meeting the definition of a small river. Although nutrient enrichment was apparent in the form of moderate concentrations of TKN, total phosphorus, and highly elevated TIN (early season only for TIN), these values were typical of the other small river sites evaluated on the Scioto River main stem (Appendix F-1, Figure 56, Figure 28, Figure 60).

Trends analysis showed little change between results obtained in 1995 compared with those obtained in 2009 although small increases in median concentrations of chloride and TKN were noted (Figure 50, Figure 56). Judging the effects of these increases is problematic due to the consequences of the fish kill upstream in HUC 01.

Glade Run-Scioto River

Two sampling sites were evaluated on the Scioto River main stem for this drainage. Neither site revealed any violations of chemical water quality standards. As with other sub-basins in this hydrologic unit, both sites showed evidence of nutrient enrichment, primarily from TKN and total phosphorus along with the typical seasonal uptick from TIN (Appendix F-1). Chemistry values were similar in most respects to the other small river sites with a notable exception. The site at RM 179.05 revealed TIN maximum and median concentrations nearly one-tenth of the other small river sites (Figure 59). The cause of this anomaly is unknown. Trends analysis also revealed a similar decrease in median TIN values between 1995 and 2009 at RM 179.05 (Figure 29). Increases in TKN and Cl were also noted (Figure 56, Figure 50).

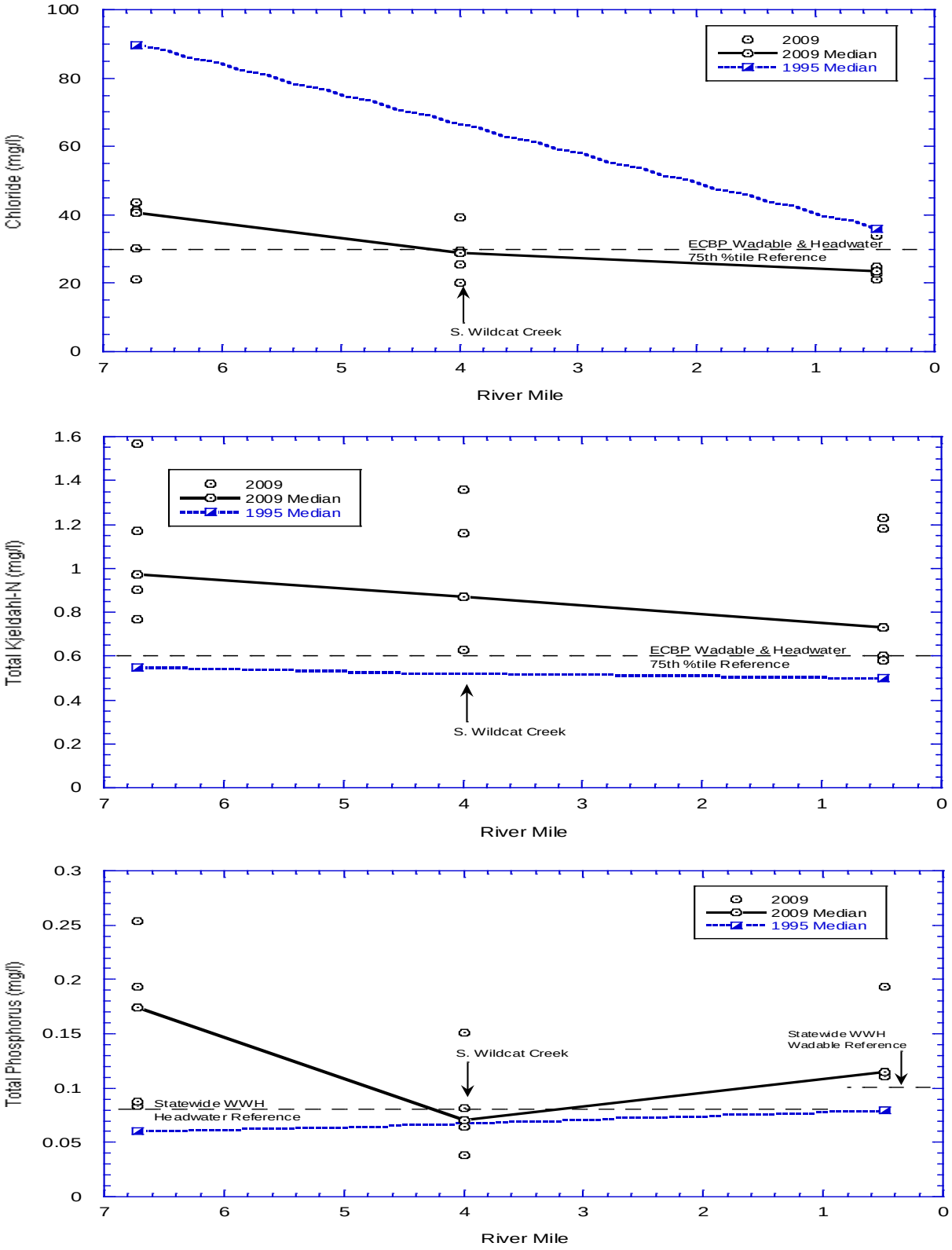

Figure 58. Chloride, total Kjeldahl-N, and total phosphorus (mg/l) trends for Wildcat Creek, 1995 vs. 2009.

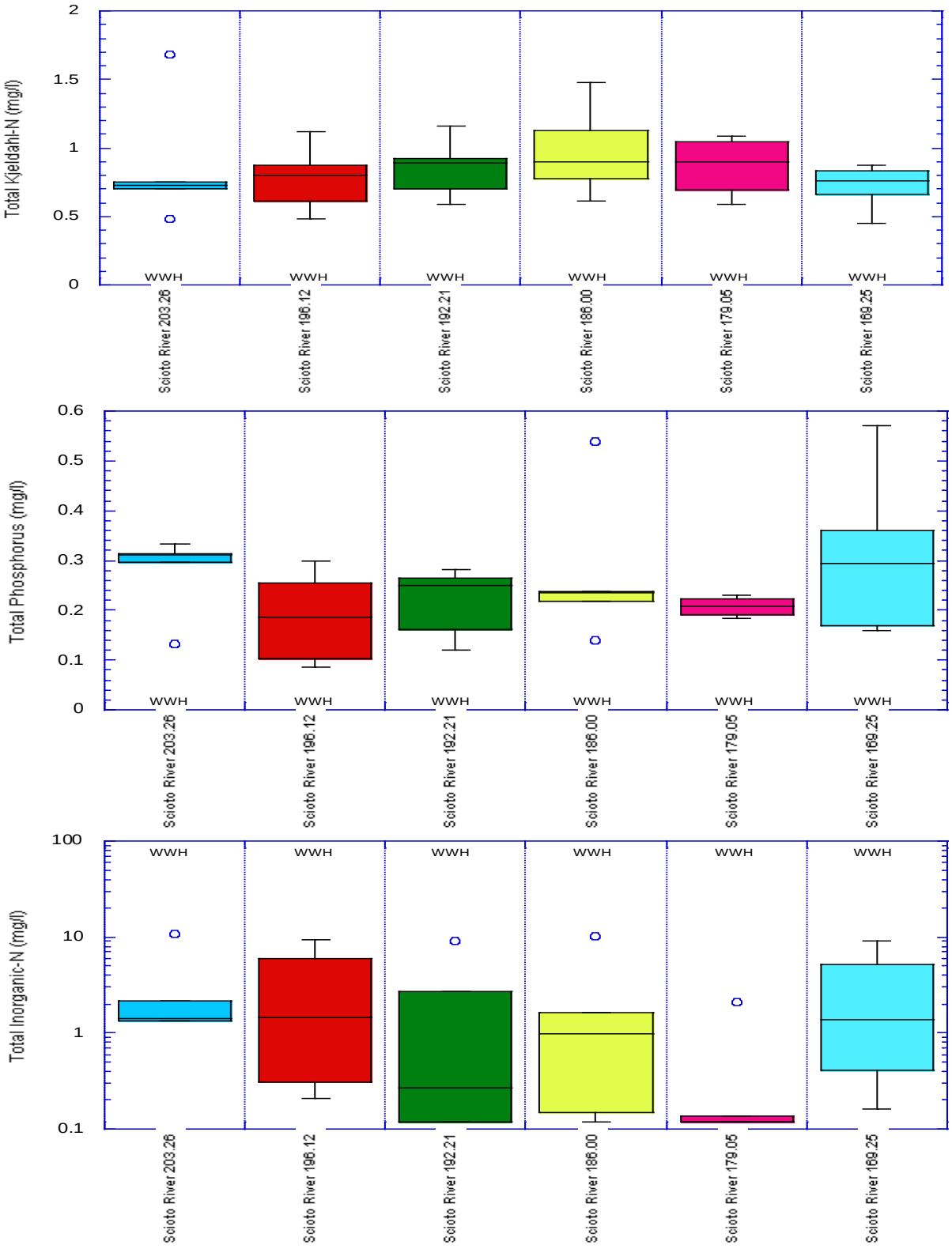

Figure 59. Total Kjeldahl-N, total inorganic-N, and total phosphorus (mg/l) values for the upper Scioto River main stem, 2009.

Table 21. Violations of chemical water quality standards in the Panther Creek-upper Scioto River basin (HUC 0506000104) in 2009. Wastewater treatment facilities are listed where their discharge points occur. Sites with no entries do not have any violations.

River/Stream (Uses)	River Mile	QHEI	Biological Use Attainment	NPDES Discharge	Parameter	Code
Gander Run-Scioto River (HUC 050600104-01)						
Scioto River (WWH, AWS, IWS, PCR-A)	212.47					
Scioto River		NA	NA	Kenton WWTP		
Scioto River (WWH, AWS, IWS, PCR-A)	210.07					
Panther Creek (HUC 0506000104-02)						
Panther Creek (WWH, AWS, IWS, PCR-B)	8.91				Dissolved oxygen	c
Panther Creek (WWH, AWS, IWS, PCR-B)	7.80				Dissolved oxygen	c
Panther Creek (WWH, AWS, IWS, PCR-B)	1.80				Dissolved oxygen	c
Wolf Creek-Scioto River (HUC 0506000104-03)						
Wolf Creek (WWH, AWS, IWS, PCR-B)	0.51				Dissolved oxygen	c
Scioto River (WWH, AWS, IWS, PCR-A)	207.26					
Wildcat Creek (HUC 0506000104-04)						
Wildcat Creek (WWH, AWS, IWS, PCR-B)	6.72					
Wildcat Creek (WWH, AWS, IWS, PCR-B)	4.00					
Wildcat Creek (WWH, AWS, IWS, PCR-B)	0.49					
LaRue-Scioto River (HUC 0506000104-05)						
Scioto River (WWH, AWS, IWS, PCR-A)	203.36					
Scioto River (WWH, AWS, IWS, PCR-A)	196.12					
Scioto River (WWH, AWS, IWS, PCR-A)	192.21					
Glade Run-Scioto River (HUC 0506000104-06)						
Scioto River (WWH, AWS, IWS, PCR-A)	186.00					
Scioto River (WWH, AWS, IWS, PCR-A)	179.05					

MWH_c—Modified Warmwater Habitat, channel modification
WWH—Warm Water Habitat
AWS—Agricultural Water Supply
IWS—Industrial Water Supply
PCR—Primary Contact Recreation (A=, B=, C=)
SCR—Secondary Contact Recreation
NA—Not Applicable
a—violates an NPDES permit limit
c—violates the aquatic life protection criterion outside the mixing zone (minimum or maximum)

Fulton Creek Watershed

This particular HUC grouping encompasses all of the Fulton Creek drainage plus several minor Scioto River tributaries. This drainage is divided into 5 smaller drainages including Patton Run, David's Run-Scioto River, Kebler Run, Fulton Creek, and Ottawa Creek-Scioto River. Twelve sites were sampled in this area during the summer of 2009. Lack of historical sampling data prevented an analysis of water chemistry trends in the Fulton Creek HUC except at the lone site on the Scioto River at RM 169.25.

Patton Run

There were no violations of chemical water quality standards noted at the single site monitored in this drainage. Nutrient enrichment from nitrogen compounds was also less intense than other headwater streams of the upper Scioto watershed (Figure 34 & Figure 48). Total phosphorus concentrations instream were akin to those of other headwater streams (Figure 34).

Kebler Run

Kebler Run was evaluated at a single site near the mouth at RM 0.87. Since it was a sentinel sampling site, additional samples were collected beginning in February 2009 and ending in November 2009. Chemical water quality standards were not violated in any of the water samples obtained from the stream. Light to moderate nutrient enrichment was in evidence. TIN concentrations were especially noteworthy in early season samples from February until June with concentrations attenuating markedly after June. Both total phosphorus and TKN were slightly elevated as well. Agricultural activities, including row crop production, are likely sources for the nutrients. Cool instream temperatures coupled with high strontium concentrations (median = 3300 mg/l) suggest significant groundwater influence in this stream (Appendix F-1).

Fulton Creek (HUC 04)

Fulton Creek is one of the larger tributaries of the upper Scioto basin. Seven stream sampling stations were evaluated as was the Richwood WWTP discharge for a total of 8 locations. Six of the 7 stream sampling sites exhibited violations of chemical water quality standards for dissolved oxygen (Table 22). Elevated concentrations of ammonia, TKN, and TIN in addition to highly elevated concentrations of total phosphorus were apparent in Fulton Creek and indirectly influenced dissolved oxygen concentrations via increased primary productivity. A portion of this nutrient load (mostly ammonia and some of the total phosphorus) emanated from the Richwood WWTP, however this does not account for nutrient loadings originating upstream from Richwood (Appendix F-1). Elliot Run (a small tributary to Fulton Creek) was also determined to be a major source of ammonia, TIN, total dissolved solids, and TKN to Fulton Creek. Part of the nutrient problem in Fulton Creek resulted from an ammonia-nitrogen spill which occurred in Elliot Run resulting in the death of both fish and crayfish. A single sample taken from Elliot Run at Kenny Pike on May 27, 2009 revealed toxic concentrations of ammonia-N (81 mg/l). Investigators determined that the spill was accidental and that the mitigation from the responsible party was both timely and effective in reducing the

negative consequences of the 600 gallon spill (Robin Sweeney, USDA, e-mail communication).

Ottawa Creek-Scioto River (HUC 05)

Three sites were evaluated in this drainage including single sites on Ottawa Creek, Battle Run, and the Scioto River. There was a single violation of the dissolved oxygen WWH minimum standard found in Battle Run. Otherwise, there were no other violations of water quality standards in this drainage. Depressed daytime dissolved oxygen in Battle Run was likely the result of significant nutrient enrichment with significant concentrations of ammonia detected in the same sample exhibiting low dissolved oxygen concentrations (Appendix F-1). Total phosphorus concentrations were also consistently amongst the highest seen in any headwater stream (Figure 34). Agricultural production is a likely source for the nutrient conditions at this site.

Ottawa Creek was not similarly endowed with elevated nutrient concentrations, although there was the typical spring spike of TIN (Appendix F-1). Total phosphorus concentrations in Ottawa Creek were also slightly elevated during the entire survey period (Appendix F-1). Agricultural land use conditions also dominate this subwatershed.

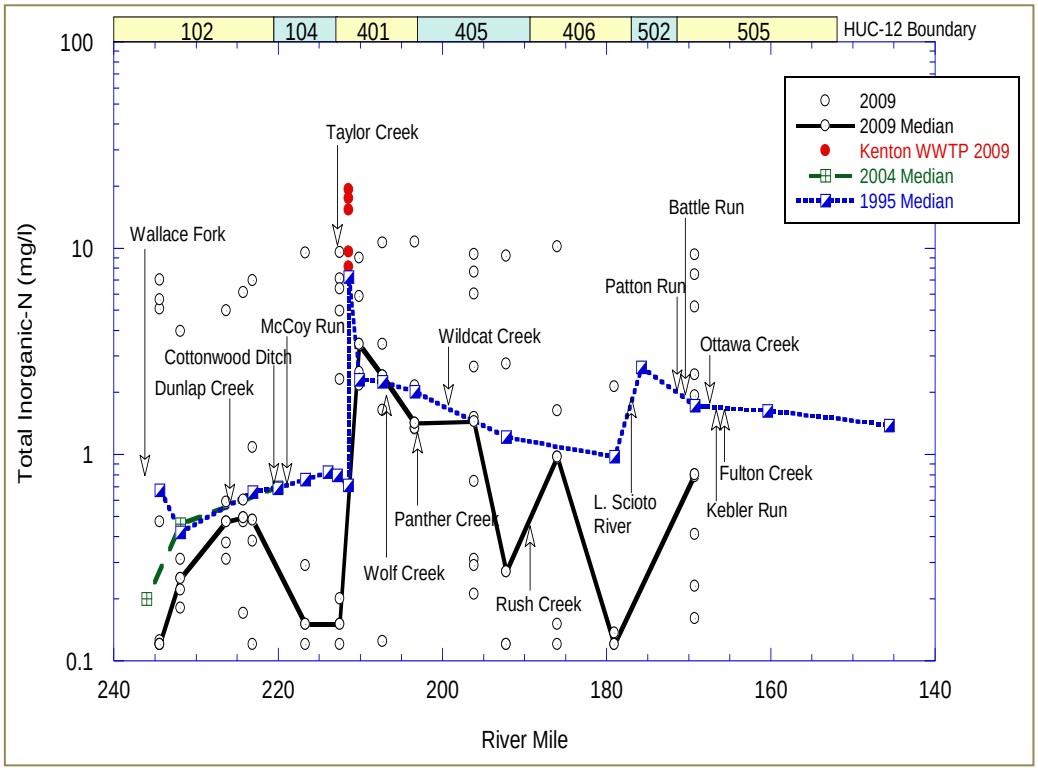

Figure 60. Total inorganic-N (mg/l) values for the upper Scioto River main stem, 2009.

The Scioto main stem site at RM 169.25 was a sentinel sampling location with samples gathered over an 8 month period. Nutrient enrichment was highly evident at this site with the winter and spring period dominated by TIN and the summer dominated by total phosphorus (Appendix F-1). Median concentrations of most parameters did not differ markedly from samples obtained in 1995 indicating a flat trend (Figure 28 & Figure 30) or even decreased concentrations (Figure 59). The only parameter with a significantly increased concentration between 1995 and 2009 was chloride (Figure 50).

Table 22. Violations of chemical water quality standards in the Fulton Creek-upper Scioto River basin (HUC 0506000105) in 2009. Wastewater treatment facilities are listed where their discharge points occur. Sites with no entries do not have any violations.

River/Stream (Uses)	River Mile	NPDES Discharge	Parameter	Code
Patton Run (HUC 0506000105-01)				
Patton Run (WWH, AWS, IWS, PCR-B)	2.25			
Kebler Run (HUC 0506000105-03)				
Kebler Run (WWH, AWS, IWS, PCR-B)	0.87			
Fulton Creek (HUC 0506000105-04)				
Elliot Run (U)	1.25		Dissolved oxygen	c
Fulton Creek (WWH, AWS, IWS, PCR-B)	16.30		Dissolved oxygen	c
Fulton Creek (WWH, AWS, IWS, PCR-B)	10.35		Dissolved oxygen	c
	9.50	Richwood WWTP		
Fulton Creek (WWH, AWS, IWS, PCR-B)	8.70		Dissolved oxygen	c
Fulton Creek (WWH, AWS, IWS, PCR-B)	6.44		Dissolved oxygen	c
Fulton Creek (WWH, AWS, IWS, PCR-B)	1.20		Dissolved oxygen	c
Fulton Creek (WWH, AWS, IWS, PCR-B)	0.22			
Ottawa Creek-Scioto River (HUC 0506000105-05)				
Battle Run (WWH, AWS, IWS, PCR-B)	0.25		Dissolved oxygen	c
Scioto River (WWH, AWS, IWS, PCR-B)	169.25			
Ottawa Creek (WWH, AWS, IWS, PCR-B)	0.08			

MWH_c—Modified Warmwater Habitat, channel modification
WWH—Warm Water Habitat
AWS—Agricultural Water Supply
IWS—Industrial Water Supply
PCR—Primary Contact Recreation (A=, B=, C=)
SCR—Secondary Contact Recreation
NA—Not Applicable
U—Undesignated (treat as WWH, AWS, IWS, PCR or SCR)
a—violates an NPDES permit limit
c—violates the aquatic life protection criterion outside the mixing zone (minimum or maximum)

Public Drinking Water Supplies

The public water supply (PWS) beneficial use in the WQS (OAC 3745-1-33) currently applies within 500 yards of drinking water intakes and for all publicly owned lakes. Ohio EPA has developed an assessment methodology for this beneficial use which focuses on source water contaminants not effectively removed through conventional treatment methods. The 2010 Integrated Water Quality Report describes this methodology and is available on OEPA's website:

http://www.epa.state.oh.us/dsw/tmdl/OhioIntegratedReport.aspx.

Impaired source waters may contribute to increased human health risk or treatment costs. For the case when stream water is pumped to a reservoir, the stream and reservoir will be evaluated separately. These assessments are designed to determine if the quality of source water meets the standards and criteria of the Clean Water Act. Monitoring of the safety and quality of treated finished drinking water is regulated under the Safe Drinking Water Act and evaluated separately from this assessment. For those cases when the treatment plant processes do not specifically remove a source water contaminant, the finished water quality data may be considered representative of the raw source water directly feeding into the treatment plant.

One public water system (Marion - Aqua Ohio) is directly served by surface water sources within the study area. Marion has an intake on the Little Scioto River at RM 7.1 and an intake on the Scioto River at RM 180.04. Table 23 provides a summary of water quality data for the PWS use while Appendix F-1 contains all of the water quality analytical results.

Aqua Ohio Marion operates a community public water system that serves a population of approximately 42,000 people through 16,770 service connections. A community public water system is a system that regularly supplies drinking water from its own sources to at least 15 service connections used by year-round residents of the area or regularly serves 25 or more people throughout the entire year. The water treatment system obtains its water from the Little Scioto River, the Scioto River and the Marion Wellfield. The system's treatment capacity is approximately 9.1 million gallons per day, but current average production is 6.74 million gallons per day. Water is pumped from the Scioto and Little Scioto Rivers and 16 ground water wells to the water treatment plant. Approximately one-third of the water is obtained from the wellfield and two-thirds from the two river intakes. Marion's treatment processes include pre-chlorination, aeration, lime softening, coagulation, sedimentation, sand filtration, powdered activated carbon adsorption, fluoridation, and disinfection.

Since Marion blends surface and ground water source waters and has advanced treatment capabilities, the treated water quality data is not representative of the water quality of the Scioto and Little Scioto source waters and cannot be used to assess the PWS beneficial use. Treated water data did show elevated atrazine (max 6.9 ug/L in June 2008) and since pesticides are more likely to be attributed to surface water sources, the source waters for Marion were placed on the pesticide watch list until additional stream data could be obtained.

Ohio EPA collected a total of four water quality samples one mile downstream of Marion's intake on the Scioto River in 2009. To assess the PWS beneficial use, samples were analyzed for nitrate. Nitrate ranged from non-detect to 2.1 mg/L and averaged 0.53 mg/L. Pesticides samples were not collected. Additional nitrate and pesticide samples are needed to complete a full assessment of the PWS use.

Ohio EPA collected one water quality sample in 1998 approximately 0.8 miles upstream of Marion's intake on the Little Scioto River and six water quality samples in 2009 and 2010 approximately 0.6 miles downstream of the Little Scioto River intake. Nitrate ranged from 0.23 to 4.9 mg/L. Pesticides samples were not collected. Additional nitrate and pesticide samples are needed to complete a full assessment of the PWS use

Table 23. Summary of available water quality data for parameters of interest at sampling sites near PWS intakes.

Location(s)	PDWS Parameters of Interest			
	Nitrate-Nitrite WQC = 10 mg/L[1, 2]		Atrazine WQC = 3.0 ug/L[3]	
	Average/ (sample count)	Maximum (# samples >WQC)	Average / (sample count)	Maximum
Scioto River adjacent Green Camp Road (RM 179.05)	0.53 mg/L n=4	2.1 mg/L (0)	No Data	No Data
Little Scioto River at Marion Upstream of Marion WWTP (RM 6.5)	1.4 mg/L n=6	4.9 mg/L (0)	No Data	No Data
Little Scioto River at Marion at SR 309 (RM 7.86)	2.2 mg/L n=1	2.2 mg/L (0)	No Data	No Data

1 Nitrate Water Quality Criteria (WQC) evaluated as maximum value not to be exceeded, impaired waters defined as having two or more excursions about the criteria.

2 Insufficient data available to assess the PDWS beneficial use. Need a minimum of 10 samples per intake collected during critical spring runoff period (no samples were collected April through early June).

3 Insufficient data available to assess the annual average for the PDWS beneficial use.

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	Fish Community: Ben Rich with college interns: Caleb Shields (2009), Josh Britton (2009), Mathew Bourne (2011-resampling), and John "Dan" Welch (2011-resampling)

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*Some of the references not in the report can be found in the Appendix E-1 (Table 11) which includes Methods, Biosurvey Background Information, and Notice to Users.