

Lower Coast Fork Willamette River Oregon Watershed Assessment

Chapter 3 Hydrology and Water Use

3.1 Introduction

The hydrologic component of this assessment is intended to identify land uses and water uses that potentially impact the hydrologic processes of the watershed. For this analysis, simplified techniques are used to screen for possible impacts. Identifying the specific cause or degree of impact would require more in-depth technical analysis and is beyond the scope of this assessment.

Understanding the distribution and movement of surface and subsurface water in the Lower Coast Fork Watershed is an important part of protecting water quality, fish & wildlife habitat, and our ability to use surface and ground water. Beneficial uses of surface water in this watershed include trout spawning and rearing habitat, habitat for other aquatic life, agriculture, municipal and industrial water supplies, and recreation and aesthetic enjoyment.

3.2 Methods and Key Questions

The hydrology assessment was conducted using hydrologic data (e.g., stream flow records), existing reports, other information, and interviews with resource professionals.

The following are key questions addressed in this document:

1. What land uses and processes generate peak flows?
2. What is the flood history of the area?
3. What are the effects of dam regulation on Lower Coast Fork Willamette River flow patterns?
4. What are the ecological effects of altered flow patterns?

3.3 Results

The results of this section are organized to address the critical questions.

What Land Uses and Processes Generate Peak Flows?

Flow Processes

Peak and low flows are natural elements of the hydrologic cycle, but human activities or modifications can accentuate them. In turn, human caused changes to a watershed's hydrology can affect the in-stream habitat of fish and other aquatic life as well as other beneficial uses of surface water. Elevated peak flows increase the erosion of stream

banks and scouring of stream beds. This can damage habitat for fish and other aquatic life, lead to loss of streamside property and increase sediment going downstream. High peak flows can lead to flooding and can damage personal property. Low flows generally lead to higher water temperatures and lower dissolved oxygen levels. Low flows also concentrate nutrients, sediment and pollutants. Higher nutrient concentrations can lead to increased algal growth, which further decreases oxygen and can create sluggish and stagnant streams.

The purpose of flow assessment is to identify the main processes that contribute to peak runoff in each watershed. Determining which process is most responsible for peak runoff is not an exact science. There are various “rules of thumb” which are used, as well as professional judgment and experience. Hydrologists generally agree that, in this region, it snows above 4,200 feet and rains below 1,500 feet. In the transition zone between these two, havoc is created when a cold front drops snow which is followed by heavy rains, causing the snow to melt quickly. (BLM, 1997; USFS, 1997). This process is known as rain-on-snow and creates additional runoff. Of the six watersheds in the assessment area, Bear Creek and Gettings Creek account for 95% of the rain-on-snow condition while Wild Hog Creek is the only watershed with no rain-on-snow condition. Rain-on-snow comprises approximately 13%, 18 sq. mi. of the Lower Coast Fork Willamette River assessment area. See map figure 9. Another process, high spring runoff from seasonal melting of long-term snowpack is not a significant factor in producing the peak flows in any of the watersheds due to their relatively modest elevations. Rain and Rain-on-snow percentages are shown in **table 3-1**.

Table 3-1. Dominant Peak Flow Processes

Watershed Name	Watershed Area sq. mi.	Rain Dominant		Rain-On-Snow Dominant	
		sq. mi.	%	sq. mi.	%
Gettings Creek	16.74	9.14	55%	7.60	45%
Hill Creek	23.80	23.54	99%	0.26	1%
Camas Swale	43.40	43.17	99%	0.23	1%
Bear Creek	27.50	17.94	65%	9.56	35%
Papenfus Creek	13.60	13.16	97%	0.44	3%
Wild Hog Creek	13.91	13.91	100%	0.00	0%

Land Use

The differences in basic watershed characteristics noted in the previous section are correlated with differences in land use among the watersheds. **Table 3-2** compares the area and percentage of different land uses for the 6 watersheds.

Table 3-2. Land Uses In The Assessment Area

Watershed	Ag/Rural Residential	Forestry	Urban	Other	Total	

	mi2	mi2	mi2	mi2	mi2	%
Gettings	4.66	12.00	0.00	0.07	16.74	12.04%
Hill Creek	11.02	10.67	1.32	0.82	23.83	17.15%
Camas Swale	22.18	19.45	0.74	0.99	43.36	31.20%
Bear Creek	9.11	18.35	0.00	0.05	27.51	19.80%
Papenfus	7.47	3.90	0.18	2.09	13.64	9.81%
Wild Hog	7.71	3.82	0.92	1.45	13.90	10.00%
Total	62.15	68.20	3.17	5.47	138.99	
%	44.72%	49.07%	2.28%	3.93%		

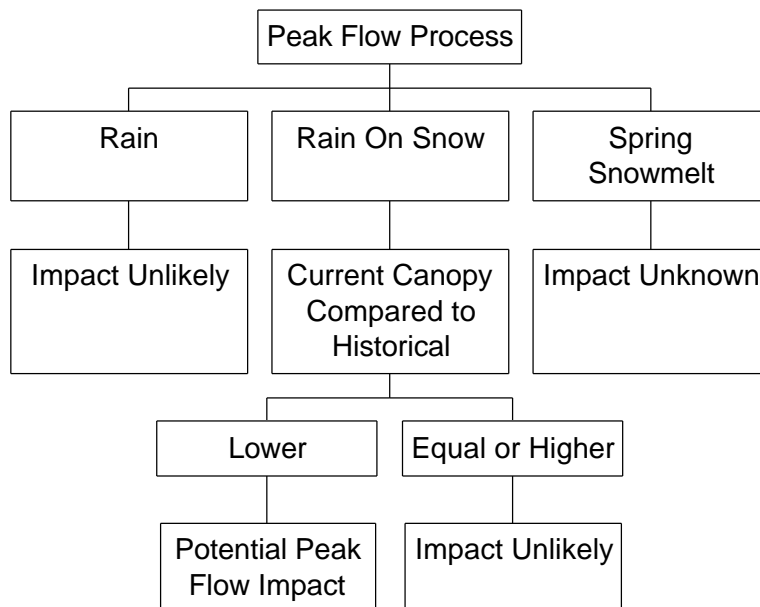
Land Use Effects on Peak Flows

Forest Land Use

The Potential for forest land use to affect peak flows is related to the openings in the forest canopy caused by clearcut harvesting. Research has shown that more snow can accumulate in these openings and the snow can also melt faster because it is more directly exposed to wind and rain than it would be if the canopy were intact. Several steps are prescribed in the OWEB manual to determine if forest land use has a high likelihood of increasing peak flows. **Chart 3-1** summarizes these steps.

Chart 3-1

Forestry Impacts on Hydrology



It is unlikely that impacts from forest land use would significantly increase peak flows. The Bear Creek and Gettings Creek watersheds have 35% and 45% of their watershed

area in the rain-on-snow precipitation zone. Since the area in this precipitation zone is used for forestry there is the potential to impact peak flows.

To determine the likelihood of impacts, the current amount of forest canopy closure is compared to historical conditions. In the Western Cascades Ecoregions, map figure 11, forests historically had greater than 30% crown closure. Map figure 10 outlines the areas of forest in the rain-on-snow zone with less than 30% crown closure.

Table 3-3 shows that in the Bear Creek sub-basin a total of 28.87% of the forested landscape in the rain-on-snow zone has less than 30% crown closure. Gettings Creek has 26.32%. These percentages are below the threshold which can cause measurable change in peak flows (OWEB 1999). Bear Creek would require a threshold value of 80% and Gettings Creek would require a 70 % value in the rain-on-snow (ROS) zone to be in an “open canopy” condition to cause a detectable increase in peak flows.

Table 3-3 Forestry-Related Impacts During Rain-on-Snow Events

Watershed	% of watershed in ROS Zone	Historic Crown Closure in ROS	% of ROS with < 30% current Crown Closure	Threshold value where % ROS with < 30% crown closure may increase peak flow	Risk of Peak Flow Impacts from Forest Land Use
All Lower	13	NA	NA	NA	Low
Bear Creek	34.76	> 30%	28.87%	80%	Low
Gettings Creek	45.4	> 30%	26.32%	70%	Low

Agriculture/Rural Land Use

The analysis of the effects of Agriculture/Rural Residential land use on runoff uses another screening procedure to detect the chance of significant change from natural conditions. NO ANALYSIS AVAILABLE.

Roads

For the LCFW watershed there is 691 miles of road (BLM 2002). **Table 3-4** shows the road summary for the LCFW watershed.

Table 3-4 Road Summary

	Forest	AG	Urban	Rural Resid	Total
Road miles	344	198	28	121	691
Road Area sq. mi.	73	48	3	15	139
Length as % of Total	50	29	4	18	100
Area %	52	35	2	11	100

Research has shown that dense road networks can contribute to increases in peak flows. To screen for potential hydrologic impacts of roads, the percent of total area occupied by roads is calculated for Forest and Agriculture/Rural land use in each watershed. Road density (mi/mi²) is used as a measurement of impervious surfaces for the area of urban land use in the LCFW watershed.

The results of these calculations are compared to threshold values to determine the likelihood of impacts. Different levels of roaded area are associated with levels of potential impacts to peak flows as shown in **table 3-5**.

Table 3-5. Potential Road Effects on Peak Flows

Percent Roaded Area in forest or Ag/Rural Land Use	Potential Risk of Peak Flow Enhancement	Road Density in Urban and Rural Res. Land Use	Total Impervious Area Associated with Urban & Rural Res. Road Density	Potential Risk of Peak Flow Enhancement
<4%	Low	<4.2 mi/mi ²	<5%	Low
4-8%	Moderate	4.2-5.5 mi/mi ²	5-10%	Moderate
>8%	High	>5.5 mi/mi ²	>10%	High

Table 3-6 summarizes the road assessment for the LCFW watershed.

Table 3-6 Roaded Area And Risk of Peak Flow Impacts.

Watershed	Percent Forest Area in Roads	Risk of Impacts from Forest Roads	Percent Ag Area in Roads	Risk of Impacts from Ag Roads	Urban Road Density	Risk of Impacts From Urban Roads	Rural Res. Road Density	Risk of Impacts from Rural Res. Roads
LCFW	2.22	Low	2.71	Low	8.82	moderate	8.1	High

Combined Land Use Effects on Peak Flow

The Results of the screening procedure described in the previous sections indicate the potential for impacts to peak flow runoff from forest and agricultural roads across the watershed is low. However, the risk rating for urban and rural residential land use is quite high and further investigation may be warranted especially if urban land use is expected to expand significantly in the future.

3.4 What is the Flood History of the Area?

Stream gage records provide a view of the annual peak flows that have occurred over time in the watershed. Understanding the flood history of a watershed is helpful in interpreting observations of channel form, riparian condition and fish habitat.

Lower Coast Fork Willamette River Flood History

There is one active stream gage located in the assessment area and historical records are available from two gage stations. Both gage stations are/were located on the Coast Fork Willamette River. There are no available flow records for Hill Creek, Gettings Creek, Bear Creek, Camas Swale Creek or Papenfus Creek.

USGS Station 14157500 Coast Fork Willamette near Goshen, OR provides historic information from water years 1906 through 1911 and 1951 through water year 2002 with data gaps for water years 1987 and 1992. This gage station is actively monitored today.

USGS Station 14157000 Coast Fork Willamette River at Saginaw, OR provides information for water years 1924 through 1951.

The gage station near Goshen provides flow information for the entire CFW River basin covering a drainage area of approximately 642 square mile. **Chart 3-2, 3-3 and 3-4** provides peak flow information for both the Goshen and Saginaw Gage Stations.

The records from the early 1900's represent natural flows that existed before the Cottage Grove and Dorena dams became operational. A comparison of the peak flow data from the gage station near Goshen for the period 1906 thru 1912 and 1951 thru 2001 shows a 37 % reduction in maximum peak flow after the dams became operational.

By comparing peak flow information from the gage station near Goshen and the gage station at Saginaw for the year 1951 we see that the stream network between the two stations contributed approximately 30% to flow rate. This represents the network contribution from Gettings Creek, Hill Creek, Camas Swale Creek and Bear Creek.

3.5 What are the effects of dam regulation on the Coast Fork Willamette River Flow Patterns?

The primary purpose of the Army Corps of Engineers' system of dams and reservoirs is flood control. This system has been effective in reducing peak flows in the CFW River. The regulation of peak flows for flood control is accomplished through short-term storage of storm runoff followed by releases of the stored water over a period of days. Other secondary purposes of the reservoir system, recreation, navigation and irrigation require regulating flows on a longer-term seasonal basis. **Chart 3-5** displays the change in seasonal flow pattern of the CFW River.

With regulation, the average monthly flows from January thru April are 20-30% of what they were under natural conditions. In contrast, flows during the dry months of August Through October are more than double what they were naturally, due to the gradual release of stored water. In the main flood months of December and January, the average monthly flows are similar because flood storage is relatively brief.

Additional statistics comparing the natural and regulated flow regimes of the CFW River are shown in **Table 3-7**. This data examines the altered flow regimes and provides tools

for evaluating the ecological restoration potential of flood plain sites that are subject to altered flow regimes (Dykaar, 2000). The statistical values are defined as follows:

Mean Annual Flow (cfs): The average of the individual daily flows for a water year.

Mean Annual Peak Flow (cfs): The average of the maximum daily flows of each water year for the designated period.

Mean Summer Flow (cfs): The average of the average daily August flow of each water year for the designated period.

Seasonal Flow Range (dimensionless): Ratio of the mean annual peak flow to the mean annual flow. Rivers with large seasonal flow range tend to form wider and shallower channels to accommodate the variation in flow (Xu, 1996).

Bankfull Flow (cfs): Flow sufficient to fill a channel up to the floodplain. Bankfull is considered a channel forming flow. It is a measure of those flows most effective in transporting coarse bedload sediment which creates the forms and features of the river channel. A recurrence interval of 1.5 years is used to define a bankfull flow.

Time Above Bankfull (days/year): Average number of days per water year that the daily flow equals or exceeds a specified bankfull flow value. From a geomorphic perspective, this parameter indicates the amount of channel and floodplain forming work the river can do (Andrews and Nankervis, 1995). Sustained bankfull flow is required to form new habitat. This parameter also indicates the degree of hydrologic connection between channel and floodplain.

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Table 3.7 Summary Flow Statistics For The CFW River Near Goshen (14157500)

Period	Mean Annual Flow(cfs)	Mean annual Peak Flow (cfs)	Mean Summer Flow (cfs)	Seasonal Flow Range (ratio)	Bankfull Flow (cfs)	Time Above Bankfull (days/year)
Pre-dam 1906-1911	1,355	20,810	71	15.4	17,140	1.4
Post-dam 1951-2002	1,622	13,110	414	8.1	-	0.32

Dimensionless Ratio of Post-dam to Pre-dam Statistics

Change	1.20	0.63	5.83	0.53	-	0.22
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The data indicates the post-dam mean annual flow is 120% of the pre-dam flow, the peak flows have been reduced by 37%, and low flows are 5.8 times higher. Natural seasonal variability, as measured by the seasonal flow range, is half in the post-dam period.

Reservoirs have reduced the time that flows are above bankfull discharge to one-fifth of natural.

3.6 What are the Ecological Effects of Altered Flow Regimes?

Major alterations to a river's flow regime have important implications for the restoration potential of instream and floodplain habitat. The dynamic physical environment, including processes of flooding, erosion, and deposition create habitat and provide the foundation for complex biological interactions. Ecological relationships are adapted to, and supported by, the system of physical processes in which they have developed. Though a full enumeration of the potential effects of altered flow regimes is beyond the scope of this assessment, some key implications for consideration are excerpted from A Hydrogeomorphic Index for River-Floodplain Habitat Assessment in the Willamette Basin (Dykaar, 2000).

The Willamette floodplain appears to be composed of innumerable bars and islands which have been deposited and dissected by the river over thousands of years. Through the shifting and filling of channels and the establishment and growth of pioneering trees, river forms gradually merge with the surrounding floodplain. New forms are created through continual recycling of sediment. This process maintains a variety of aquatic and floodplain habitats through time. A diverse array of physical forms has been produced by the historically wide variation of flood forces. Without this variable "power source" of flooding the process of floodplain habitat creation, modification, and renewal is greatly diminished. Many of those features, habitats, and organisms adapted to the previous pattern of river/floodplain interaction may decline over time, even with land use protection, if the land-forming process of flooding continues to be severely limited.

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Habitat for Pioneer Riparian Trees

Perhaps the biggest change in the floodplain environment since regulation is the near elimination of new sites for the establishment of pioneer riparian species such as black cottonwood, red alder, and willow. These species are uniquely adapted to the rigorous conditions found on incipient floodplain landforms. They are shade intolerant, grow rapidly on infertile mineral substrates, and maintain direct access to the water table through vigorous root development. Mature stands of pioneer trees typically do not reseed in place because full sun is required for establishment and growth. Without large freshly formed bars and islands available for colonization, the total area occupied by pioneer riparian species will likely decrease over time, while the area occupied by mid-successional species such as bigleaf Maple and Oregon Ash will likely increase.

Changes in Inundation Duration

In addition to being a physical force that creates landforms, the distribution of water on a floodplain is a key factor regulating ecosystem function and organizing habitat structure, and may be characterized in terms of its seasonal timing, frequency, amount, and duration. Map figure 13 displays the 100 and 500 year floodplain for the LCFW watershed.

Inundation duration, a measure of the length of time different levels of a floodplain site are submerged under water, is an example of the kind of physical condition that has been altered in ways which affect ecological function. Floodplain surfaces that are subject to frequent, but not too persistent submergence, have the potential to provide the greatest variety of habitat functions because they experience the greatest variation in physical conditions. Floodplain surfaces that are at high elevations relative to the main channel are less hydraulically connected to the river and provide less diverse habitat.

Changes in Seasonal Timing

While inundation durations can provide some indication of the degree of annual connection between floodplain surfaces and river water, the seasonal timing of various flow levels is another factor that independently affects ecological functions. Even though a feature may be submerged for an equivalent amount of time during the year, if inundation occurs in the fall where it formerly occurred in the spring, ecological relationships can be disrupted.

The habitat requirements of the Northern Red-legged Frog are directly related to the seasonal timing of flows.

“In the Willamette Valley frogs breed in February, eggs hatch in March, and metamorphosis begins in June... Continuously flooded conditions are required for about 5 months through metamorphosis. Seasonal (ephemeral) wetlands without surface water in the summer preclude the establishment of exotic predatory fish, and larval bullfrogs which require 1-3 years of continuously flooded conditions to reach metamorphosis.” (Dykaar pp. 76-77)

Chart 3-2

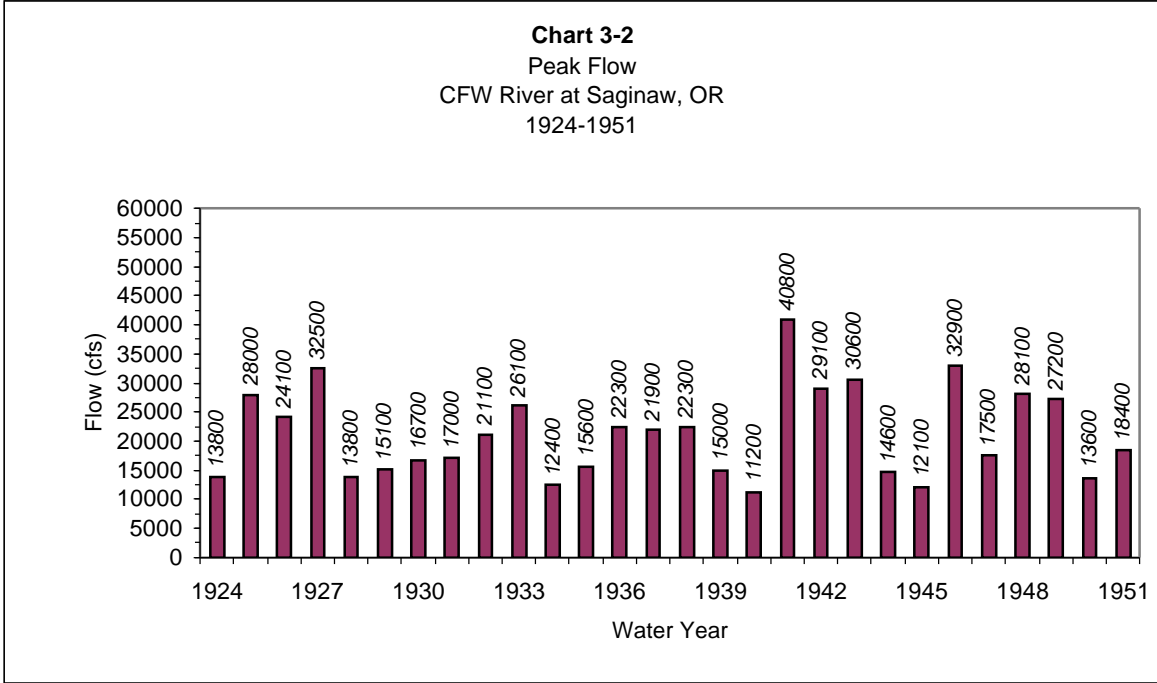


Chart 3-3

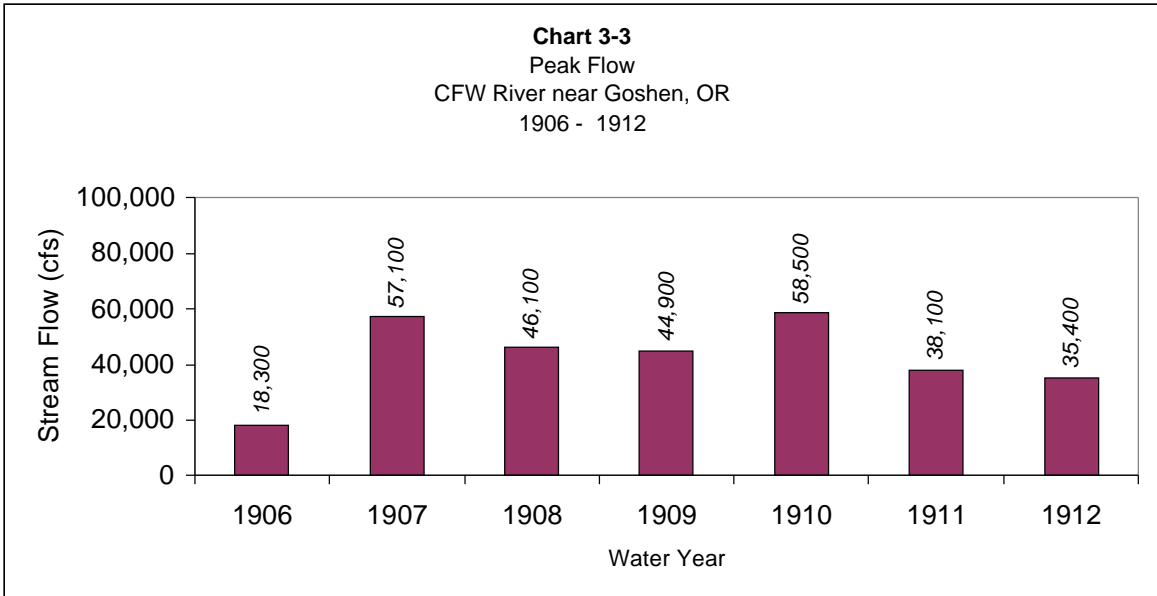


Chart 3-4

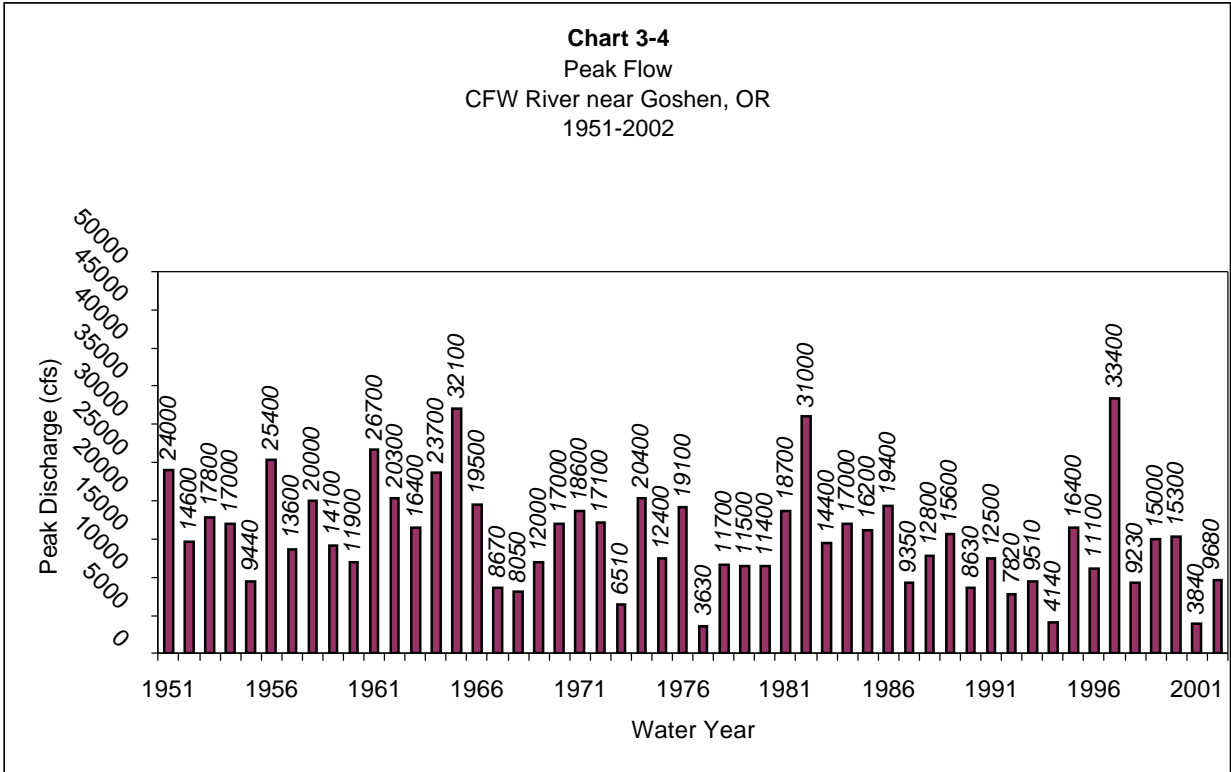
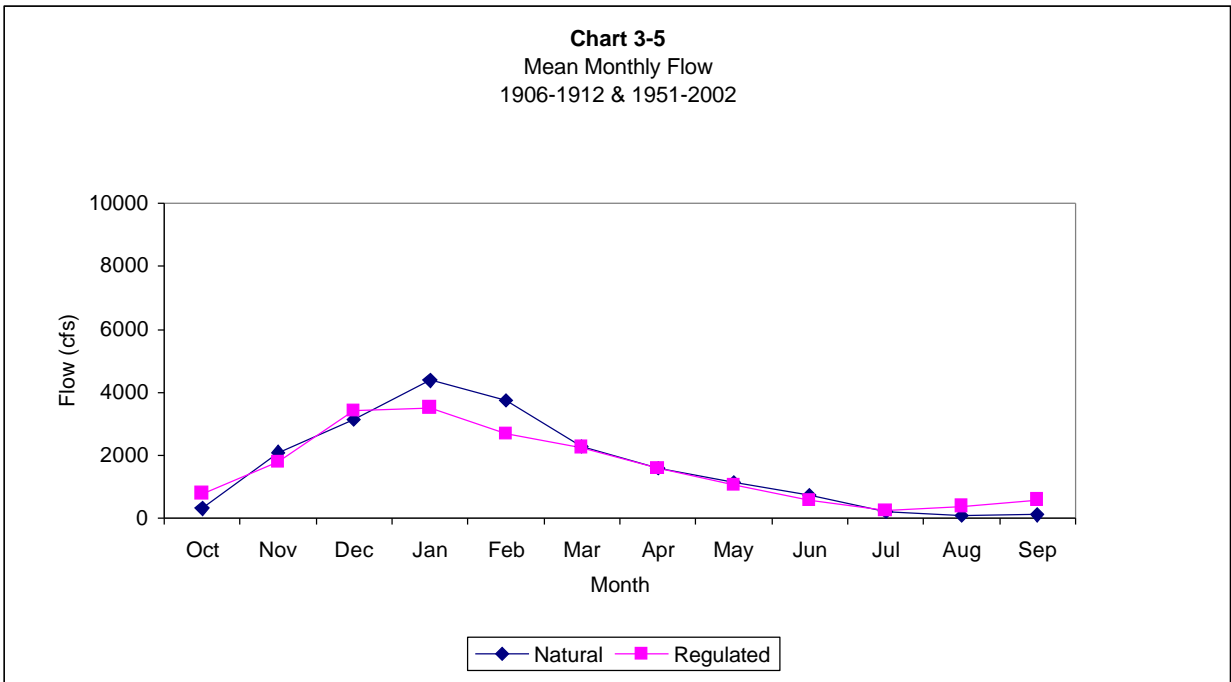


Chart 3-5



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As noted in **chart figure 3-5**, regulated spring flows during the period of frog development are 70-80% of the natural flow level. Some areas that formerly flooded

every spring may no longer be flooded at all or may be much smaller in extent. Conversely, since the regulated summer flow is quadruple what it was naturally in September and October; many areas that would have formerly dried up may remain wet on the surface and thus facilitate the survival of the frog's predators.

In addition to favoring the persistence of some exotic species, elevated summer water levels also reduce plant root depth by raising the water table. This can make trees more vulnerable to blowdown.

The ecological consequences of other aspects of changes to flow patterns have not been fully analyzed. However, one may speculate that the shift in timing or the rapid decrease in average flow may indeed have multiple ecological effects. Under natural conditions, average flow dropped rapidly in May as snow melt and rainfall simultaneously declined. This is a time of rapid vegetation growth along the land/water fringe area call the "littoral zone", as well as the time of seed dispersal for cottonwood and willow. Under the regulated flow regime, the river stage drops rapidly in the middle of winter, between January and February, months before any of these other ecological events, which were formerly coincident with the changing river stage, occur. The rapid mid-winter decline in flow may also disrupt the primary productivity of the river ecosystem as large areas of riverbed algae are desiccated by exposure to the air.

3.7 Floodplain Restoration Potential

Many valuable floodplain features such as islands, bars, sloughs, braided channels, and riparian woodlands still exist along the river. Physical manipulation of the landscape for improved flood detention, such as reconnecting side channels, creating alcoves and backwaters should be undertaken but must be considered in the context of the current flow regime.

The present system of regulating dams and reservoirs in the Willamette basin does provide at least one advantage over natural conditions that can be utilized for restoration purposes. Modest flood spikes can be created separately at different times in different river systems, thus creating a localized river response while avoiding the cumulative downstream flood effects that a large storm event would produce.

3.8 Water Use

The quantity of water used in a basin is important because overuse can lead to dry streams. Surface water is the source of current water use by primary water right holders. What we know about water usage in the LCFW basin is based on permitted water rights through the Water Resources Department (WRD). **Table 3-8** shows a summary of these uses in the LCFW Basin.

Table 3-8 Permitted Water Usage

	Cubic Feet per Second	Acre-Feet	Percent Usage

Irrigation	90.19	316.84	52.68%
Fish/wildlife	0.6	0	0.35%
Agriculture	3.31	0	1.93%
Industrial	43.41	0	25.36%
Municipal	31.7	0	18.52%
Domestic	1.04	0	0.61%
Recreation	0.25	0	0.15%
Misc.	0.7	0	0.41%

Agriculture

Water use in the LCFW watershed follows a pattern found in many watersheds, with irrigated agriculture placing the greatest demand on the water resources. In the LCFW watershed irrigation accounts for 52.68% of water usage in the basin.

Urban

In urban settings, water providers for residential, commercial and some industrial uses. Water is diverted, treated and then distributed throughout the municipality. The city of Creswell obtains its water from the Coast Fork Willamette River. Creswell's wastewater is treated and returned to the Coast Fork Willamette River.

Interbasin Transfers

There is no inter-basin transfer of water affecting the Lower Coast Fork Willamette River.

Water Availability

Water available for future use is determined by the Oregon Water Resources Department (OWRD) based on the natural streamflow minus consumptive use from both out-of-stream and in-stream water rights. Currently, no new permits are being issued for withdrawal from natural surface flows.

3.8 Conclusions

The following actions may be considered to help reduce human impact on hydrology:

- Reduce or prevent the creation of more impervious surfaces.
- Reduce or prevent the creation of more stream channelization.
- Allow flooding into adjacent wetland habitat in areas where wetlands have become disconnected from streams.
- Monitor stream flow to become aware of seasonal low flow problems.