Regional Water Quality NEWSLETTER

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Sampling conducted July 6 & 7 2009
A Phoenix, Tempe, Glendale, Peoria, CAP, SRP – ASU Regional Water Quality Partnership

http://enpub.fulton.asu.edu/pwest/tasteandodor.htm

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SUMMARY: EVALUATION AND RECOMMENDATIONS

1. MIB plus geosmin levels above 10 ng/L in finished water lead to noticeable earthy-musty odors by customers. **Currently MIB+geosmin levels are near or slightly above 10 ng/L in several WTPs raw waters**. However, treatment with PAC or GAC is bringing these levels down to less noticeable levels.
2. MIB and geosmin levels are now detectable in the reservoirs and rivers as the summer progresses. This is typical as the lake temperatures go above 20 ^{o}C and cyanobacteria that produce these compounds start to grow. We usually observe the highest concentrations in lakes between now and September. There is no evidence of MIB or geosmin production in the SRP canal system.
3. Several City of Phoenix treatment plants are adding copper sulfate for in-plant algae control.
4. Two City of Phoenix plants now use ferric chloride for coagulation (particle removal and DOC removal) instead of alum.
5. For a new twist on our regional water issues – we discuss organics (bulk DOC and trace pharmaceuticals) that are present in wastewaters around Arizona.

Table 1a Summary of WTP Operations July 6, 2009

	Verde WTP	Union Hills	24th Street WTP	N.Tempe J.G. Martinez	Deer Valley	Glendale Cholla WTP [3]	Peoria Greenway WTP	Val Vista	South Tempe
	Verde River	CAP Canal	Arizona Canal					South Canal	
PAC Type and Dose	None	None	Calgon WPH 15 ppm		Calgon 15 ppm	None	None (uses GAC)	Calgon 12 ppm	Aqua Nuchar 15 ppm
Copper Sulfate	0.02 ppm	None	0.5 ppm		None	None	None	0.25 ppm	None
PreOxidation	none	None	None		None	1x per week for 6 hours at 2 ppm	2.25 ppm ozone	None	None
Alum Dose Alkalinity pH	56 ppm 156 7.0	12.5 ppm[1] 125 7.2	50 ppm 135/105 6.8		48 ppm 148/111 6.85	40 ppm 135 8.3	25 ppm 140 7.3	30 ppm[1] 115 7.2	31 ppm 144 7.5
Finished water DOC DOC removal[2]		2.5 mg/L 20%	3.0mg/L 29%		2.8 mg/L 42%	3.3 mg/L[3] 30%	3.9 mg/L 16%	3.3 mg/L 30%	3.5 mg/L 18%
Average turbidity over last 7 days	2 ntu	<1 NTU	5-10 ntu		12-15 ntu	12 ntu	6.5	5 ntu	3 ntu
Notes from operators		Trying to achieve 20-23% TOC removal and TTHMs 35-39ppbs	lot of dead algal material at raw water barscreens						
Recommendations							Improved DOC removal could be achieved by increasing alum dose		Improved DOC removal could be achieved by adding acid to reduce pH during coagulation

[1] Ferric chloride instead of alum; plus ppm sulfuric acid

[2] Calculated based upon influent and filtered water DOC (note that DOC and not TOC is used in this calculation)

[3] Sample from finished water includes a blend of surface and ground water sources

Why feed copper?

I should have clarified in my earlier email that 24th St WTP is feeding 0.5 ppm of copper sulfate -- this is not the "active copper" feed, which would be 0.32 ppm "active copper." We are feeding copper sulfate to help control algae in the final sedimentation basins. We are feeding 0.5 ppm copper sulfate because we found that feeding 0.25 ppm was not effective at 24th St. We didn't have a high enough residual carrying into the final sedimentation basins, so algae was still growing there. When we increased the feed to 0.5 ppm, this seemed to keep the algae under control. It is more of a "preventative" dosage; we are trying to keep the algae from starting to grow in the basins more than we are trying to kill established algae. This is why we try to start feeding it around April, when the water gets warmer and there is more sunlight. Then we stop feeding it around October/November. (Allison Shepherd/COP)

Val Vista WTP switches to Ferric Chloride for the past several months
(valuable information from Charolette Jones / City of Phoenix)

A few years back an Engineering study was completed and it was determined that ferric would be a "better" coagulant. Last fall the plant was modified to feed ferric. We were at 20 ppm - but then when we increased the fed rate to 30 (in 2 basins initially) we saw an increase in TOC removals:

- East side 20 ppm - TOC = 3.2 mgl (38% removal)
- West side 30 ppm - TOC = 2.93 mgl (43% removal)

Table 1
SRP/CAP OPERATIONS - Values in cfs, for July 6, 2009

System	SRP Diversions	CAP
Arizona Canal	756	0
South Canal	612	0
Pumping	148	0
Total	1516	0

- **SRP is releasing water from both Verde and Salt River Systems**. Salt River release from Saguaro Lake: 1355 cfs; Verde River release from Bartlett Lake: 15 cfs.

Table 2 - Water Treatment Plants – July 6, 2009			
Sample Description	**MIB (ng/L)**	**Geosmin (ng/L)**	**Cyclocitral (ng/L)**
24th Street WTP Inlet	**5.0**	**6.3**	**<2.0**
24th Street WTP Treated	**2.8**	**<2.0**	**<2.0**
Deer Valley Inlet	**4.3**	**5.0**	**<2.0**
Deer Valley WTP Treated	**<2.0**	**<2.0**	**<2.0**
Val Vista Inlet	**4.1**	**2.0**	**<2.0**
Val Vista WTP Treated –East	**3.4**	**2.0**	**<2.0**
Val Vista WTP Treated -West	**3.7**	**<2.0**	**<2.0**
Union Hills Inlet	**2.2**	**<2.0**	**<2.0**
Union Hills Treated	**2.7**	**2.6**	**<2.0**
Tempe North Inlet			
Tempe North Plant Treated			
Tempe South WTP	**4.1**	**2.0**	**<2.0**
Tempe South Plant Treated	**2.4**	**<2.0**	**<2.0**
Greenway WTP Inlet	**2.2**	**2.0**	**<2.0**
Greenway WTP Treated	**2.4**	**<2.0**	**<2.0**
Glendale WTP Inlet	**<2.0**	**4.9**	**<2.0**
Glendale WTP Treated	**<2.0**	**<2.0**	**<2.0**

MIB plus geosmin levels above 10 ng/L in finished water lead to noticeable earthy-musty odors by customers. Currently MIB+geosmin levels are near or slightly above 10 ng/L in several WTPs. However, treatment with PAC or GAC is bringing these levels down to less noticeable levels.

Glendale blends surface and groundwaters, and is not using PAC or GAC for control of T&O compounds. Union Hills WTP is on the CAP canal which has lower MIB and Geosmin levels than the SRP system.

Table 3 - Canal Sampling – July 6, 2009

System	Sample Description	MIB (ng/L)	Geosmin (ng/L)	Cyclocitral (ng/L)
CAP	Waddell Canal	<2.0	<2.0	<2.0
	Union Hills Inlet	2.2	<2.0	<2.0
	CAP Canal at Cross-connect			
	Salt River @ Blue Pt Bridge	3.5	2.7	<2.0
	Verde River @ Beeline	6.6	3.4	<2.0
AZ	AZ Canal above CAP Cross-connect	4.3	2.7	<2.0
Canal	AZ Canal below CAP Cross-connect	4.1	2.0	<2.0
	AZ Canal at Highway 87	4.0	4.9	<2.0
	AZ Canal at Pima Rd.	3.5	<2.0	<2.0
	AZ Canal at 56th St.	5.1	2.2	<2.0
	AZ Canal - Inlet to 24th Street WTP	5.0	6.3	<2.0
	AZ Canal - Central Avenue	4.8	5.8	<2.0
	AZ Canal - Inlet to Deer Valley WTP	4.3	5.0	<2.0
	AZ Canal - Inlet to Glendale WTP	<2.0	4.9	<2.0
South	South Canal below CAP Cross-connect	5.4	3.2	<2.0
and	South Canal at Val Vista WTP	4.1	2.0	<2.0
Tempe	Head of the Tempe Canal	2.2	2.2	<2.0
Canals	Tempe Canal - Inlet to Tempe's South Plant	4.1	2.0	<2.0

Table 4 - Reservoir Samples – July 7, 2009

Sample Description	Location	MIB (ng/L)	Geosmin (ng/L)	Cyclocitral (ng/L)
Lake Pleasant (6/09)	Eplimnion	3.9	2.6	<2.0
Lake Pleasant (6/09)	Hypolimnion	2.4	<2.0	<2.0
Verde River @ Beeline		6.6	3.4	<2.0
Bartlett Reservoir	Epilimnion	2.2	3.1	<2.0
Bartlett Reservoir	Epi-near dock	3.4	2.9	<2.0
Bartlett Reservoir	Hypolimnion	<2.0	<2.0	<2.0
Salt River @ BluePt Bridge		3.5	2.7	<2.0
Saguaro Lake	Epilimnion	6.1	7.9	<2.0
Saguaro Lake	Epi - Duplicate	6.3	9.9	<2.0
Saguaro Lake	Epi-near dock	3.4	26.5	<2.0
Saguaro Lake	Hypolimnion	3.2	2.1	<2.0
Verde River at Tangle Creek (6/09)		<2.0	4.9	<2.0

MIB and geosmin levels are now detectable in the reservoirs and rivers as the summer progresses. This is typical as the lake temperatures go above 20 ^{o}C and cyanobacteria that produce these compounds start to grow. We usually observe the highest concentrations in lakes between now and September. There is no evidence of MIB or geosmin production in the SRP canal system.

Organic Matter Status In the Treatment Plants

Table 2 - Water Treatment Plants – July 06, 2009

Sample Description	DOC (mg/L)	UV254 (1/cm)	SUVA (L/mg-m)	TDN		DOC removal (%)
24th Street WTP Inlet	4.81	0.105	2.18	0.31		
24th Street WTP Treated	2.95	0.040	1.35	0.27		39
Deer Valley Inlet	4.71	0.105	2.24	0.32		
Deer Valley WTP Treated	2.75	0.035	1.26	0.25		42
Val Vista Inlet	4.69	0.104	2.21	0.29		
Val Vista WTP Treated –East	3.25	0.052	1.59	0.24		31
Val Vista WTP Treated -West	3.27	0.054	1.64	0.25		30
Union Hills Inlet	3.14	0.043	1.38	0.49		
Union Hills Treated	2.50	0.023	0.93	0.40		20
Tempe North Inlet						
Tempe North Plant Treated						
Tempe South WTP	4.33	0.096	2.21	0.55		
Tempe South Plant Treated	3.54	0.060	1.69	0.34		18
Greenway WTP Inlet	4.63	0.102	2.20	0.36		
Greenway WTP Treated	3.88	0.039	1.01	0.35		16
Glendale WTP Inlet	4.78	0.104	2.17	0.32		
Glendale WTP Treated	3.34	0.041	1.24	0.25		30

DOC = Dissolved organic carbon
UV254 = ultraviolet absorbance at 254 nm (an indicator of aromatic carbon content)
SUVA = UV254/DOC
TDN = Total dissolved nitrogen (mgN/L)

Organic Matter Status In the Canals

Sample Description	DOC (mg/L)	UV254 (1/cm)	SUVA (L/mg-m)	TDN
Waddell Canal	3.15	0.045	1.41	0.52
Union Hills Inlet	3.14	0.043	1.38	0.49
CAP Canal at Cross-connect				
Salt River @ Blue Pt Bridge	4.74	0.105	2.21	0.33
Verde River @ Beeline	2.82	0.070	2.47	0.39
AZ Canal above CAP Cross-connect	4.78	0.104	2.17	0.34
AZ Canal below CAP Cross-connect	4.72	0.104	2.20	0.33
AZ Canal at Highway 87	4.78	0.104	2.17	0.28
AZ Canal at Pima Rd.	4.85	0.104	2.15	0.31
AZ Canal at 56th St.	4.81	0.106	2.19	0.32
AZ Canal - Inlet to 24th Street WTP	4.81	0.105	2.18	0.31
AZ Canal - Central Avenue	4.75	0.105	2.21	0.32
AZ Canal - Inlet to Deer Valley WTP	4.71	0.105	2.24	0.32
AZ Canal - Inlet to Glendale WTP	4.78	0.104	2.17	0.32
AZ Canal - Inlet to Greenway WTP	4.63	0.102	2.20	0.36
South Canal below CAP Cross-connect	4.71	0.107	2.26	0.34
South Canal at Val Vista WTP	4.69	0.104	2.21	0.29
Head of the Tempe Canal	4.48	0.099	2.21	0.29
Tempe Canal - Inlet to Tempe's South Plant	4.33	0.096	2.21	0.55

Reservoirs

Table 4 - Reservoir Samples – July 06, 2009

Sample Description	Location	DOC (mg/L)	UV254 (1/cm)	SUVA (L/mg-m)	TDN
Lake Pleasant (june 2009)	Eplimnion	**3.45**	**0.047**	**1.35**	**0.44**
Lake Pleasant (june 2009)	Hypolimnion	**3.87**	**0.044**	**1.14**	**0.27**
Verde River @ Beeline		**2.82**	**0.070**	**2.47**	**0.39**
Bartlett Reservoir	Epilimnion	**4.24**	**0.080**	**1.89**	**0.30**
Bartlett Reservoir	Epi-near dock				
Bartlett Reservoir	Hypolimnion	**4.07**	**0.097**	**2.38**	**0.30**
Salt River @ BluePt Bridge		**4.74**	**0.105**	**2.21**	**0.33**
Saguaro Lake	Epilimnion	**5.12**	**0.108**	**2.11**	**0.33**
Saguaro Lake	Epi - Duplicate	**5.25**	**0.109**	**2.07**	**0.34**
Saguaro Lake	Epi-near doc				
Saguaro Lake	Hypolimnion	**5.14**	**0.105**	**2.05**	**0.47**
Verde River at Tangle	Jun-09	**1.34**	**0.030**	**2.27**	**0.15**
Havasu	Jun-09	**4.82**	**0.045**	**0.94**	**0.66**

Organic Matter in wastewater treatment plant effluents from around Arizona

Wastewater is an important resource for Arizona. Increasingly, treating wastewater to higher levels is resulting in a merger of drinking water and wastewater expertise and personnel. Therefore, this month we decided to highlight a study we are conducting to compare different wastewaters from around Arizona.

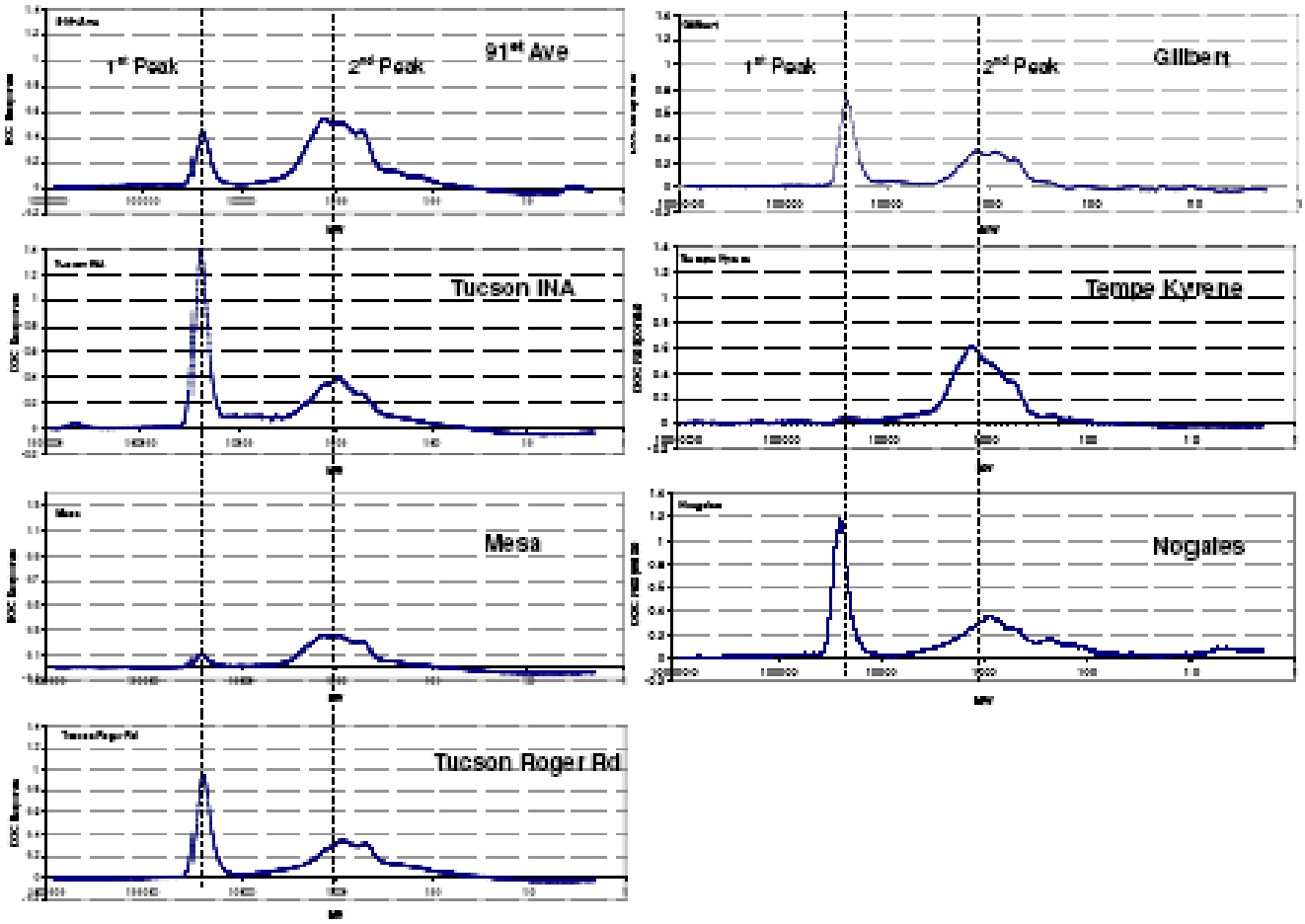
First, the table below compares **bulk organic matter properties** of several wastewaters. SUVA is UV absorbance at 254 nm divided by DOC. The data in the table reported as TOC, are actually filtered samples (i.e, DOC). Compared to CAP or SRP waters (above portions of this newsletter), the wastewaters have a higher DOC level and slightly lower SUVA.

Table2.TOC, UV and SUVA results of the samples

WWTP Name	TOC (mg C/L)	UV	SUVA
Phoenix 91st Ave	8.57	0.17	1.98
Gilbert water ranch	5.28	0.062	1.17
Tucson WWTP in Ina Road	9.18	0.164	1.78
Tempe Kyrene	6.69	0.139	2.07
Mesa WWTP	4.31	0.099	2.29
Nogales WWTP	6.8	0.129	1.89
Tucson WWTP in Roger Road	8.98	0.163	1.81

Second, we compare **molecular weight distributions** of organic matter using size exclusion chromatography with total organic carbon detection (SEC-TOC). We have shown similar plots for SRP and CAP water over the past few months in our previous newsletters. Several features are quite striking about these wastewaters. First is the colloidal material that is detected around the molecular weight range labeled "1st Peak". This material is usually responsible for fouling membranes, and it can be seen that membrane effluents (Tempe Kyrene has submerged membranes) or tertiary filtration (Mesa) have lower levels of this colloidal material. The "2nd peak" has similar characteristics in most waters, but just different peak areas which relate back to the waters having different DOC levels (above table). The Nogales sample tends to have more lower molecular weight organics, possibly because the Nogales region uses almost entirely groundwater as its drinking water supply.

Many of the organics in wastewater effluents originate from sources: 1) DOC in drinking water which conveys the sewage (usually 2 to 3 mg/L; < 1 mg/L in groundwater systems), 2) non-biologically degradable organics (pharmaceuticals, pesticides, etc), and 3) organics released from bacteria in the wastewater process as they grow, decay and die.



Third, below are **pharmaceutical and personal care product (PPCP)** data from 7 wastewater treatment plants (WWTPs) in metro Phoenix, Tucson and Nogales. The names of the facilities are coded and the intent of this presentation is to highlight compounds that routinely occur at higher concentrations. All concentrations are in ng/L. Compared to any of the surface waters (previous page), the levels of PPCPs in wastewaters are commonly 2 to 3 times higher.

Samp.date	Note	Acetaminophen	Caffeine	Carbamazepine	Cotinine	DEET	Diazepam	Fluoxetine
WWTP								
4/23	WWTP #1	0	48.8	514	6.43	348	1.86	14.6
4/23 (Dup)	WWTP #1 - duplicate	< 0	46.6	550	6.35	651	1.88	14.7
4/27	WWTP #2	0.284	49.4	530	21.3	63.2	3.21	4.62
4/27	WWTP #3	2.41	854	203	33.8	773	0	< 0
4/23	WWTP #4	564	57.1	533	37.7	429	3.84	26.4
5/01	WWTP #5	79.2	10.9	194	14.1	161	3.07	2.03
5/01	Effluent dominated river	52.8	18.2	257	34	228	3.02	0.324
5/01	WWTP #6	87.7	259	407	629	152	5.23	54.6
5/01	WWTP #7	587	4020	348	277	127	2.6	17.4
5/01 (Dup)	WWTP #7 - duplicate	491	3750	321	247	111	2.46	17.2

Samp.date	Note	Hydrocodone	Meprobamate	Pentoxifylline	Primidone	Oxybenzone	Sulfamethoxazole	Erythromycin
WWTP								
4/23	WWTP #1	94.3	627	7.34	298	16.6	3660	0
4/23 (Dup)	WWTP #1 - duplicate	99.7	592	4.36	297	15.8	3890	0
4/27	WWTP #2	80.1	507	0.473	242	35.5	1080	0
4/27	WWTP #3	< 0	13.6	0	97.2	20.8	12.3	0
4/23	WWTP #4	73.2	929	0	150	61.8	2560	75.9
5/01	WWTP #5	9.87	74.8	20	34.2	14.2	2410	45.7
5/01	Effluent dominated river	9.37	112	29.5	47.4	22.2	3430	0
5/01	WWTP #6	120	668	21.9	171	25.9	1680	58.8
5/01	WWTP #7	79.3	588	33.2	81.4	148	1620	0
5/01 (Dup)	WWTP #7 - duplicate	92	535	28.4	80.7	114	1450	0

Samp.date	Note	Trimethoprim	Ibuprofen	Naproxen	Dilantin	Triclosan	TBBA	
WWTP								
4/23	WWTP #1	75.8	0	29.4	570	54.3	32.2	
4/23 (Dup)	WWTP #1 - duplicate	88.4	0	14.4	321	33.7	0	
4/27	WWTP #2	39.1	89.1	17.2	282	17.1	0	
4/27	WWTP #3	< 0	0	< 0	51.9	20.7	0	
4/23	WWTP #4	2410	311	312	257	286	31.5	
5/01	WWTP #5	2110	205	67	142	115	17.2	
5/01	Effluent dominated river	2730	90.5	53.3	125	44.3	0	
5/01	WWTP #6	1120	268	426	241	196	0	
5/01	WWTP #7	697	676	1490	275	372	0	
5/01 (Dup)	WWTP #7 - duplicate	738	746	1380	247	386	5.99	

Pharmaceutical Data from May 2009 in Water Supplies

Red/pink boxes indicate levels of PPCPs above 100 ng/L. All concentrations are in ng/L. These are only present in wastewaters. The issue becomes, what is the fate of these compounds during recharge? Fortunately, many undergo slow transformations. The use of this water for other reuse applications may not permit time for such transformations, and more advanced treatment (ozone or reverse osmosis) may be needed to meet lower target levels of these compounds.

Green boxes indicate PPCPs that occur in drinking water treatment plant influents, but are well removed by treatment including chlorination.

Reference data for laboratory and field blanks are included, and show low levels of potential contamination from DEET, caffeine, oxybenzone (sunscreen).

Samp.date	Note	Acetaminophen	Caffeine	Carbamazepine	Cotinine	DEET	Diazepam	Fluoxetine
4/24	Lab blank	0	0.531	< 0	0	3.91	< 0	0.0624
4/23	Field blank	0	2.78	< 0	0	3.06	< 0	< 0
5/07	Lab blank	0	2.18	< 0	< 0	3.44	< 0	< 0
5/07	Field blank	0	1.71	< 0	0	3.01	< 0	< 0
5/04	Waddel Canal	< 0	5.3	3.18	4.91	8.34	< 0	< 0
5/04	WTP after chlorination	0	< 0	< 0	0.25	3.41	< 0	< 0
5/04	WTP settled water	< 0	< 0	< 0	0.06	3.97	< 0	< 0
5/04	WTP Influent	0	10.5	< 0	1.97	11.7	0	< 0
5/04	Verde River at 87 Hwy	0	3.18	< 0	1.03	8.16	0	< 0
5/04	Blue Point Bridge	0	6.07	< 0	2.28	8.83	0	< 0
5/07	WWTP Effluent	0	43.6	600	10.5	322	1.91	37.7
5/07	WWTP Effluent (before UV)	0	29.7	583	3.73	329	1.89	47.5
5/07 (Dup)	WWTP Effluent (before UV) Duplicate	5.38	21.5	629	3.42	397	2.32	28.9

Samp.date	Note	Meprobamate	Pentoxifylline	Primidone	Oxybenzone	Sulfamethoxazole	Erythromycin	Trimethoprim
4/24	Lab blank	< 0	0	0	5.14	0	0.327	< 0
4/23	Field blank	< 0	0	0	3.4	< 0	0.184	0
5/07	Lab blank	< 0	0	0	3.24	0	0.0953	< 0
5/07	Field blank	< 0	0	< 0	3.43	0	0.118	< 0
5/04	Waddel Canal	12.3	0	4.17	5.64	17.3	0	0.819
5/04	WTP after chlorination	< 0	0	< 0	2.41	0	0.141	0
5/04	WTP settled water	< 0	0	< 0	2.91	< 0	0.198	< 0
5/04	WTP Influent	< 0	0	< 0	14.5	1.26	0.161	< 0
5/04	Verde River at 87 Hwy	< 0	0	0	2.87	1.78	0.208	< 0
5/04	Blue Point Bridge	< 0	0	0	114	< 0	0	1.18
5/07	WWTP Effluent	1350	0	207	15.9	1900	62	583
5/07	WWTP Effluent (before UV)	1280	0.706	205	15.5	2310	48.4	530
5/07 (Dup)	WWTP Effluent (before UV) Duplicate	1280	7.78	249	16.2	2890	0	192

Samp.date	Note	Naproxen	Dilantin	Triclosan	TBBA	Hydrocodone	Ibuprofen
4/24	Lab blank	< 0	0.0508	< 0	< 0	0	0
4/23	Field blank	0	0	< 0	< 0	0	0
5/07	Lab blank	< 0	0	< 0	0	0	0
5/07	Field blank	0	0	< 0	< 0	0	0
5/04	Waddel Canal	< 0	2.5	< 0	0	0	0
5/04	WTP after chlorination	0	< 0	< 0	0	0	0
5/04	WTP settled water	< 0	0	< 0	0	0	0
5/04	WTP Influent	< 0	0	< 0	0	0	0
5/04	Verde River at 87 Hwy	0	2.5	< 0	0	0	0
5/04	Blue Point Bridge	< 0	0.683	< 0	0	0	0
5/07	WWTP Effluent	24.4	269	90.4	0	89	0
5/07	WWTP Effluent (before UV)	21.4	249	128	< 0	99.8	0
5/07 (Dup)	WWTP Effluent (before UV) Duplicate	30.9	336	137	0	82.6	62