South Prairie Creek Total Maximum Daily Load Phase I Assessment

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Quality Assurance Project Plan

by
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Washington State Department of Ecology
Environmental Assessment Program
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Table of Contents

List of Figures

List of Tables

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Introduction

Located in the South Puget Sound region, South Prairie Creek is a tributary to the Carbon River, which is a tributary to the Puyallup River. The watershed includes all or portions of the towns of Wilkeson, Buckley, South Prairie, and Burnett (Figure 1). Lower South Prairie Creek is the most important salmonid spawning area in the Puyallup River basin, with runs of fall chinook, pink, coho, chum, and winter steelhead. Lower South Prairie Creek exceeded water quality standards for fecal coliform bacteria, based on Ecology monitoring data from 1992-93, and a segment was placed on the 303(d) list. Upstream sections are listed for temperature, based on data collected by the Muckleshoot Tribe in 1997.

The purpose of the Total Maximum Daily Load (TMDL) is to determine contributors to the fecal coliform bacteria exceedences and to determine whether other nonpoint-source-related parameters meet water quality standards. Temperature, in particular, may exceed water quality standards.

The monitoring will be conducted in two phases. The purpose of the Phase I monitoring described in the present Quality Assurance Project Plan (QAPP) is to assess conditions in the lower South Prairie Creek watershed during summer 2000. The results will be used to refine the sampling program that will form the basis of the overall technical study. A second QAPP, which will describe the Phase II 12-month monitoring program, will be prepared following completion of the Phase I monitoring.

1998 303(d) listings addressed in this study:

Water Body	T	R	S	New ID	Old WBID	Parameter
South Prairie Creek	19N	06E	14	VC19MO	WA-10-1085	Fecal Coliform

Project Description

Study Area

The 90.7-square-mile watershed varies in elevation from 5,933 (Pitcher Mountain) to 285 ft MSL at its confluence with the Carbon River (Mastin, 1998). Mean annual average precipitation over the watershed is 61 in/yr but varies from 85 in/yr at the higher elevations to 38 in/yr at the mouth. Geology of the basin includes well compacted glacial till and stratified drift deposits. The lower valley was impacted by the Osceola mudflow from Mt. Rainier. The United States Geological Survey (USGS) has operated stream gage 12095000 (79.5 square miles, 430 ft NGVD) continuously since 1988; the gage was also in operation from 1950 to 1979.

The river flows 21.65 miles from its headwaters in the Snoqualmie National Forest, near the northwest corner of Mount Rainier National Park. The upper watershed is characterized by steep gradients and high velocities not conducive to salmonid spawning, and the Buckley diversion dam at river mile 15.7 blocks upstream fish migration. Land cover is predominately forested, with logging activity throughout the region (Lund, 1994).

The lower watershed provides more moderate to gentle gradients, with good gravel substrate and pool/riffle proportions providing excellent salmon habitat (Lund, 1994). Land cover is a mix of deciduous and evergreen forest, with agricultural and residential land use (Figure 2).

Towns in and near the watershed rely on local water resources for drinking water and wastewater needs. The town of Wilkeson owns and operates a wastewater treatment plant that discharges to Wilkeson Creek (river mile 4.0). Its drinking water supply consists of local springs. Burnett residents replaced many onsite disposal systems in 1998 following problems with poor soils (Hanowell, pers. comm.). South Prairie, which relies on local springs for drinking water, also discharges treated wastewater to South Prairie Creek at river mile 5.8. Buckley diverts a portion of South Prairie Creek for its drinking water supply, but wastewater discharges are external to South Prairie Creek. The Buckley diversion also provides drinking water to the Rainier State School and Washington State University Dairy Forage Facility[1]; both discharge wastewater to the White River system. Other scattered residential developments rely on private wells and septic systems. The Pierce County Watershed Ranking Committee, a temporary group, determined that most of the undeveloped sections of land in the Puyallup River watershed are generally not suitable for septic systems.

Much of the Spiketon Ditch is an artificial channel that replaced a natural waterway. Historically, the drainage served local forestry needs. At present, Spiketon Ditch serves to convey stormwater from a part of Buckley as well as receive local surface water runoff. The tributary area contains good riparian shading (Ladley, pers. comm.).

USGS completed a flood study of the South Prairie Creek watershed in 1998, following several destructive floods, including January 1990 and February 1996. Local citizens were concerned that timber harvesting and road construction had increased the potential for flooding. The study found no statistically significant trend in increased peak runoff, contrary to current literature (Mastin, 1998).

The Soil Survey of Pierce County (USDA SCS, 1979) included the lower half of South Prairie Creek watershed. The areas impacted by the Osceola mudflow have low permeabilities (0.6 to 2 in/hr) and include the developed areas of Buckley, Burnett, South Prairie and Wilkeson. Upland areas south of Wilkeson Creek and north of lower South Prairie Creek have highly permeable soils (6 to 20 in/hr). The lower South Prairie Creek valley has moderately permeable soils (2 to 6 in/hr). Upper South Prairie Creek watershed soils were not included in the soil survey.

The Pierce County Conservation District identified two dairies in the South Prairie Creek Watershed (PCCD, 1992), which had farm plans in place as of 1994 but had not implemented BMPs. By August 2000, both should have updated and approved farm plans in accordance with the Dairy Waste Management Act (Abbott, pers. comm.) Several small farms, some with horses, are also located adjacent to South Prairie Creek.

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[1] The WSU facility has ceased dairy operations as of July 2000, but will continue farming operations (Clowers, written comm.).

Wilkeson was a mining center, and coal waste products have been reported (Lund, 1994). An unconfirmed report presented in Lund (1994) describes 100% coho salmon fry mortality due to sulfur-laden water from the Wilkeson coal mines. However, salmon have been sighted spawning in active mine seeps, and pH is not believed to be a problem (Ladley, pers. comm.).

Previous forest practices impacted South Prairie Creek (Schuett-Hames, 1994). New forestry regulations developed as part of the 1999 Washington State Forest and Fish Agreement, have been adopted by the Washington State Legislature and the State Forest Practices Boards. These laws provide for stronger riparian protection, road management, and mass wasting practices in addition to an upgraded monitoring program and adaptive management. Operations active in the South Prairie Creek watershed met in January 2000 and discussed the possibility of a monitoring program for assessing the effectiveness of best management practices, although a pilot program would not begin before summer 2001 (Light, pers. comm.). Plum Creek anticipates deploying several Onset StowAway Tidbits in upstream reaches of Wilkeson Creek, Gale Creek, and/or the East Fork of South Prairie Creek in July 2000 (Light, pers. comm.). Champion/IP Pacific Timberlands also anticipates monitoring stream temperature in the upper watershed (Liquori, pers. comm.). Exact locations were not available at the time of publication, but the area of interest is well upstream of the anticipated deployments under this QAPP. The two programs will monitor temperature in areas under consideration for future forestry operations.

Project Objectives

Overall project objectives include the following:

- Determine sources of fecal coliform bacteria to lower South Prairie Creek
- Determine whether other water quality standards are being met

The objective of the Phase I assessment is to identify potential sources of fecal coliform bacteria and determine whether temperature and other parameters meet water quality standards.

Sources of Pollution

Potential sources of fecal coliform bacteria include both point and nonpoint sources. Both the Wilkeson and South Prairie wastewater treatment plants discharge upstream of lower South Prairie Creek. South Prairie effluent fecal coliform bacteria levels and temperature are monitored regularly, as well as flow, 5-day biochemical oxygen demand (BOD5), copper, cadmium, lead, ammonia-nitrogen, nitrate, nitrite, pH, settleable solids, suspended solids, and zinc. At the Wilkeson plant, effluent is monitored for fecal coliform bacteria, temperature, flow, BOD5, chlorine, total suspended solids, pH, copper, mercury, ammonia, zinc, and ultraviolet intensity.

Potential nonpoint sources of fecal coliform bacteria and other pathogens include the following:

- Wildlife
- Septic systems

- Human recreation
- Domestic animals (dogs, horses, cats)
- Agriculture operations (cattle, field applications of manure)

Potential contributors to high instream temperatures include the following:

- Upper watershed impairments due to historical riparian cover removal
- Loss of riparian cover in lower watershed associated with agricultural, residential, and recreational development
- Variations in groundwater inflows to surface water
- Surface water withdrawals
- Modifications to high- and low-flow regimes due to changes in watershed or river channel characteristics

Additional potential nonpoint sources of pollution include the following:

- Sediments from land cover disturbance (residential, agricultural or recreational practices)
- Sediments from bank erosion
- Sediments and nutrients from residential, forestry, or agricultural practices

Water Quality Standards

The water quality standards, set forth in Chapter 173-201A of the Washington Administrative Code, include designated beneficial uses, classifications, numeric criteria, and narrative standards for surface waters of the state.

South Prairie Creek discharges to the Carbon River, which is a tributary to the Puyallup River. Neither South Prairie Creek nor the Carbon River are classified separately from the Puyallup River. Because they discharge to the Class A portion of the Puyallup River (WAC 173-201A-030), South Prairie Creek and its tributaries are considered Class A (excellent) water bodies. Characteristic uses for Class A water bodies include water supply (domestic, industrial, agricultural), stock watering, fish and shellfish (salmonid and other fish migration, rearing, spawning, harvesting), wildlife habitat, recreation (primary contact recreation, sport fishing, boating, aesthetic enjoyment), and commerce and navigation. Numeric criteria for particular parameters are intended to protect designated uses. For Class A freshwater bodies,

> *"…fecal coliform organism levels shall both not exceed a geometric mean value of 100 colonies/100 mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 200 colonies/100 mL"*
>
> [WAC 173-201A-030 (2)(c)(i)(A)].

Fecal coliform bacteria, while not disease-causing organisms, have been adopted as indicator organisms for other pathogens with a fecal pathway that could impact human health. In addition, *E. coli* and/or *Enterococci* could be adopted into the water quality standards as potential indicator organisms for fecal pathogens.

The water quality standards also state that temperature shall not exceed 18.0°C due to human activities. When natural conditions exceed 18.0°C (freshwater only), no temperature increases will be allowed which will raise the receiving water temperature by more than 0.3°C. If natural conditions are below 18.0°C, incremental temperature increases resulting from nonpoint source activities shall not exceed 2.8°C or bring the temperature above 18.0°C at any time. Temperature is of greatest concern to salmonid species, and temperature can reduce the area available for spawning and rearing habitat for steelhead. Temperatures exceeding 18.0°C have been recorded in areas upstream of lower South Prairie Creek, although no previous continuous temperature monitoring has been conducted on lower South Prairie Creek.

Numeric criteria for dissolved oxygen, pH, and turbidity are not expected to be exceeded, but these parameters will be monitored in the Phase I assessment. Dissolved oxygen must exceed 8.0 mg/L, while pH must be within the range 6.5 to 8.5 for freshwater bodies, with human-caused variation within the range of less than 0.5 units. Turbidity increases due to human activities shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or exceed 10 percent of the background turbidity when the background turbidity is more than 50 NTU.

Finally, toxic, radioactive, or deleterious material concentrations shall be below those which have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health.

Historical Data Review

Organizations that have collected data on South Prairie Creek include the Department of Ecology, USGS, Pierce County, Pierce County Conservation District, Muckleshoot Tribe, Puyallup Tribe, and the Federal Emergency Management Agency (FEMA).

Washington State Department of Ecology

- Ecology monitored flow and water quality in South Prairie Creek in 1992-93 under the Ambient Monitoring Program. AMS station 10F090 (Route 162 Bridge 4, 2.8 miles north of the Carbon River bridge; included in the Phase I assessment as station SPCB4) exceeded fecal coliform standards for a class A water body, as evident in Table 1. All other parameters met water quality standards.

- Ecology conducted total maximum daily load studies for the entire Puyallup River system for BOD, ammonia, and residual chlorine (Pelletier, 1993). Data include total organic carbon, chlorophyll a, BOD5 and ultimate BOD for point source discharges and instream conditions. The Wilkeson wastewater treatment plant was monitored, as were three stations along South Prairie Creek (SPR07.2, SPR05.8, and SPR01.1); hydraulic parameters were estimated for South Prairie Creek for modeling purposes.

Table 1
Ecology Ambient Monitoring Station 10F090 Water Quality Data

Date	Time	Flow (cfs)	Temperature (^oC)	Conductivity (umhos/cm)	DO (mg/l)	DO (%sat)	pH	FC (#/100 ml)	TSS (mg/l)	NH3 (mg/l)	TP (mg/l)	Dissolved Soluble Phosphorus (mg/l)	Turbidity (NTU)	NO23N (mg/l)
10/27/92	1020	226	7.8	95	12.2	102.1	7.7	13	1	0.010k	0.010k	0.010k	0.4	0.3
11/22/92	1100	876	2.1	53	11.6	84.8	7.3	67s	22	0.014	0.024	0.010k	5.2	0.9
12/21/92	1035	346	4.5	57	12.2	94.4	7.5	84	4	0.011	0.014	0.010k	2.4	0.9
1/26/93	950	1590	6	32	12.1	97	7.0	110	65	0.033	0.049	0.010k	18	0.7
2/23/93	910	74	1	78			7.5	40	1	0.015	0.011	0.010k	0.7	0.6
3/23/93	945	1770	6.4	35	11.5	94.3	6.9	800s	100	0.022	0.089	0.010k	33	0.7
4/27/93	1035	361	7.5	56	11.6	95.9	7.7	2400s	4	0.021	0.02	0.010k	1.9	0.4
5/25/93	940	211	11.5	58	10.3	94.7	7.3	28s	2	0.052	0.013	0.010k	1	0.3
6/29/93	1045	388	10.6	53	10.9	97.7	7.3	1000	12	0.012	0.029	0.010k	3.8	0.3
7/27/93	1000	263	11.5	57	11	101	7.4	43	2	0.010k	0.01	0.010k	1.5	0.3
8/24/93	1015	88	12	98	10.6	97.4		88	5	0.013	0.021	0.010k	1.1	0.4
9/28/93	1115	45	10.6	108	11.2	100.1	7.6	440	2	0.010k	0.017	0.011	0.7	0.5

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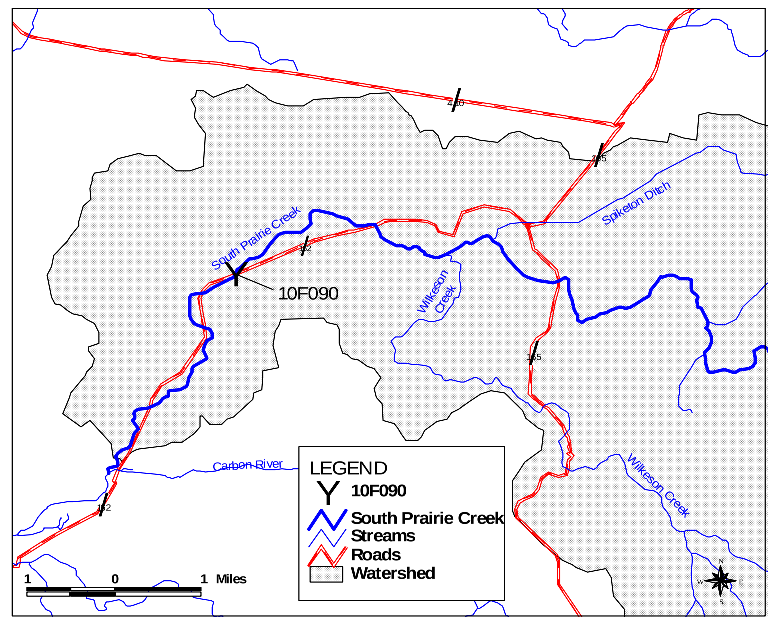

- More recently, Ecology conducted a one-year survey of wastewater treatment plant effluent metal concentrations within the Puyallup River watershed, including the Wilkeson WWTP (Hoyle-Dodson, 1997). The study found that copper and zinc were associated with TSS concentrations, and Wilkeson flows and 24-hour sample effluent TSS loads were greater than NPDES permitted monthly average limits. Effluent parameters measured included hardness, TSS, zinc, copper, mercury, temperature, pH, and conductivity. A follow-up study will be conducted from August 2000 through July 2001, which will reassess copper concentrations in the Wilkeson WWTP effluent and in Wilkeson Creek. Field work, conducted from August through November 2000, will include flow, temperature, pH, conductivity, total suspended solids (TSS), and hardness. The objectives are to evaluate the impact of the WWTP on Wilkeson Creek copper concentrations and determine an appropriate permit limit (Johnson, 2000).

- Ecology conducted a 1997 macroinvertebrate and habitat assessment study, including a site on South Prairie Creek (Plotnikoff, written comm.). Data include canopy cover, flow, temperature, pH, velocity, DO, and bottom materials size fractions (cobble, gravel, sand, silt/clay) for a site just downstream of Burnett.

USGS

- USGS maintains a gaging station on South Prairie Creek at the town of South Prairie. Gage 12095000 (79.5 square miles) lies just upstream of the lower floodplain area. Flow varies from 24 cfs to 6700 cfs, with an annual average flow of 229 cfs and a median of 159 cfs[2]. Daily flow statistics are available from water year 1950 to 1972 and from 1988 to present. From 1972 to 1979, a crest-stage gage was operated. A meteorology station was added recently, and the station records precipitation and temperature. While not available as part of the real-time streamflow network, gage data may be accessed through the USGS ADAPS system through a cooperator agreement with the Department of Ecology.

- USGS evaluated the flood potential of South Prairie Creek, in cooperation with Pierce County Surface Water Management, following several large floods (Mastin, 1998). The study evaluated the increase in cleared area and logging road construction using historical aerial photos, evaluated flooding trends, and mapped expected inundation zones for 100- and 500-year floods. While cleared areas increased from 11.2 percent of the watershed area in 1965 to 34.5 percent in 1990, and road length increased from 119.6 miles to 237.0 miles, the study found no statistically significant trend in flood potential over time. The study included 28 floodplain and channel cross sections near the same locations as the FEMA 1976-77 cross sections in 1994-95, and an additional 13 sections in 1996. Comparisons among the cross sections showed no significant channel fill. Finally, a backwater hydraulic model was used to delineate flood zones. Portions of Route 162, Spring Site Road, South Prairie Road, and the Town of South Prairie lie within the 100- and 500-year inundation zones, which includes most of the lower valley.

[2] For the period 10/1/87 through 9/30/98, including some estimated values for water year 1998.

FEMA

- The Flood Insurance Study of 1981 included 51 floodplain and channel cross sections from the mouth to upstream of South Prairie in 1976 and 1977 (FEMA, 1981; FEMA, 1987). The studies were conducted to identify 100-year flood zones.

Muckleshoot Indian Tribe

- The Muckleshoot Indian Tribe installed continuous temperature monitors at several locations in the South Prairie Creek watershed during the summer of 1997. Temperatures in Gale Creek, above the confluence with Wilkeson Creek, exceeded the 18^{o}C standard for Class A water bodies, while temperatures in South Prairie Creek at RM 11.0, upstream of Page Creek, and Wilkeson Creek at RM 7.1, near confluence with Gale Creek, exceeded 16^{o}C but not the 18^{o}C standard (Stevens, 1997). Beaver Creek did not exceed 16.0^{o}C. Figure 3 presents the thermographs.

Puyallup Tribe

- The Puyallup Tribe has monitored temperature, pH, and dissolved oxygen at three locations along lower South Prairie Creek since 1999 (Naylor, pers. comm.). Data are collected using a YSI probe. Data show high dissolved oxygen levels throughout the year, somewhat low pH in the spring, and somewhat elevated temperature in the summer.

- During the fall, Fisheries staff float lower South Prairie Creek identifying salmonid redds.

Pierce County

- Pierce County conducted a flow study in South Prairie Creek in the mid 1990s (Kibby, pers. comm.). Extent and content were not available at the time of publication.

- While Pierce County owns several levees along lower South Prairie Creek, the County does not maintain them (Kibby, pers. comm.).

Pierce County Conservation District

- The Conservation District surveyed 531 culverts in the Puyallup River watershed; 250 culverts represent blockages to fish. The Culvert Inventory, which will be available on CD ROM in July 2000 (Melmore, written comm.), includes some structures in the South Prairie Creek watershed.

- The Conservation District also administers a volunteer water quality monitoring program, including one site on South Prairie Creek, at Fettig Road and Lower Burnett Road downstream of the bridge (Udd, written comm.). Data for temperature, dissolved oxygen, pH and nitrate, available for spring 1999, show neutral waters with high DO. Nitrate is determined with a field kit made by InQuest. While the group conducts macroinvertebrate characterization, no data were available for South Prairie Creek.

- The District has been working with two dairies in the watershed, Soler Dairy and Bert Inglun Dairy, to develop farm plans and implement BMPs. The files include the number of livestock on site over time as well as site-specific soils information and recommendations for waste management (Abbott, pers. comm.). The Soler Dairy plan has been accepted, and the Inglun plan is being finalized.

Study Design

The Phase I assessment includes continuous temperature monitoring and field surveys of flow and water quality parameters. Sampling dates (presented below) were selected to characterize the low flow season, with wet weather possible in October. Sampling locations cover lower South Prairie Creek, the prime spawning area and area subject to recreational use. Stations were selected to distinguish upstream contributions from tributary (Spiketon Ditch and Wilkeson Creek) and local (residential, agricultural and recreational) contributions. Table 2 provides monitoring station identifications and descriptions.

Table 2
South Prairie Creek and Tributaries Summer 2000 Monitoring Stations

ID	Water Body	Description
SPCM	South Prairie Creek	At mouth, from South Prairie Creek Road
SPCB4	South Prairie Creek	At Route 162, fourth bridge north of Carbon River
SPCSP	South Prairie Creek	At South Prairie, access from Route 162 fire station
SPCLB	South Prairie Creek	At Lower Burnett Road, downstream of Route 165 bridge
SPCSR	South Prairie Creek	At Spiketon Rd, approached from north out of Buckley
SD165	Spiketon Ditch	At Route 165, 128th St. East (pvt)
WCM	Wilkeson Creek	At mouth, from Route 162 across train trestle (inactive)

Continuous Temperature Monitoring

No continuous temperature data are available for lower South Prairie Creek within the prime salmonid areas. Residential, agricultural, and recreational development have impacted riparian cover, and upstream reaches may have temperature impairments[3].

Upstream of Burnett, the creek lies within steep-sided canyons and is subject to steep gradients and a series of cascades. Riparian vegetation and runoff characteristics are influenced by logging activities. Two tributaries, Spiketon Ditch and Wilkeson Creek, reach South Prairie Creek between Burnett and South Prairie, and temperature will be monitored near the mouth of each. The South Prairie USGS gage lies near the widening of the valley floor and reduction in riparian width. Bridge 4, the Route 162 bridge over South Prairie Creek approximately 2.8 miles north of the Carbon River bridge, lies near the middle of the prime spawning areas. Finally, the mouth of South Prairie Creek is the downstream extent of the present project.

Water temperature will be measured with Onset StowAway Tidbits (-5^{o}C to +37^{o}C), installed in the active stream channel and shaded from direct sunlight. The temperature monitors will be installed at approximately mid-depth close to the thalweg, and away from potentially stratified pools. Each of the monitoring locations is free flowing without pooling immediately upstream. The monitors will log temperature at 15-minute intervals to provide sufficient information to characterize peak temperatures and diurnal variations.

Field Surveys and Data Collection

Six field surveys will be conducted during the summer 2000 low flow season, beginning with one in July, two each in August and September, and one in October. Each survey will be completed in one day. Parameters to be monitored during each survey include flow (*in situ*), fecal coliform (grab sample), and temperature (*in situ*). Once a month, grab samples will be collected for TSS, nutrients (total persulfate nitrogen, ammonia, nitrite/nitrate, nitrite, orthophosphorus, total phosphorus), dissolved oxygen (DO), *E. coli*[4], and *Enterococci* analyses, and pH will be determined *in situ*.

Figure 5 presents flow monitoring locations, to be included in each of the six surveys. Flows will be monitored at all but the USGS gage using standard methods for estimating stream flow (WAS, 1993). The provisional USGS-measured flows at gage 12095000 throughout the monitoring program will be retrieved from the USGS' ADAPS database, although the actual stage will be recorded at the time of sample collection.

Figure 6 presents locations for fecal coliform grab samples and discrete temperature measurements. Fecal coliform and instantaneous temperature will be monitored at each site during all six surveys.

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[3] One reach each on South Prairie Creek and Wilkeson Creek are currently 303(d) listed for temperature, based on continuous temperature monitoring (Stevens, 1997). However, the segments were mistakenly listed based on the Class AA standard of 16^{o}C (Beckett, written comm.), and the reaches will be delisted in the next cycle.

[4] No additional sample collection is needed; *E. coli* analyses use fecal coliform analysis filters.

Three surveys will include samples analyzed for TSS, *E. coli* and *Enterococci*. The three TSS stations are shown in Figure 7, while the *E. coli* and *Enterococci* stations are shown in Figure 8. The seven stations in Figure 8 will also be monitored for nutrients, DO, and pH.

Source Identification

In addition to the fecal coliform samples collected at the seven fixed stations, up to eight samples will be collected as needed in areas suspected to contribute elevated fecal coliform levels.

Field Schedule

Table 3 presents the tentative schedule for the Phase I assessment field activities.

Table 3
Tentative Phase I Assessment Field Schedule

Date	*Parameter*	*Activity*
July 12	Temperature	Install temperature monitors and launch probes
July 19	Flow, temperature, fecal coliform	Twice-monthly parameters
August 1	Flow, temperature, DO, pH, fecal coliform, *E. coli*, *Enterococci*, TSS, nutrients	Monthly parameters; download early temperature data and re-launch probes
August 23	Flow, temperature, fecal coliform	Twice-monthly parameters
September 5	Flow, temperature, DO, pH, fecal coliform, *E. coli*, *Enterococci*, TSS, nutrients	Monthly parameters
September 20	Flow, temperature, fecal coliform	Twice-monthly parameters
October 3	Flow, temperature, DO, pH, fecal coliform, *E. coli*, *Enterococci*, TSS, nutrients	Monthly parameters
October 18	Temperature	Remove temperature monitors

Project Organization

The roles and responsibilities of Ecology staff are as follows:

- ***Mindy Roberts*** *(Project Lead, Environmental Assessment Program, Watershed Studies Unit)*: Responsible for managing and implementing TMDL technical study. Defines project objectives, scope, and study design. Conducts data collection program, data quality review and analysis. Writes TMDL technical study report.

- ***Greg Pelletier*** *(Technical Review, Environmental Assessment Program, Watershed Studies Unit)*: Provides technical review of interim products as well as QAPPs and final TMDL report.

- ***Jeannette Barreca*** *(TMDL Regional Office Project Lead, Water Quality Program, Southwest Regional Office)*: Acts as point of contact between Ecology technical study staff and interested parties and coordinates information exchange and meetings. Supports, reviews and comments on QAPPs and technical reports. Responsible for project web page updates. Coordinates preparation of TMDL documents for submittal to EPA.

- ***Sandy Howard*** *(Communications, Southwest Regional Office)*: Coordinates public participation and provides external project updates.

- ***Keli McKay*** *(Section Supervisor, Water Quality Program, Southwest Regional Office)*: Reviews and comments on QAPP and technical reports. Responsible for approval of TMDL submittal to EPA.

- ***Will Kendra*** *(Section Supervisor, Environmental Assessment Program, Watershed Ecology Section)*: Responsible for approval of project QAPP and final TMDL report.

- ***Karol Erickson*** *(Unit Supervisor, Environmental Assessment Program, Watershed Studies Unit)*: Reviews project QAPPs, final TMDL report, and technical study budget.

- ***Cliff Kirchmer*** *(Quality Assurance Officer, Environmental Assessment Program)*: Reviews QAPP and all Ecology quality assurance programs. Provides technical assistance on QA/QC issues during the implementation and assessment of project.

Data Quality Objectives

The Phase I assessment objective is to provide additional information to adequately and efficiently scope the second phase of monitoring. While the results will be compared against water quality standards, results will not be used to determine absolute compliance with water quality standards or to establish trends in time. The data quality objectives are presented in Table 4. The laboratory's data quality objectives and quality control procedures are documented in the Manchester Environmental Laboratory (MEL) Lab Users Manual (MEL, 1999).

Table 4
Data Quality Objectives

Parameter	Accuracy (2*precision + bias)	Precision (%RSD)	Bias	Lowest Level of Interest	
Velocity	N/A	N/A	N/A	N/A	*In situ*
Temperature (discrete)	N/A	N/A	N/A	N/A	
pH	40	15	10	N/A	
Temperature (continuous)	N/A	N/A	N/A	N/A	
Fecal Coliform Bacteria	66	28*	10	10/100mL	Laboratory Parameters
E. coli	70	30	10	unknown	
Enterococci	70	30	10	unknown	
Dissolved Oxygen	40	15	10	0.5 mg/L	
Total Suspended Solids	40	15	10	1 mg/L	
Total Persulfate Nitrogen	40	15	10	0.1 mg/L	
Ammonia-Nitrogen	40	15	10	0.01 mg/L	
Nitrite/Nitrate-Nitrogen	40	15	10	0.1 mg/L	
Nitrite-Nitrogen	40	15	10	0.01 mg/L	
Orthophosphate	40	15	10	0.01 mg/L	
Total Phosphorus	40	15	10	0.01 mg/L	

%RSD = Percent Relative Standard Deviation = 100 * s / avg(x_1,x_2) = RPD / sqrt (2)

* Based on Manchester Environmental Lab RPD < 40% for fecal coliform analyses.

Accuracy includes both precision and bias. Precision is a measure of data scatter due to random error, while bias is a measure of differences between a parameter value and the true value due to systematic errors. Precision can be quantified using a number of parameters, including relative percent difference (RPD)[5], standard deviation (s)[6], pooled standard deviation (s_p)[7], or percent relative standard deviation (%RSD)[8]. For paired results, %RSD = RPD/sqrt(2). The %RSD will be used to assess data quality, as listed in the table. Since random error affects the determination of bias, bias quantification is very difficult. Adherence with established protocols will eliminate most sources of bias (QAS, 1991). A bias of 10% is acceptable, for a total accuracy[9] of 40 to 70%, depending on the parameter.

Analytical and Sampling Procedures

Laboratory methods available from MEL are appropriate for the data quality objectives and expected concentrations. Clean techniques or low-detection-limit methods are unwarranted.

Analytical methods, sample containers, volumes, preservation and hold time are listed in Table 5. Field sampling and measurement protocols will follow those described in the Field Sampling and Measurements Protocols for the Watershed Assessments Section (WAS, 1993). Samples for laboratory analysis will be stored on ice and delivered to MEL within 24 hours of collection. While the hold time for fecal coliform samples will meet the 30-hour limit specified in the Watershed Assessment Section Protocols (WAS, 1993), samples will exceed the 6-hour hold time recommended in Standard Methods (Greenberg, et al., 1992) for legal actions. However, samples could meet the 24-hour hold time recommended in Standard Methods (Greenberg, et al., 1992) for samples collected for purposes other than legal actions.

Grab samples will be collected directly into pre-cleaned containers supplied by MEL and described in MEL (1999). An extra set of sample containers will be available should any of the bottles be lost or contaminated.

Quality Control Procedures

Total variation for field sampling and analytical variation will be assessed by collecting replicate samples in addition to lab duplicates and comparing to data quality objectives. Replicate samples will be collected at one site per survey for fecal coliform. For parameters analyzed monthly (three surveys total), replicate samples will be collected once per survey except for TSS. Due to the low number of samples (three rounds at three sites), only one TSS duplicate will be collected during one survey.

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[5] Calculated for a pair of results, x_1 and x_2, as $200*(x_1 – x_2)/(x_1 + x_2) = 100*(x_1 – x_2)/(\text{avg } [x_1 \text{ and } x_2])$.
[6] Calculated for a pair of results, x_1 and x_2, as $(x_1 - x_2) / \text{sqrt}(2)$.
[7] Calculated for a group of paired results as $s_p = \text{sqrt}(\Sigma D^2 / 2 m)$, where ΣD^2 is the sum of the square of the differences between each pair and m is the number of pairs.
[8] Calculated for a pair of results, x_1 and x_2, as $100*s /(\text{avg } [x_1 \text{ and } x_2])$, where s is the standard deviation.
[9] accuracy = bias + 2*precision for 95% confidence limits

Table 5
Summary of Field and Laboratory Measurements, Target Precision and Reporting Limits, and Methods

Parameter	Precision Target (Field Measurements)	Reporting Limit (Lab Measurements)	Method	Equipment	Container	Volume	Preservation	Hold Time
Velocity	+/- 0.5 ft/s	N/A	N/A	March-McBirney Model 2000 Flow Meter	N/A	N/A	N/A	N/A
Temperature (discrete)	+/- 0.2°C	N/A	N/A	Brooklyn Thermometer Co., Inc., Alcohol, -5°C to +37°C	N/A	N/A	N/A	N/A
pH	+/- 0.1 SU	N/A	N/A	Orion Model 250A	N/A	N/A	N/A	N/A
Temperature (continuous)	+/- 0.2°C	N/A	N/A	Onset StowAway Tidbit	N/A	N/A	N/A	N/A
Fecal Coliform Bacteria	N/A	1/100 mL	MF 9222D [1]	(grab sample)	Clean and sterile polypropylene or glass	250 mL[3]	none	as soon as possible [2,3]
E. coli	N/A	1/100 mL	EPA 1105	(grab sample)	N/A[4]	N/A	none	as soon as possible [4]
Enterococci	N/A	1/100 mL	MF 9230C [1]	(grab sample)	Clean and sterile polypropylene or glass	250 mL[3]	none	as soon as possible [3]
Dissolved Oxygen	N/A	0.10 mg/L	EPA 360.2[5]	(grab sample)	300-mL glass	300 mL	2 mL manganous sulfate; add 2 mL alkali-iodide-azide solution	8 hours
Total Suspended Solids	N/A	1 mg/L	EPA 160.2	(grab sample)	1-L wide-mouthed polyethylene	1000 mL (minimum)	Refrigerate at 4°C	7 days
Total Persulfate Nitrogen	N/A	0.01 mg/L	SM 4500-NO3- F Modified	(grab sample)	125-mL clear wide-mouthed polyethylene, pre-acidified	125 mL (minimum)	Refrigerate at 4°C; pre-acidified with H_2SO_4	28 days
Ammonia-Nitrogen	N/A	0.01 mg/L	EPA 350.1	(grab sample)	125-mL clear wide-mouthed polyethylene, pre-acidified	125 mL (minimum)	Refrigerate at 4°C; pre-acidified with H_2SO_4	28 days
Nitrite/Nitrate-Nitrogen	N/A	0.01 mg/L	EPA 353.2	(grab sample)	125-mL clear wide-mouthed polyethylene, pre-acidified	125 mL (minimum)	Refrigerate at 4°C; pre-acidified with H_2SO_4	28 days
Nitrite-Nitrogen	N/A	0.01 mg/L	EPA 353.2	(grab sample)	125-mL amber wide-mouthed polyethylene	125 mL	Refrigerate at 4°C	48 hours
Orthophosphate	N/A	0.01 mg/L	EPA 365.3	(grab sample)	125-mL amber wide-mouthed polyethylene	125 mL	Refrigerate at 4°C	48 hours
Total Phosphorus	N/A	0.01 mg/L	EPA 365.4	(grab sample)	125-mL clear wide-mouthed polyethylene, pre-acidified	125 mL (minimum)	Refrigerate at 4°C; pre-acidified with H_2SO_4	28 days

[1] Standard Methods, membrane filter method
[2] 30 hours maximum
[3] Fecal coliform and *Enterococci* samples collected in one 500-mL bottle.
[4] No separate sample container; *E. coli* read from the fecal coliform analysis filter
[5] Modified, as described in WAS (1993)

MEL will follow standard quality control procedures (MEL, 1999). Field sampling and measurements will follow quality control protocols described in WAS (1993).

Continuous temperature monitor variations will be checked using the calibrated field thermometer upon deployment and retrieval, and during the sampling season[10]. Field sampling and measurement procedures will follow quality control protocols described in the WAS protocol manual (WAS, 1993). The Onset StowAway Tidbits will be pre- and post-calibrated in accordance with TFW Stream Temperature Survey protocols (Schuett-Hames, *et al.*, 1999) to document instrument bias and performance at representative temperatures. A certified reference thermometer (HB Instrument Co., -8°C to +32°C, ISO9000, part 61099-035, serial 2L2087) will be used to calibrate the field thermometer (Brooklyn Thermometer Co., Inc., Safety Red Liquid Thermometer, -1°C to +50°C, +/-0.2°C). At the completion of the monitoring, the raw data will be adjusted for instrument bias based on the pre- and post-calibration results in accordance with the TFW Stream Temperature Survey protocols (Schuett-Hames, *et al.*, 1999). If the field thermometer demonstrates greater than 0.2°C temperature difference, the field thermometer's temperature readings will be adjusted by the mean difference.

Replicate field temperature readings will not be recorded, because previous Ecology experience has demonstrated that the thermometers consistently show a high level of precision, rarely varying by more than 0.2°C.

The probe used for pH analyses in situ will be calibrated to manufacturer's specifications, in accordance with standard protocols (WAS, 1993).

DO samples will be analyzed in accordance with WAS (1993) protocols using the Winkler titration. Method precision can be as low as 0.02 mg/L in distilled water and up to 0.10 mg/L with interferences.

Microbiological, TSS, and nutrient samples will be analyzed at MEL. The laboratory's data quality objectives and quality control procedures are documented in the MEL Lab Users Manual (MEL, 1999).

Data Analysis and Use

Data reduction, review, and reporting will follow the procedures outlined in MEL's Lab Users Manual (MEL, 1999). In addition, lab results will be checked for missing and/or improbable data. Variability of field replicates and lab duplicates will be quantified using the methods described above. Should concentrations vary over an order of magnitude during the study at any given station, standard deviation and other parameters may be analyzed using the logarithms of concentration. If lab blanks show levels of analyte above reporting limits, the resulting data will be qualified and their use restricted as appropriate.

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[10] The first week of August was selected for verification of Onset StowAway Tidbit accuracy as the week expected to experience annual peak temperatures.

The purpose of the assessment phase is to improve the focus of the Phase II monitoring in terms of both sampling stations and parameters of interest. For example, should fecal coliform levels in the upstream South Prairie Creek station or the mouths of the two tributaries be high, the Phase II monitoring could focus on source identification and quantification further upstream. If no temperatures exceed the Class A water quality standard, continuous monitoring could be dropped from the second phase. However, even if fecal coliform levels are low in the assessment phase, the monitoring will not capture the wet weather period, when concentrations were high historically. Therefore, the program will not provide enough information to determine that water quality standards for fecal coliform are met, even if measured concentrations are low. Rather, the data will be used to refine monitoring stations for the second phase to adequately quantify sources. Finally, samples analyzed for fecal coliform, *E. coli* and *Enterococci* simultaneously will help distinguish fecal and other sources of bacteria, as well as provide early information for other parameters under consideration for water quality standards.

Reporting Schedule

The project reporting schedule includes the following documents:

August 2000	Phase I QAPP	Covers Phase I assessment monitoring
November 2000	Phase II QAPP	Covers Phase II 12-month monitoring program scheduled for 12/00-11/01
May 2002	Draft Technical Report	Summarizes technical studies
July 2002	Final Technical Report	Summarizes technical studies
October 2000 and ongoing	Quarterly Technical Memos	Summarize work completed, including provisional data collected, by quarter

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Figure 1
South Prairie Creek Watershed with 303(d) Listed Water Bodies

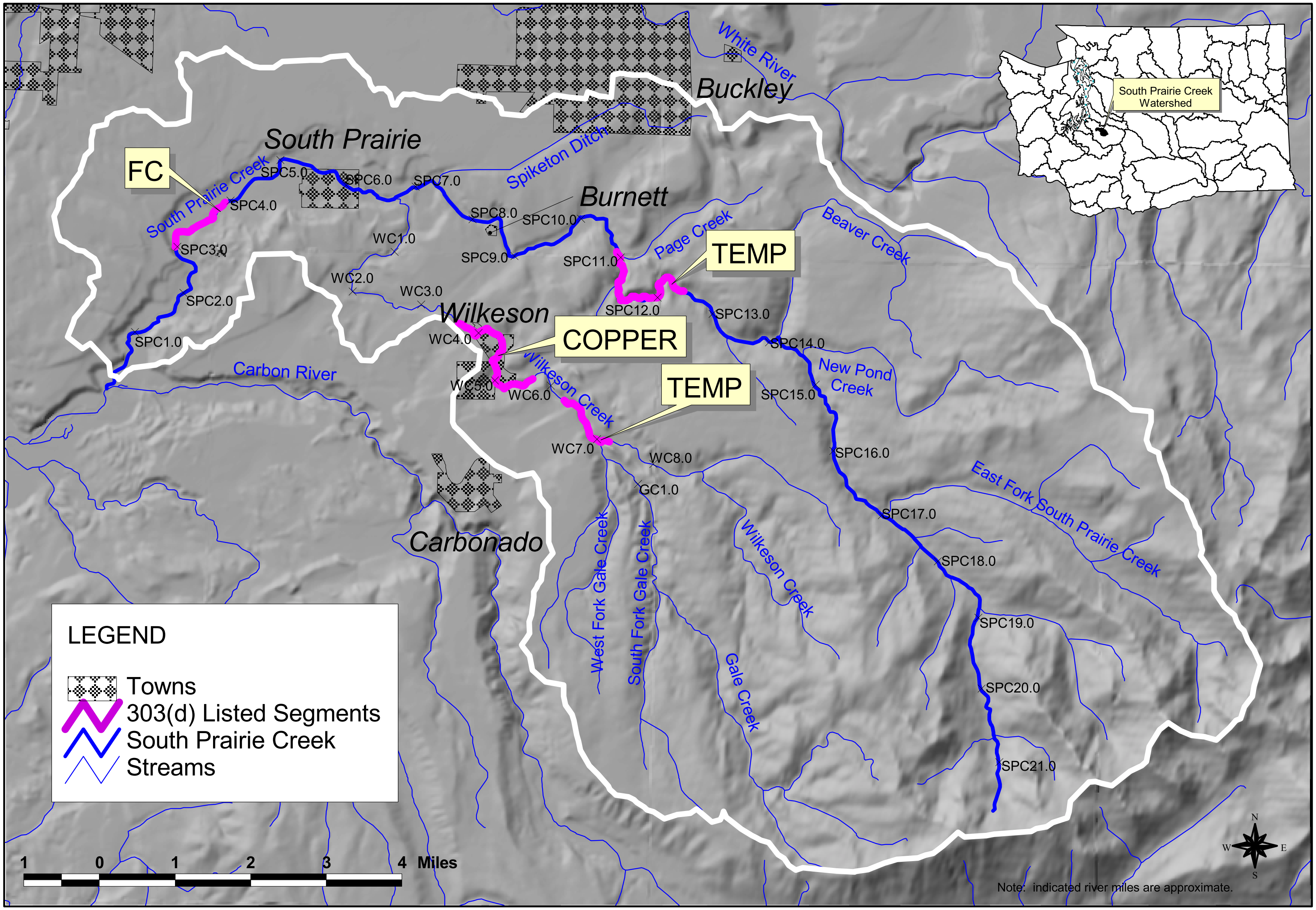


Figure 2
South Prairie Creek Watershed Land Use/Land Cover

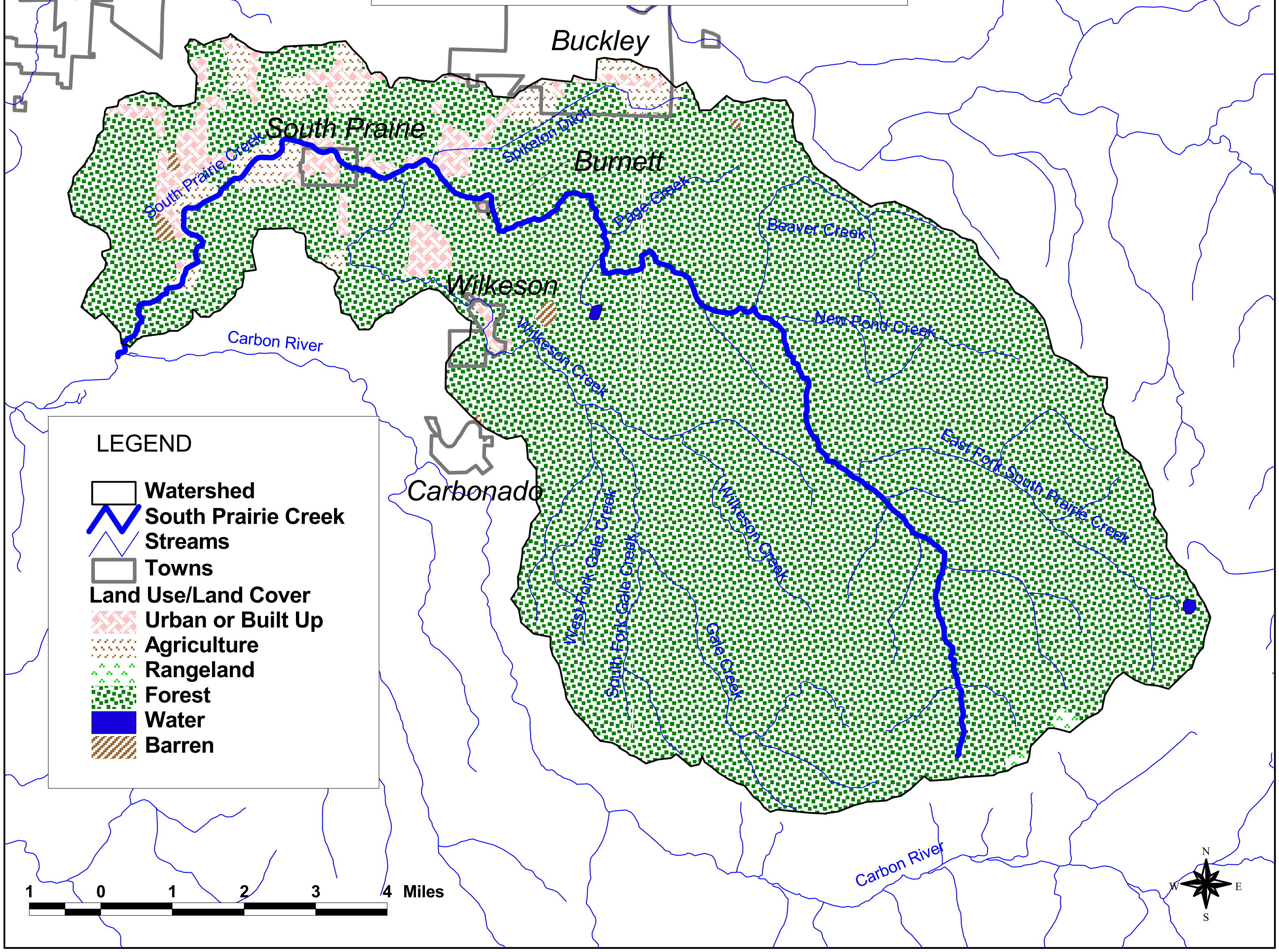
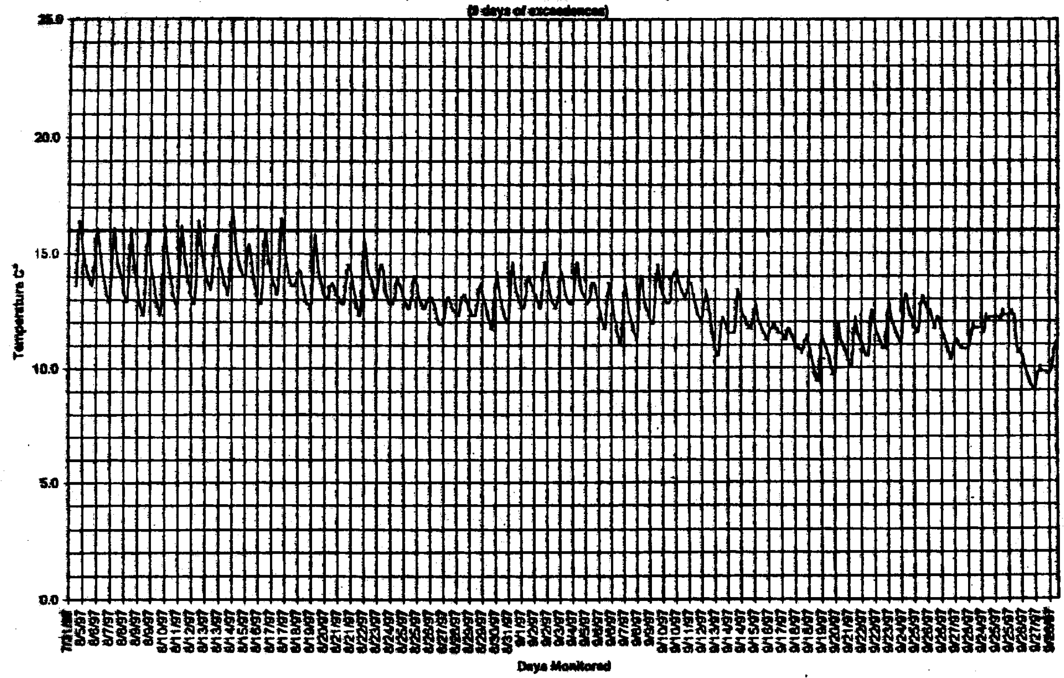
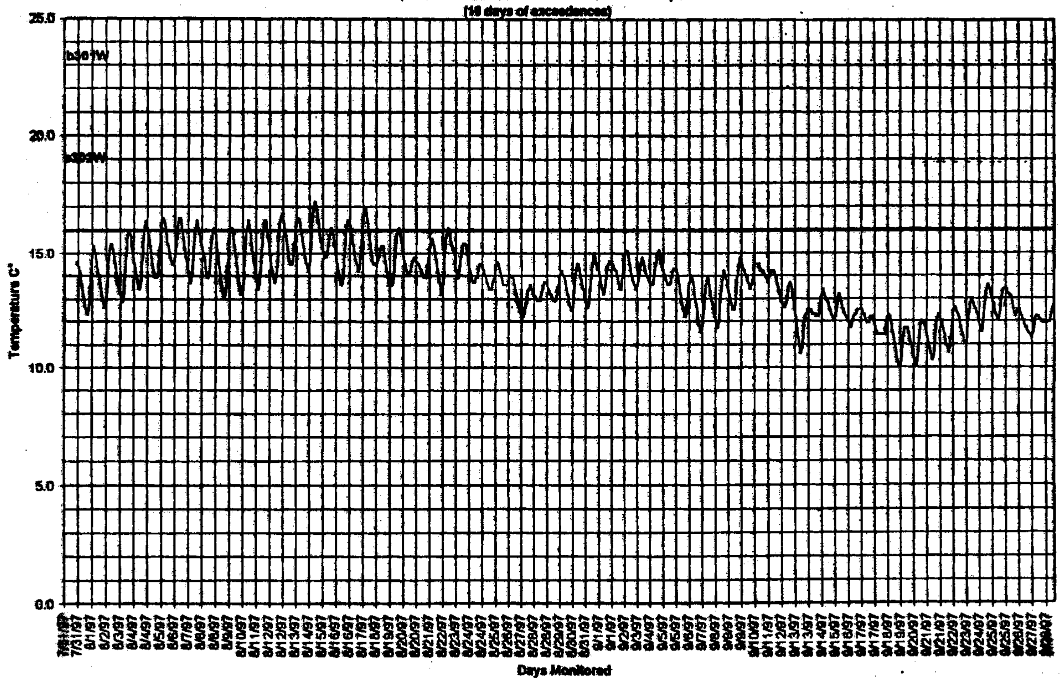


Figure 3
Muckleshoot Tribe Temperature Monitoring

South Prairie Cr. (RM 11.0)
(WRIA 10.0465 - trib. to Carbon R. at RM 21.0)
([illegible] days of exceedances)



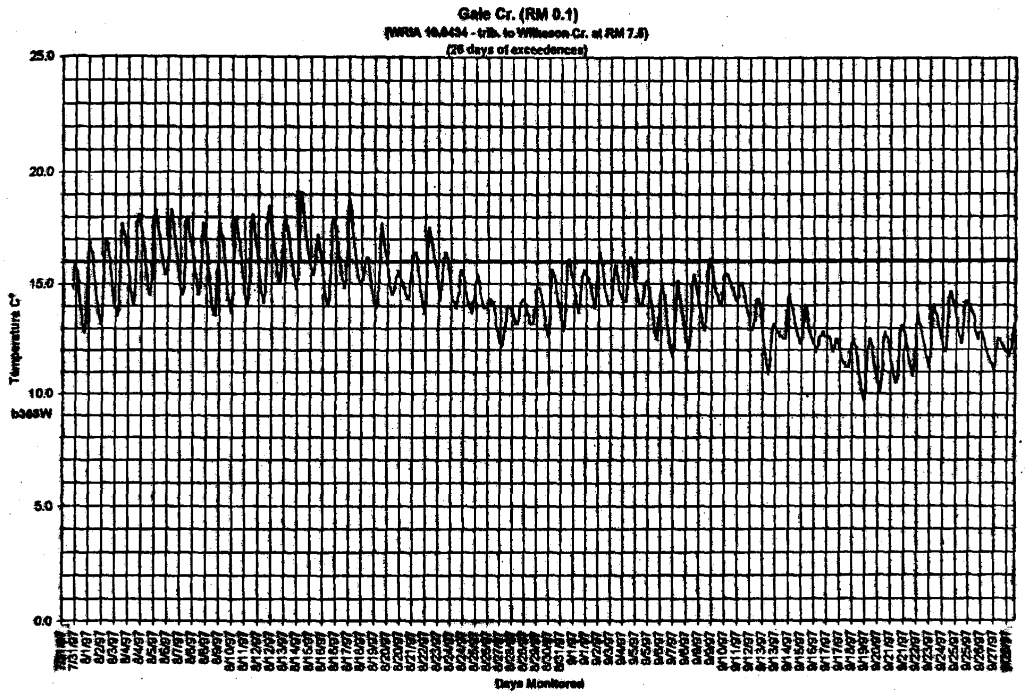
[illegible] Cr. (RM 7.1)
(WRIA 10.0432 - trib. to S. Prairie Cr. at RM 8.7)
(16 days of exceedances)

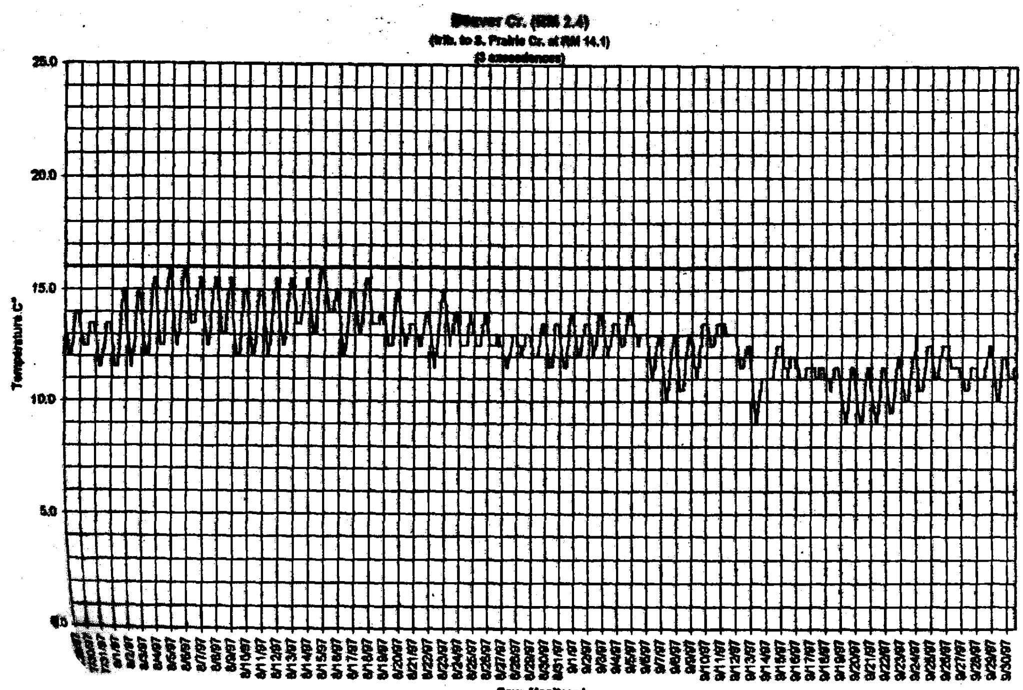


x axis tick marks
represent 12:11 AM

Muckleshoot Tribe Fisheries Dept.
October 24, 1997

Figure 3 (cont'd)
Muckleshoot Tribe Temperature Monitoring





Muckleshoot Tribe Fisheries Dept.
October 24, 1997

Figure 4
Summer 2000 Continuous Temperature Monitoring Stations

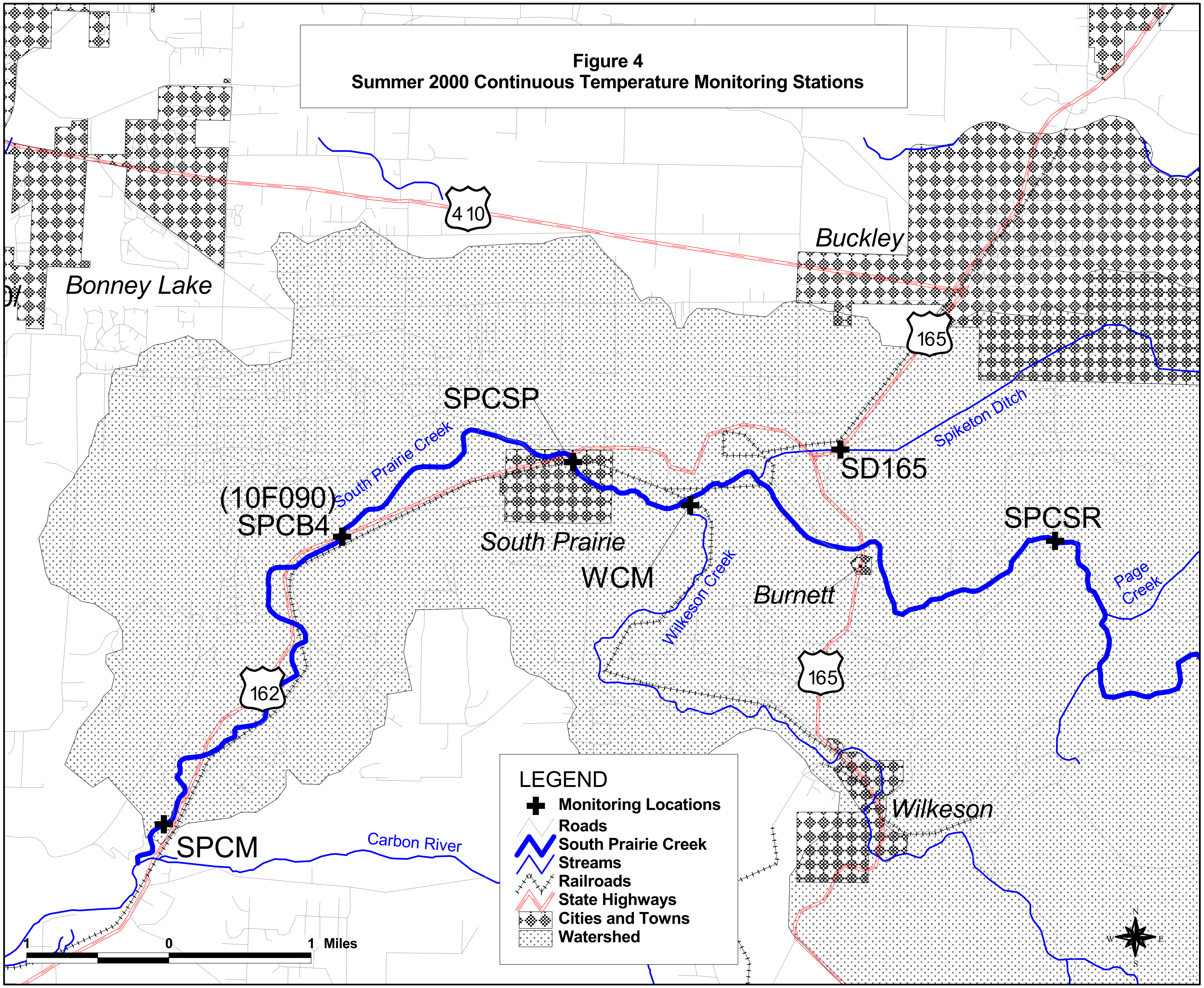


Figure 5
Summer 2000 Flow Monitoring Stations

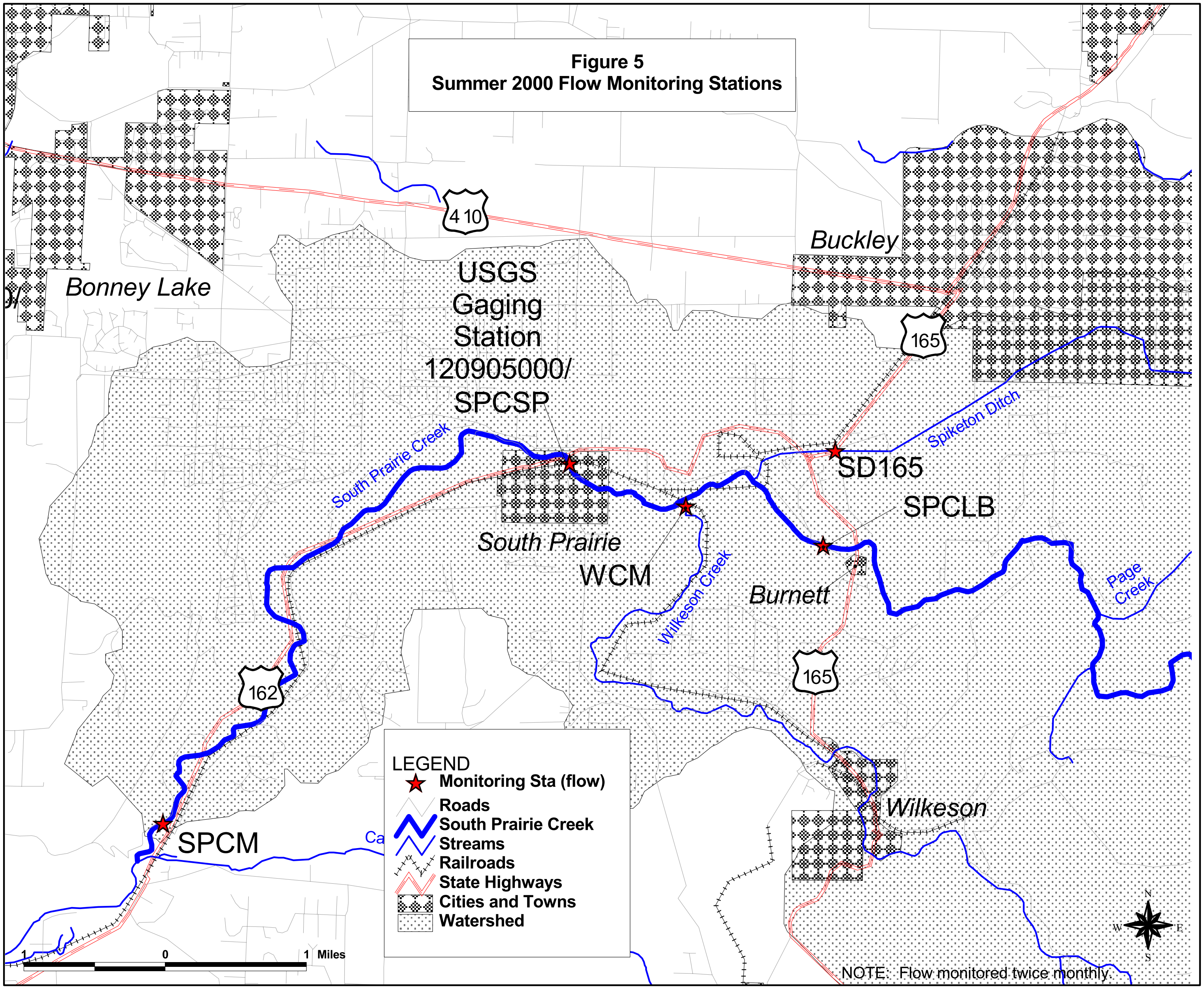
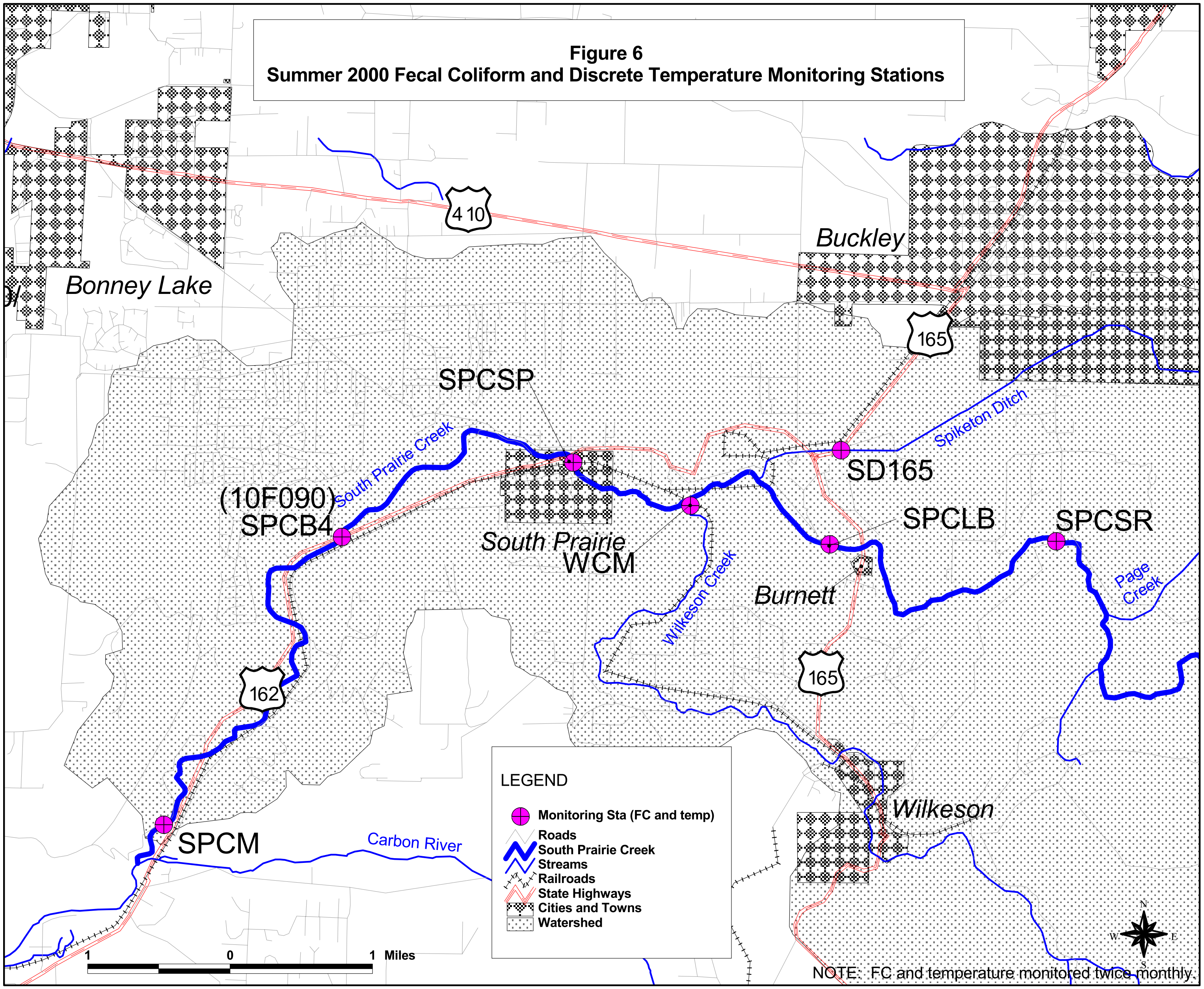


Figure 6
Summer 2000 Fecal Coliform and Discrete Temperature Monitoring Stations



NOTE: FC and temperature monitored twice monthly.

Figure 7
Summer 2000 TSS Monitoring Stations

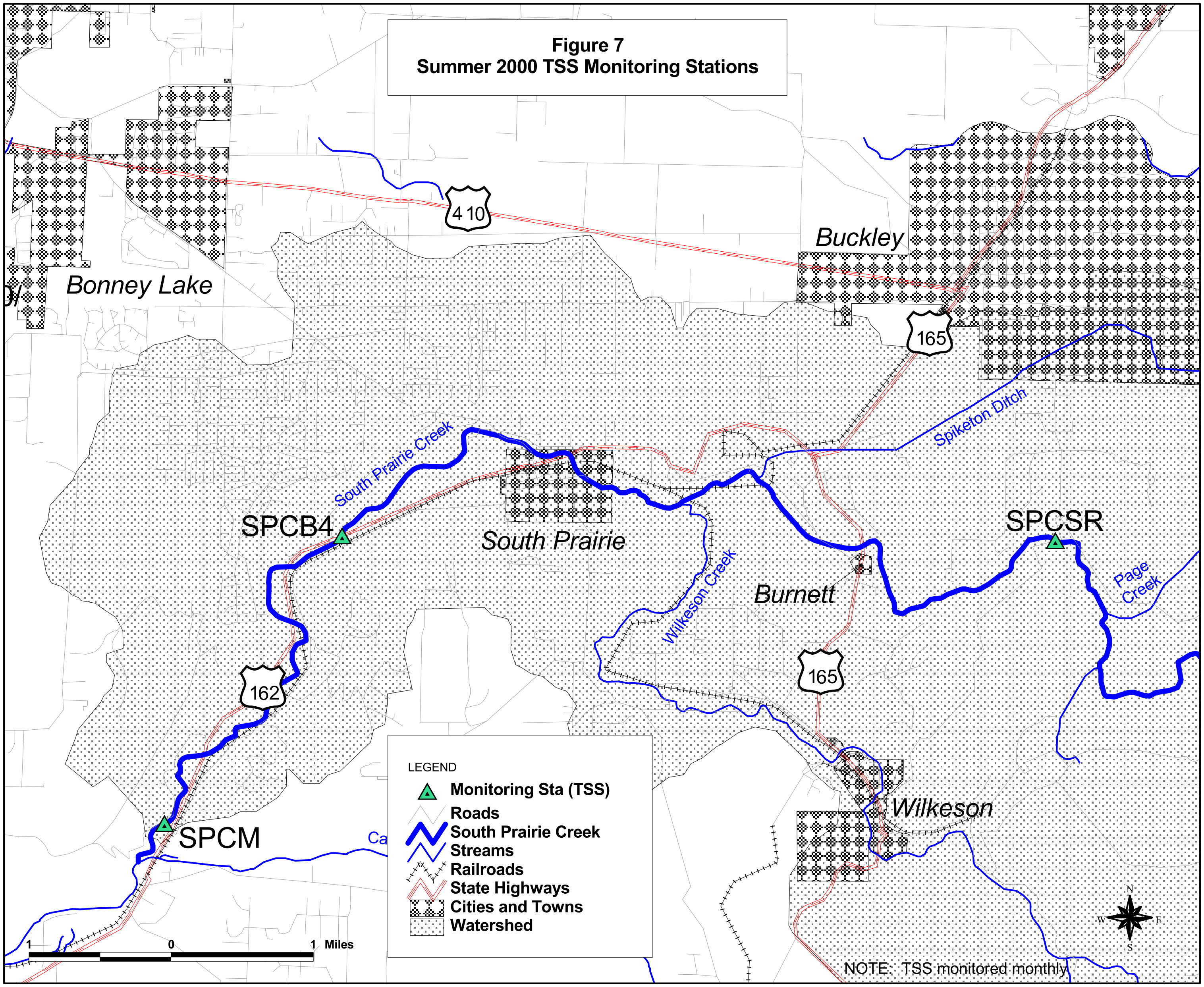


Figure 8
Summer 2000 Nutrient, DO, pH, E. coli, and Enterococci Monitoring Stations