

# McKENZIE WATERSHED COUNCIL: EXECUTIVE SUMMARY

## STORM EVENT MONITORING PILOT

### Background

The McKenzie Watershed Council's storm event monitoring pilot was designed to test an approach for assessing water quality throughout the McKenzie Watershed during winter storms. An evaluation of the experiences and data gained from the pilot will be used to design an approach for monitoring storm events in subsequent years.

The goal of the monitoring pilot is to test whether it is feasible and practical to design and sustain a storm event monitoring program. The pilot's three objectives are to:

- 1) Provide a coarse characterization of water quality in the McKenzie Basin during high flow periods, including the range and variability in key water quality parameters.**
- 2) Determine the feasibility of establishing baseline storm event data for tracking long-term water quality trends.**
- 3) Detect general areas of the watershed that may be sources of water quality problems during storm events.**

The storm event sampling was designed to capture some of the variability in storms and associated runoff in the McKenzie Watershed through the course of the heavy precipitation season. The storm event monitoring period was designed to sample one event during three seasonal windows: Fall, Winter, and Spring. Sampling was initiated using a combination of precipitation, temperature and discharge triggers.

Three storm events were sampled during the winter and fall of 1998. Four key water quality indicators were sampled: bacteria, turbidity, nutrients, and heavy metals. Samples were collected at a total of fifty-six sample sites at locations along the McKenzie and Mohawk mainstem rivers and at the lower portions of tributaries throughout the watershed. Turbidity was collected at all sites, nutrients and bacteria were collected at the seven ambient monitoring sites (McKenzie River at Coburg Road, Hendrick's Bridge, McKenzie Bridge, and below Clear Lake; and the lower portions of the Mohawk River, Blue River and South Fork of the McKenzie River), and heavy metals were collected at one site in the lower watershed (Coburg Road).

### Monitoring Results

The primary expenditures for the storm event monitoring pilot were associated with staff time from the cooperating organizations, laboratory analysis costs, and geographic information database expenses. Laboratory analysis expenditures were approximately \$1000 per event, for a total of \$3,000. A total of \$3,000 was expended for GIS database development and map products. A total of approximately 380 hours of council and partner organization staff time was used for project planning, coordination, sample analysis, database management, data analysis, evaluation, and report preparation.

The data for all of the key water quality attributes were examined to illustrate the general patterns generated by the different storms across the watershed. Where possible the data were interpreted in the context of the Department of Environmental Quality's water quality standards.

The pilot monitoring data provide an overview of water quality conditions throughout the McKenzie Watershed during three different storms. The monitoring information, in the context of a limited time period, illustrates the general patterns and variability in water quality in the watershed.

Turbidity values varied widely throughout the watershed and between the storms, with the general pattern of low turbidity values in the mainstem of the river and tributaries in the upper watershed; there were somewhat higher turbidity values in tributaries in the lower portions of the watershed and in the Mohawk Watershed. The trend for bacteria and nutrients followed the general

pattern of very low values (or no detection) in the upper portions of the watershed and increasing numbers at the lower McKenzie and Mohawk River sites. The heavy metal concentrations were very low, with all of the heavy metals sampled below the water quality criteria.

## **Evaluation of the Pilot**

The McKenzie Watershed Council's Water Quality Monitoring Subcommittee evaluated the success of the storm event monitoring pilot in the context of the three objectives:

**Objective 1:** The committee agreed that the monitoring results provided a coarse characterization of the spatial variability (over 50 sample sites) for the three events. The three events sampled, however, do not provide a valid representation of the variability in water quality through time, especially when many of the parameters are influenced by extreme flood events that happen once every 10 or more years, such as the 1996 flood.

**Objective 2:** With the extreme variability in water quality associated with flood events, the committee concluded that the monitoring pilot did not establish baseline storm event conditions for the McKenzie Watershed. Establishing background levels and tracking trends would require a large number of data points through time at each site, with controls for a number of variables (e.g., capturing all of the sites on the rising limb of the hydrograph).

**Objective 3:** The coarse characterization of storm conditions for the watershed did identify areas that may have potential water quality issues, although it did not conclusively identify problems or management-related contributions. The monitoring information can be used to inform a more targeted monitoring effort. For example, the elevated bacteria levels in the Mohawk River (at one point) warrant further investigation to begin to pinpoint source areas and management factors (e.g., leaking septic systems). Identifying "problem" areas for the other parameters, however, is more problematic. The natural variability in turbidity values, for example, makes it difficult to determine whether the observed values are within the natural range of variability or elevated from management-related factors that would warrant further investigation. It is very difficult, given the interaction of multiple land uses and management regimes with variable geology and soil types in a watershed, to determine cause-and-effect relationships between land uses and turbidity values.

## **Recommendations**

The Water Quality Monitoring Subcommittee recommends that the Council not apply the same approach used for the pilot to future storm event monitoring. Given the variability in water quality parameters across the landscape and through time, to accurately and precisely monitor storm events at the scale of the McKenzie Watershed would be a prohibitively expensive undertaking. The committee recommends that the:

Council should not continue with the comprehensive storm event monitoring.

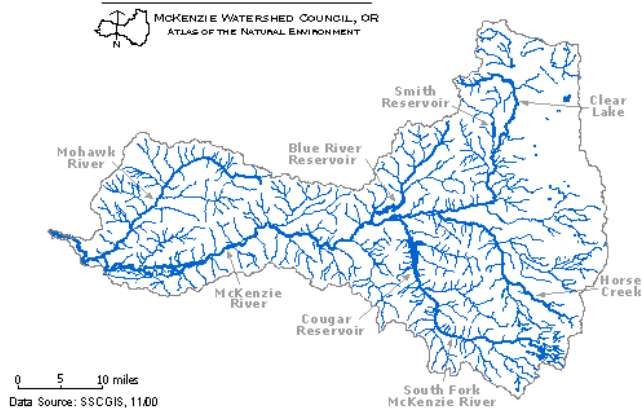
Staff presents the storm event monitoring findings and recommendations to the Council.

Monitoring Subcommittee examine future storm event monitoring strategies through the comprehensive monitoring program review.

# McKenzie Watershed Council

## 1998 Storm Event Monitoring Pilot:

McKenzie Watershed Drainage Pattern



April 1, 2001

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## McKenzie Watershed Council Storm Event Monitoring Team

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## **INTRODUCTION**

This report describes the findings from the McKenzie Watershed Council's storm event monitoring pilot. The pilot was designed to test an approach for assessing water quality throughout the McKenzie Watershed during winter storms. An evaluation of the experiences and data gained from the pilot will be used to design an approach for monitoring storm events in subsequent years.

Three storm events were sampled during the winter and fall of 1998. The goal of the monitoring pilot is to test whether it is feasible and practical to design and sustain a storm event monitoring program.

The pilot's objectives are to:

- Provide a coarse characterization of water quality in the McKenzie Basin during high flow periods, including the range and variability in key water quality parameters.

- Determine the feasibility of establishing baseline storm event data for tracking long-term water quality trends.

- Detect general areas of the watershed that may be sources of water quality problems during storm events.

## McKenzie Watershed Council Monitoring Program Objectives

### WHY MONITOR WATER QUALITY DURING STORMS?

It is important to monitor water quality in the McKenzie River Basin during storms because precipitation and high water flows can mobilize (or increase the concentration of) toxins, sediments and other constituents of water quality that may not be detected during base flow conditions. It is very difficult, however, to accurately measure and interpret water quality parameters during storm events. Watersheds are complex and dynamic. The response of a diverse watershed such as the McKenzie to a high precipitation period is extremely variable. A number of management and natural factors interact to influence water quality during storms and water quality will vary by stream sampled and between storm events. Some of the elements that influence watershed response during a storm include:

- Topography and location in the watershed
- Hydrologic response of the stream sampled
- The climate and weather patterns before the monitoring period
- Weather patterns during the monitoring period
- Geology and soil types; and
- Current and historical land use patterns

With the natural complexity (e.g., intensity of the storm event, associated stream flow response, and geologic patterns) superimposed on management and land-uses patterns, it is very difficult to determine what factors are contributing to changes in water quality during storms. The purpose, therefore, of this first attempt at storm event monitoring in the McKenzie Watershed is to begin to characterize the general variability in water quality across the watershed and through time in response to different storm events. The monitoring was not designed to determine cause and effect relationships between natural / human activities and water quality. That type of project would require rigorous experimental design and intensive measurements throughout the watershed and over a very long period.

### STORM EVENT VARIABILITY

Water quality changes during storms are complex and highly variable. The grab samples collected in the McKenzie Watershed provide a “snap-shot” of conditions during three storms but provide limited information on the range of conditions over longer time periods. For many water quality attributes, unusual events, such as floods, are more important than average conditions. Long-term turbidity data

*Monitor the overall health of the McKenzie River*

*Determine if and how water quality in the McKenzie River is changing over time, accounting for natural and seasonal variation*

*Provide credible data upon which management decisions can be made*

*Provide an affordable and sustainable measurement tool to evaluate the effectiveness of steps taken to protect and enhance water quality in the basin*

*Provide an early warning system to signal if any adverse trends are developing*

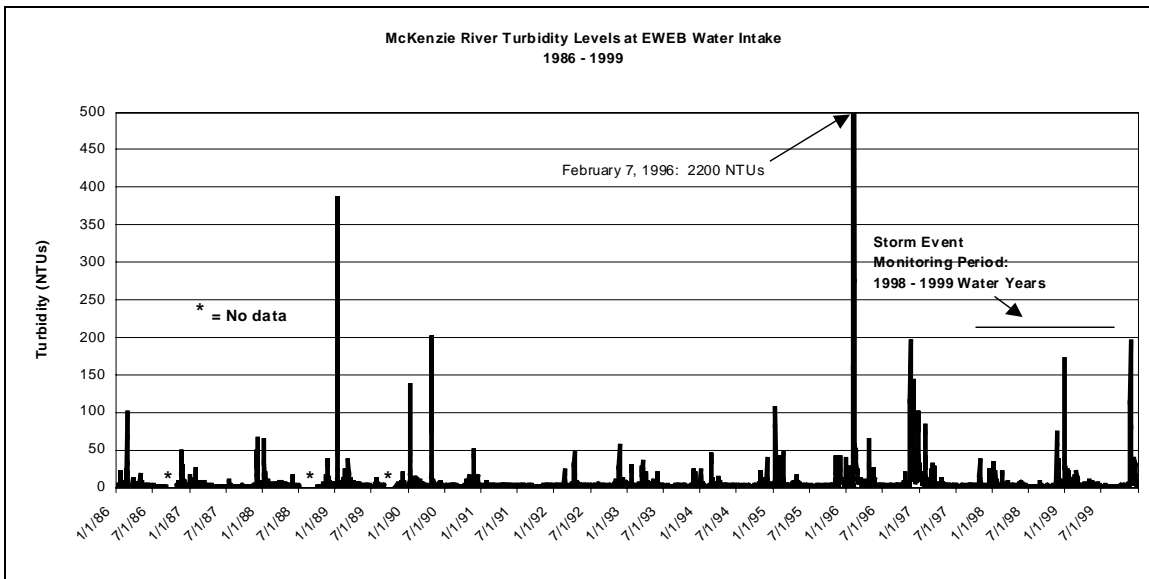
*Use historical data to develop longer trends*

collected at Eugene Water & Electric Board's intake facility at Hayden Bridge provide insights into the variability in water quality values through time. The Hayden Bridge Facility is in the lower watershed upstream from the Mohawk River. In the period beginning in 1986 and ending in 1999, daily maximum turbidity values ranged from less than 1 NTU for most of the periods to a high of 2200 NTUs during the 1996 storm (Figure 1).

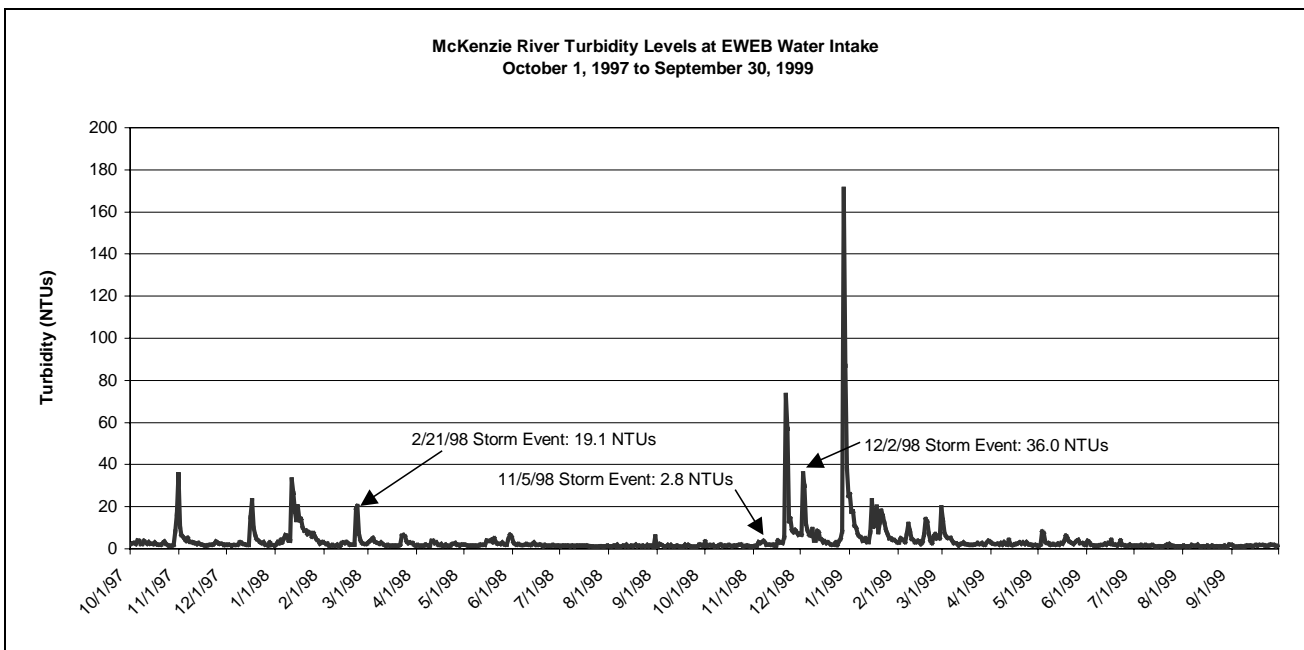
The major flood in February 1996 provides a historical context for interpreting how high precipitation periods affect turbidity values. The 6-8 February 1996 flood in the McKenzie Watershed was triggered by large amounts of warm, subtropical rain falling on a large snow pack. The large quantities of water moving through the watershed set off the movement of soil and sediment through erosion and landslides.

The extreme 1996 flood event illustrates the need for a long-term record to interpret how the watershed responds to storms with different antecedent conditions, precipitation intensities, and duration. Any short term monitoring program has a low probability of measuring rare events such as a flood that may occur only once every 25 years or more. The storm event monitoring period did capture some of the range in the turbidity levels, but did not provide a full picture of the variability through time (Figures 1 and 2). The high degree of variability of turbidity values among sites and across land uses in the McKenzie Watershed and through time makes it very difficult to determine background or natural turbidity levels for a range of storm events.

Difficulties in measuring annual sediment yields illustrates the challenge in determining background levels for water quality characteristics. Turbidity and sediment yields, though not always directly proportional since turbidity values can be influenced by other factors that affect the amount of light that is scattered or absorbed by the water sample, are often related. Sediment yields, like turbidity, are highly variable across watersheds and through time. Accelerated erosion that naturally occurs during infrequent large storms, combined with sediment from human activities, makes it very difficult to gauge natural variability in sediment yields (United States General Accounting Office 1998). A recent study by the National Council for Air and Stream Improvement found considerable variability in annual sediment yield between adjacent undisturbed basins. This study concluded that, given the complexity of watershed processes, almost a decade of measurements is needed to determine the annual sediment yield to within 100 percent of the true value for one small watershed (NCASI 1999).



**Figure 1.** Maximum daily McKenzie River turbidity levels at Eugene Water & Electric Board’s Hayden Bridge Water Treatment Facility, 1986 through 1999. The line on the right side of the graph indicates the 1998 – 1999 water year storm event monitoring period detailed in Figure 2.



**Figure 2.** Maximum daily McKenzie River turbidity levels at Eugene Water & Electric Board’s Hayden Bridge Water Treatment Facility, October 1, 1997 to September 30, 1998. The arrows indicate maximum daily turbidity values for each of the monitored storm events: February 21<sup>st</sup> storm (mid-winter hydrologic period); November 5<sup>th</sup> storm (first flush hydrologic period); and December 2<sup>nd</sup> storm (mid-winter hydrologic period).

**PLANNING FOR STORM EVENT MONITORING**

**Water Quality Characteristics Sampled**

The storm event water quality parameters to sample were selected by the McKenzie Watershed Council=s Water Quality Monitoring Committee in consultation with Department of Environmental

Quality staff. Since it is not desirable or cost-effective to sample for all of the parameters targeted in the Tier I monitoring, the committee selected parameters that could be present during high flow events and have possible impacts to beneficial uses (drinking water supplies and the aquatic ecosystem). The final selection of monitoring and analysis protocols was based on an evaluation of logistical considerations, and cost-effective sampling and laboratory methods. Four key water quality indicators were selected for storm event sampling:

- Bacteria
- Turbidity
- Nutrients
- Heavy metals

### ***Bacteria***

*Escherichia coli* (*E. coli*) bacteria are present in the gut and feces of warm-blooded animals. High flow events can flush these bacteria off the land and into the aquatic system. The presence of these and other bacteria in water have been associated with human health risks and the concentration is used as the primary criterion for measuring the sanitary condition of domestic water supplies.

### ***Turbidity***

Turbidity refers to the amount of light that is scattered or absorbed by a fluid, and is measured in a standardized unit -- the nephelometric turbidity unit (NTU). Turbidity is usually due to the presence of suspended particles of silt and clay, and organic matter. High flow events will increase the natural levels of turbidity in the system; management related turbidity increases can be due to activities that increase sediment loads such as urban development, roads, and agricultural and forest management activity. High turbidity levels can adversely affect drinking water treatment processes and impact the aquatic ecosystem.

### ***Nutrients***

*Phosphorus*: Increases in phosphorus levels can be due to increased rates of erosion and organic material inputs.

*Nitrogen*: Nitrogen in aquatic systems can be partitioned into dissolved and particulate nitrogen. Monitoring usually focuses on dissolved nitrogen since it is more likely to affect the aquatic system. Increases in nitrogen levels can be due to fire and land management activities that input organic matter and fertilizer applications. An increase in phosphorus and nitrogen levels in the water will stimulate aquatic primary production.

## ***McKenzie Watershed Council*** **Monitoring Program**

The McKenzie Watershed Council's monitoring program incorporates a tiered approach that provides a comprehensive and targeted strategy for evaluating the status of water quality through time.

### **Tier I**

This is the ambient component of the water quality monitoring program. This tier involves watershed-wide monitoring at fixed intervals at four sites arrayed up the McKenzie River and at the lower portions of three key tributaries -- Mohawk River, Blue River, and the South Fork of the McKenzie. These seven sites are used to assess the overall condition of the river system, determining long-term water quality trends, and detecting sub-basins that may be sources of water quality problems. (See Appendix 1 for a description of the Ambient Monitoring Program.)

### **Tier II**

The focus of this tier is on monitoring during high flow storm events. Assessing water quality during high flows is important since storms can flush large volumes of pollutants into streams that may impact beneficial uses such as domestic water supplies or aquatic biota such as native salmonids

### **Tier III**

This tier of monitoring program is used to pinpoint or quantify any adverse trends that are uncovered through the Tier I ambient monitoring. An example of a Tier III monitoring effort is the ongoing bacteria assessment in the Cedar Creel sub-watershed, where an extensive monitoring network is being used to assess and understand elevated bacteria levels in the watershed.

process to monitor these chemicals.

### ***Heavy Metals***

A number of heavy metals have been observed in Pacific Northwest streams, including lead, copper, zinc, mercury, manganese, iron and chromium. Urban runoff from impervious surfaces such as roadways, mining, and industrial activities are the primary non-natural contributors of heavy metals to the environment. Heavy metals can have persistent and indirect effects on the aquatic ecosystem, often accumulating in fish tissues and other organisms.

### ***Herbicides and Pesticides***

In addition to these water quality constituents, the Council's technical team considered monitoring herbicides and pesticides, a class of chemicals used to control undesired plant or animal species. High runoff events can deliver these chemicals to the aquatic environment, although delivery is usually episodic since the storm must occur shortly after application. Most exposure concerns focus on contamination of domestic water supplies. The team determined that more information on pesticide and herbicide application rates and timing was necessary before embarking on an expensive

## Sampling design

A total of fifty-six sample sites were selected at locations along the McKenzie and Mohawk mainstem rivers and at the lower portions of tributaries throughout the watershed (See Map). Mainstem river sites were selected to provide a profile of the river from the upper watershed to the lower portions of the river; tributary streams were selected to represent a range of stream sizes and subbasin parameters (i.e., geology, soil type, land use).

The storm event sampling was designed to capture some of the variability in storms and associated runoff in the McKenzie Watershed through the course of the heavy precipitation season. The storm event monitoring period is designed to sample one event during three seasonal windows (Table 1). Sampling is initiated during these three windows using a combination of precipitation, temperature and discharge Atriggers@. Because dry soil conditions in the fall limit the influence of precipitation on stream discharge, the first-flush event was determined by the intensity and duration of the early season rainstorm. Due to the wet soil conditions later in the water year, a combination of precipitation and discharge measurements for selected river discharge gauging stations were used during the winter and early spring events.

**Table 1.** McKenzie storm event monitoring sampling periods.

Hydrologic Period	Dates
First flush	October 13 through October 31
Mid-winter	December 1 through February 28
Late-winter/early spring	March through May

Information on precipitation, temperature and stream discharge levels (with the exception of the first flush event) at different locations was used to initiate storm event sampling based on criteria developed by the monitoring committee (Table 2). The storm event sampling criteria were a first approximation, and were based on the professional judgment of the monitoring committee.

The Blue River near Tidbits and the Mohawk River gauging stations were selected to serve as the indicator streams because these rivers are not influenced by dam regulation, they represent different locations and elevations within the watershed, and there is real-time flow data on the Internet. Information on precipitation and temperature patterns for the upper watershed were obtained from the H.J. Andrews Experimental Forest web site.

Grab samples collected in the river and tributary streams provide a “snapshot” of high flow water quality conditions in the watershed. Turbidity and conductance were sampled at all sites in the watershed; bacteria, nutrients were sampled at the seven fixed station sites, while heavy metals were sampled at the Coburg Road site at the lower end of the McKenzie River.

Sampling responsibilities were allocated among staff from Council organizations (Table 3). Each sampling team consisted of at least two people, and alternates. Appendix 2 describes the sampling design.

**GENERAL CLIMATE AND PEAK FLOW PATTERNS FOR THE MOHAWK RIVER AND BLUE RIVER**

The characteristics and variability in discharge and precipitation patterns across the McKenzie Watershed provide a context for interpreting the information from the sampled storm events. The two unregulated tributaries to the McKenzie River, the Mohawk River near Springfield and Blue River near Tidbits, do not always respond similarly during peak flow events (Figure 3).

Beginning in 1964, when flow was measured at both rivers, there have been 13 years when the annual peaks occurred on the same day, 8 years that were 1 day apart and 13 years when they were more than 2 days apart. This indicates that the two discharge gauges do not always respond similarly to storm events.

**Table 3.** Monitoring team responsibilities.

<b>Team</b>	<b>Lead/Crew</b>	<b>Sampling location</b>	<b>No. of sites</b>	<b>Water quality parameters tested</b>	<b>Sample delivery location</b>
1	James Ollerenshaw/ City of Eugene	Coburg Road Fixed Station Site	1	Heavy Metals: Arsenic, Barium, Cadmium, Chromium, Copper, Iron, Lead, Manganese, Mercury, Selenium, Silver, and Zinc.	Battelle Lab
2	Jim Shumway/Oregon Dept. of Forestry	Seven Fixed Station Sites	7	Bacteria, Phosphorous, and Nitrogen  Turbidity and Conductivity	Delta Environmental  Dept. of Forestry in Springfield
3	Jim Stark/Weyerhaeuser	Lower/Mid Basin Sites	24	Turbidity and Conductivity	Dept. of Forestry in Springfield

**Table 2.** Storm event sampling criteria.

**First Flush: October 13 through October 31**

**Precipitation:**

H.J. Andrews: 1.5 inches (38.1 mm) or greater in 24 hours (or projected at time of sampling); OR 1.0 inch (25.4 mm) in 24 hours (or projected at time of sampling) IF a total of at least 1.0 inch accumulated over the previous 7 day period; and

**Temperature:**

H.J. Andrews: Greater than 35 deg. F over previous 24 hours and projected at the time of sampling

**Mid-Winter: December 1 through February 28**

**Precipitation:**

H.J. Andrews: 1.0 inch or greater in 24 hours (or projected at time of sampling); and

**Temperature:**

H.J. Andrews: Greater than 35 deg. F over previous 24 hours and projected at the time of sampling; and

**Blue River Discharge:**

Greater than 1,200 CFS (or projected at time of sampling)

**Mohawk River Discharge:**

Greater than 2,100 CFS (or projected at time of sampling)

**Late Winter / Early Spring: March 1 through May 31**

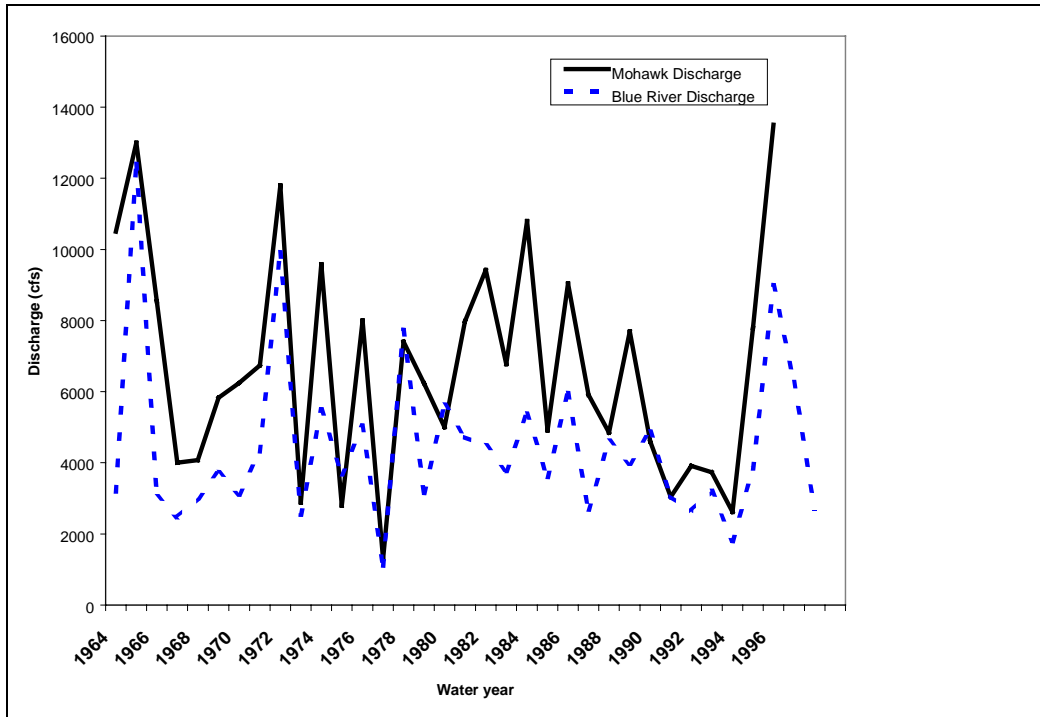
**Precipitation:**

H.J. Andrews: 1.0 inch or greater in 24 hours (or projected at time of sampling); and

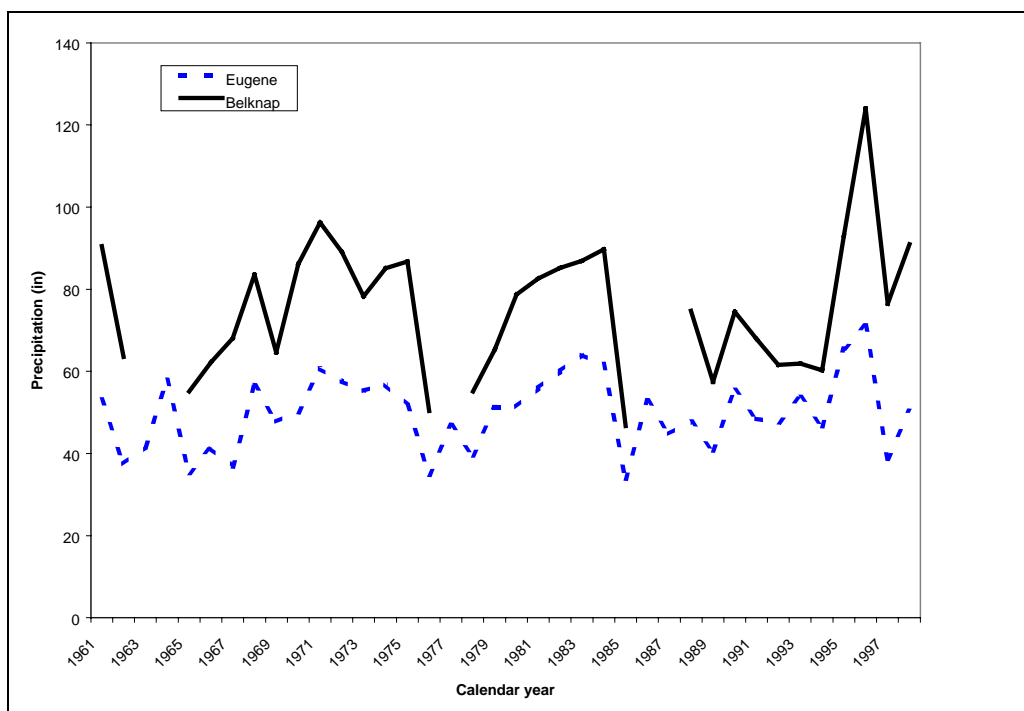
**Temperature:**

H.J. Andrews: Greater than 35 deg. F over previous 24 hours and projected at the time of sampling; and

	Co.				
4	Dave Kretzing/ U.S. Forest Service	Upper Basin	12	Turbidity and Conductivity	Dept. of Forestry in Springfield
5	Mary D'Aversa & Kris Ward/ Bureau of Land Management	Mohawk / Camp Creek Watershed	13	Turbidity and Conductivity	Dept. of Forestry in Springfield



**Figure 3.** Annual peak flows for Blue River at Tidbits (USGS gaging station 14161100) and Mohawk River near Springfield (14165000).



**Figure 4.** Annual precipitation (in) for the Belknap and Eugene climate stations.

The relative magnitude of the peak flows have been similar through time, with the exception of the early 1980s when Blue River peak flows were lower than those of the Mohawk.

Precipitation patterns have also varied through time for stations lower in the valley as compared to higher elevation sites (Figure 4). During the drought years of the mid-1980s to mid-1990s, annual precipitation amounts were closer than in previous and subsequent periods.

### THE THREE STORMS

Three storm events were monitored during the 1998 (October 1, 1997 to September 30, 1998) and 1999 (October 1, 1998 to September 30, 1999) water years:

1998 water year: February 1, 1998

1999 water year: November 5, 1998, and December 2, 1998

Although outside the October 31<sup>st</sup> date, the November storm met the criteria for the first event of the water year; the February and December storms met the criteria for the mid-winter hydrologic period. We did not sample during the late-winter/early spring hydrologic period.

Table 4 compares the sampled storms for water years 1998 to 1999. In both the November and December sampled storm events, Blue River near Tidbits peaked before the Mohawk River. This is consistent with the annual series where 52% of the Blue River peaks occurred a day or more before Mohawk River peaks. While the Mohawk River (drainage area=177 mi<sup>2</sup>) had the highest absolute discharge, Blue River (drainage area = 45.8 mi<sup>2</sup>) had much higher per unit discharge. The highest peak flow for a sampled event occurred on December 2, 1998. The

following sections provide an overview of the precipitation conditions and associated stream flows for the three storm events. Appendix 3 provides detailed information on the antecedent conditions preceding the storms and data on the patterns of precipitation during the storms.

**Table 4.** Maximum storm discharge and time of peak for the sampled storm events.

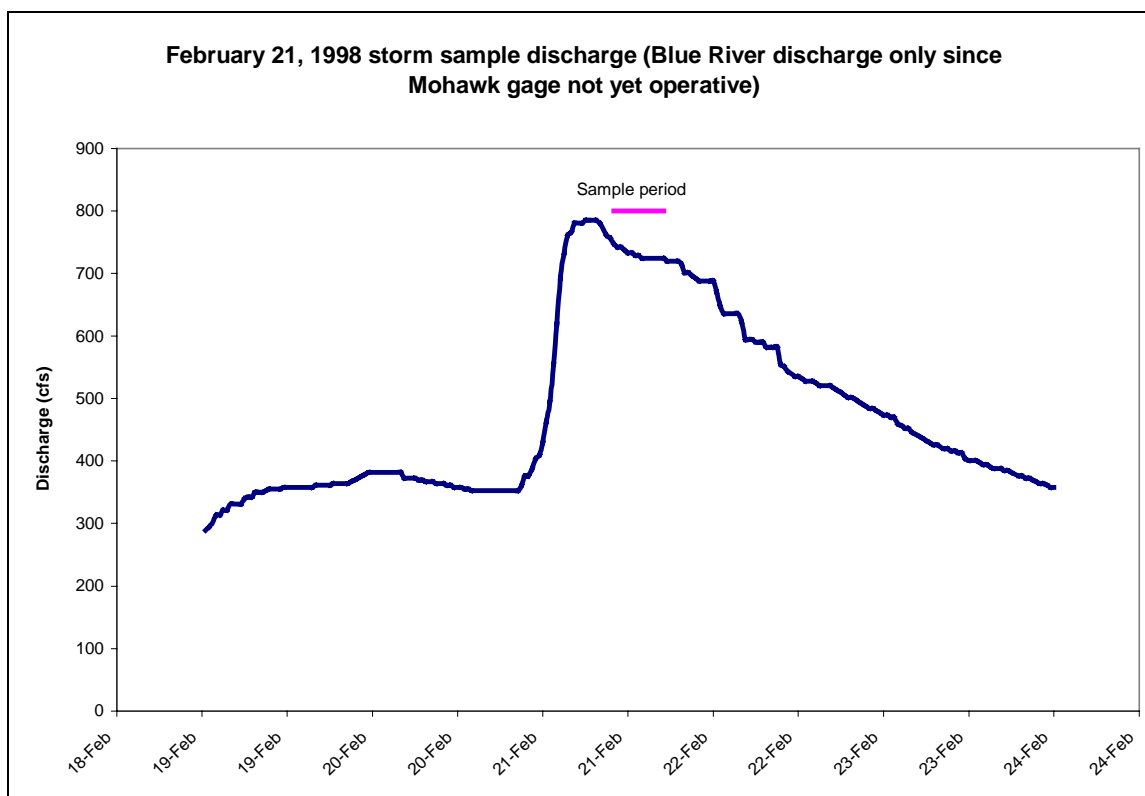
1998 Sample date	Maximum storm discharge (cfs)		Time	
	Mohawk	Blue River	Mohawk	Blue River
February 21	NA <sup>1</sup>	785	NA <sup>1</sup>	2/21 6 a.m.
November 5	280	202	11/6 5 p.m.	11/5 2 p.m.
December 2	5,407	3,553	12/2 9 p.m.	12/2 9 a.m.

1. The Mohawk gauge was not operating during the February 21<sup>st</sup> event.

**Water Year 1998: February 2, 1998 Monitoring (Mid-Winter Sampling Period)**

The storm event that was sampled on February 21<sup>st</sup> began on February 19<sup>th</sup> with minor increases in streamflow. On February 20, 1998 a strong slow moving frontal system brought strong winds, heavy rain and snow, and small stream flooding to Southwest Oregon. This storm had low elevation snow levels and dumped heavy snow on the Cascades.

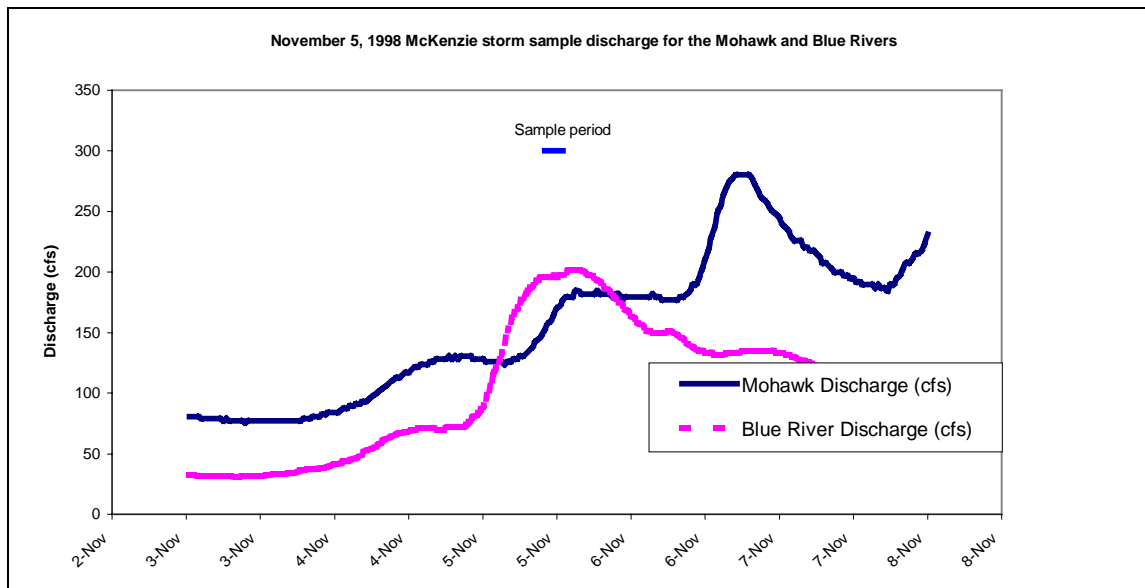
Blue River streamflow (the Mohawk gauge was not operating at this time) began to increase rapidly late on February 20<sup>th</sup> and continued a rapid rise through the night, by 6 am on February 21<sup>st</sup> the discharge was 785 cfs (Figure 5). Shortly after that time flows began to recede and were approaching normal daily flows by February 22<sup>nd</sup>. Storm sampling occurred just following the peak (Figure 5).



**Figure 5.** February 21, 1998 storm sampling discharge (cfs) for Blue River near Tidbits. (Note: There were no data available for the Mohawk gauge on this date.)

**1999 Water Year: November 5, 1998 Monitoring (First Flush Sampling Period)**

The storm event that was sampled on November 5th began on the 4<sup>th</sup> with increasing precipitation and increases in streamflow. The higher precipitation levels met the criteria for the first flush of the 1999 water year. During the sampling period, Blue River discharge peaked while the Mohawk River did not experience maximum storm flow until almost 2 days later (Figure 6). Due to the preceding dry conditions, discharge levels for this event were lower than those for other monitored events.



**Figure 6.** November 5<sup>th</sup> 1998 storm sampling discharge for Mohawk and Blue Rivers. Note the lower discharge levels relative to the other monitored storm events, corresponding to the antecedent conditions associated with first storm of the water year.

### 1999 Water Year: December 2, 1998 Monitoring (Mid-Winter Sampling Period)

The early December 1998 storm began on December 1<sup>st</sup> and lasted through December 2<sup>nd</sup>. Temperatures were near freezing for most of the storm event. The highest streamflows for Blue River occurred on December 2<sup>nd</sup> when maximum discharge reached 3,553 cfs (Figure 7), which was the largest of the 1998 and 1999 Water Years. As in the November storm, Blue River experienced maximum storm discharge before the Mohawk River. During this event, Blue River peaked approximately 12 hours before the Mohawk River.

## MONITORING METHODS

### Sampling

The water samples (with the exception of the heavy metal and nutrient samples) were delivered to the Oregon Department of Forestry office in Springfield. All of the samples were immediately analyzed for turbidity. The bacteria and nutrient samples were delivered to Delta Environmental Services in Eugene for analysis; the heavy metal samples were sent to Battelle Laboratories in Washington for testing.



**Figure 7.** December 2<sup>nd</sup> 1998 storm flow hydrograph for Blue River near Tidbits and the Mohawk River near Springfield. Note that the discharge levels were the highest of all the monitored storm events.

### Quality Assurance

Quality control samples were collected and analyzed to estimate variability in sampling and laboratory techniques for most of the constituents: turbidity, conductivity, nutrients, and bacteria. For cost reasons, replicate samples for heavy metals were not collected or analyzed. The quality control samples were used to evaluate the potential for problems for both field and laboratory samples. Quality control samples for all constituents included (1) equipment blanks to test for contamination and (2) replicate stream water grab samples to test for precision.

Contamination of the samples does not appear to be a problem for the current approach. No (or very small concentrations of) constituents were detected in the blank samples tested. Replicate stream water grab sample analytical results indicated generally good agreement for the measured constituents, with a range of 5-15%.

## MONITORING RESULTS

### Field logistics and budget

The sampling and analysis process was successful: No major problems were reported with field site access, sampling methods, or laboratory analysis. At the team debriefs following the storm events, there was general consensus that the methods worked well (despite logistical challenges such as Saturday mobilization and snow in the upper portion of the watershed during the February 21<sup>st</sup> event) and that the process can be replicated, with some challenges, in future storm events. The difficulties with scheduling staff focused on changing schedules and commitments, especially during the spring periods when field personnel are assigned to other tasks that would be interrupted by unpredictable storm events.

The primary expenditures for the storm event monitoring were associated with staff time from the cooperating organizations, laboratory analysis costs, and geographic information database

expenses. Laboratory analysis expenditures were approximately \$1000 per event, for a total of \$3,000. A total of \$3,000 was expended for GIS database development and map products. Initial project planning, including site selection and coordination, required 180 staff hours. For each storm event, 40 staff hours were required for the planning, coordination, initial sample analysis and delivery to laboratories (for a total of 120 hours). Additional staff time, approximately 80 hours, was required for database management, analysis, evaluation, and report preparation, for a total of 380 hours for the monitoring pilot.

### **Water quality**

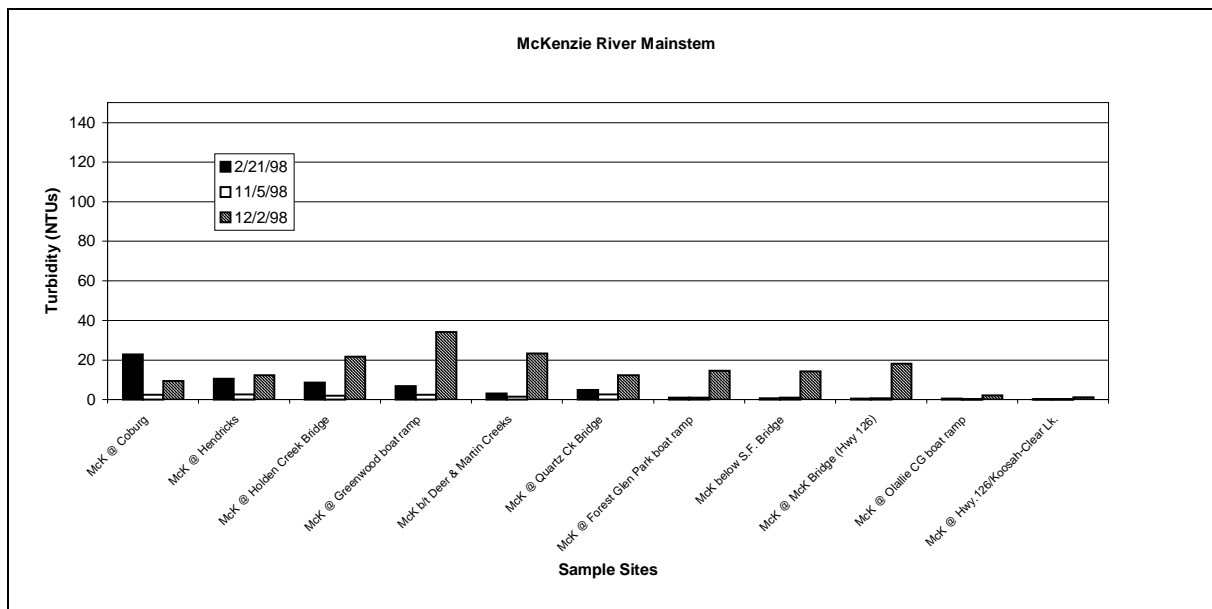
The pilot monitoring data provide an overview of water quality conditions throughout the McKenzie Watershed during three different storms. The monitoring information, in the context of a limited time period, illustrates the general patterns and variability in water quality in the watershed.

The data for all of the key water quality attributes – turbidity, bacteria, nutrients and heavy metals – are examined to illustrate the general patterns generated by the different storms across the watershed. Where possible the data were interpreted in the context of the Department of Environmental Quality’s water quality standards. Water quality standards are listed in Oregon Administrative Rules, Chapter 340, Division 41, Section 44(OAR 340-41-445).

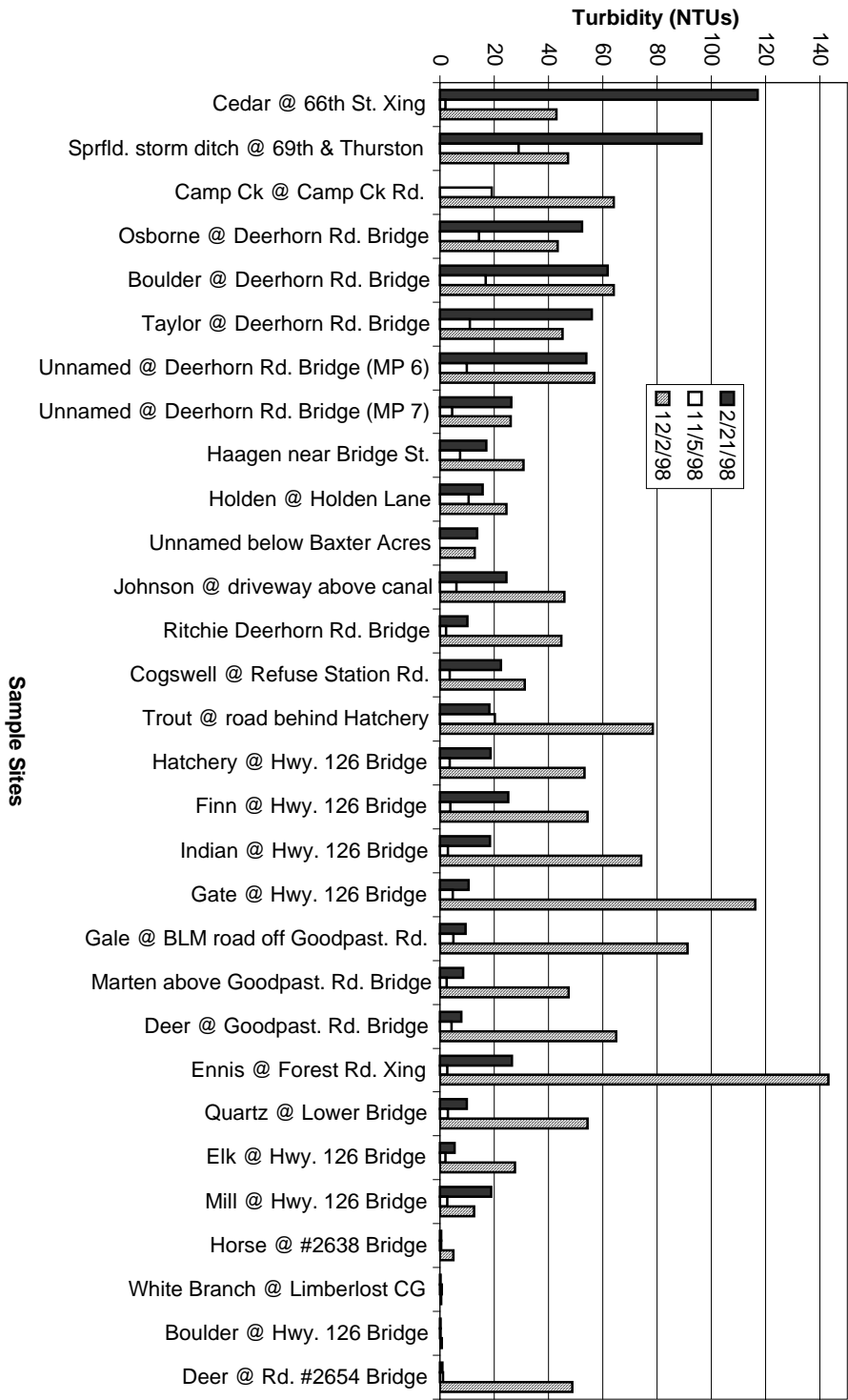
### **Turbidity**

Turbidity was measured at all river and tributary monitoring sites, for a total of fifty-six samples. The Department of Environmental Quality has not established a general water quality standard for turbidity. The standard is activity based and states that “no more than ten percent cumulative increase in natural stream turbidities shall be allowed, as measured relative to a control point immediately upstream of the turbidity causing activity” (OAR 340-41-445).

Data from the McKenzie and Mohawk watersheds, segregated by river main-stem and tributary sites, are reported separately. The storm event turbidity measurements for the Mohawk and McKenzie River watersheds varied across the sample sites and between storms (Figures 8 - 11). For all of the storm events, the turbidity levels for the McKenzie River main-stem sites (Figure 8) were consistently lower (Range: 0.30 to 34.2 NTUs) than the values for the Mohawk River main-stem sites (Figure 10; range: 5.0 to 97.6 NTUs), with the highest values for both rivers recorded in the December 2<sup>nd</sup> event. The lowest turbidity levels, across all main-stem and tributary sites, were measured during the November 5<sup>th</sup> storm event. The highest turbidity values were measured at the McKenzie River tributary sites, with the largest value recorded in the December 2<sup>nd</sup> event at Ennis Creek (143 NTUs), a stream draining the middle portion of the McKenzie River (Figure 9). In contrast, the highest turbidity value recorded for the February 21<sup>st</sup> event was measured at Cedar Creek (117 NTUs), a stream in the lower portion of the McKenzie River draining parts of Springfield and rural areas (Figure 9). Similarly, the highest value recorded for the November 5<sup>th</sup> event was measured in Springfield at a storm ditch (28.9 NTUs) draining into Cedar Creek (Figure 9). Turbidity values for the Mohawk River tributaries (Figure 11) also varied between storms and sites, with the highest values recorded at Log Creek during the December 2<sup>nd</sup> event (129 NTUs) and again in the November 5<sup>th</sup> event (9.2 NTUs). In contrast, the highest value for the February 2<sup>nd</sup> event was recorded at Cartwright Creek (60.5 NTUs).

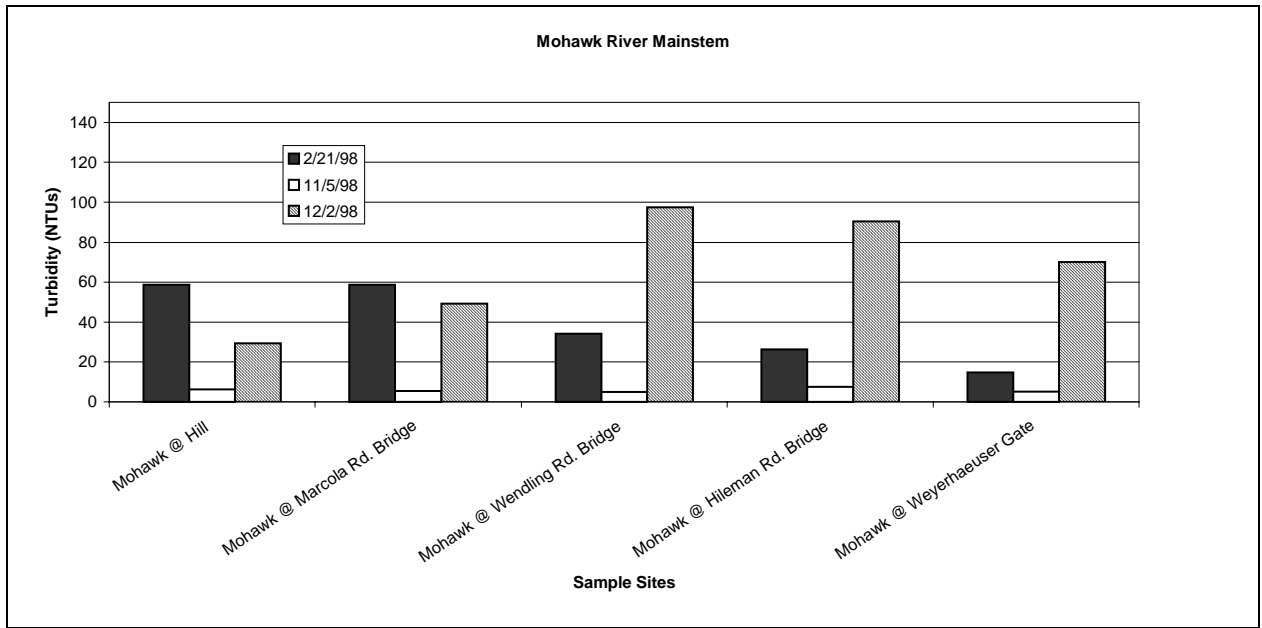


**Figure 8.** Turbidity values for McKenzie River sites for the three storm events.

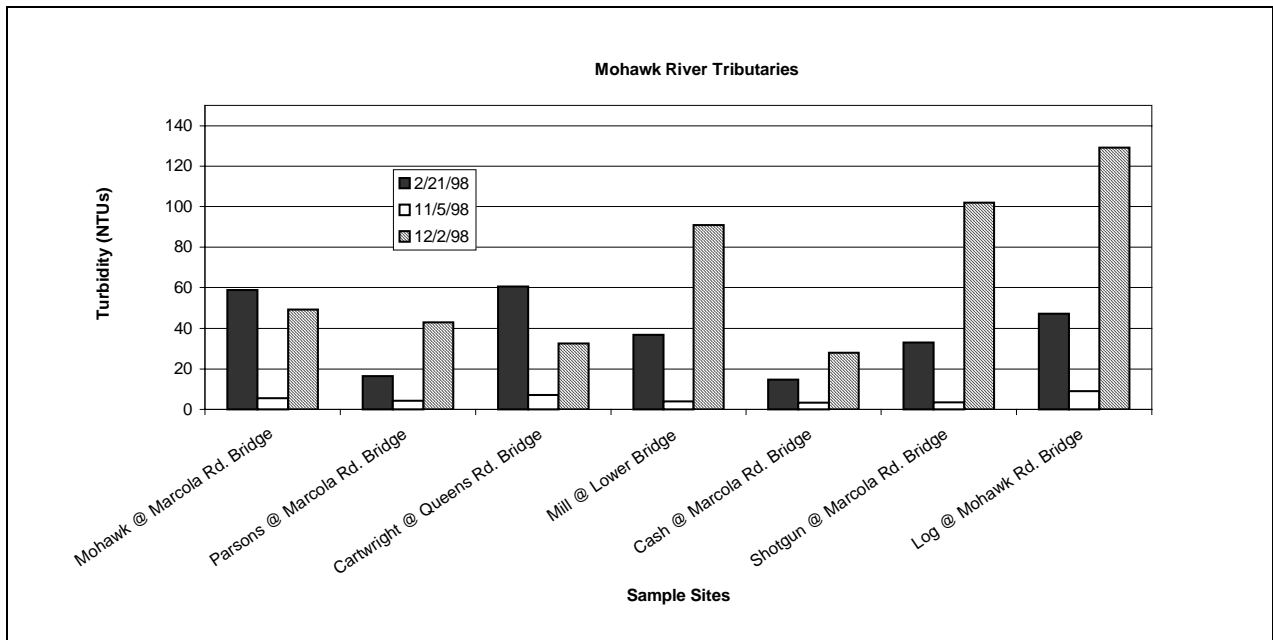


**McKenzie River Tributaries**

**Figure 9.** Turbidity values for the McKenzie River tributary sites for the three storm events. (Note: the Camp Creek site was not sampled during the February 21<sup>st</sup> event.)



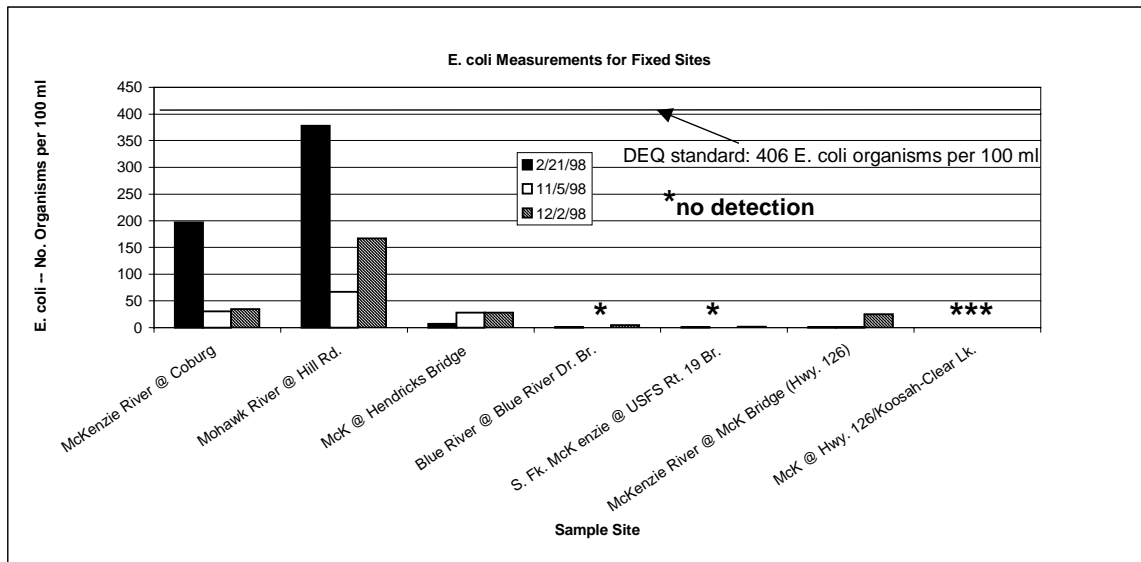
**Figure 10.** Turbidity values for the Mohawk River sites for the three storm events.



**Figure 11.** Turbidity values for the Mohawk River tributary sites for the three storm events.

## Bacteria

Bacteria samples were collected at the seven fixed station sites. The Department of Environmental Quality standard for bacteria is: “A 30-day log mean of 126 E. coli organisms per 100 ml, based on a minimum of five samples; no single sample shall exceed 406 E. coli organisms per 100 ml” (OAR 340-41-445). The trend for E. coli followed the general pattern of very low numbers (or no detection) in the upper portions of the watershed and increasing numbers at the lower McKenzie and Mohawk River sites (Figure 12).



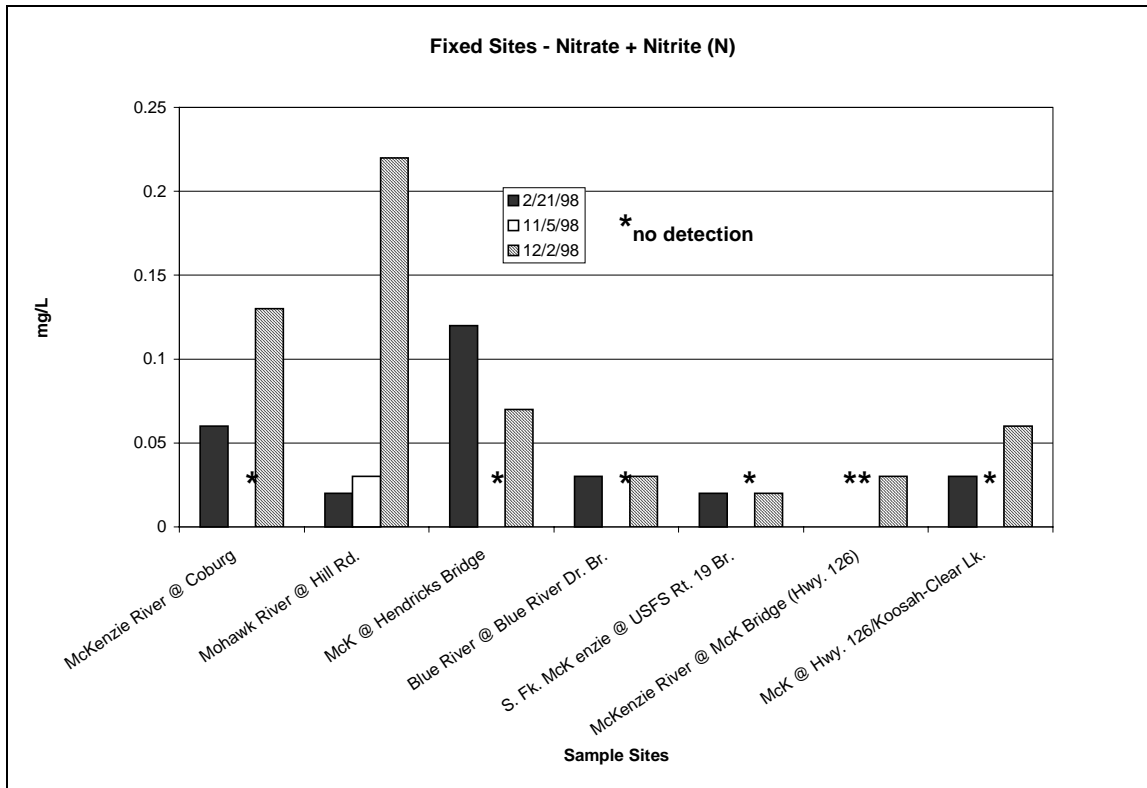
**Figure 12.** E. coli levels at the seven fixed station sites for the three storm events.

## Nutrients

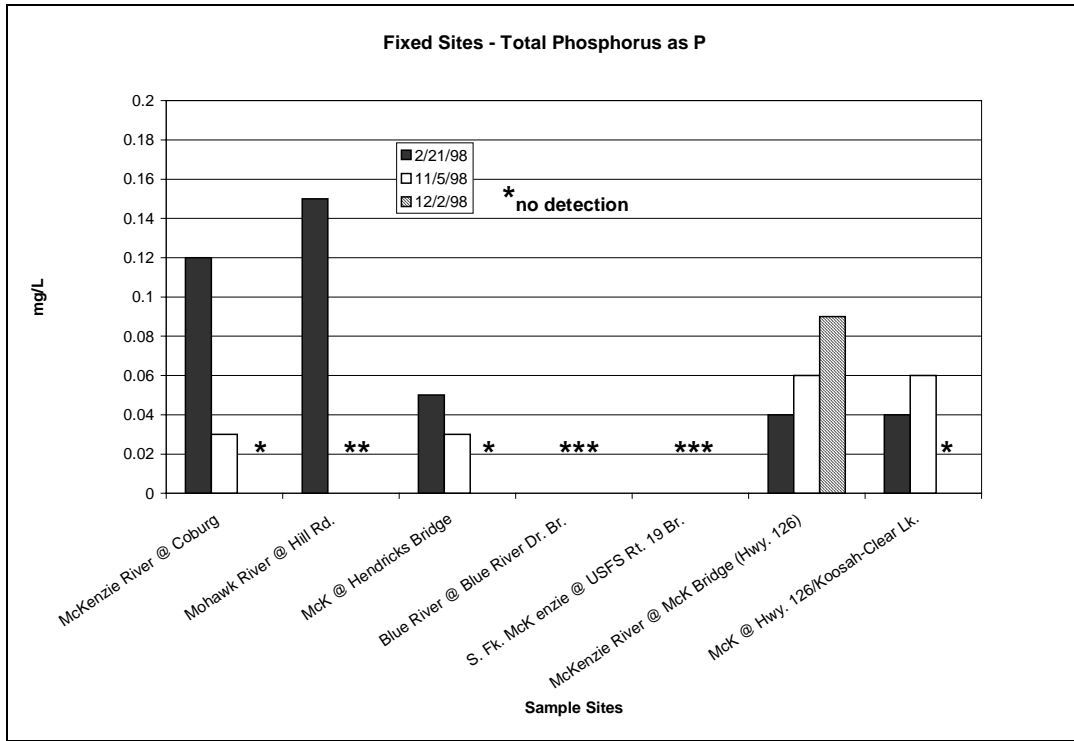
Nutrient samples were collected at the seven fixed station sites. The samples were analyzed for nitrogen and phosphorous concentrations. The Department of Environmental Quality does not have a general surface water quality standard for nutrients. (The U.S. Environmental Protection Agency nitrate standard for drinking water is 10mg/l.) Where necessary, standards are established through the total maximum daily load (TMDL) allocation process for individual waters (rivers and lakes) and are based on the characteristics of the water body, beneficial uses, and expected background nutrient levels due to geology and other factors. No nutrient standards have been established for the McKenzie watershed.

The trend for nitrogen concentrations (Nitrate + Nitrite) followed the general pattern of very low concentrations (or no detection) in the upper portions of the watershed and increasing concentrations at the lower McKenzie and Mohawk River sites (Figure 13). There was a similar trend for total phosphorous concentrations, with very low concentrations (or no detection) in the

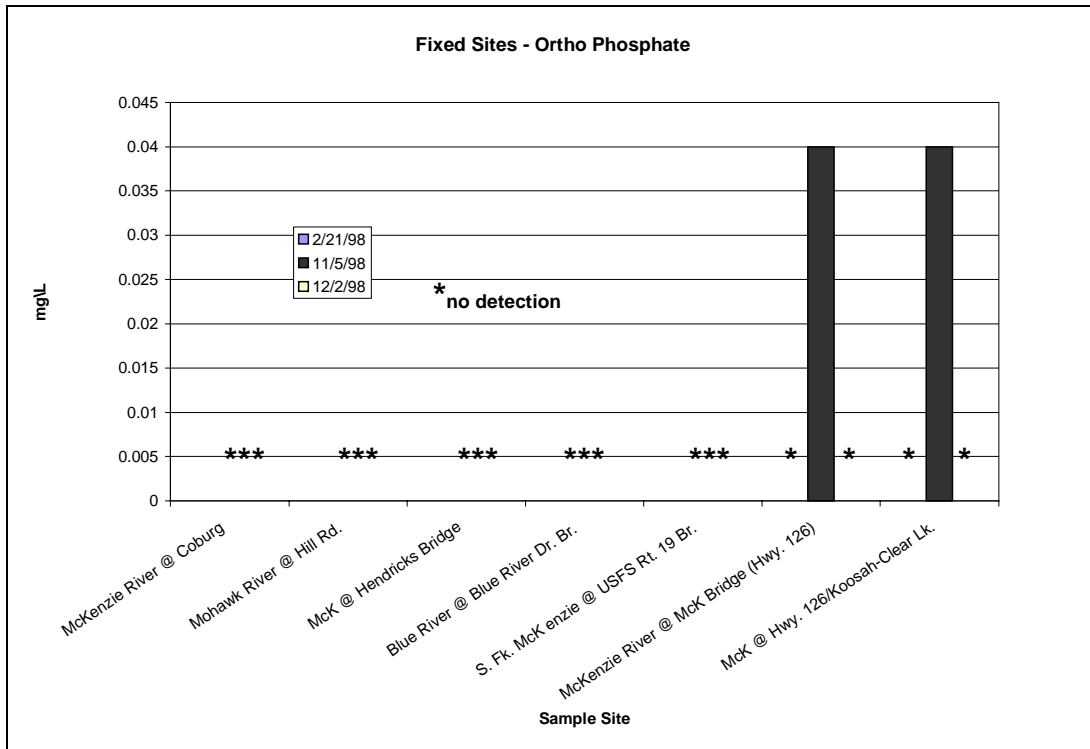
upper portions of the watershed and increasing concentrations at the lower McKenzie and Mohawk River sites (Figure 14). In contrast, ortho-phosphate was measured at the upper watershed sites and there was no detection at the lower watershed sites (Figure 13). It appears that ortho-phosphate concentrations are naturally elevated due to the volcanic geology characteristic of the upper watershed (Personal communication with Dave Kretzing, hydrologist, Willamette National Forest, McKenzie Ranger District).



**Figure 13.** Nitrogen concentrations at the seven fixed station sites for the three storm events.



**Figure 14.** Total phosphorus levels at the seven fixed station sites for the three storm events.



**Figure 15.** Ortho phosphate levels at the seven fixed station sites for the three storm events.

## Heavy Metals

Heavy metals were sampled at the Coburg Road fixed station site. The Department of Environmental Quality has established fresh water standards for heavy metals (Table 8). The heavy metal concentrations were very low, with all of the heavy metals sampled below the water quality criteria.

**Table 5.** Heavy metal concentrations for the three storm events monitored at the Coburg Road site on the McKenzie River.

<b>Element</b>	<b>Water Quality Criteria – Surface Water ug/L*</b>	<b>Heavy Metal Analysis Results ug/L</b>			
		<b>MRL<sup>1</sup></b>	<b>Storm Event</b>		
			<b>2/21/98</b>	<b>11/5/98</b>	<b>12/2/98</b>
Arsenic	190	0.043	1.54	0.307	0.242
Barium	NA	0.022	21.5	2.74	6.26
Cadmium	1.1	<0.008	<0.025	<0.008	<0.016
Chromium	11	0.187	1.48	ND	<0.187
Copper	5.2	0.070	3.33	0.272	0.783
Iron	1,000	1.75	<1.75	130	534
Lead	3.2	0.010	0.691	0.0505	0.226
Manganese	NA	0.020	88.9	10.7	26.8
Mercury	0.012	0.00004	0.0053	0.00135	0.00213
Selenium	35	<5.16	<1.42	<0.670	<0.516
Silver	0.12	<0.008	<0.012	<0.007	<0.008
Zinc	110	1.00	6.16	0.654	0.866

\* Concentrations in Micrograms Per Liter for protection of aquatic life: Fresh water chronic criteria / guidelines as reported on the Oregon Department of Environmental Quality web site: <http://waterquality.deq.state.or.us/wq/wqrules/340Div41Tbl20.pdf>

**1** Minimum Recording Level for 12/2/98 as reported by Battelle Marine Sciences Laboratory, Sequim, WA.

## EVALUATION

The three monitoring objectives provide a framework for evaluating the storm event monitoring pilot. The goal of the monitoring pilot is to test whether it is feasible and practical to design and sustain a storm event monitoring program. The McKenzie Watershed Council's Water Quality Monitoring Subcommittee evaluated the success of the storm event monitoring pilot in the context of the three objectives:

*(1) Provide a coarse characterization of water quality in the McKenzie Basin during high flow periods, including the range and variability in key water quality parameters.*

The committee agreed that the monitoring results provided a coarse characterization of the spatial variability (over 50 sample sites) for the three events. The three events sampled, however, do not provide a valid representation of the variability in water quality through time, especially when many of the parameters are influenced by extreme flood events that happen once every 10 or more years, such as the 1996 flood.

***(2) Determine the feasibility of establishing baseline storm event data for tracking long-term water quality trends.***

With the extreme variability in water quality associated with flood events, the committee concluded that the monitoring pilot did not establish baseline storm event conditions for the McKenzie Subbasin. Establishing background levels and tracking trends would require an large number of data points through time at each site, with controls for a number of variables (e.g., capturing all of the sites on the rising limb of the hydrograph). The NCASI study, for example, concluded that almost a decade of measurements is needed to determine the annual sediment yield to within 100 percent of the true value for one small watershed. The committee recommended that the Council not commit to the kind of intensive and long-term commitment of staff and resources that would be necessary to establish statistically valid baseline values and trends.

***(3) Detect general areas of the watershed that may be sources of water quality problems during storm events.***

The coarse characterization of storm conditions for the subbasin did identify areas that may have potential water quality issues, although it did not conclusively identify problems or management-related contributions. The monitoring information can be used to inform a more targeted monitoring effort. For example, the elevated bacteria levels (the one parameter that approached DEQ water quality standards) in the Mohawk River (at one point) warrant further investigation to begin to pinpoint source areas and management factors (e.g., leaking septic systems). Identifying “problem” areas for the other parameters, however, is more problematic. The natural variability in turbidity values, for example, makes it difficult to determine whether the observed values are within the natural range of variability or elevated from management-related factors that would warrant further investigation. It is very difficult, given the interaction of multiple land uses and management regimes with variable geology and soil types in a watershed, to determine cause-and-effect relationships for the sites where we measured turbidity. A more efficient, and statistically valid, method for identifying management-related turbidity and associated sedimentation increases would be to monitor at the potential source (e.g., road side ditch, building construction site) of the turbidity.

## **RECOMMENDATIONS**

The McKenzie Watershed Council’s Water Quality Monitoring Subcommittee recommends that the Council not pursue future storm event monitoring with the same approach used for the pilot study. Given the variability in water quality parameters across the subbasin and through time, to accurately and precisely monitor storm events at the scale of the McKenzie Subbasin would be a prohibitively expensive undertaking. The committee recommends that the Council:

- (1)** Pursue a more targeted monitoring effort for some of the key water quality parameters identified as potential issues. For example, exploring methods to begin to pinpoint the sources of elevated bacteria levels in the Mohawk River.
  
- (2)** Encourage landowners and watershed council partner organizations to monitor key water quality parameters such as turbidity at the potential source (e.g., roadside ditch, building construction site, agricultural operation). This kind of targeted monitoring can provide

information on sources of water quality problems and provide feedback on methods to control the issue at the source.

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