2000 ANNUAL REPORT

Spring Creek Watershed Community Water Resources Monitoring Project

Supported by

The ClearWater Conservancy

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EXECUTIVE SUMMARY

The Spring Creek Watershed Community is a broad-based stakeholders project of the ClearWater Conservancy and is the largest organization in Centre County that is exclusively watershed-focused in its activities. The Water Resources Monitoring Project started in January 1998 as part of the strategic planning process of the Spring Creek Watershed Community.

The Water Resources Monitoring Project was designed to establish baseline water quality and quantity data for Spring Creek and its tributaries. Baseline data are used to evaluate the present condition of an environmental resource, as well as to assess changes or trends. The project began by monitoring base flow conditions. However, with the award of two Pennsylvania Department of Environmental Protection Growing Greener Grants in 2000, the project has expanded to included stormwater and groundwater monitoring.

Monitoring base flow will allow the Water Resources Monitoring Committee to describe the current relationship between stream flows and water quality. Stormwater monitoring will provide essential information regarding non-point source pollution and will provide the necessary data to determine the total load of pollutants being delivered to streams by stormwater runoff. Comparisons between base flow and stormwater data will allow a user to evaluate changes in water quality caused by urbanization and associated land use changes. Groundwater monitoring will assess groundwater storage within the watershed and provide several educational opportunities for the Water Resources Monitoring Committee. Data will be collected for the purpose of demonstrating the effects of groundwater withdrawals on groundwater levels, the connection between groundwater levels and stream flow, and how land use and zoning affect groundwater levels. The Water Resource Monitoring Project, comprised of base flow, stormwater, and groundwater monitoring, is a comprehensive monitoring network that will be used for the long-term protection of Spring Creek and its tributaries.

The Spring Creek Watershed is comprised of 175 square miles, and is home to 120,000 people, 14 municipalities, and The Pennsylvania State University. An increase in urbanization coupled with changing land use patterns threaten the overall health of Spring Creek and its tributaries by increasing groundwater withdrawal, decreasing the volume of groundwater recharge, and potentially increasing the volume of pollutants that enter it.

Base flow data are collected from twelve monitoring stations that are located on Spring Creek and its tributaries. Stream level and temperature are continuously being monitored while water quality data is collected monthly. This data will allow us to describe the amount of suspended and dissolved materials contributed from each sub-basin and describe how the quantity and quality of water in the main stem of Spring Creek changes as it travels from the upper part of the watershed near Boalsburg to its confluence with Bald Eagle Creek in Milesburg. Stormwater and groundwater monitoring will be initiated in 2001. All data collected by the Water Resources Monitoring Project is available to the public.

1.0 INTRODUCTION

THE SPRING CREEK WATERSHED COMMUNITY

The Spring Creek Watershed Community is a broad-based stakeholders project of the ClearWater Conservancy and is the largest organization in Centre County that is exclusively watershed-focused in its activities. The Community was created to be a public forum for discussion in which all viewpoints are welcomed. It is comprised of over 2,000 stakeholders living throughout the watershed, including private business and industry, municipalities, elected officials, government agencies, the farming community, land owners, developers, other non-profit organizations, and individual citizens who have a desire to preserve and protect the integrity of the Spring Creek Watershed. The Watershed Community works closely with its sponsoring organization, the ClearWater Conservancy, on numerous projects and activities in the watershed. Since the Spring Creek Watershed Community is not incorporated, ClearWater Conservancy administers grants on behalf of the Community and provides staffing for the organization. The Spring Creek Watershed Community also works closely with the Spring Creek Watershed Commission, an organization of government officials from the fourteen watershed municipalities and the Centre County Board of Commissioners.

THE WATER RESOURCES MONITORING PROJECT

The Water Resources Monitoring Project started in January 1998 as part of the strategic planning process of the Spring Creek Watershed Community to directly address one of our five strategic goals: Measure watershed quality and set goals for improvement. The project began by monitoring base flow conditions. With the award of two Pennsylvania Department of Environmental Protection (PA DEP) Growing Greener Grants in 2000, the project has expanded and now includes stormwater and groundwater monitoring components. Monitoring base flow will allow the Water Resources Monitoring Committee to describe the current relationship between stream flows and water quality. Stormwater monitoring will provide essential information regarding non-point source pollution and will provide the necessary data to determine the total load of pollutants being delivered to streams by stormwater runoff. Comparisons between base flow and stormwater data will allow a user to evaluate changes in water quality caused by urbanization and associated land use changes. Groundwater monitoring will assess groundwater storage within the watershed and provide several educational opportunities for the Water Resources Monitoring Committee. Data will be collected for the purpose of demonstrating the effects of groundwater withdrawals on groundwater levels, the connection between groundwater levels and stream flow, and how land use and zoning affect groundwater levels. The Water Resource Monitoring Project, comprised of base flow, stormwater, and groundwater monitoring, is a comprehensive monitoring network that will be used for the long-term protection of Spring Creek and its tributaries.

THE WATERSHED

The Spring Creek Watershed is comprised of 175 square miles, and is home to 120,000 people, 14 municipalities, and The Pennsylvania State University. The average daily flow from the Spring Creek Watershed is approximately 150 million gallons. This water leaves the watershed at Milesburg where it flows into Bald Eagle Creek, which flows into the West Branch of the Susquehanna River and then flows into the Chesapeake Bay. Fifteen million gallons of groundwater are pumped everyday from the limestone and dolomite aquifers located under the valley floor to meet the drinking water needs of these permanent residents and students.

An increase in urbanization coupled with changing land use patterns threaten the overall health of Spring Creek and its tributaries by increasing groundwater withdrawal, decreasing the volume of groundwater recharge, and potentially increasing the volume of pollutants that enter it.

WATER QUALITY AND QUANTITY

This project is designed to establish baseline water quality and quantity data for Spring Creek and its tributaries. Baseline data are used to evaluate the present condition of an environmental resource, as well as to assess changes or trends. Baseline data are being collected for:

Base flow – Sustained stream flow that is not influenced by storm event runoff.

Stormwater – The quantity of water that is generated by a storm event. Typically this volume of water increases as the area of impervious surface increases. The quality of this water is dependent on land use.

Groundwater – The water that is found underground in spaces between particles of soil and rock fractures.

PROJECT OBJECTIVES

1. Provide a description of the quantity and quality of surface waters,
2. Provide a description of the quality of stormwater runoff,
3. Monitor groundwater levels,
4. Provide the means to detect changes in quantity and/or quality of base flow, stormwater, and groundwater,
5. Provide sufficient measurement sensitivity to permit assessment of these changes.

THE WATER RESOURCES MONITORING COMMITTEE

The Water Resources Monitoring Committee is a volunteer group comprised of technical and environmental professionals who oversee and guide the activities of the Water Resources Monitoring Project (Table 1).

2.0 PROJECT FUNDING

Financial support for the monitoring project has come from a variety of watershed stakeholders including industries, institutions, municipalities, authorities, and foundations. To date, the Water Resources Monitoring Committee has raised approximately $79,000 that has paid for project start-up costs and operational expenses from 1998-2000 (Table 2). ClearWater's 2001 fundraising efforts will include securing funding for the Water Resources Monitoring Project for 2001-2004 which is anticipated to have an average annual budget of approximately $58,000.

Table 1. The 2000 Water Resources Monitoring Committee.

NAME	Profession	AFFILIATION
Mark Ralston P.G.*	Committee Chair, Hydrogeologist	Converse Consultants
Robert Carline, Ph.D.	Committee Vice-Chair, Adjunct Professor and Leader	Pennsylvania Cooperative Fish & Wildlife Research Unit, United States Geological Survey
Andrew Cole, Ph.D.	Assistant Director	Centre for Watershed Stewardship, Penn State University
Steve Foard, P.E.	Environmental/Safety Manager	Murata Electronics North America, Inc.
Bert Lavan	Senior Process Engineer	Corning Asahi Video Products
Todd Giddings Ph.D., P.G.	Hydrogeologist	Todd Giddings and Associates, Inc.
Katie Ombalski	Watershed Coordinator/Project Manager	ClearWater Conservancy/Spring Creek Watershed Community
Mike O'Driscoll	Ph. D. Candidate, PSU	Penn State University
Gene Proch	Regulatory Affairs & Facilities Manager	Corning Asahi Video Products
John Sengle	Water Quality Specialist	PA Department of Environmental Protection
David Smith	Assistant Executive Director	University Area Joint Authority
Malcolm Taylor	Environmental Engineer	The Sear Brown Group
Shana Tritsch, P.G.	Senior Hydrogeologist	USFilter Groundwater Services
Kirk Vodopals	Water Resources Monitoring Technician	ClearWater Conservancy/Spring Creek Watershed Community
Rick Wardrop, P.G.	Hydrogeologist and Industrial Contamination Specialist	USFilter Groundwater Services
Jason Wert	Environmental Engineer	Herbert, Rowland, and Grubic

* Professional Geologist
** Professional Engineer

Table 2. WRMP Annual funding summary.

Year	Income	Expenses
1998 (start-up year)	$30,000	$11,305
1999: Year One	$25,860*	$26,164
2000: Year Two	$23,304*	$29,037
2001: Year Three	$22,173* (pledged)	$57,500 (budgeted)
TOTALS	**$101,337**	**$111,506**

*Includes funding from COG

YEAR 2000 FINANCIAL CONTRIBUTORS

Municipalities

- Centre Region Council of Governments (College, Ferguson, Halfmoon, Harris, and Patton Townships, and State College Borough)
- Benner Township
- Bellefonte Borough
- Milesburg Borough
- Spring Township

Authorities

- State College Borough Water Authority
- University Area Joint Authority

Industry

- Corning Foundation

Institutions

- Penn State Office of Physical Plant

IN-KIND CONTRIBUTORS

The Water Resources Monitoring Project received over $50,000 of in-kind contributions during the year 2000. These contributions included laboratory analyses, professional services, printing and publication of the 1999 WRMP Annual Report, well casing and installation, technical assistance, chemical supplies, and transportation.

In-kind contributors include:

- Converse Consultants
- Corning Asahi Video Products
- Centre Analytical Laboratories
- Pennsylvania Cooperative Fish and Wildlife Research Unit, U.S. Geological Survey
- Pennsylvania Department of Environmental Protection
- Volunteer Field Assistants
- Water Resource Monitoring Committee

3.0 PROJECT HISTORY

1998

- Developed a monitoring work plan
- Raised funds for startup and operating capital
- Began installation of monitoring equipment

1999

- Raised funds for operations
- Produced and distributed 1998 WRMP Annual Report
- Completed installation of monitoring equipment
- Initiated monitoring

- Completed and published the searchable bibliographic database
- Complete and published the Spring Creek Watershed Water Sampling Protocol
- Initiated the development of a monitoring database

2000

- Continued surface water data collection
- Produced and distributed 1999 WRMP Annual Report
- Awarded Stormwater Monitoring grant from PA DEP Growing Greener program
- Obtained project equipment and installed storm event monitoring equipment
- Awarded Groundwater Monitoring grant from PA DEP Growing Greener program
- Continued to refine and update database
- Continued to calibrate and update stream flow rating curves for nine stations (the USGS provides stream flow data for the three remaining stations)

4.0 MONITORING LOCATIONS

The rationale used to establish monitoring locations was to divide the watershed into smaller hydrologic units, typically called sub-watersheds or sub-basins, and to characterize the quantity and quality of water flowing from these sub-basins into the main stem of Spring Creek. The existence of three U.S. Geological Survey gaging stations on the main stem of Spring Creek and three gaging stations maintained by the Pennsylvania Cooperative Fish and Wildlife Research Unit was also taken into account.

If land use patterns in a sub-basin were similar over the entire area, a single monitoring station at the point where flow from the sub-basin joined Spring Creek would be appropriate to describe water quantity and quality from the sub-basin. Because land use patterns change throughout most of the sub-basins, monitoring stations were located near the middle of the sub-basin and near its confluence with Spring Creek (Table 3). Thus, data collected from the monitoring stations will allow us to describe the amount of suspended and dissolved materials contributed from each sub-basin and describe how the quantity and quality of water in the main stem of Spring Creek changes as it travels from the upper part of the watershed near Boalsburg to its confluence with Bald Eagle Creek in Milesburg (Figure 1).

5.0 METHODS

CONTINUOUS MEASUREMENTS

Stream flow - Stream flow is monitored at all 12 monitoring stations. Nine of the 12 monitoring stations are equipped with instruments that continuously measure water levels every half-hour. The water level data are then converted to stream flow using station-specific rating curves. A rating curve relates water level to flow. Stream flow is recorded hourly at the three USGS stations (Spring Creek at Axemann, Spring Creek at Houserville, and Spring Creek at Milesburg).

Water temperature - Water temperature monitoring instruments are located at all monitoring stations and record data every hour.

Table 3. Water Resources Monitoring Stations.

STATION	STREAM REACH	LOCATION	OPERATOR
1	Spring Creek	Downstream of McCoy Dam in Milesburg	USGS
2	Buffalo Run	Upstream of the confluence with Spring Creek in Coleville	SCWC
3	Logan Branch	100 feet upstream of SR150 crossing in Bellefonte	SCWC
4	Spring Creek	50 feet downstream of the bridge on Fisherman's Paradise Road	USGS
5	Logan Branch	Behind International Order of Odd Fellows building on SR144	SCWC
6	Spring Creek	50 feet upstream of the intersection of Houserville, Trout, and Rock Roads	USGS
7	Slab Cabin Run	In Millbrook March, behind College Township Municipal Building	SCWC
8	Thompson Run	In Millbrook Marsh behind the Millbrook Marsh Nature Center.	SCWC
9	Slab Cabin Run	20 feet upstream of the bridge on South Atherton, near Branch Road	PCFWRU
10	Cedar Run	200 feet upstream of the intersection of Brush Valley & Linden Hall Roads.	PCFWRU
11	Spring Creek	100 feet upstream from the Linden Hall Bridge at Oak Hall	PCFWRU
12	Buffalo Run	Off SR550, approximately 1000 feet upstream of the village of Filmore	SCWC

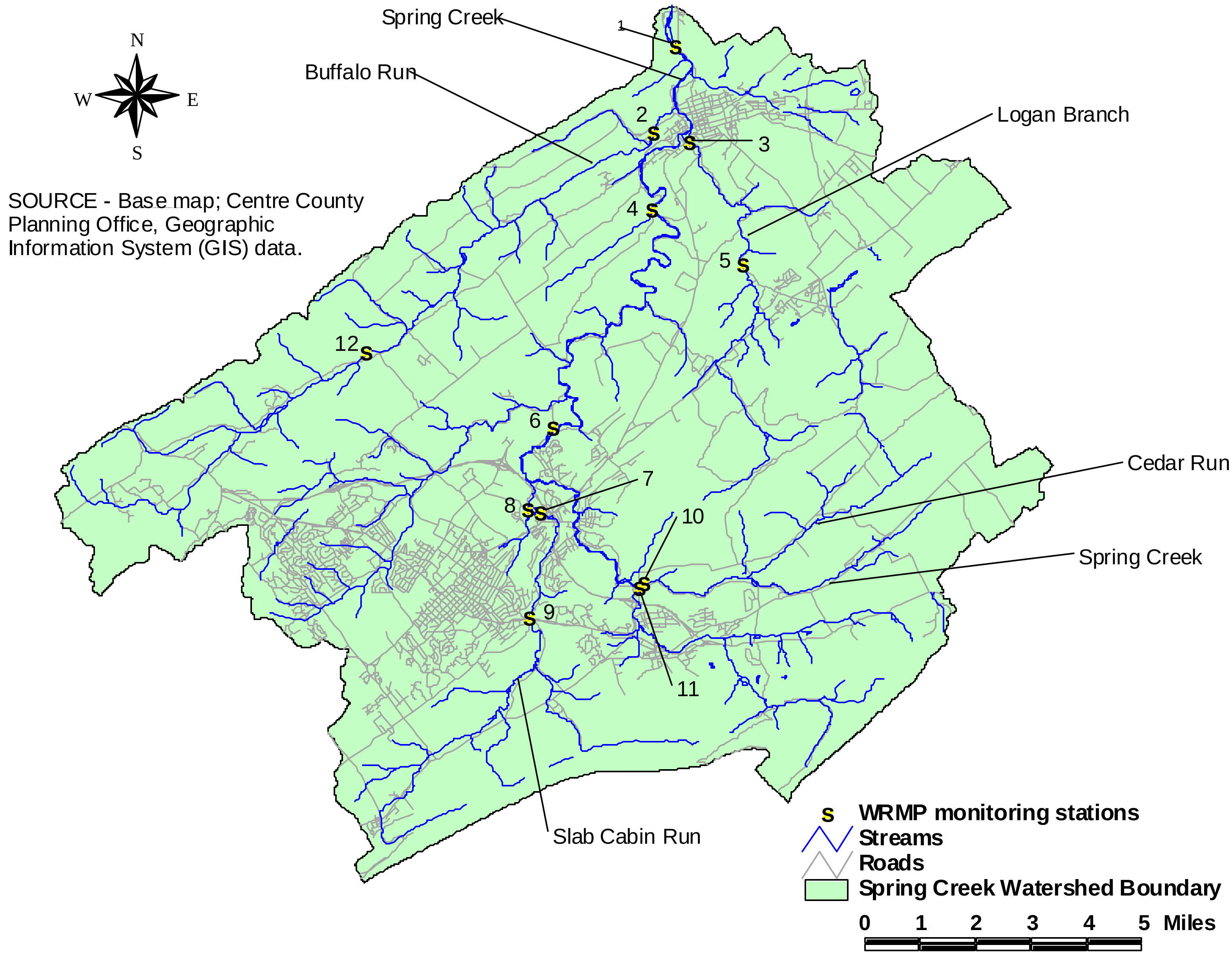


Figure 1. Water Resources Monitoring Station Locations

MONTHLY MEASUREMENTS

Every month a sample is taken during base flow conditions at each of the 12 monitoring stations using standardized procedures and sent to a laboratory for analysis. Samples are analyzed for 10 variables (Table 4). Monthly measurements also include dissolved oxygen and pH, which are measured in the field at each station when water quality samples are collected.

6.0 RESULTS

CONTINUOUS MEASUREMENTS

Stream flow - The year 2000 marks the first time in which all stream gaging stations were fully functional for 12 months and a nearly complete record was obtained from all sites. Some stream flow data during July were lost from the Upper Logan Branch station because of vandalism and an electronic record for part of February was lost from the Lower Slab Cabin Run station. We also had difficulty in accurately measuring intermittent flow at the Upper Slab Cabin Run station during summer months. All other stream flow records were complete and accurate.

Monthly variations in stream flow among stations were moderately high (Appendix A, Table A.1). Flows were highest in April at nearly all stations and lowest in November. In most years, stream flows are lowest in October, but in 2000 rainfall in November was more than one inch below normal, hence, stream flow continued to decline.

The mean monthly flow at the Milesburg station on Spring Creek was 177 cubic feet per second in 2000, which represents the watershed's contribution to Bald Eagle Creek. Among the tributaries, Logan Branch accounted for about 36% of the total flow (Figure 2). The other five tributaries each contributed less than 10% and together those five accounted for 29% of the total stream flow.

Table 4. Monthly water quality analysis.

VARIABLE	SOURCES	PA DEP CRITERIA*	ENVIRONMENTAL EFFECTS
Total suspended solids (TSS) & turbidity	Urban & agricultural runoff	None established	High levels harmful to fish & invertebrates
Dissolved Oxygen (DO)	Produced by plants, atmosphere	>7.0 mg/L for HQ-CWF**	Low levels harmful to fish & aquatic organisms
pH	Acid rain, industry	6-9	Very high or low levels harmful to fish & aquatic organisms
Chloride	Road salt	<250mg/L	Toxic to invertebrates
Metals: Copper Lead Zinc	Vehicles, industry, urban development	 <12.66 ug/L*** <3.90 ug/L*** <167ug/L***	Toxic to fish & invertebrates
Nitrates	Agriculture, wastewater	<10mg/L	Promotes excessive plant growth
Ortho phosphates	Agriculture, wastewater	Varies by stream	Promotes excessive plant growth
Petroleum Hydrocarbons & total organic carbon (TOC)	Petroleum fuels	None established	Urban development

*From Pennsylvania Code, chapters 16 and 93.
**High Quality Cold Water fishery
*** Assuming water quality hardness of 150 mg/L. ug/L = Micrograms per liter, or parts per billion.

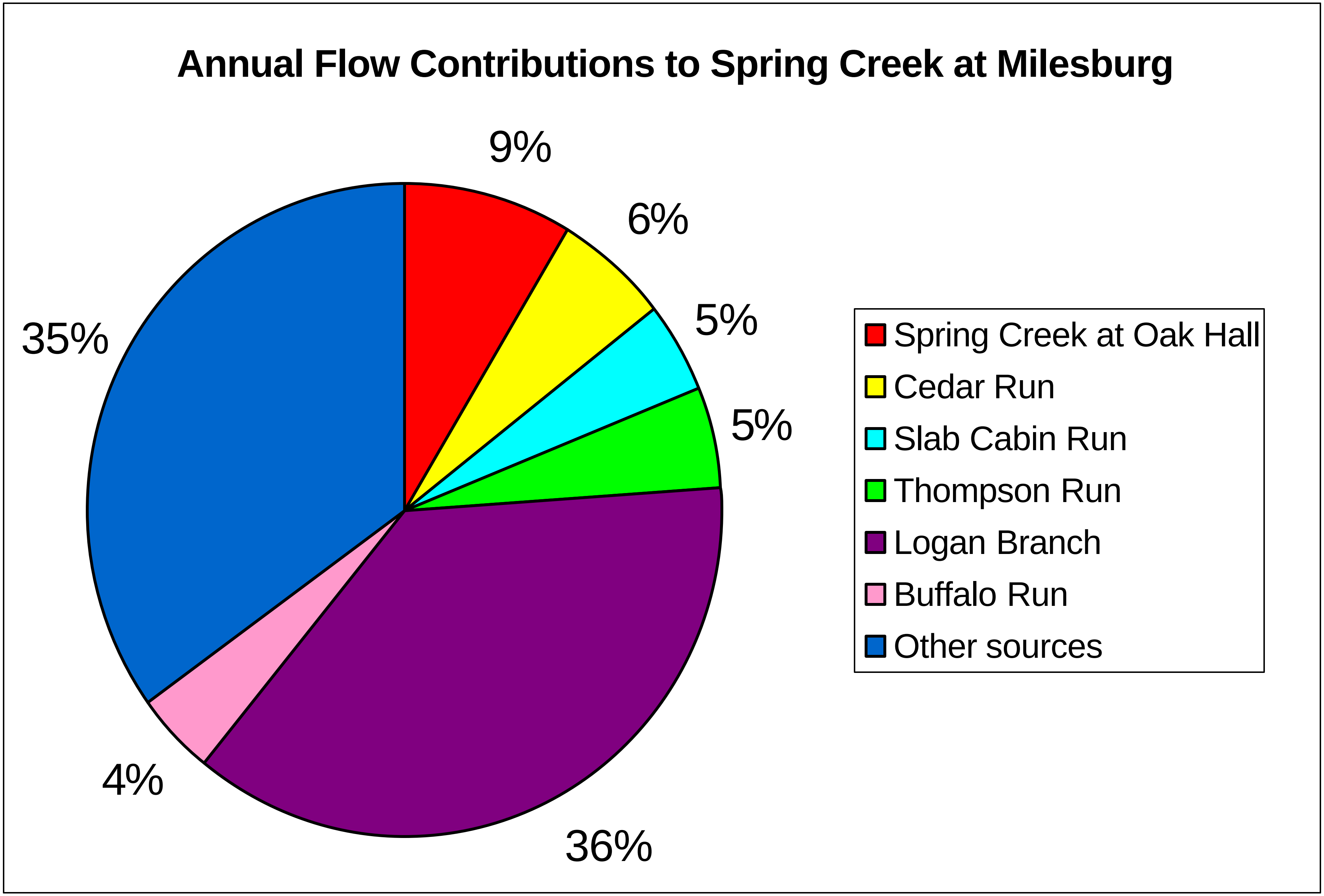


Figure 2. Annual flow contributions to Spring Creek at Milesburg for the year 2000.

The remaining 35% of the total flow was contributed by Big Spring and smaller springs entering Spring Creek between Oak Hall and Milesburg, and discharges from University Area Joint Authority wastewater treatment plant, Bellefonte wastewater treatment plant, Benner Spring fish hatchery, and Bellefonte fish hatchery at Fisherman's Paradise.

The amount of water flowing in Spring Creek and its tributaries is related to precipitation and groundwater levels. Significant amounts of rainfall or rapid snowmelt cause stream flows to increase rather quickly, and then following the event stream flows gradually return to levels approximating those prior to the storm or snowmelt. Stream flow between storms is largely related to the height of the water table, which reflects the amount of stored groundwater.

Groundwater levels rise and fall in response to rainfall and snowmelt, but they do so much more slowly than stream levels. To understand why groundwater levels change through time, one needs to examine precipitation records over extended periods, e.g., several years. This relation between rainfall and groundwater levels is dramatically illustrated by data from the year 2000.

Total precipitation measured at the Penn State University weather station in State College during 2000 was 31.56 inches, which was 6 inches less than the long-term average (Table 5). The Penn State weather station has 105 years of precipitation records. The year 2000 ranked 93rd on a scale of 1 (wettest) to 105 (driest). Lack of rainfall in 2000 resulted in a continued drop in groundwater levels.

A continuous record of groundwater level has been maintained from a monitoring well (Giddings well) in Cato

Table 5. 1994-2000 rainfall for State College, PA (PSU Department of Meteorology, Rock Springs weather station).

	1994	1995	1996	1997	1998	1999	2000	Normal
Jan	4.84	3.25	6.56	1.73	3.99	5.31	1.45	2.44
Feb	3.78	1.73	2.04	1.87	4.27	1.42	2.87	2.56
Mar	6.81	1.29	3.71	3.62	3.32	4.64	2.32	3.15
Apr	3.84	2.27	2.83	0.96	7.55	3.56	4.02	2.91
May	2.81	3.57	4.1	4.36	3.57	2.7	3.22	3.63
June	3.33	4.16	7.02	2.73	3.96	3.57	4.15	4.03
July	4.75	1.61	5.72	2.31	2.75	2.71	1.21	3.63
Aug	7.14	0.98	3.18	6.5	3.29	3.87	3.43	3.17
Sept	2.89	1.57	11	4.38	1.36	5.37	1.99	3.22
Oct	0.71	6.58	4.74	0.54	2.71	1.37	2.78	2.82
Nov	4.89	3.69	2.76	7.19	0.8	3.17	1.86	3.24
Dec	2.46	2.06	5.55	2.4	0.98	2.08	2.26	2.7
Total	48.3	32.8	59.2	38.6	38.6	39.8	31.6	37.48

Park, State College. During the period of January 1, 1997 to December 31, 2000, the water table was highest in mid May 1998 when it was about 36 feet below ground level. The water table increased rather steadily from early November 1997 until May 1998 because precipitation during this 6-month period was nearly 12 inches above normal. Since May 1998, rainfall has generally been below normal and the water level in the Giddings well had dropped 97 feet by December 31, 2000. Though not all wells in the watershed have had as large a decrease as the Giddings well, it is certain that all wells have undergone a decline since May 1998.

Because groundwater levels strongly influence stream flow, trends in the water table and stream flow tend to parallel one another. Figure 3 shows the mean monthly stream flow of Spring Creek at the U.S. Geological Survey's gaging station at Houserville in relation to the water levels in the Giddings well. High and low monthly flows at this gaging station correspond to high and low levels in the well. Stream flow at other gaging stations on Spring Creek behaved in a similar manner.

During the year 2000, stream flow at the Houserville, Axemann, and Milesburg gaging stations ranged from about 24% to 35% below normal. This was the second consecutive year in which stream flow was substantially below normal. We can anticipate that stream flows will remain low until adequate rainfall recharges the groundwater.

Water temperature. The average monthly temperature among all stations ranged from a low of 4.26 °C (39.7 °F) in December to a high of 16.16 °C (61.1 °F) in August (Appendix A, Table A.2). During the coldest and warmest months there was considerable variation among stations owing primarily to stream discharge and proximity to large springs. The lowest temperature in December was recorded at the Upper Buffalo Run site, which has a rather small base flow, hence it is readily influenced by air temperatures. In contrast, the warmest temperatures in December were measured at the Upper Spring Creek station, which is just downstream from large spring inputs; springs are typically close to 10 °C (50 °F) year-round. These same variations in temperature were noted during August, when the highest temperatures (19.11 °C, 66.4 °F) were recorded at the Lower Slab Cabin Run station. Stream flow during summer was extremely low at this station because of so little input of groundwater. The lowest August temperatures (12.49 °C, 54.5 °F) were recorded at the Upper Spring Creek station, again showing the influence of spring inputs.

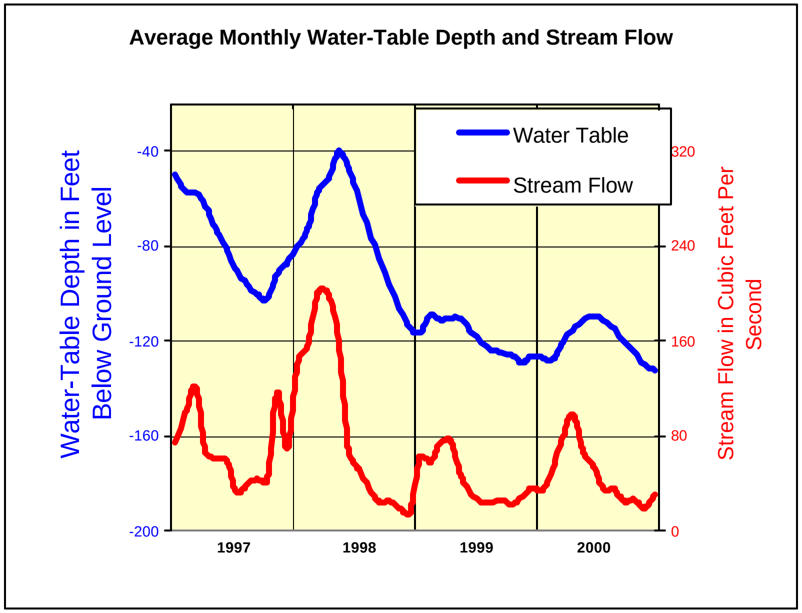


Figure 3. Average monthly water table depth and stream flow from the Giddings well (1997-2000).

MONTHLY MEASUREMENTS

All water samples were collected during periods of base flow. Concentrations of many water quality variables change during periods of storm flow. Some variables may increase during high flows and some will decrease. Hence, one must exercise caution when interpreting water quality information. The data presented here (Appendix A) are based on unfiltered water samples. Both filtered and unfiltered samples were analyzed, but for brevity sake, our discussion is limited to unfiltered samples. Data for filtered samples will be made available through our web site in the near future.

Turbidity. This water quality variable is a measure of how well light passes through a sample of water, such that low turbidity values mean excellent transmission of light. Runoff from disturbed riparian areas will result in rapid increases in turbidity. In general, turbidity values were low at all stations in the year 2000. The only exception to this trend was at the Upper Slab Cabin Run station in September when turbidity was 58.3 Nephelometric Turbidity Units (NTUs), more than 25 times the average of all other stations. During this time, flow in Slab Cabin Run had nearly ceased and the turbid conditions at the station may have been caused by animal (probably ducks) activity or possibly an algal bloom.

Total suspended solids (TSS). This measure of water quality is roughly proportional to turbidity, though it is a more sensitive measure at low levels. Disregarding Upper Slab Cabin Run for the above-mentioned reason, noticeable variation in TSS was observed among stations. All stations had modest levels of TSS at some time during the year, though not necessarily in the same month - possibly suggesting that local disturbances were influencing sediment inputs. The three stations with the highest mean annual TSS are closely associated with urban runoff: Upper Spring Creek, Lower Slab Cabin Run, and Lower Thompson Run.

Dissolved Oxygen (DO). DO is generally related to the uptake of atmospheric oxygen plus plant photosynthetic input minus losses to chemical or biological demand, such as the microbial metabolism of organic matter. In the absence of DO demand, oxygen saturation in water is a function of temperature; cold water may hold up to approximately 13 mg/l of DO, while warmer water may hold approximately 7 mg/l of DO. Groundwater may be relatively low in DO, although aeration will restore DO to groundwater upon discharge from springs or seeps to surface water bodies. Small streams may exhibit natural, measurable daily variation in DO due to plant output of oxygen during daylight hours versus plant uptake of oxygen at night.

pH. pH is a measure of the acidity of water. Pure water has a pH of 7.0, whereas acid rain may have a pH of approximately 4.0 or lower, and alkaline water (from carbonate bedrock areas) will tend to have a slightly alkaline pH of greater than 7.5. In our area, the pH of surface water is generally low in most of the tributaries and mountain streams (such as Roaring Run). Groundwater in the valleys acquires dissolved carbonates from bedrock, which raises the pH of both groundwater and of the valley streams. The pH of streams may decrease during storm events due to the dominance of low pH precipitation. The carbonate chemistry of our valley streams is a fundamental aspect of the aquatic ecosystems of Spring Creek, Logan Branch, Buffalo Run, Cedar Run, etc.

Chloride. This common chemical is typically associated with runoff from roadways, where it is applied for deicing in the form of calcium chloride or sometimes sodium chloride. It is not toxic to most aquatic organisms except at exceptionally high concentrations, but it is a good surrogate measure of runoff from paved surfaces. As expected, chloride concentrations were lowest in the predominately agricultural basin of Cedar Run and highest in the urbanized sub-basins measured at the Lower Slab Cabin Run and Lower Thompson Run stations. It is noteworthy that chlorides increase from Upper Spring Creek downstream to the Axemann station, but then decrease at the Milesburg station, which is probably due to dilution from flows contributed by Logan Branch, Big Spring, Buffalo Run, and groundwater inflow.

Lead. This heavy metal is toxic to humans and aquatic life. Over most of the watershed, concentrations of lead were quite low. In about 70% of all samples, concentrations of lead were below detectable limits. Detectable levels were consistently measured in Logan Branch, but no values exceeded the PA DEP water quality criterion of 3.9 µg/L.

Copper. Like lead, copper is toxic to humans and aquatic life. Concentrations of copper were below detection limits in 73% of all samples. Copper concentrations were highest in Thompson Run, which drains the most urbanized sub-basin. On five occasions copper concentrations exceeded the PA DEP criterion of 12.7 µg/L, and four of these instances occurred in April at stations well dispersed throughout the watershed. There is no apparent explanation for these unusual observations.

Zinc. This heavy metal is somewhat toxic to humans and aquatic life. It is typically found in concentrations substantially higher than copper or lead. Generally, zinc concentrations were low and in 82% of the samples they were below detection limits. The most notable station for zinc was Lower Logan Branch, where concentrations averaged 20.6 µg/L, which was two to four times higher than all other stations. The highest observed concentration of zinc was 53 µg/L, well below the PA DEP criterion of 167 µg/L.

Nitrates. This nutrient can be derived from a number of different sources including agricultural runoff, wastewater treatment plants, fish hatcheries, and urban runoff. Nitrates are not toxic at typical concentrations, though they can contribute to excessive growth of aquatic plants and nuisance algae. Nitrate concentrations were well below the PA DEP criterion of 10 mg/L at all stations. Concentrations exceeded 4 mg/L at three stations with the highest values at Cedar Run. Concentrations were lowest in Buffalo Run.

Total phosphates. The primary concern with this nutrient is its potential to stimulate nuisance levels of algae and higher aquatic plants. Sources are similar to those for nitrates. The average concentration at the Upper Slab Cabin Run station is high, owing to a single aberrant value in September when flows were quite low. At all other stations, average concentrations were less 0.07 mg/L. The highest average value was observed at Upper Logan Branch, but this concentration declined at the mouth of Logan Branch, probably because of dilution from large inputs of spring flows.

Total organic carbon. Animal wastes, human wastes, plant material, and petroleum compounds can account for large amounts of total organic carbon. These compounds are consumed by microorganisms in streams and can result in reductions of dissolved oxygen. Low concentrations of dissolved oxygen are harmful to all aquatic life. Concentrations of total organic carbon were generally low among all stations, indicating no significant inputs of pollution.

Petroleum hydrocarbons. Petroleum hydrocarbons are monitored because these compounds largely originate from vehicle fuels and lubricants. Concentrations of these compounds should reflect the intensity of vehicular traffic and the associated pollution that runs off of paved surfaces. These compounds are moderately toxic to aquatic life. Among all samples, only six had petroleum hydrocarbon concentrations above the detectable limits.

7.0 Examples of Data uses

Surface water quantity and quality data collected by the Water Resources Monitoring Project have been requested by several stakeholders and also have been identified as a critical component for several proposed Spring Creek Watershed projects. The Source Water Protection Project for the State College Borough Water Authority, University Area Joint Authority's Beneficial Reuse Project, and the Watershed Plan for the Spring Creek Watershed are examples of such projects.

SOURCE WATER PROTECTION
(Contributed by State College Borough Water Authority)

The State College Borough Water Authority (SCWA), partnering with the University Area Joint Authority (UAJA), was awarded a PA DEP Growing Greener Grant to develop a source water protection program for its drinking water sources which include seven wellfields and the Shingletown Reservoir. This project will complete 1) a comprehensive wellhead protection program for all of the SCWA wellfields and 2) create a watershed protection program for the upper portion of the Slab Cabin Run basin.

The ultimate goal of developing a Source Water Protection Program for the SCWA is to protect all of its drinking water sources. The State College area is a high-growth area with increased amounts of development occurring through new housing developments, new industry, and improved infrastructure. This high growth and development increases the impervious coverage of the land, increasing the potential for stormwater runoff to adversely impact the wellfields and watershed and therefore the SCWA water supply. The basis on which to protect each of the SCWA drinking water sources is to characterize the contributing area of each source and minimize or manage activities within those contribution areas that have the potential to degrade source water quality. Characterization of the contributing area of each source will be used to create both conceptual and computer models of each wellfield and watershed contributing area that can be used as a valuable planning tool to assess if and how future changes in land use may affect each water source.

The basic approach to development of both the watershed and wellhead protection programs is through review of the available information for the Upper Slab Cabin Run watershed and each SCWA wellfield (e.g. water quality and quantity data collected on Slab Cabin Run by the Water Resources Monitoring Project). Any existing information will be coupled with additional characterization activities (e.g. fracture-trace analysis, aquifer testing, etc.) to delineate each water source's contribution area to provide the foundation around which conceptual and computer models will be created for each source. In addition, contaminant source inventories and proper management of each source's contribution area will be conducted to ensure long-term source water protection.

The benefits of developing a Source Water Protection Program for the SCWA are ensuring a reliable, high-quality water supply to all consumers through protection of the SCWA's wellfields and the Slab Cabin Run watershed. In addition, the characterization of the contributing area of each source and the resultant conceptual and computer models will be valuable planning tools for assessing future land-use impacts.

The wellhead and watershed protection programs are necessary to ensure that proper management techniques

Table A.1. Year 2000 WRMP stream flow (cms*).

	Lower Cedar Run	Upper Slab Cabin Run	Lower Slab Cabin Run	Lower Thompson Run	Upper Logan Branch	Lower Logan Branch	Upper Buffalo Run	Lower Buffalo Run	Upper Spring Creek	Spring Creek Houserville	Spring Creek Axemann	Spring Creek Milesburg
Jan	0.2190	0.1175	0.2028	0.2105	0.4003	1.5244	0.1286	0.4066	0.3141	0.9647	1.5494	4.2242
Feb	0.2527	0.1306	0.2110	0.2065	0.7091	1.7003	0.1862	0.8056	0.4397	1.4844	2.0742	5.1220
Mar	0.4303	0.3268	0.4981	0.2133	1.0075	2.4630	0.2807	0.8024	0.6423	2.2437	2.8430	6.9064
Apr	0.5503	0.4178	0.6522	0.2729	1.0232	2.7079	0.5724	0.9301	0.7083	2.7754	3.5419	8.3468
May	0.4522	0.2776	0.3839	0.2850	0.6499	2.3299	0.2009	0.4998	0.6087	1.8801	2.6959	6.3026
Jun	0.4131	0.2338	0.3163	0.3407	0.4502	1.8712	0.1526	0.3863	0.5518	1.5378	2.4591	5.5951
Jul	0.2935	0.1234	0.1493	0.2713	0.3870	1.6151	0.0876	0.2413	0.4412	1.0076	2.0107	4.4490
Aug	0.2207	0.0746	0.0954	0.2525	0.4020	1.6828	0.0810	0.2281	0.4284	0.9939	1.7906	4.5586
Sep	0.1855	0.0040	0.0472	0.2133	0.4923	1.6151	0.0272	0.1901	0.2376	0.7080	1.4434	3.7722
Oct	0.1870	0.0029	0.0561	0.2192	0.6336	1.6057	0.0301	0.1926	0.2253	0.7500	1.4187	3.7392
Nov	0.1570	0.0028	0.0443	0.2134	0.6004	1.5236	0.0233	0.1884	0.2323	0.5494	1.3405	3.4701
Dec	0.2245	0.0146	0.0737	0.2153	0.9726	1.5703	0.3588	0.2104	0.2975	0.8633	1.6115	3.7921
Average	0.2988	0.1439	0.2275	0.2428	0.6440	1.8508	0.1774	0.4235	0.4273	1.3132	2.0649	5.0232
Median	0.2386	0.1205	0.1761	0.2172	0.6170	1.6490	0.1406	0.3138	0.4340	1.0008	1.9006	4.5038

* Cubic meters per second

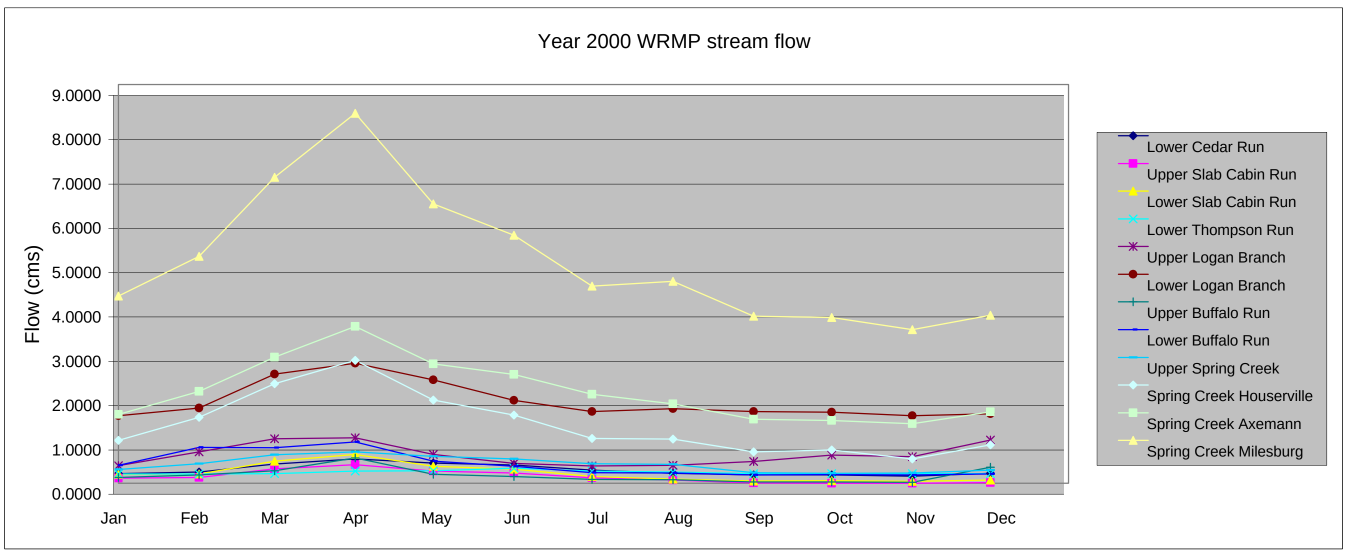


Figure A.1. Year 2000 WRMP stream flow (cms).

Table A.2. Year 2000 WRMP stream temperature (C).

	Lower Cedar Run	Upper Slab Cabin Run	Lower Slab Cabin Run	Lower Thompson Run	Upper Logan Branch	Lower Logan Branch	Upper Buffalo Run	Lower Buffalo Run	Upper Spring Creek	Spring Creek Houserville	Spring Creek Axemann	Spring Creek Milesburg	Average Monthly Temperature
Jan	4.3	2.6	1.2	7.7	6.6		2.0	2.4	8.0	3.4	4.3	5.9	4.4
Feb	5.9	3.2	4.0	8.5	7.6		2.9	4.0	7.8	4.8	5.9	7.0	5.6
Mar	9.2	8.2	8.5	10.1	8.8		7.1	8.0	8.2	8.0	9.1	9.1	8.6
Apr	10.9	10.5	10.8	11.4	10.3		9.5	10.3	9.2	9.8	11.3	10.9	10.4
May	13.6	14.4	15.1	13.2	13.5		13.3	14.4	10.2		15.3	14.1	13.7
Jun	14.8	17.0	17.5	14.2	15.7	13.5	15.3	17.2	12.1		17.5	15.9	15.5
Jul	15.1	18.4	18.7	13.8	16.8	13.0	15.9	17.2	12.1	16.0	17.8	15.9	15.9
Aug	15.6	19.4	19.1	13.9	17.1	13.0	16.4	17.2	12.5	16.4	17.8	15.7	16.2
Sep	14.2	16.8	16.7	12.9	16.0	12.1	14.1	15.3	11.8	14.4	15.8	14.1	14.5
Oct	11.4	11.1	12.0	11.4	13.3	11.1	10.1	11.3	10.8	11.4	12.2	11.6	11.5
Nov	6.7	5.0	6.1	9.2	9.9	10.0	4.3	6.0	9.3	7.2	7.9	8.6	7.5
Dec	2.8		1.3	7.0	6.5	8.6	0.1	1.2	7.4	3.1	3.4	5.3	4.3
Avgerage	10.4	11.5	10.9	11.1	11.8	11.6	9.3	10.4	9.9	9.5	11.5	11.2	10.7
Median	11.1	11.1	11.4	11.4	11.8	12.1	9.8	10.8	9.7	8.9	11.8	11.2	11.0

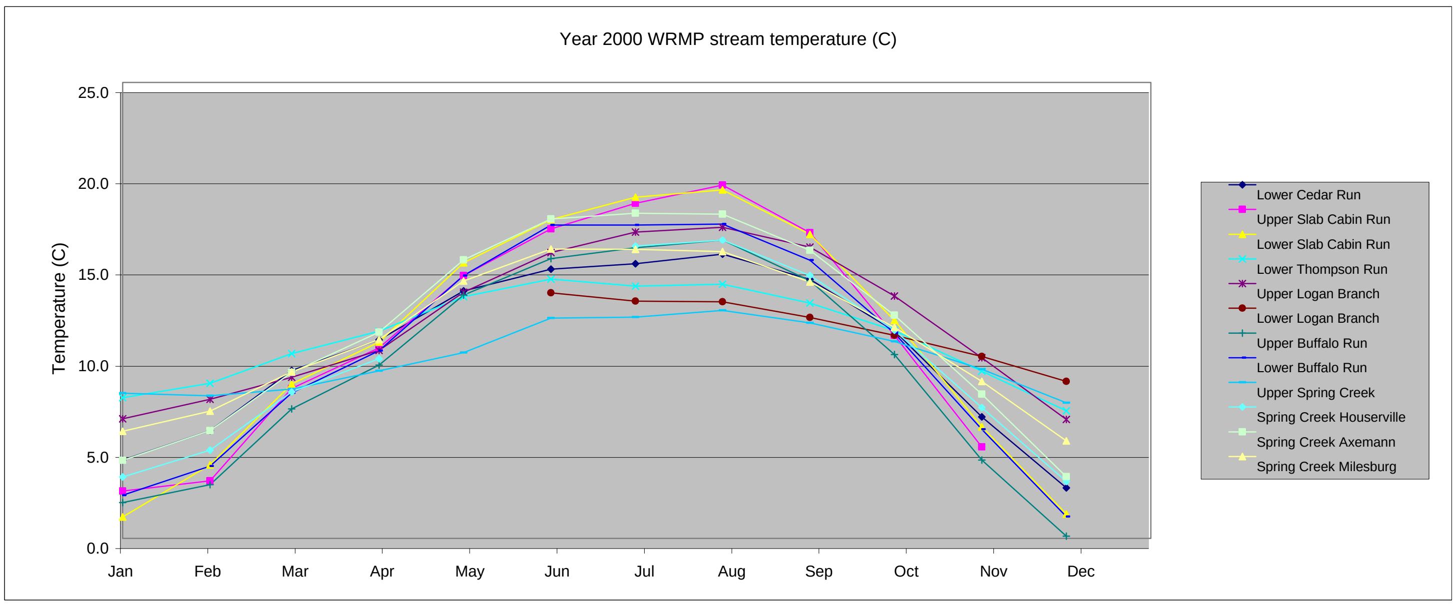


Figure A.2. Year 2000 WRMP stream temperature of Spring Creek and its tributaries

Table A.3. Year 2000 WRMP total suspended solids concentrations* (mg/L).

	Lower Cedar Run	Upper Slab Cabin Run	Lower Slab Cabin Run	Lower Thompson Run	Upper Logan Branch	Lower Logan Branch	Upper Buffalo Run	Lower Buffalo Run	Upper Spring Creek	Spring Creek Houserville	Spring Creek Axemann	Spring Creek Milesburg
Jan	8	24	34	2	6	1	1	1	20	1	1	1
Feb			20	8	1	1	1	22	12	1	1	1
Mar	1	4	1	4	4	1	1	16	4	1	1	1
Apr	4	6	14	1	4	12	1	8	10	1	8	1
May	4	10	8	12	1	12	1	6	18	6	10	1
Jun	1	1	1	4	10	1	10	4	1	1	20	1
Jul	1	6	12	1	6	1	14	4	4	8	1	4
Aug	4	12	1	26	1	1	1	1	14	1	1	1
Sep	1	138	1	12	1	1	6	1	1	1	1	14
Oct	16		6	6	6	12	8	10	1	1	1	12
Nov	1		1	1	28	1	1	8	16	6	8	12
Dec	46		1	22	1	1	16	4	30	12	1	1
Average	7.9	25.1	8.3	8.3	5.8	3.8	5.1	7.1	10.9	3.3	4.5	4.2
Median	4.0	8.0	3.5	5.0	4.0	1.0	1.0	5.0	11.0	1.0	1.0	1.0

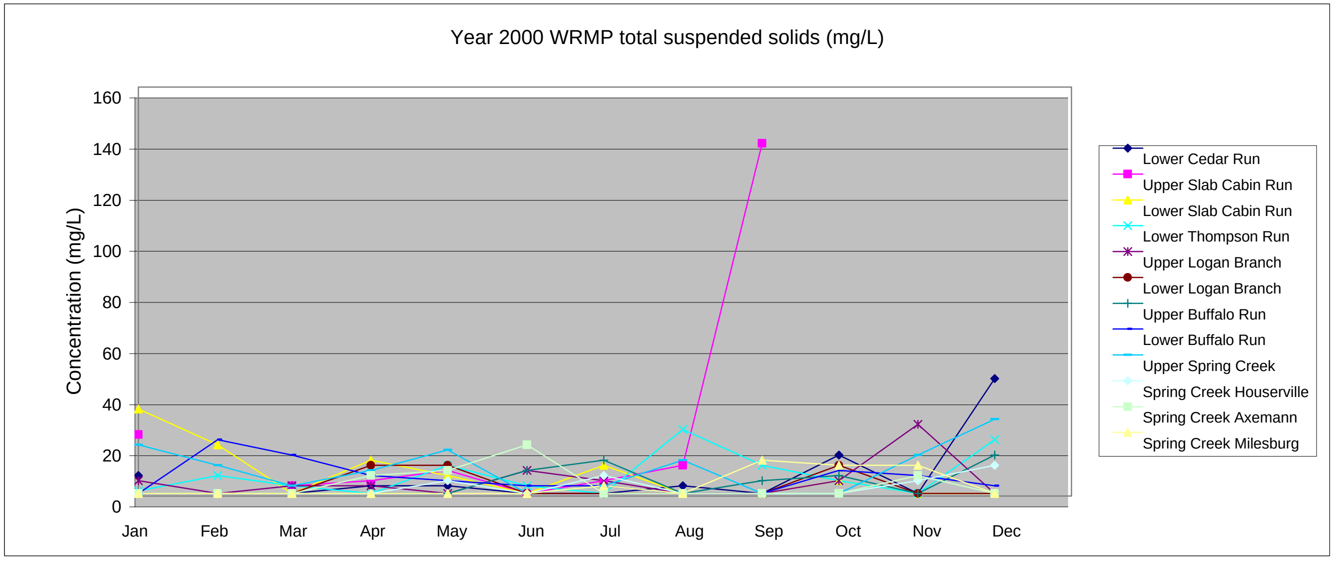


Figure A.3. Year 2000 WRMP total suspended solids concentrations* (mg/L).

*Non-detected values shown at one-half detection limit (2 mg/L).

Table A.4. Year 2000 WRMP turbidity levels* (NTU).

	Lower Cedar Run	Upper Slab Cabin Run	Lower Slab Cabin Run	Lower Thompson Run	Upper Logan Branch	Lower Logan Branch	Upper Buffalo Run	Lower Buffalo Run	Upper Spring Creek	Spring Creek Houserville	Spring Creek Axemann	Spring Creek Milesburg
Jan	0.5	3.2	1.45	1.56	4.4	0.5	0.5	0.5	0.5	1.94	1.28	1.89
Feb			5.31	2.85	2.46	0.5	1.26	8.97	0.5	1.11	0.5	0.5
Mar	2.14	1.81	1.2	1.47	2.87	1.67	1.32	3.44	1.68	1.33	2.08	1.85
Apr	1.87	4.89	3.8	1.13	5.94	2.37	3.54	5.7	2.07	1.83	2.88	2.3
May	1.8	1.46	1.32	1.19	3.24	1.5	1.45	2.55	1.24	1.55	1.62	1.64
Jun	1.16	1.45	1.41	1.96	2.73	2.1	2.37	2.03	1.84	1.58	3.23	2.05
Jul	1.32	1.76	0.5	1.34	2.06	0.5	2.25	3.34	1.14	1.35	2.24	1.76
Aug	2.9	5.13	1.63	2.21	3.62	1.13	17	10.4	2.46	2.4	2.88	3.13
Sep	2.18	53.8	1.64	1.6	4.02	1.94	6.87	5.15	2.14	1.86	3.59	2.01
Oct	2.08		1.85	1.26	1.86	0.5	1.84	1.63	0.5	1.77	1.49	1.09
Nov	2.06		1.35	0.5	1.57	0.5	1.32	1.12	0.5	1.89	1.07	0.5
Dec	1.77		2.75	1.66	1.84	0.5	1.79	1.51	0.5	1.75	1.18	1.75
Average	1.8	9.2	2.0	1.6	3.1	1.1	3.5	3.9	1.3	1.7	2.0	1.7
Median	1.9	2.5	1.5	1.5	2.8	0.8	1.8	2.9	1.2	1.8	1.9	1.8

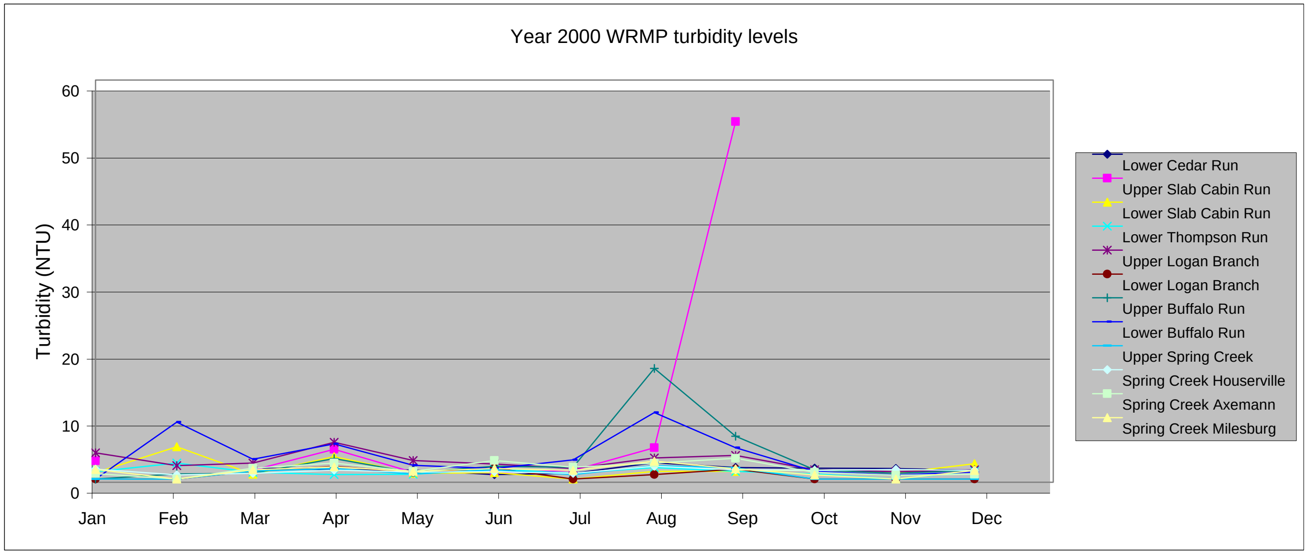
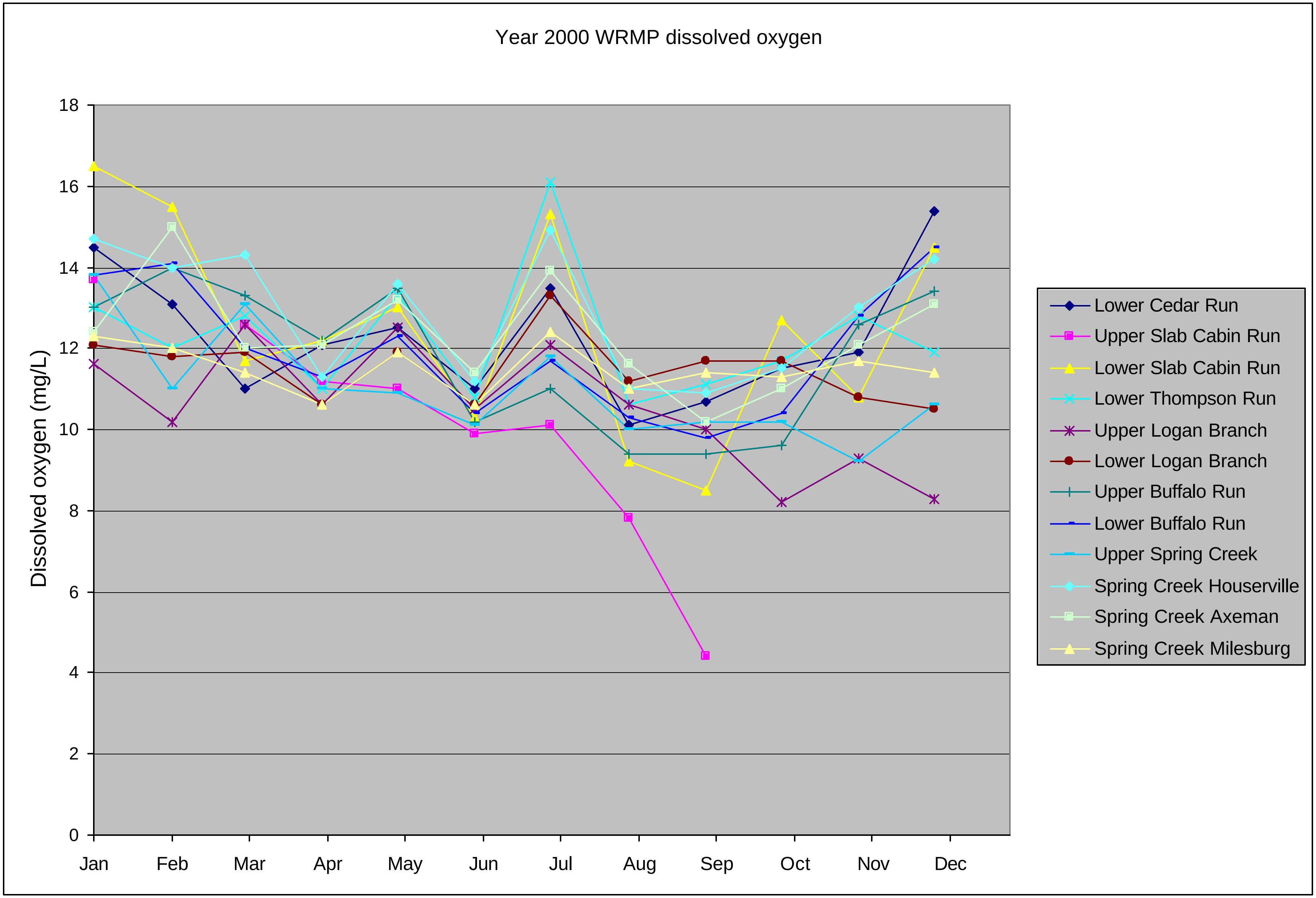


Figure A.4. Year 2000 WRMP turbidity levels* (NTU).

*Non-detected values shown at one-half detection limit (1 NTU)



Year 2000 WRMP dissolved oxygen
Dissolved oxygen (mg/L)
0
2
4
6
8
10
12
14
16
18
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Lower Cedar Run
Upper Slab Cabin Run
Lower Slab Cabin Run
Lower Thompson Run
Upper Logan Branch
Lower Logan Branch
Upper Buffalo Run
Lower Buffalo Run
Upper Spring Creek
Spring Creek Houserville
Spring Creek Axeman
Spring Creek Milesburg

Table A.6. Year 2000 WRMP stream pH (IU).

	Lower Cedar Run	Upper Slab Cabin Run	Lower Slab Cabin Run	Lower Thompson Run	Upper Logan Branch	Lower Logan Branch	Upper Buffalo Run	Lower Buffalo Run	Upper Spring Creek	Spring Creek Houserville	Spring Creek Axeman	Spring Creek Milesburg
Jan	7.8	7.5	8	7.8	7.8	7.7	7.9	7.9	7.3	8	7.7	7.9
Feb	7.9		8	7.7	7.9	7.8	7.8	8	7.6	8	8.1	8.1
Mar	8	7.6	8.1	8	7.5	7.7	8.1	7.5	7.8	8	7.8	7.8
Apr	8	7.7	7.8	7.8	7.9	7.9	8.1	7.9	7.8	8	8.1	8.1
May	8	7.4	8	7.8	7.9	7.9	8.1	8.2	6.7	8.2	8.5	8.4
Jun	8.1	7.6	7.6	7.5	8	7.9	8.1	8.3	7.3	9	8.1	8.3
Jul	8.1	7.7	8.3	8.3	8	7.8	7.8	8.2	7.1	8.3	8.2	8.3
Aug	8.1	7.2	8	7.9	7.9	7.7	7.4	7.8	7.1	8.1	8	8.2
Sep	7.5	7.2	7.3	7.7	7.5	7.3	7.7	8.1	7	7.8	7.6	8.1
Oct	7.3		7.3	8.1	7.1	7.5	7.1	8.1	7.1	7.7	7.3	8
Nov	8.1		7.1	8.1	7.1	7.3	6.9	8.1	7.3	8.1	7.1	7.9
Dec	8.1		7.6	8.1	7.4	7.6	7.4	8.1	7.1	8.2	7.9	8.1
Average	7.92	7.49	7.76	7.90	7.67	7.68	7.70	8.02	7.27	8.12	7.87	8.10
Median	8	7.55	7.9	7.85	7.85	7.7	7.8	8.1	7.2	8.05	7.95	8.1

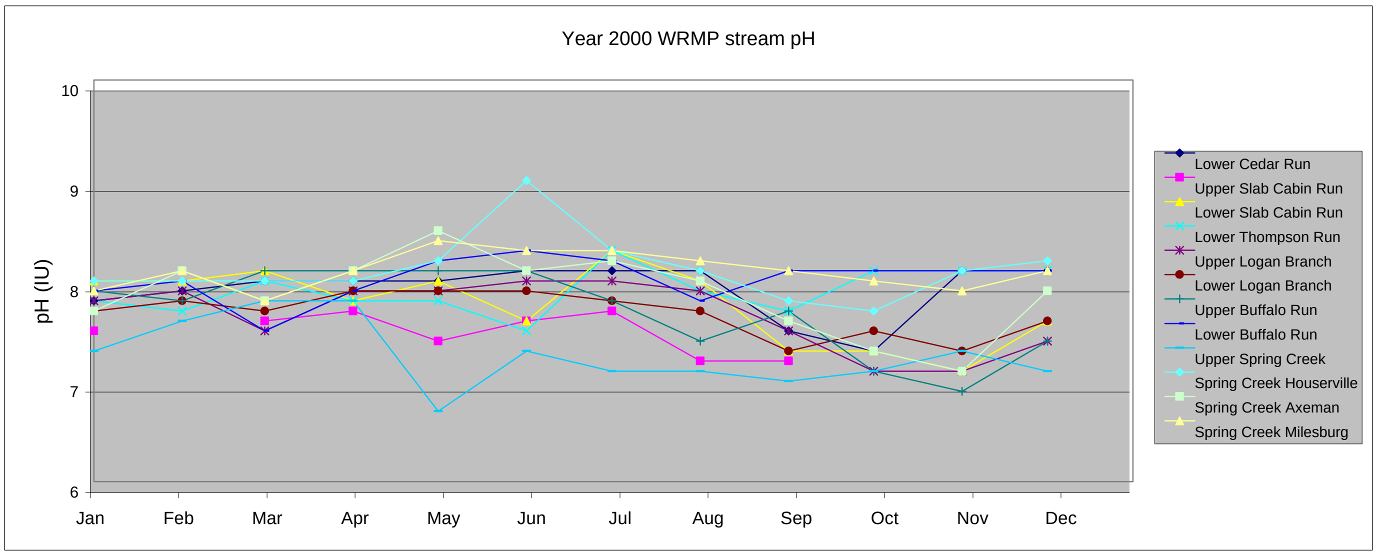


Figure A.6. Year 2000 WRMP stream pH (IU).

Table A.7. Year 2000 WRMP chloride concentrations* (mg/L).

	Lower Cedar Run	Upper Slab Cabin Run	Lower Slab Cabin Run	Lower Thompson Run	Upper Logan Branch	Lower Logan Branch	Upper Buffalo Run	Lower Buffalo Run	Upper Spring Creek	Spring Creek Houserville	Spring Creek Axemann	Spring Creek Milesburg
Jan	14	20	31	46	24	16	20	14	14	26	42	30
Feb	13.7		67	66	32	18	23	14	17	36	50	35
Mar	14	23	35	53	24	17	24	16	12	27	39	28
Apr	13	18	29	55	20	17	20	16	12	24	37	29
May	11	19	27	60	16	16	17	14	11	23	29	26
Jun	12	21	32	45	27	18	20	14	13	24	39	28
Jul	13	22	32	44	24	18	20	13	16	23	40	28
Aug	14	25	37	58	27	19	21	16	14	28	41	26
Sep	14	54	55	52	38	20	20	13	15	30	44	31
Oct	13		68	49	45	20	20	13	15	33	45	34
Nov	15		72	63	61	21	21	14	16	33	49	34
Dec	15		80	63	38	20	23	14	13	34	47	31
Average	13.5	25.3	47.1	54.5	31.3	18.3	20.8	14.3	14.0	28.4	41.8	30.0
Median	13.9	21.5	36.0	54.0	27.0	18.0	20.0	14.0	14.0	27.5	41.5	29.5

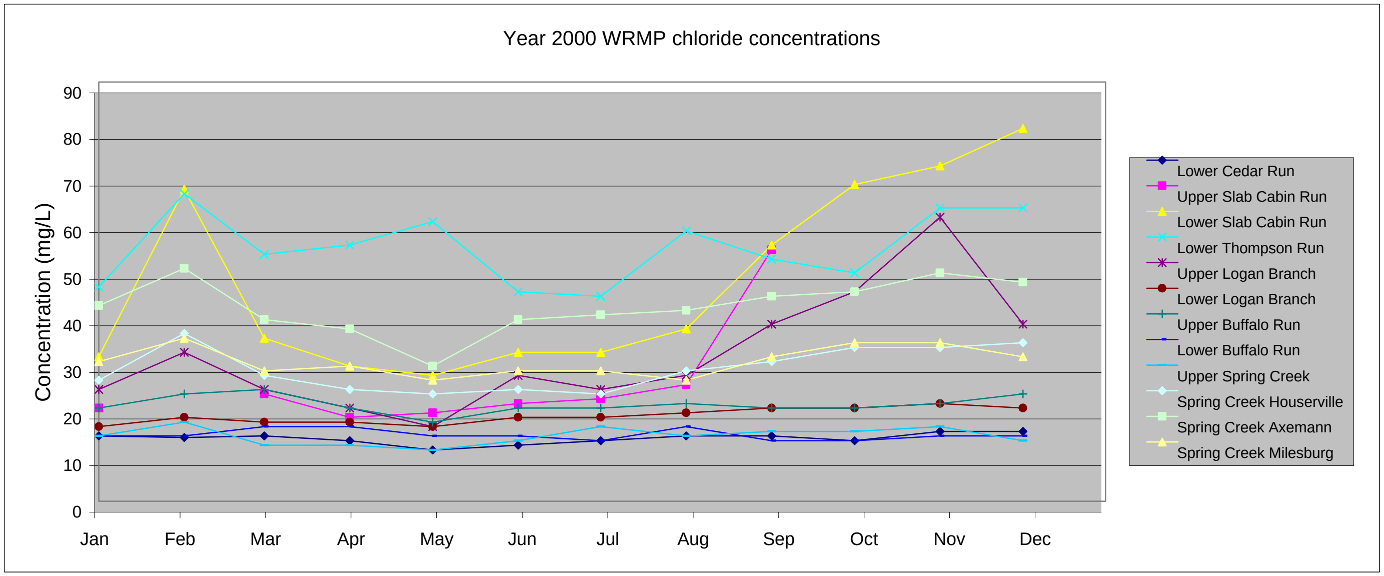


Figure A.7. Year 2000 WRMP chloride concentrations* (mg/L).

*Non-detected values shown at one-half detection limit (1.0 mg/L).

Table A.9. Year 2000 WRMP total lead concentrations* (ug/L).

	Lower Cedar Run	Upper Slab Cabin Run	Lower Slab Cabin Run	Lower Thompson Run	Upper Logan Branch	Lower Logan Branch	Upper Buffalo Run	Lower Buffalo Run	Upper Spring Creek	Spring Creek Houserville	Spring Creek Axemann	Spring Creek Milesburg
Jan	0.5	0.5	0.5	0.5	1.6	1.1	0.5	0.5	0.5	0.5	0.5	0.5
Feb			0.5	0.5	3.3	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Mar	0.5	0.5	0.5	0.5	1.6	1	0.5	0.5	0.5	0.5	0.5	0.5
Apr	0.5	0.5	0.5	0.5	3.1	1.4	0.5	0.5	0.5	0.5	0.5	1.2
May	0.5	0.5	0.5	0.5	2	1.5	0.5	0.5	0.5	0.5	0.5	0.5
Jun	0.5	0.5	0.5	0.5	3.1	1.4	0.5	0.5	0.5	0.5	0.5	0.5
Jul	0.5	0.5	0.5	0.5	3.2	1.1	0.5	0.5	0.5	0.5	0.5	0.5
Aug	0.5	0.5	0.5	1.4	3.3	1.7	0.5	0.5	0.5	0.5	0.5	0.5
Sep	0.5	3.6	0.5	0.5	3.1	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Oct	0.5		0.5	0.5	3	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Nov	0.5		0.5	0.5	4	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Dec	0.5		0.5	0.5	2.8	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Average	0.5	0.9	0.5	0.6	2.8	1.0	0.5	0.5	0.5	0.5	0.5	0.6
Median	0.5	0.5	0.5	0.5	3.1	1.1	0.5	0.5	0.5	0.5	0.5	0.5

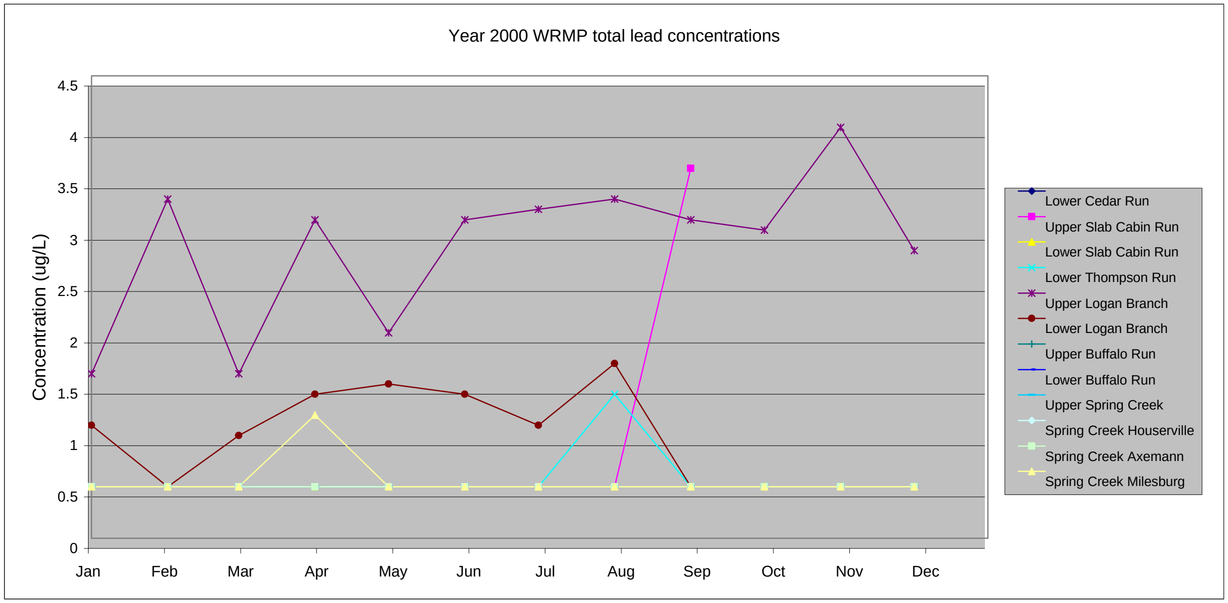


Figure A.9. Year 2000 WRMP total lead concentrations* (ug/L).

*Non-detected values shown at one-half detection limit (1.0 ug/L).

Table A.8. Year 2000 WRMP total copper concentrations* (ug/L).

	Lower Cedar Run	Upper Slab Cabin Run	Lower Slab Cabin Run	Lower Thompson Run	Upper Logan Branch	Lower Logan Branch	Upper Buffalo Run	Lower Buffalo Run	Upper Spring Creek	Spring Creek Houserville	Spring Creek Axemann	Spring Creek Milesburg
Jan	5	5	5	18	5	5	5	5	5	5	5	5
Feb			5	5	5	5	5	5	5	5	5	5
Mar	2	2	2	2	2	4.4	2	2	2	2	2	2
Apr	14.5	11	5.3	31	21.3	4.6	2	2	11.6	2	2	18.2
May	2	2	2	2	2	2	2	2	2	2	2	2
Jun	2	2	2	4	2	2	2	2	4.2	2	2	2
Jul	2	2	2	2	2	2	2	2	2	2	2	2
Aug	2	2	2	2	2	4.5	2	2	2	2	2	2
Sep	2	7.1	2	6.5	2	4	2	2	2	2	2	2
Oct	2		2	2	2	2	2	2	2	2	2	2
Nov	2		2	2	2	2	2	2	2	2	2	2
Dec	2		2	2	2	2	2	2	2	2	2	2
Average	3.4	4.1	2.8	6.5	4.1	3.3	2.5	2.5	3.5	2.5	2.5	3.9
Median	2	2	2	2	2	3	2	2	2	2	2	2

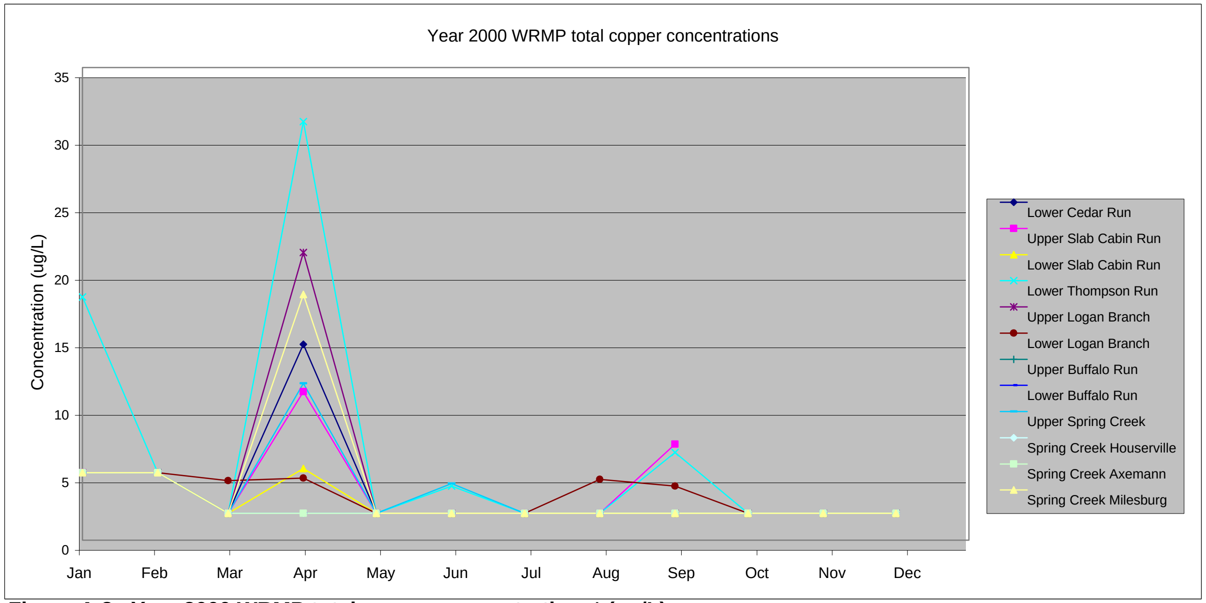


Figure A.8. Year 2000 WRMP total copper concentrations* (ug/L).

*Non-detected values shown at one-half detection limit.
**NA - not available

Table A.10. Year 2000 WRMP total zinc concentrations* (ug/L).

	Lower Cedar Run	Upper Slab Cabin Run	Lower Slab Cabin Run	Lower Thompson Run	Upper Logan Branch	Lower Logan Branch	Upper Buffalo Run	Lower Buffalo Run	Upper Spring Creek	Spring Creek Houserville	Spring Creek Axemann	Spring Creek Milesburg
Jan	5	5	5	5	10	44	5	5	5	5	5	18
Feb	5		5	5	5	33	5	5	53	5	5	16
Mar	19	5	5	5	5	11	5	5	5	5	5	5
Apr	5	5	5	5	5	21	5	5	5	5	5	11
May	5	5	5	5	5	5	5	5	5	5	5	5
Jun	5	5	5	10	5	18	5	5	5	5	5	10
Jul	5	5	5	5	5	12	5	12	5	5	5	5
Aug	5	5	5	5	5	35	11	5	5	5	11	11
Sep	5	15	5	5	5	25	5	5	5	5	5	5
Oct	5		5	5	5	14	5	5	5	5	5	14
Nov	5		5	5	5	15	5	5	5	5	5	5
Dec	5		5	5	5	14	5	5	5	5	5	5
Average	6.2	6.3	5.0	5.4	5.4	20.6	5.5	5.6	9.0	5.0	5.5	9.2
Median	5.0	5.0	5.0	5.0	5.0	16.5	5.0	5.0	5.0	5.0	5.0	7.5

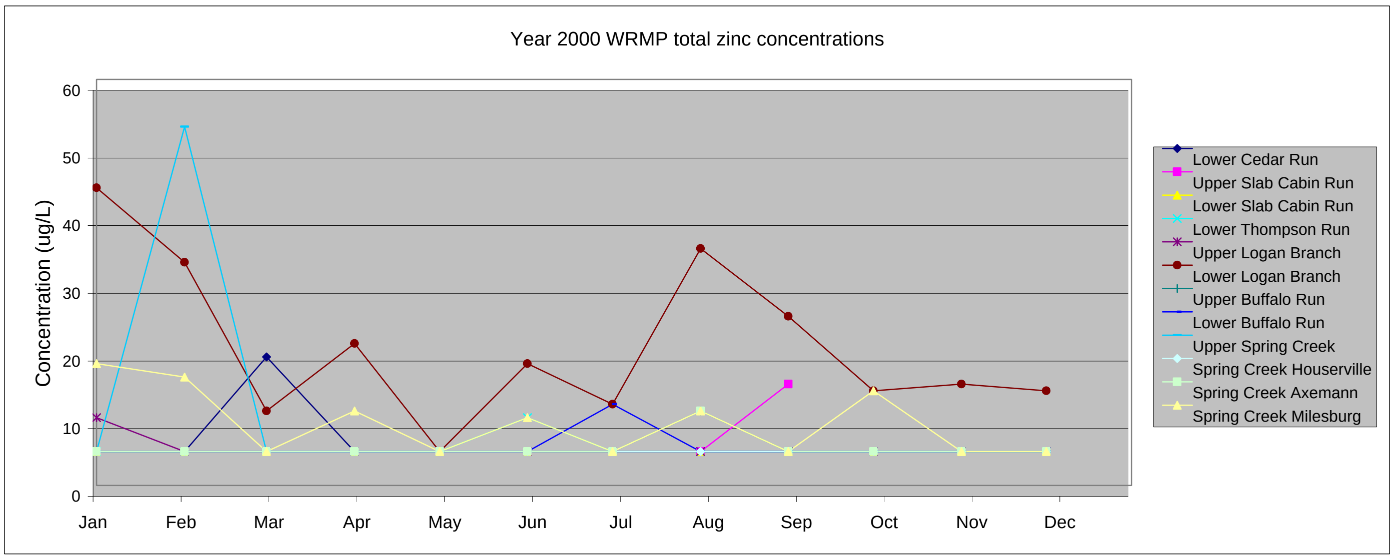


Figure A.10. Year 2000 WRMP total zinc concentrations* (ug/L).

*Non-detected values shown at one-half detection limit (10 ug/L).

Table A.11. Year 2000 WRMP total nitrate concentrations* (mg/L).

	Lower Cedar Run	Upper Slab Cabin Run	Lower Slab Cabin Run	Lower Thompson Run	Upper Logan Branch	Lower Logan Branch	Upper Buffalo Run	Lower Buffalo Run	Upper Spring Creek	Spring Creek Houserville	Spring Creek Axemann	Spring Creek Milesburg
Jan	5.41	4.83	2.83	3.88	2.65	2.74	1.53	2.06	2.28	3.07	4.5	3.51
Feb			4.56	4.17	2.87	2.85	1.85	2.26	2.63	3.4	5.37	3.98
Mar	4.11	2.71	2.42	4.49	2.05	2.54	1.3	1.74	1.64	2.67	4	3.05
Apr	4.07	2.02	1.95	3.85	1.94	2.51	1.05	1.52	1.49	2.48	3.81	2.98
May	4.08	2.84	2.45	4.09	2.14	2.56	1.1	1.59	1.65	2.59	3.39	3.18
Jun	3.96	3.03	2.76	3.32	2.5	2.77	1.33	1.69	1.95	2.77	4.01	3.04
Jul	4.38	2.91	2.09	3.91	3	2.93	1.43	1.92	2.55	3.19	4	3.25
Aug	4.13	2.67	2.06	3.92	5.82	3.14	1.26	1.61	2.09	2.87	4.98	4.43
Sep	4.19	1.01	1.1	4.17	2.86	2.8	1.39	1.86	2.44	3.12	4.46	3.64
Oct	4.33		0.82	4.04	2.78	2.79	1.18	1.8	2.86	3.78	5.08	4.23
Nov	4.38		0.87	4.29	3	2.74	1.34	2.03	3.01	3.49	5.46	3.96
Dec	4.3		1.6	4.03	2.68	2.76	1.5	2.3	2.36	3.13	4.9	3.96
Average	4.3	2.8	2.1	4.0	2.9	2.8	1.4	1.9	2.2	3.0	4.5	3.6
Median	4.2	2.8	2.1	4.0	2.7	2.8	1.3	1.8	2.3	3.1	4.5	3.6

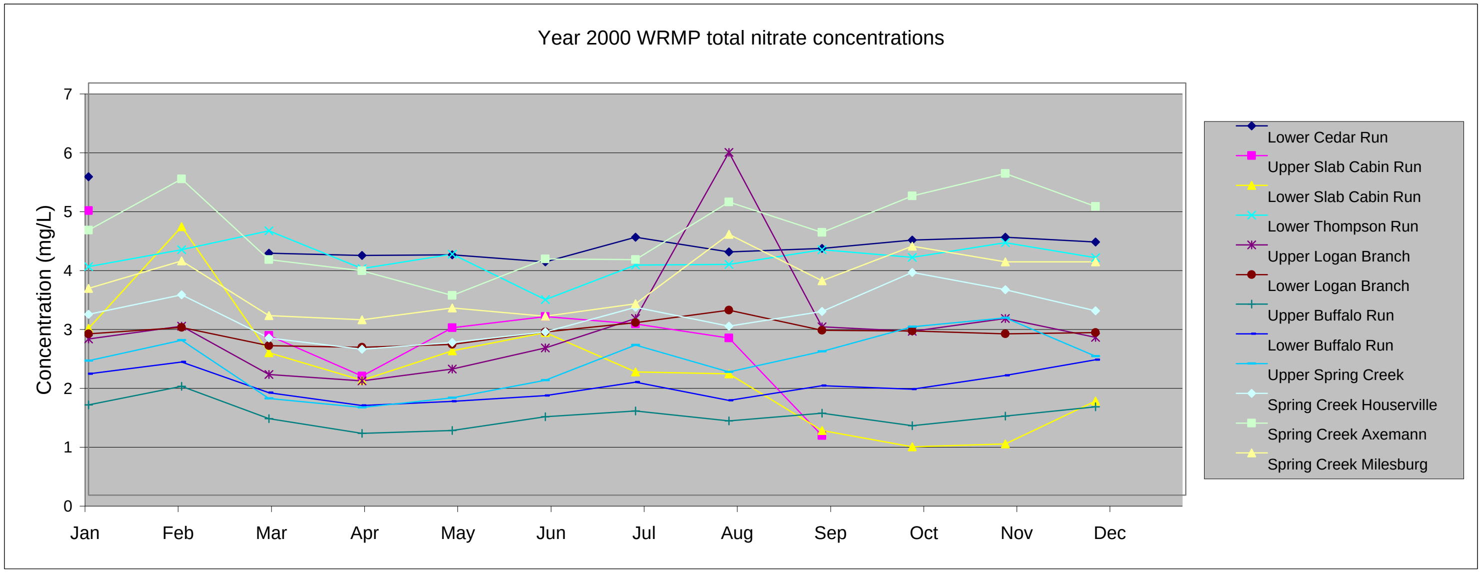


Figure A.11. Year 2000 WRMP total nitrate concentrations* (mg/L).

*Non-detected values shown at one-half detection limit (10 mg/L)

Table A.12. Year 2000 WRMP total phosphate concentrations* (mg/L).

	Lower Cedar Run	Upper Slab Cabin Run	Lower Slab Cabin Run	Lower Thompson Run	Upper Logan Branch	Lower Logan Branch	Upper Buffalo Run	Lower Buffalo Run	Upper Spring Creek	Spring Creek Houserville	Spring Creek Axemann	Spring Creek Milesburg
Jan	0.034	0.027	0.022	0.024	0.052	0.032	0.005	0.022	0.015	0.014	0.04	0.035
Feb			0.21	0.054	0.133	0.018	0.031	0.021	0.055	0.013	0.032	0.033
Mar	0.021	0.025	0.05	0.044	0.087	0.026	0.037	0.023	0.023	0.026	0.038	0.032
Apr	0.019	0.044	0.024	0.023	0.044	0.026	0.037	0.023	0.024	0.024	0.033	0.027
May	0.013	0.026	0.011	0.012	0.027	0.028	0.024	0.019	0.019	0.033	0.021	0.019
Jun	0.017	0.061	0.041	0.033	0.037	0.012	0.013	0.016	0.31	0.024	0.035	0.048
Jul	0.034	0.04	0.06	0.035	0.074	0.017	0.042	0.042	0.043	0.021	0.033	0.032
Aug	0.021	0.052	0.069	0.03	0.068	0.031	0.081	0.047	0.038	0.035	0.048	0.053
Sep	0.012	0.4	0.036	0.041	0.075	0.028	0.026	0.014	0.011	0.018	0.034	0.046
Oct	0.01		0.014	0.02	0.055	0.014	0.024	0.01	0.005	0.017	0.022	0.028
Nov	0.005		0.005	0.018	0.066	0.012	0.005	0.005	0.005	0.011	0.024	0.025
Dec	0.005		0.005	0.022	0.09	0.015	0.005	0.005	0.005	0.005	0.026	0.037
Average	0.017	0.084	0.046	0.030	0.067	0.022	0.028	0.021	0.046	0.020	0.032	0.035
Median	0.017	0.042	0.030	0.027	0.067	0.022	0.025	0.020	0.021	0.020	0.033	0.033

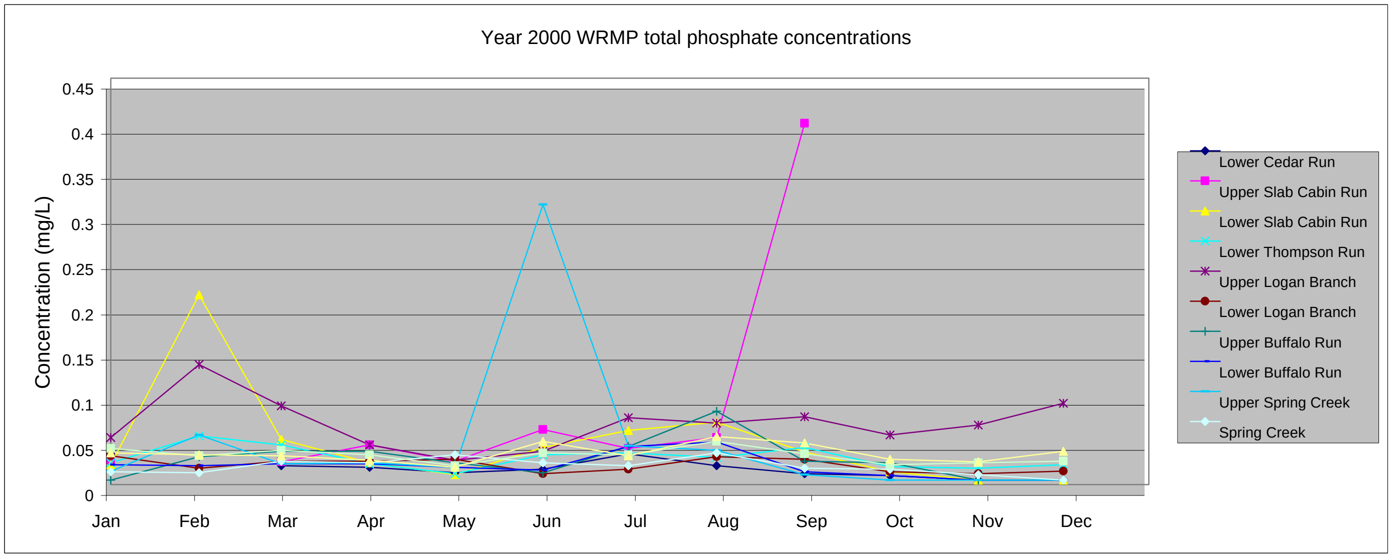


Figure A.12. Year 2000 WRMP total phosphate concentrations* (mg/L).

*Non-detected values shown at one-half detection limit (0.01 mg/L).

Table A.14. Year 2000 WRMP total organic carbon concentrations* (mg/L).

	Lower Cedar Run	Upper Slab Cabin Run	Lower Slab Cabin Run	Lower Thompson Run	Upper Logan Branch	Lower Logan Branch	Upper Buffalo Run	Lower Buffalo Run	Upper Spring Creek	Spring Creek Houserville	Spring Creek Axemann	Spring Creek Milesburg
Jan	0.5	1.5	1.7	0.5	1.7	0.5	1.2	0.5	0.5	1	1.9	1.2
Feb			4.5	0.5	2.4	0.5	0.5	0.5	0.5	0.5	1.9	1.1
Mar	1	1.3	1.5	0.5	1.6	0.5	1.1	1.1	0.5	1.1	1.8	1.3
Apr	1.1	2.4	1.9	0.5	1.8	0.5	1.3	1.2	1.2	1.1	1.7	1.4
May	1.2	1.3	1.5	1.4	1.4	0.5	1.5	1.3	0.5	1.2	1.7	1.4
Jun	1.1	2	1.6	1.3	1.5	0.5	1.6	1.3	1	1.4	1.7	1.5
Jul	0.5	1.9	2.1	0.5	1.9	0.5	1.3	1.2	0.5	1.2	1.9	1.6
Aug	1.2	2.5	2.2	0.5	1.6	0.5	2.5	1.9	1.1	1.2	2.2	1.6
Sep	1	5.3	1.8	2	2.1	0.5	1.7	1.2	0.5	1.2	1.7	1.2
Oct	1		1.7	0.5	2.3	0.5	2.8	1.3	0.5	1	2.1	1.1
Nov	1		2	0.5	2.2	0.5	1.2	1.1	0.5	1	1.9	1.1
Dec	0.5		1.4	0.5	2.9	0.5	1.2	0.5	0.5	0.5	1.8	1.1
Average	0.9	2.3	2.0	0.8	2.0	0.5	1.5	1.1	0.7	1.0	1.9	1.3
Median	1.0	2.0	1.8	0.5	1.9	0.5	1.3	1.2	0.5	1.1	1.9	1.3

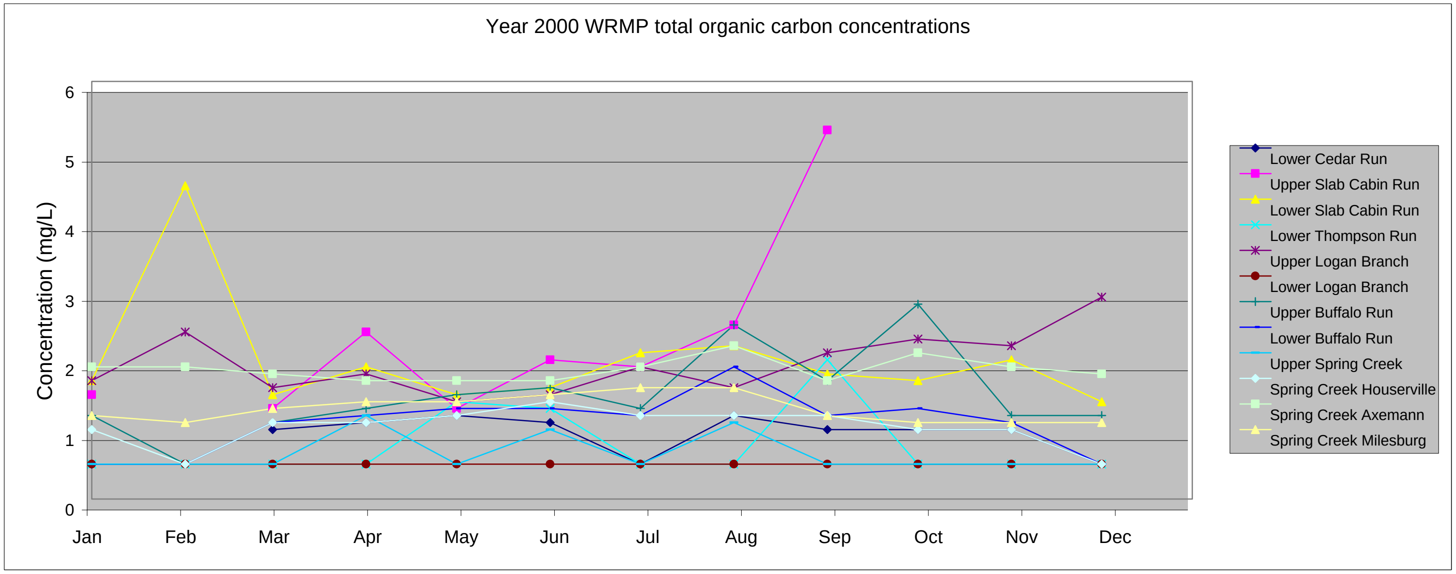


Figure A.14. Year 2000 WRMP total organic carbon concentrations* (mg/L).

*Non-detected values shown at one-half detection limit (1.00 mg/L).

Table A.13. Year 2000 petrolium hydrocarbon concentrations* (ug/L).

	Lower Cedar Run	Upper Slab Cabin Run	Lower Slab Cabin Run	Lower Thompson Run	Upper Logan Branch	Lower Logan Branch	Upper Buffalo Run	Lower Buffalo Run	Upper Spring Creek	Spring Creek Houserville	Spring Creek Axemann	Spring Creek Milesburg
Jan	2.5	5.7	5.9	5.1	2.5	2.5	2.5	2.5		5.6	2.5	2.5
Feb	2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Mar	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Apr	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
May	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Jun	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Jul	2.5	2.5	2.5	2.5	2.5	5.3	2.5	2.5	2.5	2.5	2.5	2.5
Aug	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Sep	2.5	2.5	2.5	2.5	2.5	6.7	2.5	2.5	2.5	2.5	2.5	2.5
Oct	2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Nov	2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Dec	2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Average	2.5	2.9	2.8	2.7	2.5	3.1	2.5	2.5	2.5	2.8	2.5	2.5
Median	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

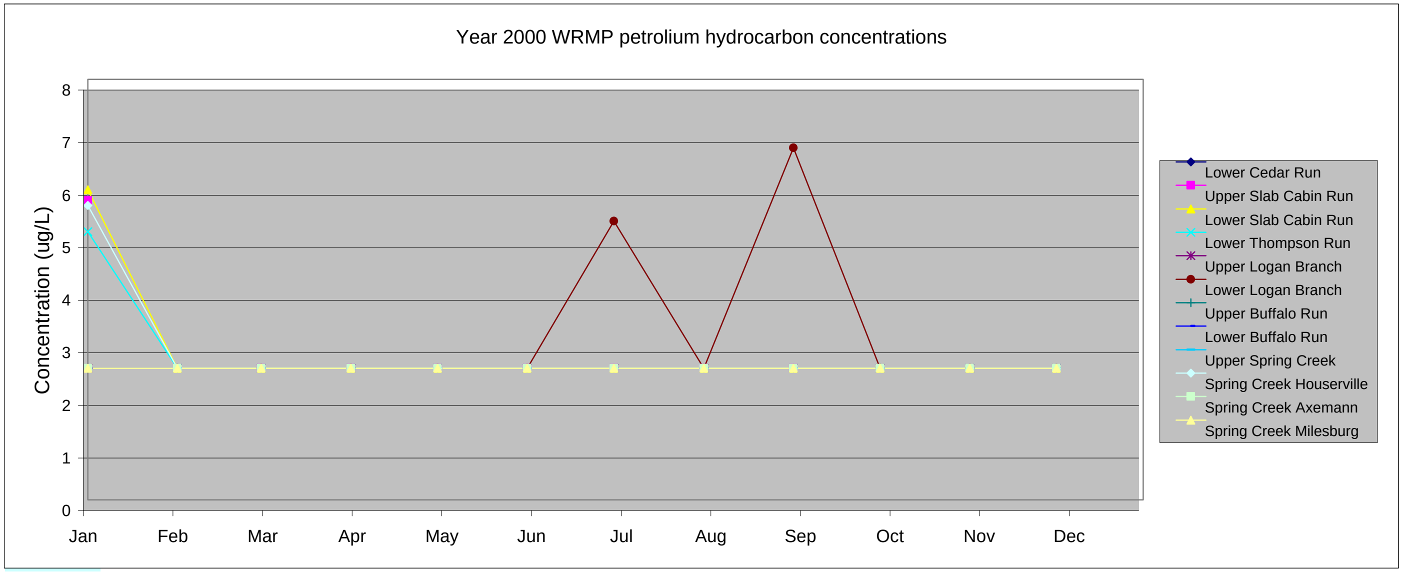


Figure A.13. Year 2000 petrolium hydrocarbon concentrations* (ug/L).

*Non-detected values shown at one-half detection limit (5.00 mg/L).

are utilized to protect the area's valuable water resources. UAJA's Beneficial Reuse Project is one example of a project that requires extensive understanding of the Slab Cabin Run watershed. The Beneficial Reuse Project has obvious benefits to the region and the environment, however any impacts it may have on the Slab Cabin Run watershed will need to be assessed prior to implementation. The Slab Cabin Run watershed protection program will characterize the watershed so that the effects of significant projects, such as the Beneficial Reuse Project, can be assessed for water quality impacts.

BENEFICIAL REUSE
(Contributed by University Area Joint Authority)

During the past decade, the University Area Joint Authority (UAJA), in cooperation with the Centre Region Planning Commission, has been conducting a comprehensive evaluation of future wastewater treatment requirements in light of continued population growth and development. A demonstration project conducted by UAJA during this period determined that wastewater discharge levels above 6.0 million gallons per day (MGD) on an average annual basis may have an adverse thermal impact on the aquatic life of Spring Creek. Fourteen treatment alternatives were considered for future wastewater requirements but were eliminated because they would have required stream discharges in excess of 6.0 MGD. After considering technical merit, economic feasibility, and environmental benefit, Beneficial Reuse was selected as the recommended alternative. In 1998 the Centre Region Council of Governments voted to endorse the Beneficial Reuse Alternative as the preferred alternative for future treated wastewater effluent disposal.

The Beneficial Reuse project consists of the treatment and purification of treated water from the UAJA wastewater treatment plant using microfiltration, reverse osmosis, and some combination of ozonation, ultraviolet light, and chlorination. Once treated, the recycled water will be distribution and used throughout the Centre Region for industrial, agricultural, and commercial reuse. The balance will be reintroduced to the Spring Creek Watershed via constructed wetlands on Slab Cabin Run.

The project incorporates improvements to the existing UAJA treatment plant; the construction of transmission, distribution, and storage systems to convey water to reuse customers and stream augmentation points; and constructed wetlands to act as natural buffers. The project will be implemented in three phases proposed for 2002, 2008, and 2013, respectively.

- Phase I will consist of upgrades to the UAJA facility, construction of a reuse water transmission main to the Dale Summit Industrial Park, and a detailed hydrogeological study of the Slab Cabin Run sub-basin with an eye toward future reintroduction there.
- Phase II will consist of additional upgrades to UAJA, extension of the transmission main to the intersection of Branch Road and Route 45, and the introduction of stream augmentation sites on Slab Cabin Run.
- Phase III upgrades to UAJA will yield a total treatment capacity of 9.0 MGD, with Beneficial Reuse capability for any discharges above 6.0 MGD.

One of the primary benefits of the Beneficial Reuse Alternative is that the water can be used year-round to enhance the natural environment. The Slab Cabin Run sub watershed was identified as a good candidate for environmental enhancement because of the impact of groundwater withdrawals via well fields in this vicinity. The reuse water could offset some of this withdrawal and help maintain the stream flow in Slab Cabin Run, which has essentially dried up in places during recent periods of low precipitation.

The surface water quantity and quality data generated by the Water Resources Monitoring Project at the two monitoring sites in the Slab Cabin Run sub-basin will be very useful in evaluating the impact of Beneficial Reuse on this stream. Since several years' worth of monitoring data will have been collected by the time reintroduction into Slab Cabin Run begins, it will be possible to compare base flow conditions before and after the reintroduction. Total flow of water can be determined for any unit of time using the rating curves developed for the Water Resources Monitoring Project. Using the rating curve in conjunction with monthly water quality data, will allow the quantity of various substances (e.g. nitrates, phosphates, etc.) to be estimated before and after Beneficial Reuse.

WATERSHED PLAN

ClearWater Conservancy, on behalf of the Spring Creek Watershed Community, has submitted a PA DEP Growing Greener Grant application for the creation of a Spring Creek Watershed Plan. This project will provide a process and framework to protect, maintain, and restore the ecological integrity of the watershed system while balancing environmental, social, and economic needs. Decisions regarding land use planning and development have a profound influence on water resources within a watershed. The Plan will use water quality and quantity as indicators or "measuring sticks" and will provide guidance to planners through tools, assessments, and recommendations. Data collected by the Water Resources Monitoring Project has been identified as a critical component of the Watershed Plan.

The Spring Creek Watershed Plan will be divided into three phases. The first phase is the collection and assessment of existing data and information. The material gathered and compiled in Phase I will provide the community with the information necessary to move forward with the full development of the Watershed Plan (Phase II) and its implementation (Phase III).

There is strong stakeholder support for this project in the Spring Creek Watershed and beyond. The Spring Creek Watershed Commission, comprised of an elected official from each of the fourteen municipalities located in the Spring Creek Watershed and the three Centre County Commissioners, endorses this project. The project is also partnering with the United States Geological Survey (USGS). In future phases of the program the USGS will compile the gathered data and form a new generation model that will link land use decisions to water resources. This model will encompass the entire watershed and will be able to simulate watershed scale impacts due to land use changes, open channel flow, surface water/groundwater interactions, water chemistry and sediment transport, and water use models.

8.0 Sources of Additional Information

WEBSITE

All data collected by the Water Resources Monitoring Project is available to the public free of charge and can be accessed at the ClearWater Conservancy office and on the Spring Creek Watershed Community's Web site at www.springcreekwatershed.org.

PUBLICATIONS

Searchable Bibliographic Database (1999) – is a compilation of all studies of Spring Creek and its tributaries. The database has 267 citations that include conference proceedings, dissertations, journal articles, maps, reports, video recordings, and web pages that are searchable by author, journal, title, type of document, and a list of keywords. This document is available electronically at the ClearWater Conservancy office and will soon be available online on the Spring Creek Watershed Community's Web site at www.springcreekwatershed.org. Hard copies are also available for $10, which covers publication costs incurred by the Conservancy. Updates will be made to this document every 5 years.

Water Resources Monitoring Protocol (1999) – this document was designed to provide quality assurance for water monitoring data. It provides standardized methods for sample collection and processing for volunteers, interns and staff who perform monthly sampling procedures. It also includes a checklist of sampling materials and instructions for calibrating equipment and downloading data.

9.0 PLANS FOR THE YEAR 2001

The goals for the year 2001 for the Water Resources Monitoring Project, as established by the Water Resources Monitoring Committee are as follows:

- Continue monthly sampling and laboratory analysis of surface water from all 12 monitoring stations
- Continue collecting flow and temperature data from all 12 monitoring stations
- Incorporate the Water Resources Monitoring Project database into the new Spring Creek Watershed Community's Web site www.springcreekwatershed.org
- Continue with stormwater sampling (Figure 4) and add the stormwater component into the database
- Incorporate the geomorphic classification into the database that will be collected at eight of the 12 monitoring stations
- Partnering with USGS, initiate groundwater level monitoring and add the groundwater component into the database

Figure 4. Stormwater sampler at Spring Creek Milesburg.

Appendix A

Measurement Equivalents	
Volume	1 liter (L) = 1000 milliliters (ml)
	1 milliliter (ml) = 1000 microliters (µl)
Mass	1 gram (g) = 1000 milligrams (mg)
	1 milligram (mg) = 1000 micrograms (µg)

Metric-English Conversions		Examples:
Volume	1 cubic meter (m^3) = 35.3 cubic feet (ft^3)	10 m^3 = 353 ft^3
	1 cubic meter (m^3) = 264.17 gal	10 m^3 = 2641.7 gal
	1 liter (L) = 0.264 gallons (gal)	10 L = 2.64 gal
Mass	1 milligram (mg) = 0.000035 ounces (oz)	10 mg = 0.00035 oz
Temperature	°C = (°F – 32) * 5/9	70°F = 21.1°C
	°F = (°C * 5/9) + 32	12°C = 53.6 °F
Flow (Discharge)	1 cubic meter/second = 35.3 cubic feet/second	10 m^3/sec = 353 ft^3/sec