

Section 5

Problem Definition and Analysis

The watershed “indicators” described in Section 4 are used both to characterize the current state of the TTF Watershed, and to set a baseline for future comparison. Here, Section 5 identifies the wide range of potential problems that have been identified in the watershed, and describes the analysis tools used to define them.

Many of the problems in the TTF Watershed have been identified through the assessments carried out by the project team and others. Other problems were identified through stakeholder participation. Water quality problems were identified by taking samples and comparing results to water quality criteria. Several criteria were relevant to the analysis, many of which provided specific numeric standards with which to comply. Others were less specific, but nonetheless relevant. These are often referred to as narrative standards.

National water quality criteria include aesthetic qualities that protect the quality of streams. The criteria state:

“All waters free from substances attributable to wastewater or other discharges that:

- (1) settle to form objectionable deposits;
- (2) float as debris, scum, oil, or other matter to form a nuisance;
- (3) produce objectionable color, odor, taste, or turbidity;
- (4) injure or are toxic or produce adverse physiological responses in humans, animals or plants; and
- (5) produce undesirable or nuisance aquatic life.” (EPA, Goldbook, 1986)

Also, PA DEP’s general water quality criteria state:

- (a) Water may not contain substances attributable to point or non-point source discharges in concentration or amounts sufficient to be inimical or harmful to the water uses to be protected or to human, animal, plant, or aquatic life.
- (b) In addition to other substances listed within or addressed by this chapter, specific substances to be controlled include, but are not limited to, floating materials, oil, grease, scum and substances which produce color, tastes, odors, turbidity or settle to form deposits. (PA DEP, Chapter 93 § 93.6.)

Some standards were related to the uses of the creek. The Tookany/Tacony-Frankford Creek’s protected uses as designated by PA DEP are:

- Aquatic Life – Warm Water Fishes
- Water Supply – Potable Water Supply
- Recreation and Fish Consumption – Boating, Fishing, Water Contact Sports, and Esthetics

5.1 Visual Stream Assessment (Aesthetics and Narrative Criteria)

The Tacony-Frankford RCP Team and Tookany Creek Watershed Management Plan Steering Committee conducted visual assessments along the major tributaries and mainstem streams. These assessments provided a baseline inventory of the existing conditions along the stream corridor. The method utilized a modified version of the USDA's Visual Streambank Assessment Protocol. Members of these committees and volunteers conducted the visual stream assessments.

The visual assessments assisted in identification of problems and problem locations in the Tookany/Tacony-Frankford Watershed. Generally, the issues found in the watershed included:

- Erosion of creek banks (undercutting, exposed roots).
- Appearance of invasive species – Disturbed areas throughout the watershed are susceptible to invasion by non-native exotic vegetation. Japanese knotweed, kudzu, purple loosestrife, and multiflora rose were identified as issues within the watershed.
- Trash and debris – Along the creeks, there was an abundance of trash and debris.
- Illegal dumping – Dumping of trash, cars, and appliances are an issue for Tacony Creek Park and vacant land. Secluded open areas are especially susceptible to dumping. Sites of abandoned cars often become targets for fire. Illegal dumping ranges from trucks dumping construction materials and appliances to residents throwing trash directly into the creek.
- Illegal recreational activities (e.g., ATVs, swimming) – ATV use is illegal in Tacony Creek Park and has had a detrimental effect on the health of the park. Illegal trails disturb native vegetation and open habitat for invasives while contributing to erosion on slopes of the creek banks.
- Sewage and odors.
- Lack of riparian buffer – The lack of riparian buffer was observed on both public and private property. Native vegetation usually found in the riparian buffer often has been removed or mowed. Sections of the creeks where flooding has been problematic tend not to have riparian buffer areas, coupled with a high percentage of impervious surface.
- Exposed and eroded sewer and stormwater pipes.
- Instream flow obstructions.
- Chemical runoff which may include but is not limited to fertilizers, pesticides, herbicides, oil and grease, antifreeze, and industrial spills.
- Illicit and disconnected sewers.
- Lack of best management practices (BMPs).

Figure 5.1 displays the results of the visual stream assessments, with the locations of problems identified by stream reach.

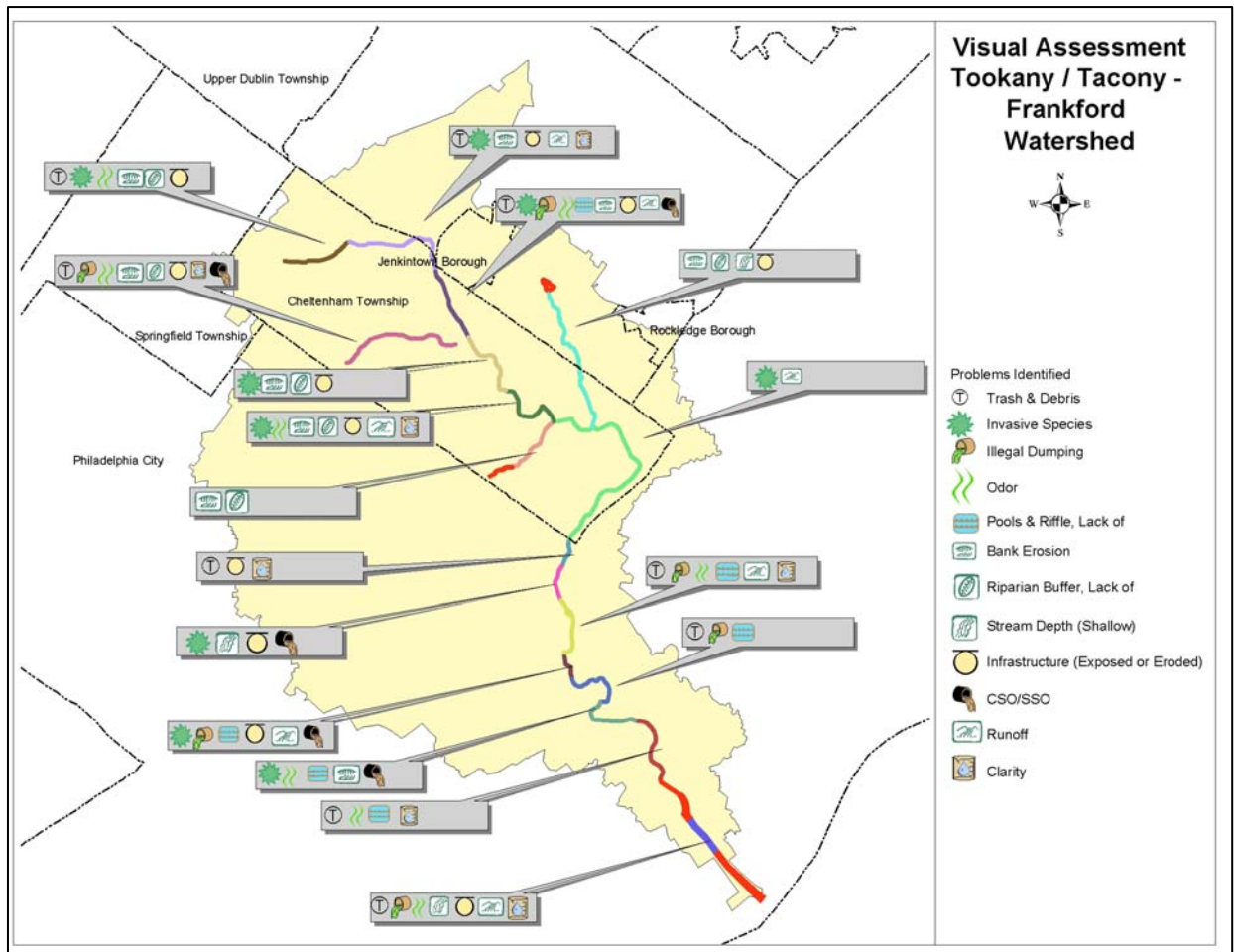


Figure 5.1 Summary of Visual Assessments

Various problems have been identified throughout the watershed. Evidence of streambank erosion was observed at all but one reach of the visually assessed streams. Trash and debris and invasive species were recorded at most reaches. There is no pattern with regards to the location of the reaches, with problems identified both in the city and outside the city.

5.2 Streamflow Analysis

Indicator 2, Streamflow, measures baseflow and runoff to analyze the impact of urbanization on watershed hydrology. As noted previously in Sections 2.2.1 and 4.2.1, the flow records at each of the USGS gauges in the Tookany/Tacony-Frankford Watershed were separated into runoff and baseflow components.

In Table 5.1, the results for Tacony-Frankford Creek are compared with French Creek, a rural stream, and Darby Creek, a stream in a mixed urban and suburban watershed. Results for French Creek are somewhat typical of an undeveloped watershed, with baseflow comprising 64% of mean annual streamflow and stormwater only 17% of annual precipitation.

At the Frankford Creek gauge, representing most of the urbanized Tacony-Frankford watershed, the stormwater component of streamflow is a much greater percentage of total annual streamflow (62%), and baseflow represents a much smaller percentage of total annual streamflow (only 38%). These results are indicative of a highly urbanized stream. The Tacony Creek USGS gauge, representing the headwaters of the Tacony-Frankford Watershed, exhibits a relationship between stormflow and baseflow that is between the two extremes.

Table 5.1 Summary of Hydrograph Separation Results over the Period of Record

USGS Gauge	Period of Record	Baseflow	Baseflow	Stormwater Runoff
		(% of Total Flow)	(% of Precip)	(% of Precip)
Tacony Creek near Jenkintown 01467083	10/1/73 - 9/30/78	56%	27%	21%
Rock Creek 01467084	5/1/71 – 9/30/78	46%	28%	33%
Jenkintown Creek 01467085	5/1/71 – 9/30/78	60%	27%	18%
Tacony Creek at County Line 01467086	10/1/65 - 11/17/88	58%	29%	21%
Frankford Creek at Castor Ave 01467087	7/1/82 - 9/30/03	38%	17%	27%
Frankford Creek at Torresdale Ave 01467089	10/1/65 - 9/30/81, 5/14/82 – 6/29/82	35%	17%	31%
French Creek 01475127	10/1/68 – 9/30/03	64%	31%	17%
Darby Creek 01475510	2/1/64 – 10/3/90	62%	34%	21%
Cobbs Creek 01475550	2/1/64 – 10/3/90	43%	19%	26%

5.3 Water Quality Analysis

As noted above, water uses relevant to the TTF Watershed include the following:

- Aquatic Life – Warm Water Fishes
- Water Supply – Potable Water Supply
- Recreation and Fish Consumption – Boating, Fishing, Water Contact Sports, and Esthetics

As described in Section 2.2.2, an analysis was conducted on the water quality data collected in the Tookany/Tacony-Frankford Watershed. A number of constituents, which are listed in Table 5.2, were used as indicators of watershed health in Section 4.3. Using the data collected from discrete wet and dry weather sampling, comparisons were made to water quality standards. National water quality standards and reference values were used if state water quality standards were not available. The water quality standards or reference values and their sources are also listed in Table 5.2.

The aquatic life criteria for metals were “established to control the toxic portion of a substance in the water column. Depending upon available data, aquatic life criteria for metals are expressed as either dissolved or total recoverable.” (PA DEP, Chapter 16)

A color coding is used to indicate problems (red) and potential problems (yellow). Problems are identified if more than 10% of samples exceed the applied water quality standard or criteria. Potential problems are identified if between 2% and 10% of samples exceed the standard or criteria.

Table 5.2 Water Quality Standards and Reference Values

Parameter	Criteria	Water Quality Criteria or Reference Value	Source
Alkalinity	Minimum	20 mg/L	PA DEP
Aluminum	Aquatic Life Chronic Exposure Standard	87 mg/L (pH 6.5-9.0)	53FR33178
Aluminum	Aquatic Life Acute Exposure Standard	750 mg/L	PA DEP
Chlorophyll A	Reference reach frequency distribution approach for Ecoregion IX, subregion 64, 75th percentile	seasonal median: 3 ug/L, (Spectrophotometric)	EPA 822-B-00-019
Dissolved Cadmium	Aquatic Life Acute Exposure Standard	Hardness Dependent	PA DEP
	Aquatic Life Chronic Exposure Standard	Hardness Dependent	PA DEP
	Human Health Standard	10 mg/L	EPA Goldbook
Dissolved Chromium	Aquatic Life Acute Exposure Standard	16 mg/L	PA DEP
	Aquatic Life Chronic Exposure Standard	10 mg/L	PA DEP
Dissolved Copper	Aquatic Life Acute Exposure Standard	Hardness Dependent	PA DEP
	Aquatic Life Chronic Exposure Standard	Hardness Dependent	PA DEP
	Human Health Standard	1000 mg/L	EPA Goldbook
Dissolved Iron	Maximum	0.3 mg/L	PA DEP

Parameter	Criteria	Water Quality Criteria or Reference Value	Source
Dissolved Lead	Aquatic Life Acute Exposure Standard	Hardness Dependent	PA DEP
	Aquatic Life Chronic Exposure Standard	Hardness Dependent	PA DEP
	Human Health Standard	50 mg/L	EPA Goldbook
Dissolved Zinc	Aquatic Life Acute Exposure Standard	Hardness Dependent	PA DEP
	Aquatic Life Chronic Exposure Standard	Hardness Dependent	PA DEP
	Human Health Standard	5000 mg/L	EPA Goldbook
DO	Instantaneous Minimum	4 mg/L	PA DEP
	Average Minimum	5 mg/L	PA DEP
Fecal coliform	Maximum	Geometric Mean of 5 consecutive samples on different days within a 30 day period may not exceed 200/100mL (Summer) or 2000/100mL (Winter)	PA DEP
Fluoride	Maximum	2.0 mg/L	PA DEP
Iron	Maximum	1.5 mg/L	PA DEP
Manganese	Maximum	1.0 mg/L	PA DEP
NH3-N	Maximum	pH dependent	PA DEP
NO2+NO3	Nitrates – Human Health Consumption for water + organisms	10 mg/L	PA DEP
NO23-N	Maximum	10 mg/L	PA DEP
Periphyton Chlorophyll A		Ecoregion IX – 20.35 mg/m2	Goldbook
pH	Range	6.0 mg/L - 9.0 mg/L	PA DEP
Phenolics	Maximum	0.005 mg/L	PA DEP
TDS	Maximum	750 mg/L	PA DEP
Temperature		Varies w/ season. Additionally, waters may not result in a change by more than 2°F during a 1-hour period.	PA DEP
TKN	Maximum	Ecoregion IX, subregion 64 seasonal median: 0.675 mg/L	EPA 822-B-00-019
TN	Maximum	Ecoregion IX, subregion 64 seasonal median: 4.91 mg/L	EPA 822-B-00-019
TP	Maximum	Ecoregion IX, subregion 64 seasonal median: 140 ug/L	EPA 822-B-00-019
TSS	Maximum	25 mg/L	Other US states
Turbidity	Maximum	Ecoregion IX, subregion 64 seasonal median: 8.05 NTU	EPA 822-B-00-019

Based on a comparison of water quality sampling data with standards, criteria, or reference values, the problem and potential problem parameters have been identified and are discussed in this section. The issues have also been identified during wet and dry weather, if applicable.

5.3.1 Water Supply

The state's potable water supply criteria were applied to the Tookany/Tacony-Frankford Watershed. The criteria are listed above in Table 5.2. Comparisons between the water quality data and the criteria for water supply are listed in Table 5.3, which displays observed water quality exceedances of these criteria during dry and wet weather.

Table 5.3 Summary of Water Supply Criteria Exceedances

Parameter	Criteria	Dry			Wet		
		No. Obs.	No. Exceed	% Exceed	No. Obs	No. Exceed	% Exceed
Dissolved Iron (Fe)	Maximum	64	3	4.69	123	5	4.07
Fluorine (F)	Maximum	61	1	1.64	438	0	0.00
Manganese (Mn)	Maximum	90	0	0.00	461	9	1.95
Ammonia (NH ₃)	Maximum	41	0	0.00	144	0	0.00
Nitrate-Nitrite (NO ₂ +NO ₃)	Maximum	62	0	0.00	464	0	0.00
Total Dissolved Solids (TDS)	Maximum	36	0	0.00	144	2	1.39

Green – Parameter is not a problem

Yellow – Potential problem parameter

Red – Problem parameter

The results indicate dissolved iron, manganese, and total dissolved solids (TDS) as potential problem parameters. On the pages that follow, Figures 5.2 – 5.4 show the criteria comparison by monitoring location in the Tookany/Tacony-Frankford Watershed. Dissolved iron, prevalent in clay soils, has been identified to exceed the criteria more than 2% of the time in both dry and wet weather. Manganese appears to be a potential wet weather problem, and TDS a potential dry weather problem.

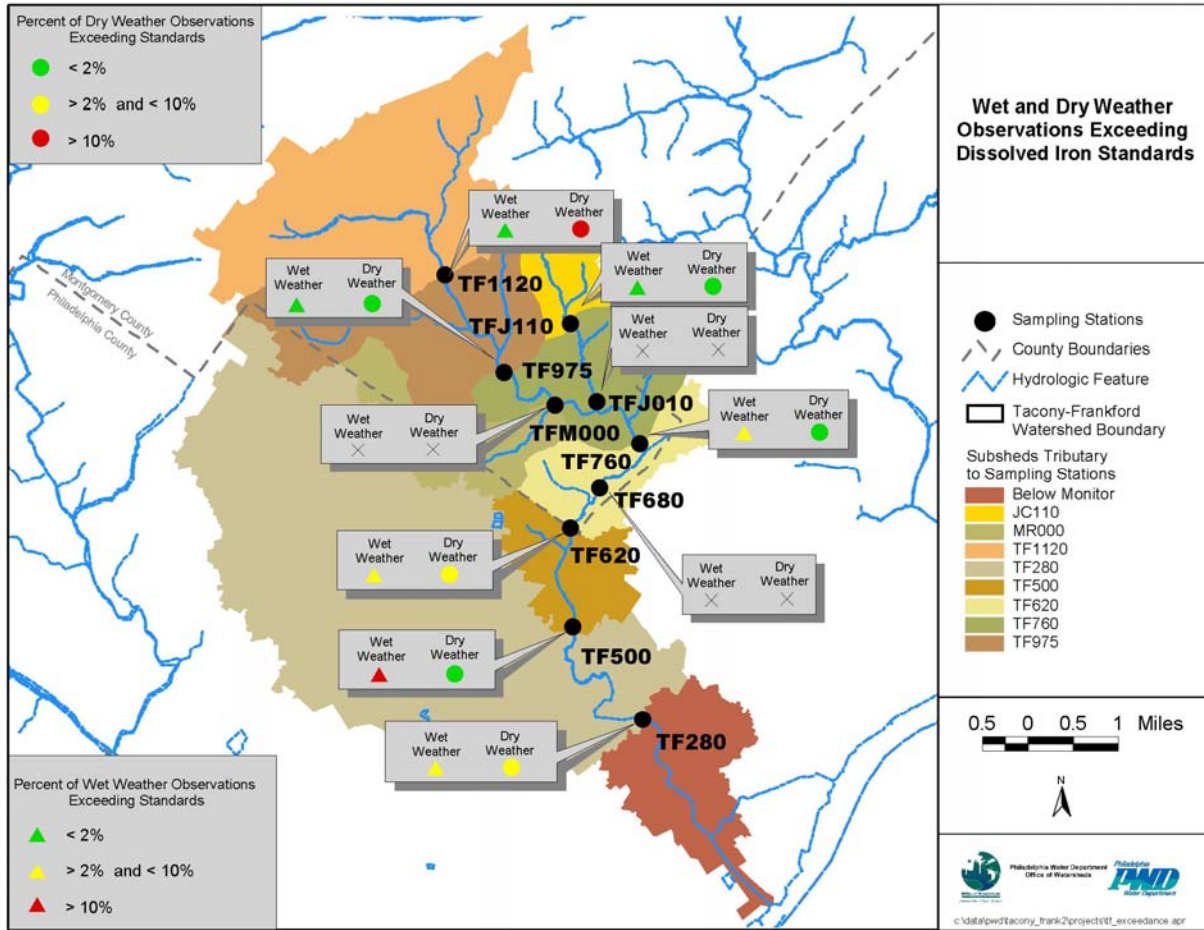


Figure 5.2 Water Supply Criteria for Dissolved Iron

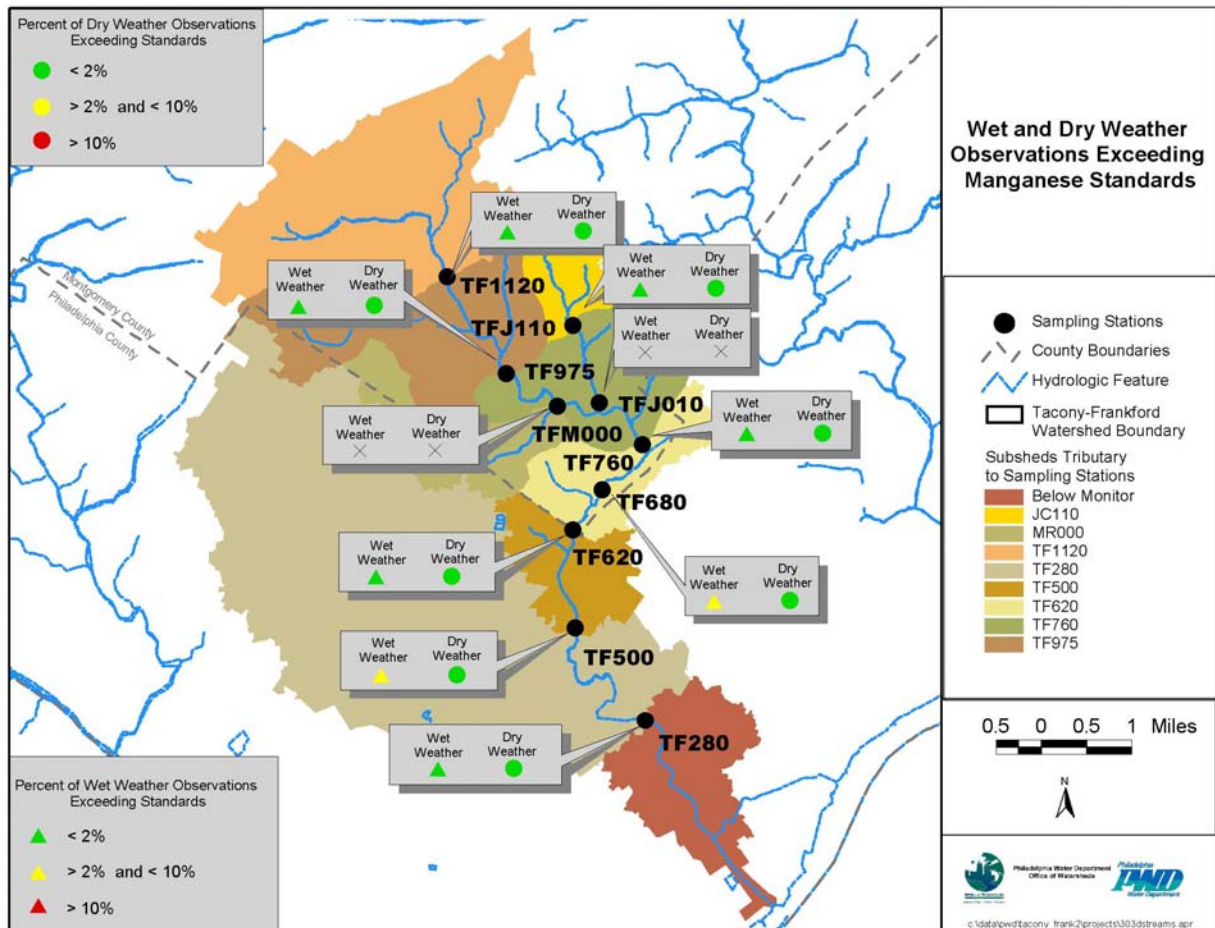


Figure 5.3 Water Supply Criteria for Manganese

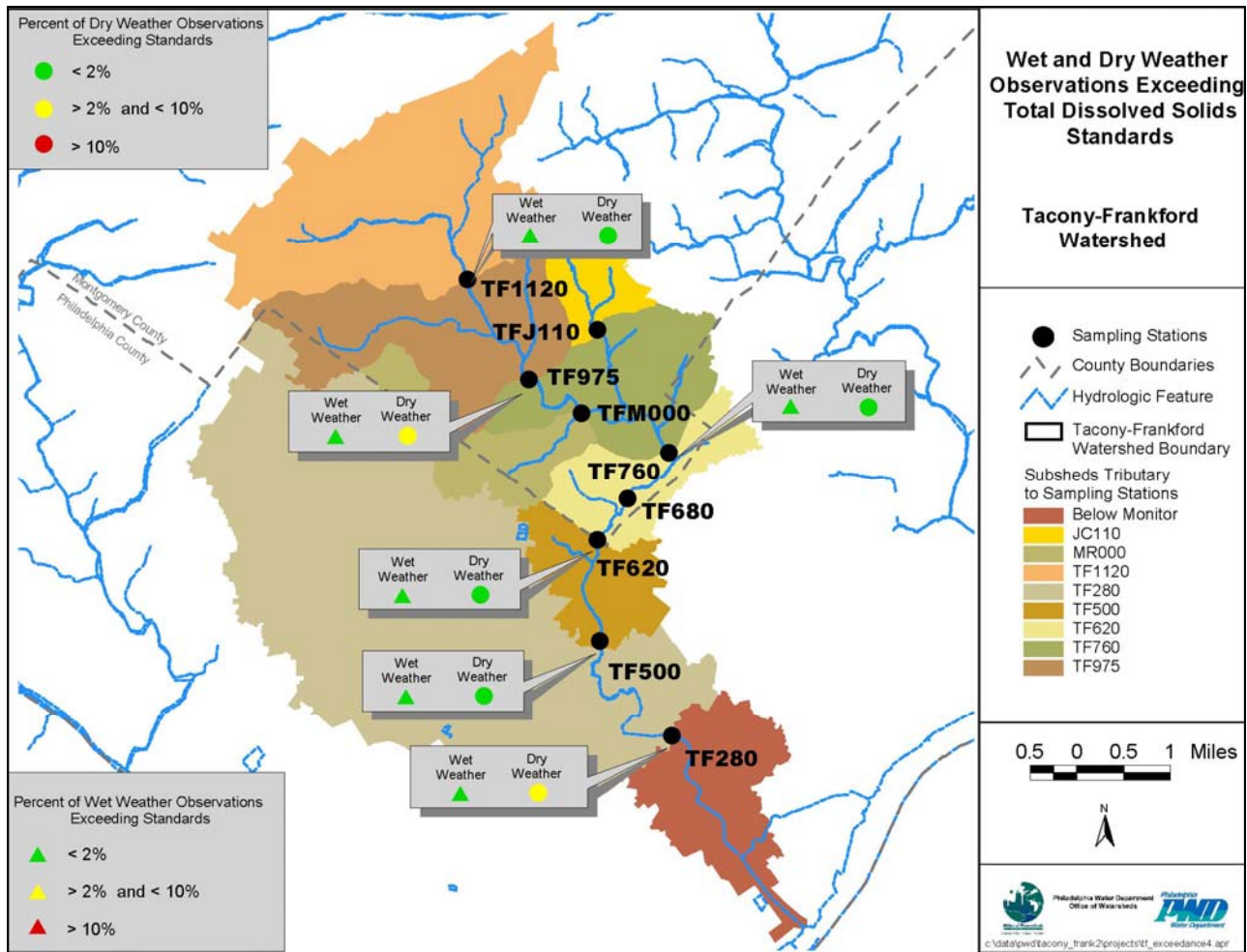


Figure 5.4 Water Supply Criteria for Total Dissolved Solids

5.3.2 Recreation and Fish Consumption

The protected and statewide water use for recreation and fish consumption applicable to the TTF Watershed is water contact sports. The specific water quality criterion for water contact is fecal coliform. Figure 5.5 displays comparisons at the monitoring locations with the criteria throughout the watershed. The data has been compared to the criteria during both swimming and non-swimming seasons. During the swimming season, fecal coliforms are identified as a problem. During the non-swimming season, they are characterized as a potential problem.

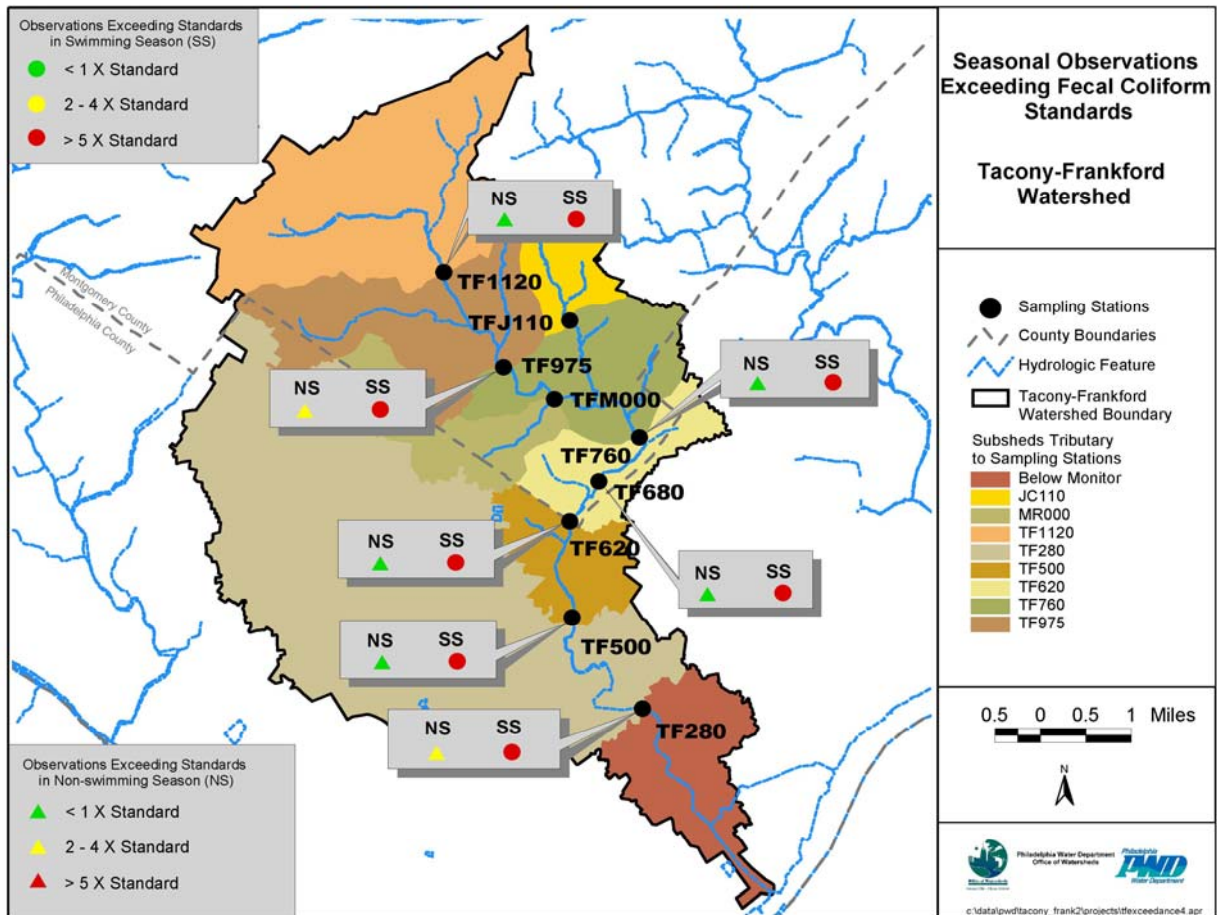


Figure 5.5 Water Contact Criteria for Fecal Coliform

Table 5.4 Summary of Recreation Criteria Exceedances

Season	Site	No. Obs.	No. Exceed	Percent Exc.
Nonswimming	TF500	1	1	100.00
	TF620	7	6	85.71
	TF760	1	0	0.00
	TF975	3	3	100.00
Swimming	TF1120	8	8	100.00
	TF280	7	7	100.00
	TF975	8	8	100.00

5.3.3 Human Health

The relevant human health criteria developed by EPA and PA DEP include exposure to toxic metals from drinking water and fish consumption. No problem parameters were identified among dissolved metals.

Table 5.5 Summary of Human Health Criteria Exceedances

Parameter	Criteria	Dry			Wet		
		No. Obs.	No. Exceed	% Exceed	No. Obs	No. Exceed	% Exceed
Dissolved Cadmium (Cd)	Human Health Maximum	37	0	0.00	118	0	0.00
Dissolved Copper (Cu)	Human Health Maximum	28	0	0.00	5	0	0.00
Dissolved Lead (Pb)	Human Health Maximum	19	0	0.00	N.A.	N.A.	N.A.
Dissolved Zinc (Zn)	Human Health Maximum	27	0	0.00	4	0	0.00
Nitrite (NO ₃)	Human Health Maximum	62	0	0.00	464	0	0.00

Green – Parameter is not a problem Yellow – Potential problem parameter Red – Problem parameter

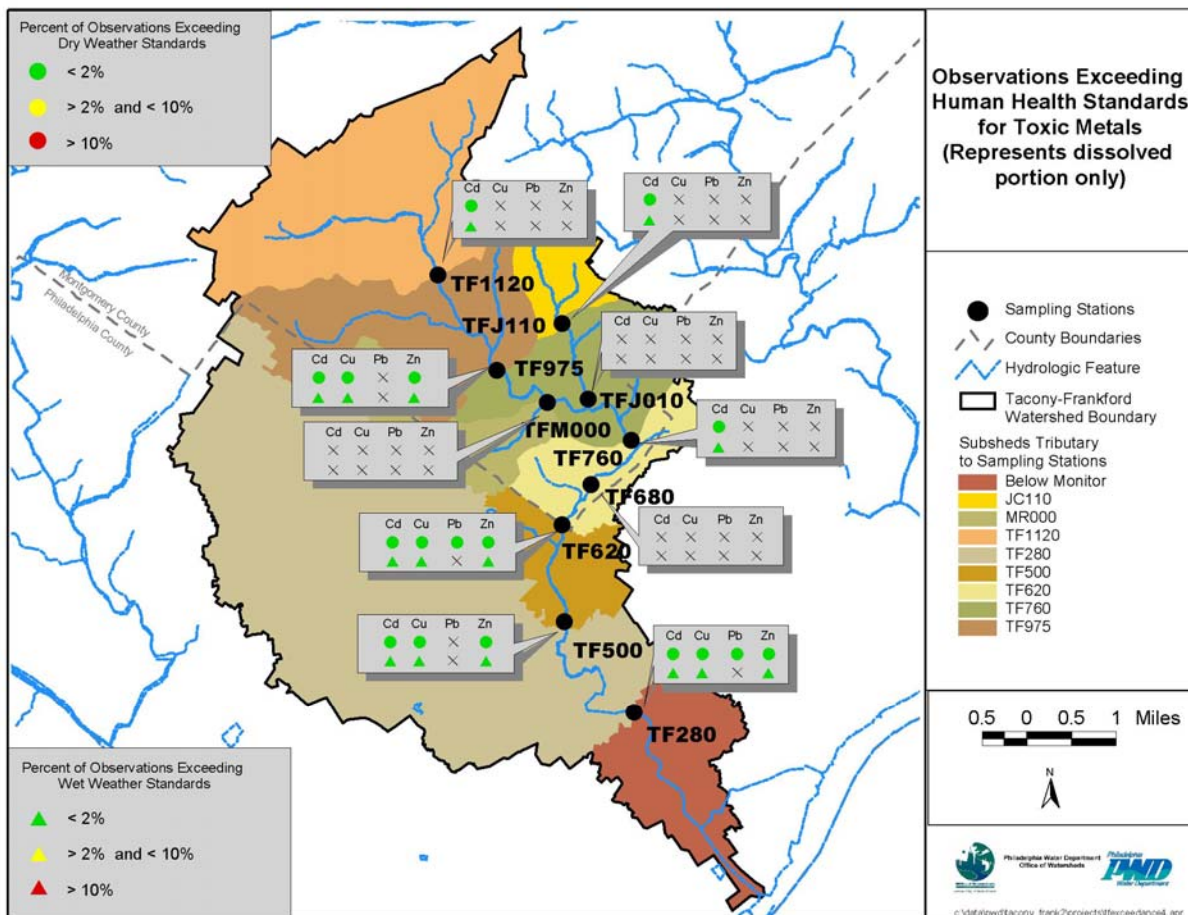


Figure 5.6 Spatial View of Human Health Criteria Exceedances

5.3.4 Aquatic Life

The criteria shown in Table 5.6 are designed to protect reproduction, growth, and survival of aquatic life from acute effects.

Table 5.6 Summary of Aquatic Life Acute Criteria Exceedances

Parameter	Criteria	Dry			Wet		
		No. Obs.	No. Exceed	% Exceed	No. Obs	No. Exceed	% Exceed
Al	Acute Maximum	78	0	0.00	402	77	19.15
Dissolved Cu	Acute Maximum	28	0	0.00	5	3	60.00
DO	Average Minimum (WWF)	59	2	3.39	143	2	1.40
DO	Instantaneous Minimum (WWF)	59	2	3.39	143	0	0.00
Dissolved Iron	Maximum (WWF)	64	3	4.69	123	5	4.07

Green – Parameter is not a problem Yellow – Potential problem parameter Red – Problem parameter

The above table suggests that there are a number of problem and potential problem parameters based on water quality criteria related to acute effects on aquatic life.

- During dry weather, only dissolved iron and dissolved oxygen (DO) are flagged as potential problems.
- During wet weather, aluminum and dissolved copper are flagged as problem parameters.
- During wet weather, dissolved iron is flagged as a potential problem.

Table 5.7 lists parameters that have been identified as problems because they exceed aquatic life chronic criteria. Since these are chronic, thus long term, exposure limits, they are not split into dry weather and wet weather results.

Table 5.7 Summary of Aquatic Life Chronic Criteria Exceedances

Parameter	Standard	No. Observations	No. Exceed	% Exceed
Al	Chronic Maximum	480	271	56.46
Dissolved Cd	Chronic Maximum	155	0	0.00
Dissolved Cu	Chronic Maximum	33	5	15.15
Dissolved Pb	Chronic Maximum	19	0	0.00
Dissolved Zn	Chronic Maximum	31	0	0.00

Green – Parameter is not a problem Yellow – Potential problem parameter Red – Problem parameter

Table 5.6 (at top of previous page) and Figure 5.7 (below) show the results of dissolved oxygen measurements. Both the figure and table suggest that, in general, dissolved oxygen is not a problem upstream of TF280. Within the tidal portion of the watershed below TF280, insufficient data exists to properly characterize the potentiality of a DO problem.

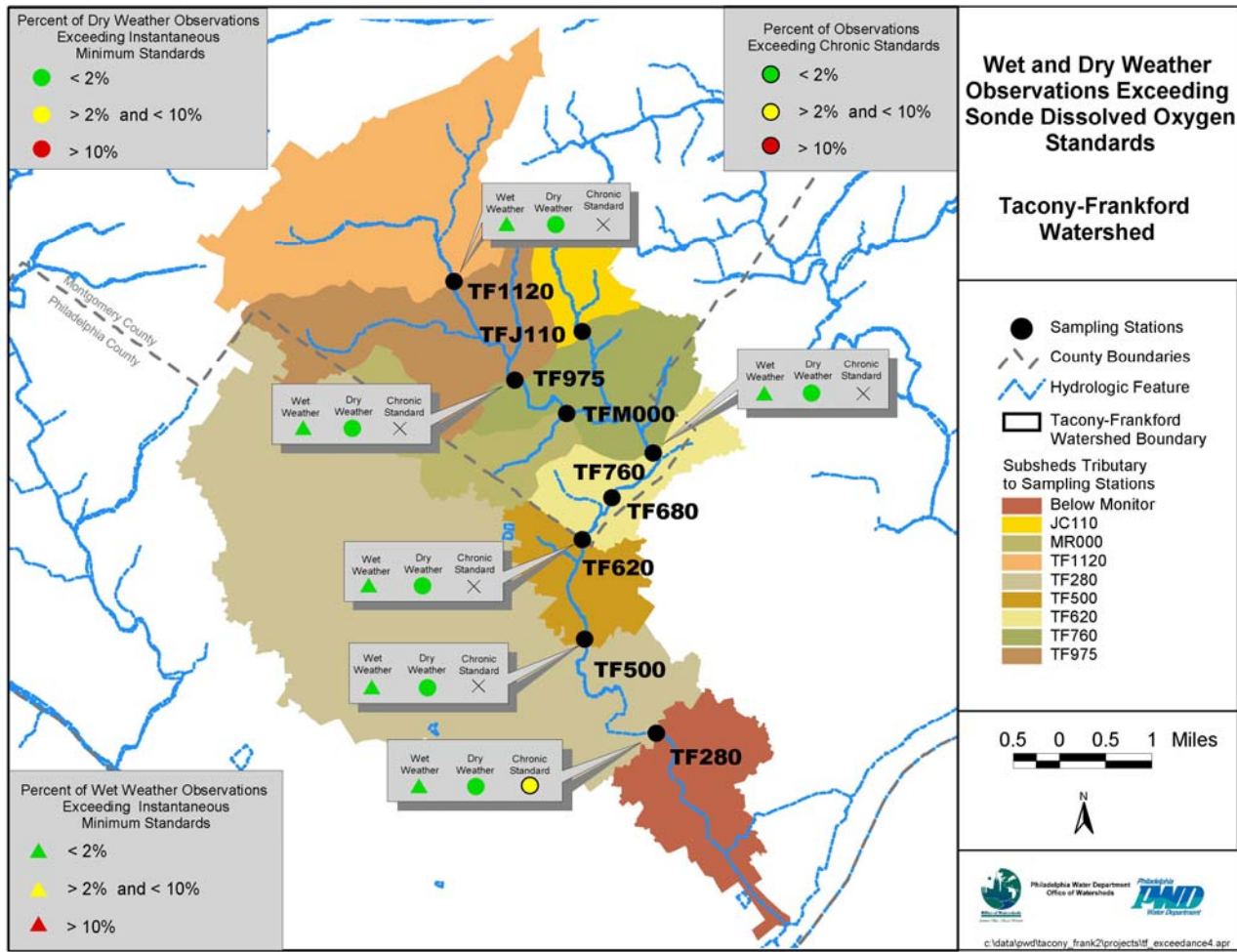


Figure 5.7 Spatial View of Dissolved Oxygen Exceedances in Wet and Dry Weather

Figure 5.8 shows dissolved oxygen measurements taken with one of the Sondes designed to take continuous DO measurements. Although the overall DO levels are adequate in this figure, the figure does point out a rather wide, diurnal fluctuation in DO, in this case over 6 mg/l. This suggests a great deal of biological activity. Although insufficient data exist at this point to indicate the fluctuations in DO are a potential problem, further investigation is important to determine the cause of these unusually wide, short term variations.

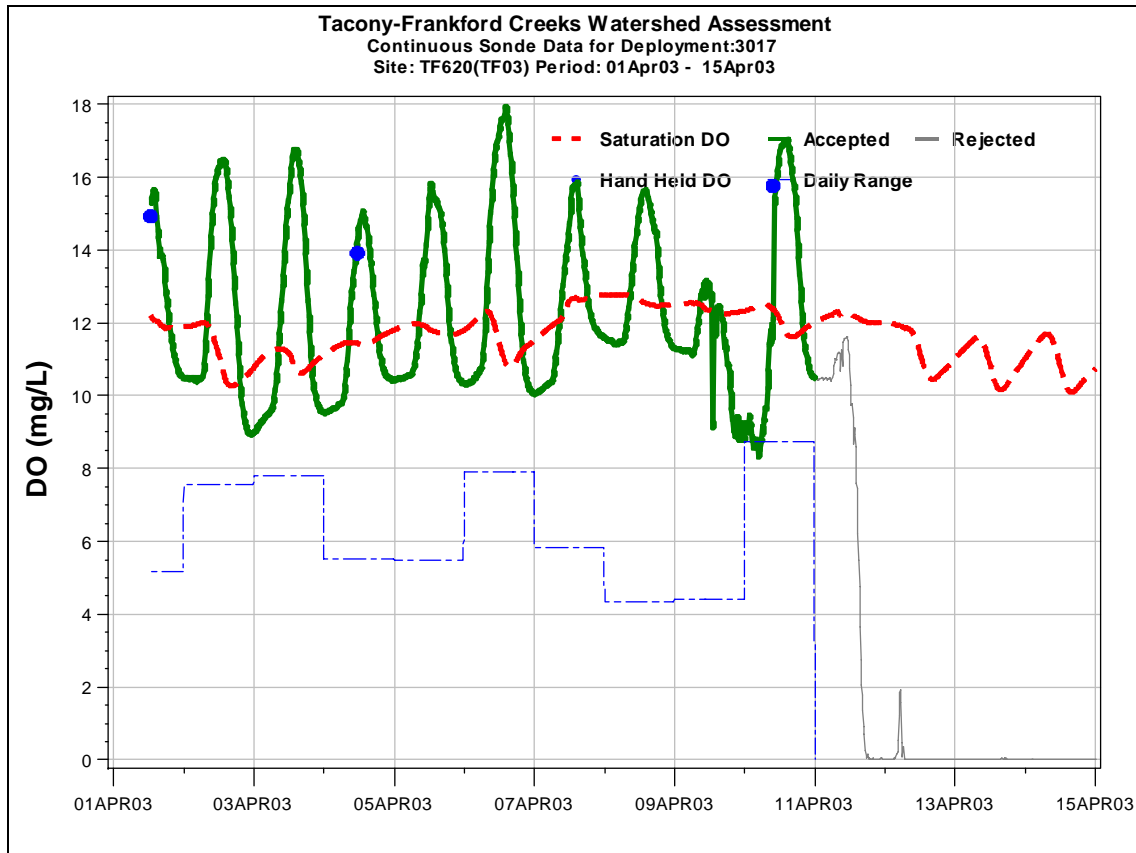


Figure 5.8 Time Series Plot of Dissolved Oxygen Exceedances in Wet and Dry Weather

Finally, Table 5.8 lists several other criteria that are related to aquatic life, but have no set regulatory limits. Criteria were established for this study as “flags of potential problems” using values relating to medians found through the U.S. EPA relevant to Ecoregion IX, subregion 64. As shown in the table, Chlorophyll A is high during both wet and dry weather, and is probably related to the above mentioned problem of large diurnal swings in DO. The nutrients nitrogen and phosphorus are also fairly high, possibly contributing to excessive algal growth. Turbidity and Total Suspended Solids are also quite high during wet weather, suggesting that bank and channel erosion may be occurring, as well as high wash loads of sediments in stormwater during rain events.

Table 5.8 Summary of Aquatic Life Criteria Exceedances

Parameter	Criteria	Dry			Wet		
		No. Obs.	No. Exceeds	% Exceed	No. Obs	No. Exceed	% Exceed
Chlorophyll A	Maximum	25	10	40.00	62	27	43.55
TKN	Maximum	55	5	9.09	404	225	55.69
TP	Maximum	67	8	11.94	451	165	36.59
TSS	Maximum	48	0	0.00	148	30	20.27
Turbidity	Maximum	61	1	1.64	441	148	33.56

Green – Parameter is not a problem

Yellow – Potential problem parameter

Red – Problem parameter

5.4 Potential Problem Parameter Summary

Based on the analysis, the problem and potential problem parameters are summarized below. The problem parameters are those constituents for which more than 10% of the samples exceed the standard. Parameters where the standards (or reference values) were exceeded over 2% of the time for all samples throughout the Tookany/Tacony-Frankford Watershed are listed as potential problems. Also, at the least, over 10% of parameter samples at one sampling location must exceed the standard to be considered a problem parameter.

In Table 5.9, the problem and potential problem parameters are listed by category. They are also broken down as either wet or dry weather problems, if applicable. For the metals, the listing is further broken down for chronic versus acute criteria.

Table 5.9 Summary of Problem and Potential Problem Parameters

Parameter	Standard	Dry	Wet	Chronic
Acute				
Al	Acute Maximum		✓	
Dissolved Cu	Acute Maximum		✓	
Chronic				
Al	Chronic Maximum			✓
Dissolved Cu	Chronic Maximum			✓
Water Supply				
Dissolved Fe	Maximum	✓	✓	
Other Parameters based on reference values				
Chla	Maximum	✓	✓	
Fe	Maximum		✓	
Phenolics	Maximum		✓	
TKN	Maximum	✓	✓	
TP	Maximum	✓	✓	
TSS	Maximum		✓	
Temp C	Maximum		✓	
Total Nitrogen	Maximum		✓	
Turbidity	Maximum		✓	
DO	Minimum	✓		
DO	Minimum Average	✓		

Green – Parameter is not a problem Yellow – Potential problem parameter Red – Problem parameter

5.5 Stream Ecology

The biological community of the TTF Watershed is heavily impacted by its urban surroundings. The impaired state of the creek is a result of habitat deterioration and water quality degradation. High levels of urbanization and development, and poor stream bank stability and flood control deeply influence the creek itself and the entire watershed. These factors have resulted in creek channelization, further inducing erosion and sedimentation problems. Natural water flows have been redirected to storm sewers and natural land surfaces replaced by block after block of impervious surfaces. Due to the changes in the hydrologic profile of the stream and watershed, storm events result in more concentrated runoff and cause more damage than they once did. Instead of percolating into the ground, stormwater is collected and rushed into an already unstable creek where it scours banks, fills pools, and covers riffles. The rushing water strips soil from the banks and deposits some of it over the embedded cobbles and takes the rest to the Delaware River, all the while holding on to the chemicals and pathogens collected on the city streets and in sewers. Figure 5.9 displays the results of the biological and habitat assessments.

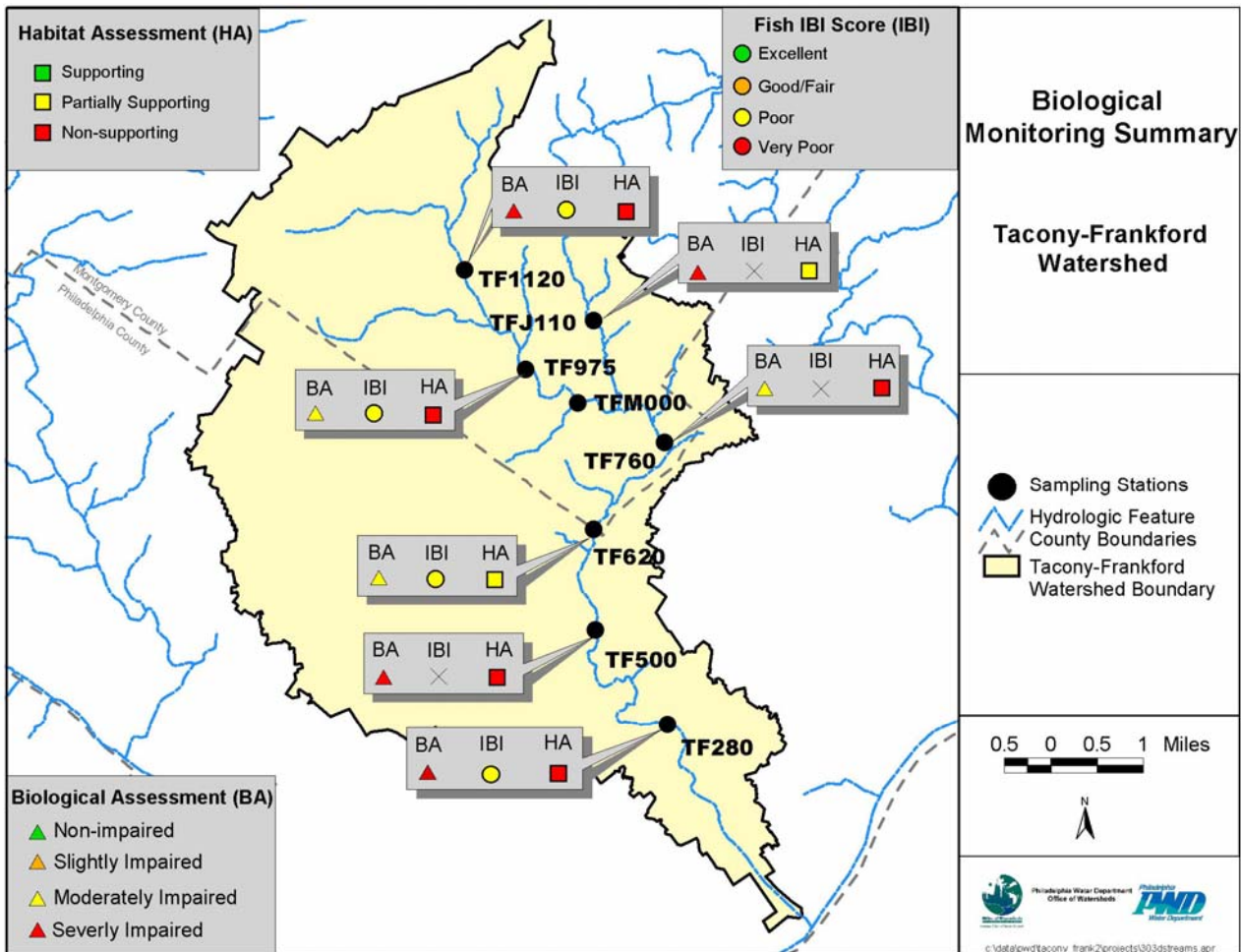


Figure 5.9 Tookany/Tacony-Frankford Biological Monitoring Summary

Biological monitoring indicates that the entire watershed suffers from impaired aquatic habitat and does not meet its designated use as a warm water fishery. As a result, the whole length of the Tacony-Frankford Creek and its tributaries were listed in PA DEP’s 303d list of impaired

waters in 1999. This impairment is due to severe water flow fluctuations, habitat alteration, point and non-point source (NPS) pollution from urban development, hydro-modification, and combined sewer overflows (CSOs) (PA DEP 2001). The tidal portion of the Frankford Creek remains unassessed because the biological assessment protocol is not applicable to tidal stream segments.

Habitat assessments of the Tacony-Frankford Watershed have determined much of the area to be non-supporting of a biological community. Eight sites within the watershed were assessed based on environmental features such as available vegetation and vegetative cover, riparian zones, stream bank stability, stream flow, riffles, pools, and other factors. Of these eight sites, six were determined to be lacking the attributes needed to support aquatic communities of organisms, while the other two were determined only capable of partially supporting aquatic communities.

Benthic macroinvertebrates rely heavily on stream riffles for at least part of their life cycle. Clinging to life in a riffle requires various adaptations, and most macroinvertebrates are not further prepared for the extreme hydrologic fluctuations that can occur in a channelized creek such as the Tookany/Tacony-Frankford. Increased stream velocities and sediment loads from eroding stream banks disrupt the benthic environment by alternately scouring the stream bottom of appropriately sized cobble substrate and burying those cobbles in sediment. Storm events lead to decreased species richness and evenness, which in turn changes the dynamics of feeding groups within the communities. Specialized feeders are greatly diminished, and generalists such as gatherer/collectors dominate the feeding community. Organisms well adapted to hydrologic extremes and to pollution also begin to dominate the communities. Of the eight sites evaluated for macroinvertebrate life, five were found to be severely impaired, and three were classified as moderately impaired. Only two of the sites were categorized as partially supporting of macroinvertebrate habitats, while the other six are non-supporting.

Like the benthic macroinvertebrate community, fish communities rely heavily on various habitats within a stream reach. An altered hydrologic profile in the stream leads to fewer offspring and decreased diversity in the fish community. The extreme flow conditions disrupt nesting habitats and routines for many species. Fish are also unable to rely on the presence of the calm pools and runs they often inhabit. A fish assessment of the Tookany/Tacony-Frankford Creek collected a total of 14 taxa, all of which being at least moderately tolerant of pollution. One of the sites evaluated had only three species of fish present. The low diversity and species richness is indicative of poor habitat and stream health.

5.6 Wetlands Assessment

As discussed in Section 4.5.2 (Indicator 13), the Philadelphia Water Department conducted an extensive wetlands assessment along the riparian corridor of the Tookany/Tacony-Frankford Watershed. Wetland indicators were used to identify possible wetland locations (e.g., soils, hydrology). Over 100 potential wetland locations were field evaluated, and 24 existing wetlands were identified. These wetlands were characterized using the Oregon Freshwater Wetland Assessment method, which evaluates how effectively a wetland performs the following functions: Wildlife Habitat, Fish Habitat, Water Quality, and Hydrologic Control.

The existing wetlands ranged in size from 0.01 to 2.5 acres. In total, only 15 acres of wetland (excluding open water) remain within the 685 acres that constitute the undeveloped riparian corridor of the Tookany/Tacony-Frankford Watershed, and most of those wetlands exhibit degraded wetland functions as a result of hydrologic disconnection from the waterways, encroachment, and invasive vegetation.

The most significant issues affecting wetlands are:

- Many wetlands have been lost to development;
- Remaining wetlands are not sufficiently inundated because stormwater is piped directly to streams;
- Wetlands are no longer hydrologically connected to the primary waterway;
- Wetlands have suffered encroachment and disturbance from urbanization;
- Wetland vegetative and wildlife diversity has been compromised by disturbance;
- Remaining wetlands are extensively compromised in terms of their water quality improvement function.

The extent of disturbance to the remaining wetlands is indicated by the degree to which the wetland functions have been degraded and the degree of human disturbance. The wetland field investigation produced ratings of the degree to which wetland functions have been compromised and the extent of human disturbance to the wetlands sites. This information is summarized in the tables and figures below.

Table 5.10 Wetland Functional Assessment Results for Tookany/Tacony-Frankford Creek Watershed (based on 24 wetland locations)

<i>Function</i>	<i>Number of Wetlands with Stated Condition</i>
Wildlife Habitat	
Diverse Habitat	10
Moderate Habitat	14
Fish Habitat	
Intact Habitat	6
Degraded	12
Lost / Not Present	6
Water Quality Improvement	
Intact Function	3
Degraded Function	21
Hydrologic Connection to Stream	
Intact Connection	16
Degraded Connection	7
Connection Lost / Not Present	1

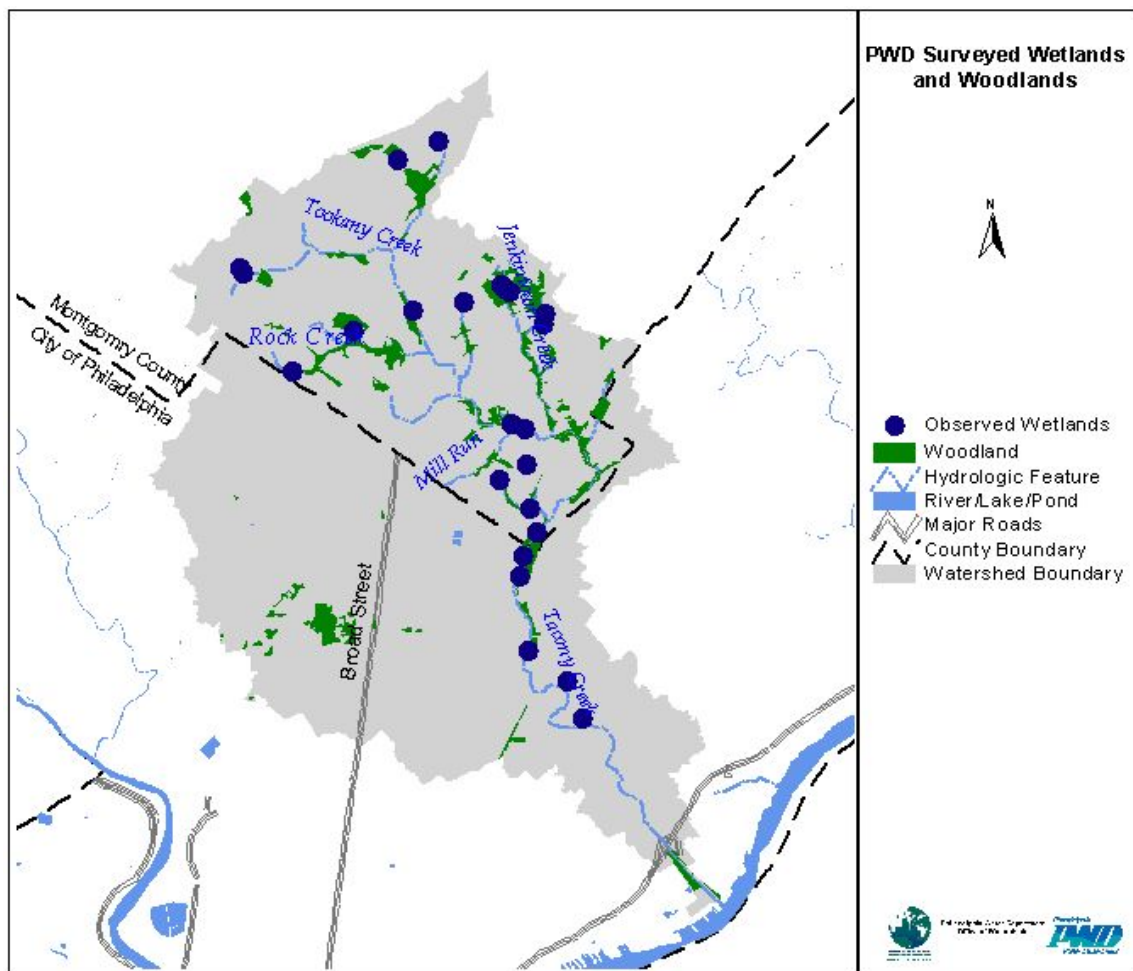


Figure 5.10 Location of Wetlands

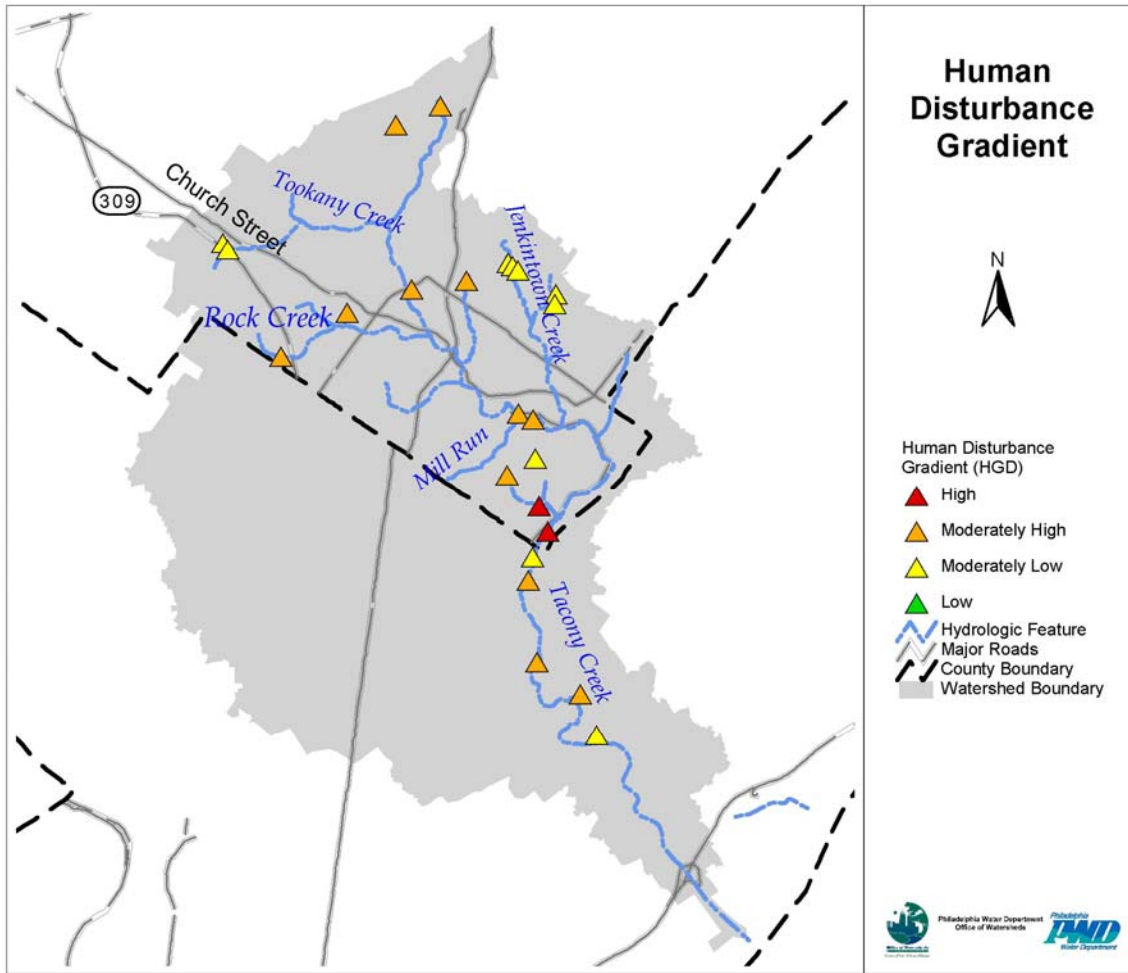


Figure 5.11 Rank of Human Disturbance Gradient

Table 5.11 Rank of Human Disturbance Gradient

Human Disturbance Gradient Rank	Number of Wetlands
Moderately Low Disturbance	10
Moderately High Disturbance	12
Highly Disturbed	2

5.7 Potential Problem Parameters and Planning Implications

Based on the comparisons to water quality criteria, the problem and potential problem parameters have been identified for the Tookany/Tacony-Frankford Watershed. Table 5.12 summarizes these parameters.

Table 5.12 Summary of Problem and Potential Problem Parameters

Parameter	Dry Weather	Wet Weather	Chronic
Fecal Coliform	✓	✓	
Chlorophyll A	✓	✓	
TKN	✓	✓	
TP	✓	✓	
Turbidity	✓	✓	
Cu	✓	✓	✓
TSS	✓	✓	
Iron		✓	
Zn		✓	✓
Al		✓	✓
Pb		✓	✓
Dissolved Fe	✓	✓	
Temperature	✓	✓	
DO	✓		
TN		✓	
Chromium			✓

Green – Parameter is not a problem

Yellow – Potential problem parameter

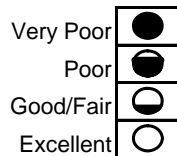
Red – Problem parameter

The Tookany/Tacony-Frankford Watershed is faced with many challenges. Stormwater outfalls (SWOs) and combined sewer overflows (CSOs) have exacerbated problems within the watershed. Poor water quality and diurnal variations in levels of dissolved oxygen are added stresses on local fauna. Insufficient habitat combined with the highly variable stream flow makes it difficult to establish a diverse and healthy biotic community. An urban watershed must overcome many obstacles to establish meaningful habitat within and alongside a stream.

Table 5.13 (below) lists the indicators that directly link to water quality and aquatic habitat. The water quality sampling locations have been graded according to sampling results and watershed assessments. For most of the Tookany/Tacony-Frankford Watershed, the indicators have been marked as poor or very poor. Dissolved oxygen, important to maintaining aquatic life, has been identified as a potential problem in the downstream portion of the watershed area.

Table 5.13 Related Watershed Indicator Ratings by Sampling Location

	<i>Indicator 1: Land Use and Impervious Cover</i>	<i>Indicator 2: Streamflow</i>	<i>Indicator 3: Stream Channels and Aquatic Habitat</i>	<i>Indicator 5: Fish</i>	<i>Indicator 6: Benthos</i>	<i>Indicator 7: Effects on Public Health (Bacteria)</i>	<i>Indicator 8: Effects on Public Health (Metals and Fish Consumption)</i>	<i>Indicator 9 : Effects on Aquatic Life (Dissolved Oxygen)</i>	<i>Indicator 10: Point Sources</i>	<i>Indicator 11: Non-point Sources</i>	<i>Indicator 12: Riparian Corridor</i>	<i>Indicator 13: Wetlands and Woodlands</i>
TF280	●	●	●	●	●	●	●	○	○	●	●	●
TF500	●	●	●	X	●	●	○	○	●	●	●	●
TF620	●	○	●	●	●	○	○	○	○	●	●	●
TF680	X	X	X	X	X	●	●	○	○	●	X	●
TF760	●	○	●	X	●	○	○	○	○	●	●	○
TF975	●	○	●	●	●	○	○	○	○	○	○	○
TF1120	●	○	●	●	●	○	○	○	○	●	●	○
TFM000	●	X	●	X	X	X	X	○	○	○	●	●
TFJ110	●	X	●	X	●	X	X	X	○	○	●	○



Results of the water quality sampling indicate that the water quality of the Tookany/Tacony-Frankford is impaired, with the problems associated primarily with wet weather conditions. Some problems have been identified during dry weather. Sources of bacterial contamination during dry weather may include inappropriate or illicit discharges from storm or sanitary sewerage systems. Detection of these sources is valuable to the management goals of the Tookany/Tacony-Frankford Watershed. Dry weather concentrations of nutrients may be

attributed to treated wastewater effluent, over-watering of lawns and gardens, pet waste, and failing septic tanks.

In wet weather, the model-estimated pollutant loadings have identified contributions from different sources. Estimated annual pollutant contributions for the Tookany/Tacony-Frankford Watershed are discussed in Section 4.4. Permitted industrial and municipal point source discharges make up less than 1% of annual streamflow in both systems. SSOs are thought to occur in both watersheds but have not been well documented to date.