

## **CHAPTER 5.**

### **SUMMARY AND RECOMMENDATIONS**

#### **SUMMARY**

Low-flow stream gauges were established at 12 sites in the upper and lower Chehalis Basin (WRIA Nos. 22 and 23). Flow data were collected over the 2002 summer low-flow season (late June through early November). Periodic current-meter measurements were taken at Charley Creek and the Middle Fork Hoquiam River where gauge installation was impractical. Flow data were not collected at Elk River because of the lack of an adequate measurement site. The Chehalis River near the Satsop River confluence site was not monitored under this study because the USGS reactivated its gauging station at that site.

Water levels at the sites where stations were installed were recorded at 1-hour intervals using the Global Water WL15 water level recorder. Overall, the recorders functioned properly, although it was necessary to correct the stage record for transducer drift. Small diurnal oscillations in the stage record were observed at several gauges, and it is not known whether this truly reflects small, cyclical changes in discharge or if it is systematic recorder error. The gauge apparatus worked very well for measuring low flows as the staff gauge and data recorder were self-contained in a single unit. Gauges were installed and removed with relative ease, and the equipment was situated unobtrusively so as to prevent theft and vandalism.

Channel ratings were developed using a combination of stage measurements, current-meter measurements, and survey information. A semi-analytical channel rating based on hydraulic parameters was tried first and checked against observed data. An empirical relation was used where observations differed greatly from the semi-analytical rating method.

The following are the key findings of the study:

- Flows were mostly below the regulatory minimums at the following sites:
  - Chehalis River at Highway 602 (Chehalis River Control Point)
  - Black River
  - Newskah Creek
  - East Fork Hoquiam River
  - East Fork Wishkah.
- Flows dropped below the regulatory minimums in August at the following sites:
  - South Fork Chehalis River
  - Middle Fork Satsop River
  - Wishkah River.

- Flows were close to the regulatory minimums all summer at the following sites:
  - Cedar Creek
  - Decker Creek
  - Johns River
  - West Fork Hoquiam.

Regulatory minimum flows were met or exceeded early in the season at most sites. Prevailing dry conditions in autumn resulted in flows lower than the regulatory minimums at all sites. The historical record from established USGS gauges also indicates unseasonably low flows in summer 2002. As discussed in the previous section, average monthly flows early in the summer at long-established gauges were slightly below the long-term means. As the summer progressed, the summer 2002 flow dropped well below the long-term mean. A similar pattern was observed at the summer 2002 gauges.

Five key factors influence a gauging station's suitability for determining whether streams are meeting regulatory minimum flows at control points:

- Gauge location relative to the control point
- Length of record
- Flow diversions
- How recently the data were collected
- Gauging station site characteristics for obtaining accurate flow data.

For the historical USGS gauging stations reviewed in this study, no information was available for two of these factors: flow diversions and site characteristics for obtaining accurate flow data. Table 5-1 summarizes the findings on these stations for the remaining three factors.

TABLE 5-1.  
SUMMARY - HISTORICAL GAUGING STATIONS

Control Point	Recency of Record <sup>a</sup>	Length of Record	Gauge Location Relative to Control Point
<b>Currently Operating Gauging Stations</b>			
South Fork Newaukum River	—	Good	Good - gauge location just upstream of control point.
Chehalis River Confluence with Elk Creek	—	Good <sup>b</sup>	Good - gauge location short distance upstream, no major tributaries between gauge and control point.
Skookumchuck River	—	Good	Good <sup>c</sup> - gauge is 4 miles upstream, no major tributaries between gauge and control point.
Chehalis River at Grand Mound	—	Good	Good - at control point.
Chehalis River at Porter	—	Good	Good - at control point.
Satsop River	—	Good	Good - gauge location is short distance upstream.
Wynoochee River	—	Good	Fair <sup>d</sup> - gauge is 4 miles upstream with significant tributary (Black Creek) between gauge and control point.
Newaukum River	—	Good	Good - gauge is 3 miles upstream with no major tributaries between gauge and control point.
<p>a. All currently operating sites have recently published data. For sites no longer in operation, the last year data was collected is given.</p> <p>b. Period of record is long; thus data could possibly be used as indicator of discharge at the 2002 Chehalis River at State Highway 603 crossing gauge.</p> <p>c. Skookumchuck Reservoir is several miles upstream and its operation influences stream flow statistics.</p> <p>d. Wynoochee Lake (a reservoir) several miles upstream influences stream flow.</p>			

TABLE 5-1 (continued).  
SUMMARY - HISTORIC GAUGING STATIONS

Control Point	Recency of Record <sup>a</sup>	Length of Record	Gauge Location Relative to Control Point
<b>Gauging Stations no Longer in Operation</b>			
South Fork Chehalis River	1980	Good	Poor - gauges 5 and 10 miles upstream of control point with significant Lake Creek tributary between gauge and control point.
Chehalis River below Confluence with Satsop River	1983 <sup>e</sup>	Poor	Good.
Elk Creek	1970	Good	Fair - gauge is 3 miles upstream of control point with 2 tributaries (Nine Creek, Deer Creek) between gauge and control point.
Salzer Creek	1971	Poor	Fair - gauge is 3 miles upstream of control point with no major tributaries between gauge and control point.
Porter Creek	1948	Poor	Fair - gauge is 2 miles upstream of confluence; however, two tributary's contribute flow between gauge and control point amounting to 5% of the basin area.
Black River	1950	Fair	Poor - gauge is 15 miles upstream of control point with inflow likely between gauge and control point.
Cloquallum Creek	1972	Good	Good - gauge is 1.5 miles upstream of control point with no major tributaries between gauge and control point.
East Fork Satsop River	1971	Good	Good - gauge is 3 miles upstream of control point with no major tributaries between gauge and control point.
<p>a. All currently operating sites have recently published data. For sites no longer in operation, the last year data was collected is given.</p> <p>b. Period of record is long; thus data could possibly be used as indicator of discharge at the 2002 Chehalis River at State Highway 603 crossing gauge.</p> <p>c. Skookumchuck Reservoir is several miles upstream and its operation may influence stream flow statistics.</p> <p>d. Wynoochee Lake is reservoir several miles upstream which influences stream flow.</p> <p>e. Station was reactivated by USGS in 2002, but flow data is not yet available.</p>			

TABLE 5-1 (continued).  
SUMMARY - HISTORIC GAUGING STATIONS

Control Point	Recency of Record <sup>a</sup>	Length of Record	Gauge Location Relative to Control Point
Humptulips River	1979 <sup>e</sup>	Good	Poor - gauge is several miles upstream of control point with at least one significant tributary (Big Creek) between gauge and control point.
Newskah Creek	1949	Poor - ten and 90% exceedence flows not available due to short length of record.	Good - gauge is upstream of control point with no major tributaries between gauge and control point.
Charley Creek	1949	Poor - ten and 90% exceedence flows not available due to short length of record.	Good - gauge is upstream of control point with no major tributaries between gauge and control point.
North Fork Newaukum River	1966	Fair	Good

a. All currently operating sites have recently published data. For sites no longer in operation, the last year data was collected is given.

b. Period of record is long; thus data could possibly be used as indicator of discharge at the 2002 Chehalis River at State Highway 603 crossing gauge.

c. Skookumchuck Reservoir is several miles upstream and its operation may influence stream flow statistics.

d. Wynoochee Lake is reservoir several miles upstream which influences stream flow.

e. Station was reactivated by USGS in 2002, but flow data is not yet available.

Table 5-2 summarizes suitability factors for the 2002 gauge sites. This information can be used to assist with determining appropriate use of the 2002 data, as well as planning future monitoring efforts.

Information on flow diversions was largely not available for consideration in the assessment of data obtained from the gauging stations installed. The length of record was limited to the 2002 low flow season, or one year of data during the low flow period. Typically a minimum of 10 years is the recommended length of time to achieve a data record which can show consistency, and capture some variability. To attempt to qualify the data taken, comparison was made a two sites to historical averages, as shown on pages 4-46 and 4-47.

TABLE 5-2.  
SUMMARY - 2002 GAUGES

Gauge Station Name	Control Point Name	Gauge Station Location Relative to Control Point	Site Characteristics for Collection of Accurate Data	Other Factors Observed
South Fork Chehalis River	South Fork Chehalis River	Good - approximately 1/4 - 1/2 mile upstream of control point	Good	Small footpath for access down steep embankment should be constructed or alternate access path found.
Chehalis River at State Highway 603 Crossing	Chehalis River	Good - within same quarter section	Good	Improvements to logger setup needed, including small stilling well.
Chehalis River near Confluence with Satsop River	Chehalis River below confluence with Satsop River	N/A	N/A	No gauge installed - USGS is installing specialized equipment to measure flows in tidally influenced channel
Black River at U.S. Highway 12 Bridge Crossing	Black River	Good - 0.3 miles upstream of control point	Good	Installation of float-type water-level recorder may be better suited to this site.
Cedar Creek	Cedar Creek	Good - 1.3 miles upstream of control point with no major tributaries between gauge and control point	Poor - slow moving water not favorable for accurate current-meter measurements	Improvement to site suitability could be made by moving 100 feet upstream.
Decker Creek at Bridge Crossing	Decker Creek	Good - within 1,000 feet of control point	Good	Periodicity in stage record occurred.
Middle Fork Stasop River	Middle Fork Satsop River	Good - 0.1 miles downstream of the control point	Good	--

TABLE 5-2 (continued). SUMMARY - 2002 GAUGES				
Gauge Station Name	Control Point Name	Suitability of Gauge Station Location Relative to Control Point	Suitability of Site for Collection of Accurate Data	Other Factors Observed
Johns River 5 miles upstream of Markham	Johns River	Good - 0.1 miles downstream of the control point	Good	--
Elk River	Elk River	N/A	Very poor - after extensive field work, no adequate sites were found	No gauge installed - additional field work required to find suitable site.
Newskah Creek	Newskah Creek	Good - 0.9 miles upstream of control point	Poor - poor flow conditions and downstream tributary inflow	Additional field work required to find suitable site.
Charley Creek	Charley Creek	N/A	Poor	No gauge installed - additional field work required to find suitable site.
West Fork Hoquiam river at Dekay Road	West Fork Hoquiam River	Good - 0.9 miles downstream of control point.	Good	Tidal influence required adjustment of stage record.
Middle Fork Hoquiam River	Middle Fork Hoquiam River	Fair - 1.2 miles upstream of control point; however, Junction Creek is tributary contributing flow between gauge and control point	Good	Additional field work to locate alternative site recommended, downstream of confluence with Berryman Creek.
Wishkah River	Wishkah River	Good - 0.2 miles downstream of control point	Good	--
East Fork Wishkah River	East Fork Wishkah River	Good - 0.1 miles upstream of control point.	Fair - measures velocities low enough to cause potential error	Site recommended for future use with additional current meter measurement.

## **RECOMMENDATIONS**

The flow data collected in 2002 under this flow monitoring program, along with historical data from other sites in the Chehalis and data collected at active USGS stations, forms the basis for understanding streamflows in the Chehalis Basin. Additional, and ongoing flow monitoring is very important, not only at the sites monitored for the first time in 2002, but also at sites that have only historical data. The information presented in this report can be used to prioritize and plan for this future monitoring.

Collection of low-flow data presents unique challenges. It is often difficult to obtain accurate flow measurements during these times because of low streamflow velocity, shallow depth of water, and areas within the channel where ponded water exists. Where these conditions existed, they are documented for each of the sites monitored during 2002. It is recommended that future monitoring efforts address these challenges, possibly through channel modifications or construction of structures within the channel that facilitate accurate measurements (e.g. weirs).

If similar low-flow monitoring is conducted in the future, set-up time would be reduced because site conditions are known. Data compilation and processing routines have been developed, and preliminary channel ratings established. Continued data collection in the coming years would provide a more complete record from which to analyze low-flow conditions of each stream.

Year-round data collection is recommended as well, but would require significant changes in the gauge equipment, the installation procedure, and the discharge measurement methods. The WL15 recorders are limited in range, so their use would be inappropriate for high flows. (The maximum depth is 3 feet; the advantage of a low-range recorder is increased accuracy). Measurement over the entire range of flows would probably require the installation of a semi-permanent stilling well and shelter. Float-encoder-type data recorders are generally more accurate and thus should be a part of a long-term data collection plan. Collection of current-meter measurements during high-flow conditions would require specialized equipment, which could include boat and bridge measurement techniques. Data collection during high flow conditions would require two people for safety reasons.