9. Measures of Success

MONITORING AND WATER QUALITY CRITERIA

Due to the dynamic nature of watersheds and the countless variables governing landscape processes across scales of time and space, some uncertainty is to be expected when a Watershed Protection Plan is developed and implemented. As the recommended restoration measures of the Plum Creek Watershed Protection Plan are put into action, it will be necessary to track the water quality response over time and make any needed adjustments to the implementation strategy.

As efforts continue, incorporation of new data will improve the understanding of watershed conditions and will drive a more efficient implementation process. Adaptive management will allow initial results to guide future restoration strategies as stakeholders learn through experience. By tracking stream trends, stakeholders will be able to evaluate whether plan execution is successful and will determine the need for new action or refocusing of existing programs. This adaptive approach relies on constant input of watershed information and the establishment of intermediate and final water quality targets.

Pollutant concentration targets were developed based on complete implementation of the Watershed Protection Plan and assume full accomplishment of pollutant load reductions by the end of the 10-year project period (Tables 9.1 and 9.2). While some of the less complex management measures recommended here will be relatively simple to implement early in the process, implementation of other measures will require more time, energy, and funding. For this reason, reductions in pollutant loads and associated concentrations initially may be gradual. However, it can be assumed that reductions in the loading of bacteria and nutrients will be tied to the implementation of management measures throughout the watershed. Thus, these projected pollutant targets will serve as benchmarks of progress, indicating the need to maintain or adjust planned activities. While water quality conditions likely will change and may not precisely follow the projections indicated here, these estimates serve as a tool to facilitate stakeholder evaluation and decision-making based on adaptive management.

Table 9.1. *E. coli* bacteria targets at selected intervals through implementation.

Month	***E. coli* Concentration (cfu/100mL)**		
	Uhland (17406)	**Lockhart (12647)**	**Luling (12640)**
Feb-2008	205	107	112
Aug-2009	192	105	107
Feb-2011	165	102	98
Aug-2012	131	98	87
Feb-2014	98	94	75
Feb-2016	84	93	71
Feb-2018	71	91	66

Table 9.2. Orthophosphorus and total phosphorus targets at selected intervals through implementation.

Month	OP Concentration (mg/L)	TP Concentration (mg/L)		
	Lockhart[1] (12647)	Uhland (17406)	Lockhart (12647)	Luling (12640)
Feb-2008	0.39	0.53	0.52	0.35
Aug-2009	0.38	0.51	0.52	0.35
Feb-2011	0.34	0.48	0.51	0.35
Aug-2012	0.29	0.45	0.50	0.35
Feb-2014	0.24	0.41	0.50	0.35
Feb-2016	0.22	0.40	0.49	0.35
Feb-2018	0.20	0.38	0.49	0.35

1 Orthophosphorus data are not collected at the Uhland and Luling sites.

For bacteria and nutrients of concern, water quality data will be compiled and a 5-year geometric mean for *E. coli* bacteria, total phosphorus, and orthophosphorus (where applicable) will be computed every 6 months to examine trends in Plum Creek. These values will be compared to the incremental reductions outlined in Tables 9.1 and 9.2 to determine the need to adjust implementation. Though a geometric mean generally is not calculated for nutrients, these indicators will enable ongoing assessment of the effects of implementation efforts on pollutant concentrations. In addition, from single grab samples will be compiled and analyzed every 6 months to determine compliance with the water quality criteria. If water quality samples continue to exceed the single sample criteria more than 20% of the time for nutrient concerns and 25% for bacterial impairment, implementation approaches will be adjusted accordingly.

Current water quality monitoring efforts in the Plum Creek Watershed rely on the existing routine monitoring stations at Uhland, and those near Lockhart and Luling. These locations form the assessment units for regulatory purposes and will be an integral part of continued efforts to track the success of plan implementation. To monitor water quality progress over the course of the project, these sites will continue to collect ambient in-stream data including:

- *E. coli*
- Nitrate
- Total Dissolved Solids
- High pH
- Low pH
- Ammonia
- Chlorophyll-a
- Sulfate
- Orthophosphorus (Lockhart)
- Total Phosphorus
- Temperature
- Chloride
- Dissolved Oxygen Grab-Minimum
- Dissolved Oxygen Grab-Screening Level (at Uhland and Luling)

Though not all of these measures coincide with current impairments or concerns, continued monitoring for a wide array of parameters will detect the development of additional water quality problems, in addition to measuring progress toward goals to address current issues. Continued routine monthly sampling at the Uhland and Luling stations is considered necessary and sufficient for these locations. In addition, the Steering Committee and work groups recommend continued and more frequent sampling be conducted at monitoring station 12647 near Lockhart. Given that *E. coli* data have been collected at this station only since 2001, current quarterly sampling is deemed inadequate. Further, to more effectively define the magnitude and timing of pollutant loads in this middle reach of the stream, the Plum Creek Watershed Partnership strongly recommends that the frequency of sampling for the same suite of pollutants be increased from quarterly to monthly at the Lockhart monitoring station.

TARGETED WATER QUALITY MONITORING

To supplement this routine sampling, a special Surface Water Quality Monitoring project funded by the TSSWCB and conducted by the GBRA will increase the temporal and spatial resolution of sampling efforts to more effectively pinpoint the timing and sources of high pollutant loads. A combination of additional routine stations, multiple targeted locations, urban stormflow monitoring, wastewater effluent sampling, and springflow sampling will be utilized (Figure 9.1). A summary of the water quality monitoring components of this project are as follows:

- Increase routine sampling sites from 2 monthly, and1 quarterly to 8 monthly (duration of 15 months)
- Conduct 24-hour dissolved oxygen monitoring monthly at 8 routine sites (8 months)
- Targeted sampling twice per season at 35 sites (12 months)
- Automated stormflow sampling of 4 events at one urban/residential site in Hays County (over 12 months)
- WWTP effluent sampling once per season at 5 sites (12 months)
- Springflow sampling once per season at 3 springs in central portion of watershed (12 months)

This short-term intensive monitoring effort will refine the focus of management efforts as well as track the performance of ongoing implementation activities during the study.

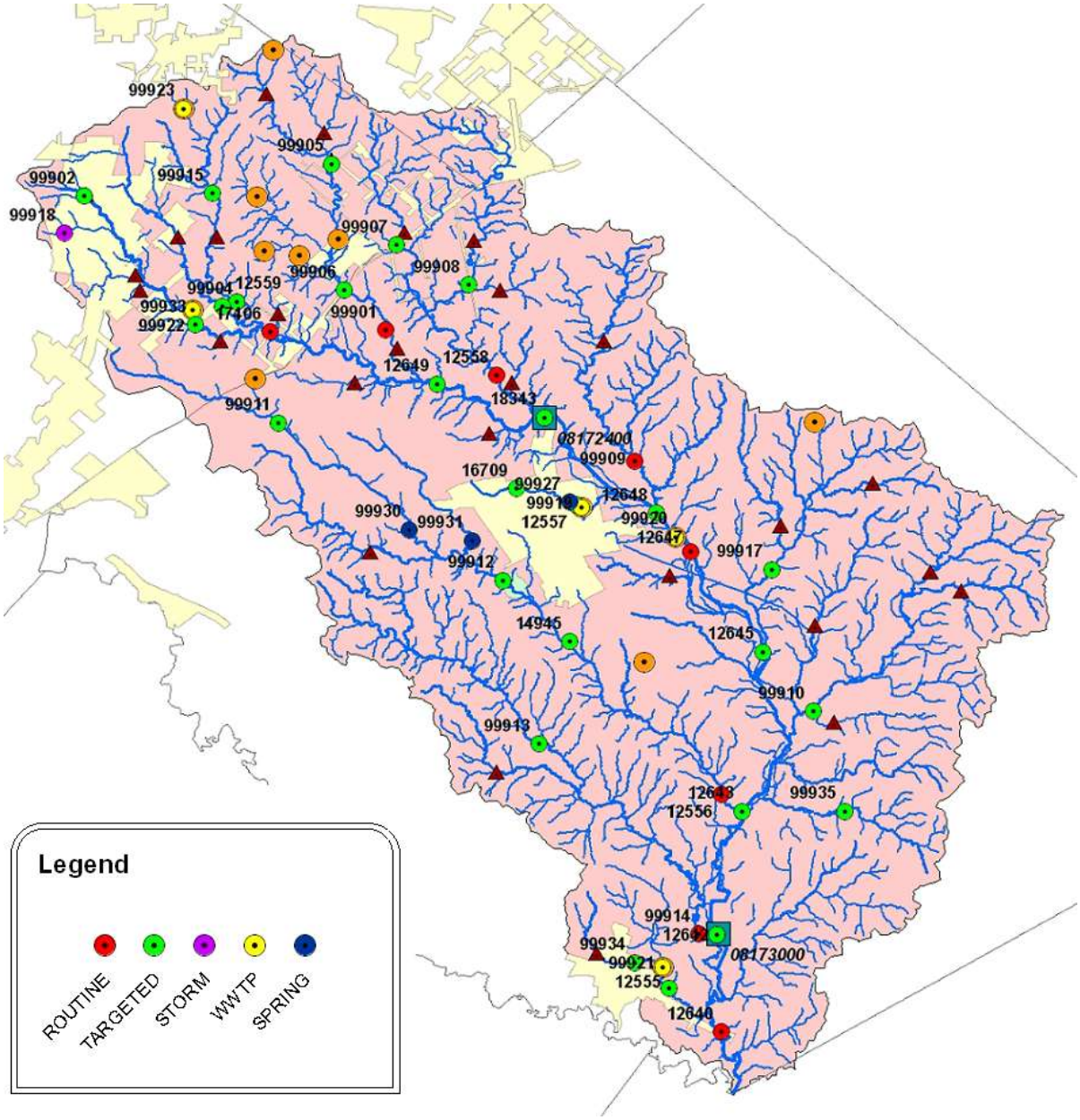

Figure 9.1. Map of locations for Plum Creek Surface Water Quality Monitoring project.

STREAM BIOLOGICAL ASSESSMENTS

In addition to these water quality analyses, the GBRA annually conducts biological and habitat assessments near the Uhland and Luling water quality monitoring stations (Figure 9.2). Surveys of the fish and macroinvertebrate communities in the stream as well as the plant communities and physical characteristics of the environment adjacent to the stream serve as indicators of positive or negative responses to changes in stream conditions. These surveys will be continued to determine if water quality trends result in measurable changes in the biological communities in Plum Creek. Reports will be developed after each survey and compared with results from previous years to determine differences between sites and over time.

Figure 9.2. GBRA technician conducts biological assessment demonstration. Such assessments will play an important role in tracking the health of the Plum Creek Watershed.

SWAT

To support adaptive management during implementation, the Soil and Water Assessment Tool (SWAT) will be used to model hydrologic processes, nutrient loading, and fate and transport of *E. coli* within the watershed. The SWAT model is a basin-scale model that simulates daily flows and events in the watershed. This tool allows prediction of management impacts on water volume and loads of nutrients, bacteria, and other pollutants over long periods of time. Initial stages of SWAT have been developed in tandem with the Plum Creek Watershed Protection Plan, and further iterations will support adaptive management in the watershed. Integration of SWAT with both long-term monitoring and the targeted sampling efforts will allow additional focusing of management measures in the watershed. As water quality monitoring data, information on animal numbers and wastewater discharges, and other inputs are collected, they will be included to adjust key management areas and further project which actions should be taken. The Spatial Sciences Laboratory at Texas A&M University will conduct the SWAT analysis for the Plum Creek Watershed Partnership to assist in adaptive management. If selected management practices are found to be insufficient, they will be adjusted accordingly during implementation (Figure 9.3).

BACTERIAL SOURCE TRACKING

The Plum Creek Watershed Partnership Steering Committee and work groups also have recommended employing Bacterial Source Tracking techniques as an additional management tool. Bacterial Source Tracking is a relatively new approach in which a bacteria DNA library is prepared using known sources from within the watershed. Water quality monitoring samples are then compared to the library to determine the most significant contributors. These data would enhance and refine results from the SELECT analysis and also could be used to confirm and/or adjust ongoing and planned implementation efforts. Funding for targeted Bacterial Source Tracking analysis within Plum Creek will be pursued as a part of the implementation strategy.

Figure 9.3. Springflow on Town Branch. A number of ongoing monitoring and assessment programs, including springflow water quality monitoring and SWAT analysis, will assist in adjusting the implementation of the Plum Creek Watershed Protection Plan.