APPENDIX I - 2-YEAR, 7-CONSECUTIVE DAY LOW FLOWS

1.0 Introduction

The 2-year 7-consecutive day low flow discharge can be calculated by methods in this Appendix. This is minimum daily discharge expected for at least seven consecutive days during the dry season during an average year. This flow is often used as the low flow design discharge for fish passage design, as discussed in the "Oregon Department of Fish and Wildlife (ODFW) "Guidelines and Criteria for Stream-Road Crossings."

The 2-year 7-consecutive day low flow is one of two low flow design discharges mentioned in the ODFW Guidelines. The 95 percent exceedance flow is the other discharge for this purpose. These two discharges are different in an important aspect. The 2-year 7-consecutive day low flow represents discharges during the driest part of the year, and the 95 percent exceedance discharge can be calculated for any month of the year. As a consequence, exceedance discharges, rather than the 2-year 7-day low flow, are used for facilities designed to pass fish on ephemeral (intermittent) streams.

Two methods to calculate the 2-year 7-day low flow discharge are presented in this Appendix, as follows:

- gage data from nearby basins, and
- USGS regression equations.

Both methods calculate similar discharges at some locations. The two methods may also calculate different discharges at other locations, and it is necessary to determine which calculated discharge, if any, is appropriate and realistic. In addition, neither of the two methods considers consumptive use or water storage in the upstream watershed. Two additional procedures are included to aid the selection of the appropriate discharge and to provide information about upstream consumptive use and storage. They are:

- water use and low flow estimates based on OWRD data, and.
- parol evidence.

Experience has shown that neither of the two calculation methods provides realistic results in all locations. Both procedures should be used during each application.

2.0 Limitations of Predictions

Discharges throughout the dry season are extremely difficult to predict using statistics from nearby watersheds or regression equations. Dry season discharges can be strongly influenced by many factors, such as:

- climatic conditions such as rainfall, snowpack, and evaporation,
- the amount and type of vegetation in the riparian areas (vegetated riparian areas tend to sustain dry season flows),
- diversions to or from the subject stream,
- infiltration into exceptionally pervious rock formations or streambed materials,
- water entering the stream from springs and seeps,
- release or retention of streamflow in storage reservoirs, and
- consumptive uses such as livestock watering or irrigation.

The prediction methods can often overestimate dry season discharges in smaller watersheds. The statistical distributions used to develop the regression equations and the low flow statistics are based on gage data. Almost all of these gages are on larger streams that flow throughout the year. As a consequence, discharge estimates based on the equations and statistics often predict there will be discharge throughout the year. This may not be the case in many smaller watersheds.

The streams draining smaller basins may be dry through portions of the year for various reasons. In some instances, streamflow ceases during the winter when the upstream watershed freezes. In other cases, there is limited or no flow during portions of the dry season. Decreased summer flows can be caused by consumptive uses or diversions upstream, or lack of runoff or water percolating into the stream from the aquifer.

Information on water use and parol evidence is used to determine if streamflow ceases during portions of the year. This evidence supplements the calculation results.

3.0 Nearby Gage Data Method

Two-year 7-consecutive day low flow discharges have been calculated by the United States Geological Survey (USGS) for many gaged basins in Oregon. The information is presented in the 1993 USGS Open-File Report 93-63 titled “Statistical Summaries of Streamflow Data in Oregon: Volume 2 – Annual Low and High Flow, and Instantaneous Peak Flow.” Data from this publication for western Oregon is summarized in Table A. Data for eastern Oregon is summarized in Table B.

Two-year 7-consecutive day low flow discharge information for gaged basins in Washington State near the Oregon border is in USGS Open-File Reports 84-145A and 84-145B. The two reports are Volumes 1 and 2 of the 1985 report titled: “Streamflow Statistics and Drainage-Basin Characteristics for the Southwestern and Eastern Regions, Washington.” Volume 1 covers southwestern Washington, and Volume 2 included the eastern half of the state.

Two-year 7-conecutive day low flow statistics for gaged basins in Idaho near the Oregon border are in the USGS Water Resources Investigations Report 94-4069 titled: "Statistical Summaries of Streamflow Data for Selected Gaging Stations in Idaho and Adjacent States Through September 1990 – Volume 1: Gaging Stations with 10 or More Years of Record. This report was published in 1996.

The listed discharges are valid for the gage locations during the periods of record. These periods are listed in the tables. The discharges will likely represent flows at the gage locations in the future if the upstream watershed characteristics are similar to conditions during the period of record. The listed discharges can also be used to predict flows from nearby basins with similar watershed characteristics.

Many watershed characteristics influence 2-year 7-consecutive day low flow. Several characteristics that significantly affect low flow were determined during the 1970 USGS study by David J. Lystrom titled "Evaluation of the Streamflow-Data Program in Oregon." This is the study that developed the regression equations. The watershed characteristics analyzed in the study that most significantly influenced 2-year 7-consecutive day low flow discharges were:

- Drainage Area (statewide),
- Storage (eastern Oregon),
- Mean Basin Elevation (western Oregon),
- Forest Cover (eastern Oregon),
- Annual Precipitation (statewide),
- Temperature Index (western Oregon), and
- Soils Index (eastern Oregon).

These characteristics are listed in Table A and Table B for gaged watersheds with low flow statistics. This will help determine if the nearby gaged basins resemble the basin to be analyzed. These characteristics are defined in more detail in Subsection 4.1.

3.1. Sites Near Gages

The 2-year 7-day low flow statistics from Table A or Table B can be used if the site to be analyzed is on the stream, near the gage, and the upstream watershed characteristics are similar to those during the period of record. The discharges should be adjusted considering water use and storage during the driest month. Water use and storage are listed in the OWRD Water Availability Report. As an example, the gage data period of record extends from 1948 through 1964. The 2-year 7-day low flow discharge listed in Table B is based on conditions during this period of record. A municipal water supply intake was built in 1974 and it uses water from the stream during the driest month. This water use is expected to occur throughout the dry season with minimal fluctuation. The municipal consumptive use needs to be subtracted from the low flow discharge listed in Table B.

Note: Intermittent or fluctuating consumptive uses through the dry season such as irrigation or domestic use would not be subtracted from the natural stream flow.

3.2. Sites Away from Gages

Two-year 7-consecutive day low flow statistics from similar nearby watersheds can be used to estimate discharges in the subject watershed with the following procedure.

Step 1 - Determine if the watershed is in western or eastern Oregon using Plate 1. Determine the watershed characteristics listed in Section 3.0. These characteristics will also be used in the regression analysis. Procedures to calculate these characteristics are in Section 4.1.

Step 2 - Look in Tables A or B to find nearby watersheds with similar characteristics. Read the "Remarks." The Remarks will mention if discharges from the gaged watershed are significantly affected by storage or diversions. Low flow statistics from these gages should not be used for estimates at nearby sites. Note the nearby gaged basins with suitable characteristics, their 2-year 7-day low flows, and their drainage areas.

Step 3 - Calculate the 2-year 7-day low flow per square mile of drainage area for suitable nearby basins. This is the "yield" from each basin.

Step 4 - Plot the yield determined in Step 3 for each basin versus its drainage area. Estimate the relationship between yield and drainage area for the nearby basins using a line or curve.

Step 5 - Estimate the yield from the subject watershed based on the line or curve drawn in Step 4.

Step 6 - Calculate the 2-year 7-day low flow by multiplying the estimated yield from Step 5 by the subject basin watershed area determined in Step 1, as follows:

2-year 7-day discharge in cubic feet per second = (2-year 7-day yield in cubic feet per second per square mile) x (basin area in square miles)

Step 7 - Consider consumptive uses or storage, as discussed in Section 5.0 of this Appendix. Adjust discharges as needed to account for consumptive uses or storage.

3.3. Example of Nearby Gage Data Method

Miner Creek is a small coastal stream in southwest Oregon near Coos Bay. The 2-year 7-consecutive day low flow will be calculated from nearby gage data.

Step 1 - The basin is in western Oregon, based on Plate 1. The watershed characteristics are determined by the methods for the regression equations. It has the following characteristics:

- Drainage Area = 1.1 square miles
- Mean Basin Elevation = 216 feet
- Mean Annual Precipitation = 60 inches
- Temperature Index = 39 degrees Fahrenheit

Step 2 - Nearby watersheds are identified in Table A, as follows. 2-year 7-day low flows are listed for the gages selected for the remainder of the procedure.

Gage 14323200 Tenmile Creek near Lakeside, drainage area = 87 square miles, mean basin elevation = 502 feet, mean annual precipitation = 80 inches, and temperature index = 36 degrees Fahrenheit. Remarks: “Flow affected by natural storage in Tenmile Lake and other lakes …”

Gage 14324500 West Fork Millicoma River near Allegany, drainage area = 46.9 square miles, mean basin elevation = 1,220 feet, mean annual precipitation = 91 inches, and temperature index = 34.0 degrees Fahrenheit. Remarks: “No regulation. Only minor diversions upstream from station.” 2-year 7-day low flow = 3.9 cubic feet per second

Gage 14326800 North Fork Coquille River near Fairview, drainage area = 73.9 square miles, mean basin elevation = 800 feet, mean annual precipitation = 75 inches, and temperature index = 34 degrees Fahrenheit. Remarks: “No regulation. Several diversions for irrigation upstream from station.”

Gage 14324600 South Fork Coquille River above Panther Creek near Illahe, drainage area = 31.2 square miles, mean basin elevation = 2,860 feet, mean annual precipitation = 85 inches, temperature index = 34 degrees Fahrenheit. Remarks: “No regulation or diversion upstream from station.” 2-year 7-day low flow = 1.6 cubic feet per second

Gage 14234700 South Fork Coquille River near Illahe, drainage area = 40.6 square miles, mean basin elevation = 2,780 feet, mean annual precipitation = 90 inches, temperature index = 34 degrees. Remarks: “No regulation or diversion upstream from station.” 2-year 7-day low flow = 2.3 cubic feet per second

Gage 14324900 South Fork Coquille River near Powers, drainage area = 93.2 square miles, mean basin elevation = 2,420 feet, mean annual precipitation = 92 inches, temperature index = 35 degrees Fahrenheit. Remarks: "No regulation or diversion upstream from station." 2-year 7-day low flow = 13 cubic feet per second.

Not all of the gages provide suitable data to predict discharges at Miner Creek. Gage 14323200 is near the outlet of a chain of large lakes. Gage 14326800 is downstream from irrigation diversions. This may significantly influence the low flow discharges, and they may not represent the Miner Creek Basin. Data from these gages are not used. 2-year 7-day low flow data from the remaining four gages will be used.

Note: 2-year 7-day low flow statistics for Gages 14323200 and 12326800 in Table A can be used for sites at or near these gages, only.

Step 3 - The 2-year 7-day low flow yield is calculated for the nearby basins as follows:

Gage 14324500, $$\frac{\text{2 - year 7 - day low flow}}{\text{drainage area}} = \frac{3.9}{46.9} = 0.083 \text{ cubic feet per second per sq mile}$$

Gage 14324600, $$\frac{1.6}{31.2} = 0.051 \text{ cubic feet per second per square mile}$$

Gage 14324700, $$\frac{2.3}{40.6} = 0.057 \text{ cubic feet per second per square mile}$$

Gage 14324900, $$\frac{13}{93.2} = 0.013 \text{ cubic feet per second per square mile}$$

Step 4 - The basin yields versus their respective drainage areas are plotted. A straight line linear interpolation is used to determine the 2-year 7-day low flow relationship for the nearby basins, as shown in Figure 1. Use of a straight line interpolation program is recommended, rather than "by hand and eye" manual interpolation estimates.

Step 5 - The straight line interpolation equation is shown on the printout. Miner Creek basin yield is calculated using the straight line interpolation equation as follows:

x = Miner Creek basin area = 1.1 square miles

2-year 7-day low flow yield = 0.0014x + 0.0063 = [(0.0014)(1.1)] + 0.0063 = 0.0078 cubic feet per second per square mile

Step 6 - Miner Creek 2-year 7-day low flow is calculated as follows:

2-year 7-day low flow = 0.0078 x 1.1 = 0.0086 cubic feet per second.

Note: The low flow estimate is based on an extrapolation of data from much larger basins. There is potential for considerable error when a prediction is based on an extrapolation of this type. This should be considered when comparing the results of *different methods prior to the final discharge estimate.*

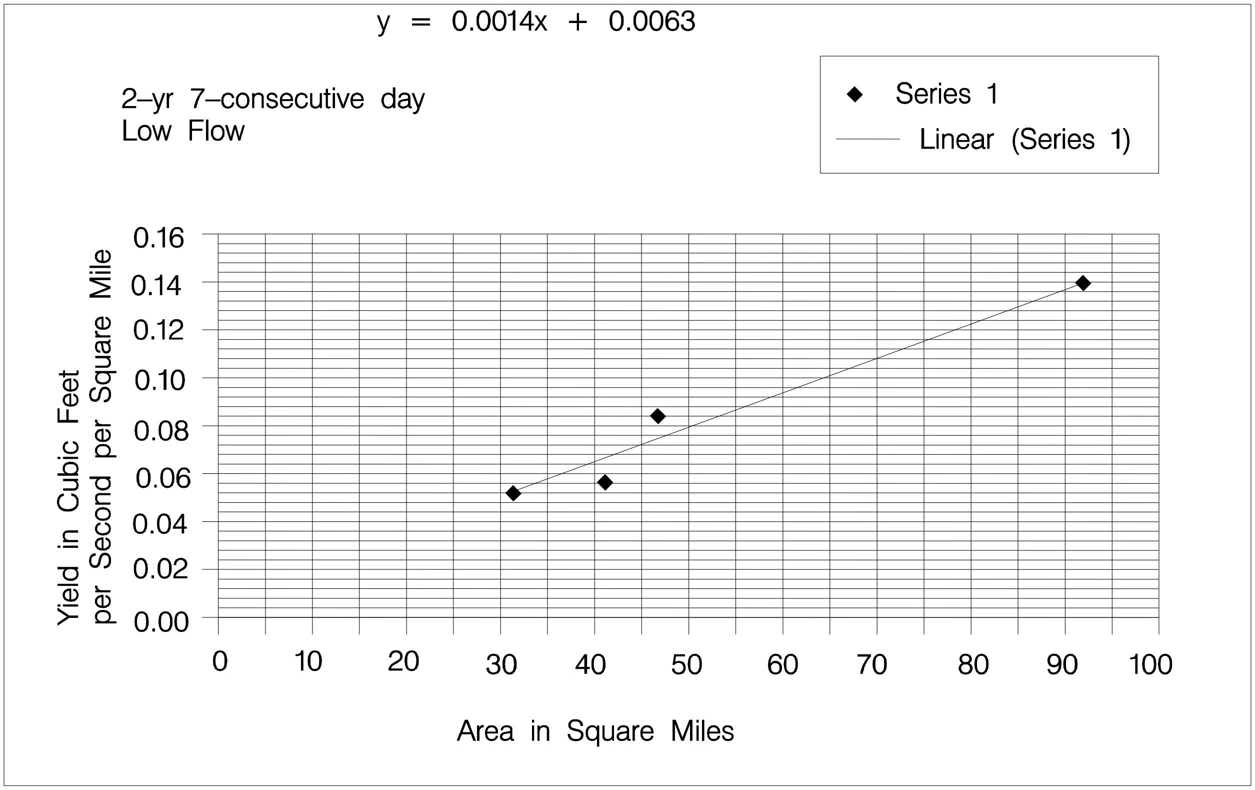

Figure 1 2-Year 7-Consecutive Day Low Flow Relationship for Basins near Miner Creek

Step 7 - The nearby gages used in the analysis are on streams with little or no consumptive uses or upstream storage. Consumptive uses and storage need to be considered. An OWRD Water Availability Report is available for a location on Miner Creek near the highway crossing. See Section 5.0 of this appendix. It lists a consumptive use of 0.01 cubic feet per second during the driest months. No discharge is reserved for streamflow from this consumptive use. The 2-year 7-day low flow discharge considering consumptive use is:

2-year 7-day low flow considering consumptive use = 0.0086 – 0.01 = -0.0014 cubic feet per second.

Note: A negative discharge value indicates there will be no stream flow.

These uses are for domestic consumption and irrigation. They may fluctuate throughout the dry season. As a result, using the nearby gage method, the natural discharge of 0.01 cubic feet per second would be listed as the 2-year 7-consecutive day low flow. Notes will be included that state the creek may be dry for at least seven consecutive days due to upstream water use.

Note: This is the result of the nearby gage method. The regression equation method will also be used, and the answers compared to parol evidence.

4.0 USGS Regression Equations

The United States Geological Survey (USGS) has developed low flow regression equations for Oregon. The equations with a detailed description of their derivation and use are in the 1970 USGS Open-File Report by David J. Lystrom titled "Evaluation of the Streamflow-Data Program in Oregon."

These equations are valid for natural streams with basin characteristics similar to typical streams in the area with little or no flow diversion into or from the upstream basin. The equations and a description of the input variables follow.

4.1. Equations and Input Variables

There are regression equations for western and eastern Oregon, and the boundary between the two regions is approximately at the crest of the Cascade Mountains. The two regions are shown in Plate 1. The equation for western Oregon is:

$$Q_{2\text{-yr, }7\text{-day}} = 2.82 \times 10^{3} (A^{1.124}) (E^{0.645}) (P^{1.255}) (T^{-4.716}) \quad \text{(Equation 1)}$$

The standard error of estimate is 65 percent.

The equation for eastern Oregon is:

$$Q_{2\text{-yr, }7\text{-day}} = 2.50 \times 10^{-4} (A^{0.745}) (St^{-2.315}) (F^{-2.685}) (P^{5.117}) (S_i^{1.586}) \quad \text{(Equation 2)}$$

The standard error of estimate is 182 percent.

Where:

$Q_{2\text{-yr, }7\text{-day}}$ = Annual minimum 7-day mean daily low flow with a 2-year (average annual) recurrence interval in cubic feet per second (cfs)

A = Drainage area in square miles (mi^2). Usually the drainage area is delineated on a USGS 7-1/2 minute quadrangle map and measured with a planimeter.

St = Area of lakes and ponds expressed as a percentage of drainage area plus 1 percent, as shown on the most recent quadrangle maps. For example, drainage basins with lakes and ponds covering 0 percent and 5 percent of their surface area would have St values of 1 and 6, respectively.

E = Mean basin elevation above sea level in feet, determined from a quadrangle map of a practical scale by laying a grid over the map, recording the elevation at each grid intersection, and averaging these elevations. The grid spacing should be selected to give at least 25 intersections within the basin boundary.

F = Forest cover expressed as a percentage of the drainage area covered by forests plus 1 percent, as shown on the most recent quadrangle map. As an example, drainage basins with 0 percent and 66 percent of their surface area covered by forest would have F values of 1 and 67, respectively.

P = Mean annual precipitation, as shown on Plate 2 of this Appendix, in inches.

T = Temperature index, T, is the mean minimum January air temperature as shown on Plate 3 of this Appendix, in degrees Fahrenheit.

S_i = Soil index. The first step in determining the soil index is to calculate the runoff curve number "CN" using methods in NRCS publications Technical Release No. 55 “Urban Hydrology of Small Watersheds" and "Oregon Engineering Handbook - Hydrology Guide." Copies of these publications are included in Appendix G of this chapter. The second step is to calculate the soil index as follows:

$$S_i = \frac{1000}{CN} - 10 \qquad \text{(Equation 3)}$$

Example:

The runoff curve number (CN) was determined from data in the Malheur County Soil Survey using NRCS methods. CN = 63. The Soil Index (S_i) was calculated using Equation 3 as follows:

$$S_i = \frac{1000}{63} - 10 = 59$$

4.2. Procedure

The regression equation procedure is to determine the input variables, enter the variables into the equation, and calculate the 2-year, 7-consecutive day low flow. The calculated discharge is adjusted to account for consumptive uses and storage, if needed. Example calculations for the Miner Creek basin follow.

4.3. Example of USGS Regression Equation Method

The 2-year 7-consecutive day low flow is to be calculated for Miner Creek using the USGS regression equations.

Step 1 – The basin is in western Oregon based on Plate 1. The western Oregon regression equation input variables are determined. The drainage area (A) is delineated on a 7.5-minute USGS quadrangle map and it is measured with a planimeter.

$$A = 1.1 \text{ square miles}$$

The mean basin elevation is determined by drawing a grid across the drainage basin outlined on the USGS quadrangle map. There are 32 data points within the basin. The average elevation is 216 feet.

$$E = (430 + 440 + 360 + 355 + 355 + 400 + 280 + 360 + 245 + 160 + 210 + 320 + 205 + 155 + 285 + 300 + 50 + 110 + 200 + 215 + 220 + 40 + 165 + 70 + 155 + 205 + 85 + 80 + 30 + 130 + 205 + 85) / 32) = 216 \text{ feet}$$

$$E = 216 \text{ feet}$$

Mean Annual Precipitation (P) is determined from Plate 2.

$$P = 60 \text{ inches}$$

The Temperature index is determined from Plate 3.

$$T = 39 \text{ degrees Fahrenheit}$$

Step 2 - The input variables determined in the first step are entered into the regression equation and the equation is solved. Using Equation 1, the western Oregon regression equation, the 2-year 7-consecutive day low flow is:

$$Q_{2\text{-yr, 7-day}} = 2.82 \text{ x } 10^{3} \, (1.1^{1.124}) \, (216^{0.645}) \, (60^{1.255}) \, (39^{-4.716}) = 0.54 \text{ cfs}$$

The lowest discharge within the standard error of prediction is:

$$0.54 - \left[\left(\frac{65}{100}\right)(0.54)\right] = 0.19 \text{ cubic feet per second}$$

The highest discharge within the standard error of prediction is:

$$0.54 + \left[\left(\frac{65}{100}\right)(0.54)\right] = 0.89 \text{ cubic feet per second}$$

Consumptive use and storage is considered. These uses are based on OWRD information and parol evidence. See Section 5.0 of this Appendix. An OWRD Water Availability Report is available for a location on Miner Creek near the highway crossing. It lists a consumptive use of 0.01 cubic feet per second during the driest month. This use is for domestic consumption and irrigation. No discharge is reserved for streamflow from this use. The 2-year 7-day low flow discharge considering consumptive use is:

2-year 7-day low flow considering consumptive use = 0.54 – 0.01 = 0.53 cubic feet per second.

This upstream consumptive use may fluctuate throughout the dry season. As a result, using the regression equation method, the Miner Creek discharge would be reported as the 0.54 cubic foot per second natural discharge. Notes accompanying this discharge state it could drop to 0.53 cubic feet per second due to upstream consumptive use.

5.0 Discharge and Water Use Estimates Based on OWRD Data

The Oregon Water Resources Department (OWRD) calculates water availability, including discharges, at selected locations throughout the state. These discharges are posted on their website: https://www.oregon.gov/owrd/Pages/index.aspx The OWRD water availability study is described in the August 2002 Technical Report by Richard M. Cooper, P.E. titled “Determining Surface Water Availability in Oregon.” This report is available from the OWRD.

The water availability is calculated at selected sites for the monthly 50 and 80 percent mean daily exceedance discharges. These sites are at the outlets of Water Availability Basins. The 80 percent exceedance discharge is the mean daily flow expected to be exceeded during the subject month, at least 80 percent of the time, on a daily basis. The 80 percent exceedance flow can also be described as the mean daily discharge expected to be exceeded approximately 24 days in a typical month. The 50 percent exceedance flow is larger than the 80 percent exceedance discharge. It is the discharge expected to be exceeded at least 15 days each month.

The 80 percent discharge for the driest month of the year is the more similar of the two exceedance flows to the 2-year 7-consecutive day low flow. It is not identical to the 2-year 7-day daily low flow. It provides a similar discharge to compare to the flows calculated by methods in Sections 3.0 and 4.0 of this appendix. This will aid the selection of the appropriate calculated discharge.

The OWRD printouts provide data about expected discharges and upstream water use for each month at the outlet of the water availability basin. These discharges are, as follows.

- The "Natural Stream Flow" is the estimated discharge that would occur from the watershed in natural conditions without consumptive uses, diversions, or storage. It is an estimate of "prehistoric" discharges.

- The "Expected Stream Flow" is the calculated discharge if consumptive uses are fully realized. The expected streamflow may be less than the discharge currently occurring because the upstream water rights are not fully utilized.

- The "Reserved Stream Flow" is the discharge reserved from-out-of-stream consumptive uses and storage. It is often reserved for in-stream uses such as navigation, power generation, scenic qualities, or aquatic habitat.

- The "Instream Water Rights" are a summation of the discharge allotted to upstream water users based on existing water rights.

- The "Net Water Available" is the discharge at the outlet of the water availability basin if all upstream users exercise their water rights. A positive value of Net Water Available indicates there would be discharge in the stream, approximately 24 days out of the month, during an average year. A negative value indicates there is insufficient water in the stream to fulfill all upstream water rights during the preceding conditions.

Often the basin used in the OWRD analyses is a different size than the basin upstream from the project site. The 80 percent exceedance discharges listed in the OWRD report can be adjusted to represent the project site as follows:

$$Q_{(adjusted)} = Q_{(in\ report)} \left(\frac{Area_{(project)}}{Area_{(in\ report)}} \right)^{1.02} \qquad \text{(Equation 4)}$$

Where:

$Q_{(adjusted)}$ = 80 percent exceedance discharge at project site in cubic feet per second,
$Q_{(in\ report)}$ = 80 percent exceedance in OWRD report in cubic feet per second,
$Area_{(project)}$ = Drainage area upstream from project in square miles, and
$Area_{(in\ report)}$ = Drainage area in OWRD report in square miles.

Note: The preceding method is applicable where the watershed upstream from the project site are on the same stream and they both have similar watershed characteristics such as land use and elevation.

Use of OWRD data to estimate low flow is shown in the following example.

5.1. Example of Use of OWRD Estimates

The Miner Creek Basin is selected on the interactive mapping section of the OWRD website. The outlet of the OWRD water availability basin is at the creek's confluence with the Pacific Ocean. This is approximately 500 feet downstream from the highway crossing. The consumptive uses and storage in the report are assumed to represent uses and storage in the watershed upstream from the highway crossing. Three reports are available:

- Peak Discharges for Selected Frequencies,
- Water Availability Table (50 percent exceedance), and
- Water Availability Table (80 percent exceedance).

The basin characteristics are listed in the Peak Discharge report. The characteristics for Miner Creek are shown in Figure 2.

SELECTED UNGAGED WATERSHED CHARACTERISTICS

Drainage area	(square miles)	0.67
Mean watershed elevation	(feet)	169.00
Mean watershed slope	(percent)	4.36
Precipitation intensity	(inches/hour)	2.89
January precipitation	(inches)	10.20
Minimum January Temperatures	(degrees F)	38.40
Maximum January Temperatures	(degrees F)	52.80
Depth to Bedrock	(inches)	55.20

Figure 2 Miner Creek Basin Characteristics From OWRD Website

The 80 percent exceedance discharges listed in the Water Availability Table for Miner Creek are shown in Figure 3. The months of the year are listed in the first column, and the natural stream flows are listed in the second column. The driest months of the year are September and October with a discharge of 0.03 cubic feet per second.

The Miner Creek drainage basin upstream from the highway crossing is 1.1 square miles, based on the USGS quadrangle map. The Miner Creek basin used in the OWRD analyses is 0.67 square miles. The natural stream flows in the OWRD report are adjusted to account for the different drainage areas using Equation 4 as follows:

$$Q_{(\text{adjusted})} = 0.03\left(\frac{1.1}{0.67}\right)^{1.03} = 0.05 \text{ cubic feet per second}$$

The OWRD report lists no effects on discharge due to upstream storage. A 0.01 cubic foot per second loss is predicted during the drier months due to consumptive use. The 80 percent exceedance discharge adjusted to account for consumptive use is:

80 percent exceedance discharge with consumptive use = 0.05 – 0.01 = 0.04 cubic feet per second
The 80 percent exceedance discharge, based on OWRD estimates, will fluctuate between 0.05 and 0.04 cubic feet per second, depending on consumptive use.

DETAILED REPORT ON THE WATER AVAILABILITY CALCULATION
Water Availability as of 11/03/2003 for
MINER CR > PACIFIC OCEAN – AT MOUTH

Watershed ID #:72506 Basin: SOUTH COAST Exceedance Level: 80
Time: 12:29 Date: 11/03/2003

Month	Natural Stream Flow	CU + Stor Prior to 1/1/93	CU + Stor After 1/1/93	Expected Stream Flow	Reserved Stream Flow	Instream Water Rights	New Water Available
1	1.37	0.00	0.00	1.37	0.00	3.00	-1.63
2	1.89	0.00	0.00	1.89	0.00	3.29	-1.40
3	1.39	0.00	0.00	1.39	0.00	2.35	-0.96
4	0.88	0.00	0.00	0.88	0.00	1.43	-0.55
5	0.43	0.01	0.00	0.42	0.00	0.62	-0.20
6	0.20	0.01	0.00	0.19	0.00	0.43	-0.24
7	0.09	0.02	0.00	0.07	0.00	0.18	-0.11
8	0.04	0.01	0.00	0.03	0.00	0.08	-0.05
9	0.03	0.01	0.00	0.02	0.00	0.04	-0.02
10	0.03	0.00	0.00	0.03	0.00	0.04	-0.01
11	0.13	0.00	0.00	0.13	0.00	0.42	-0.29
12	0.94	0.00	0.00	0.94	0.00	2.37	-1.43
Stor	862	5	0	857	0	854	5

(Discharges for driest months are included in box.)

Figure 3 Miner Creek 80 Percent Average Daily Exceedance Discharges for Each Month

6.0 Parol Evidence

Calculations provide discharge quantities, but they often do not accurately describe when, why, and how often water flows in intermittent or ephemeral streams, ditches, or canals. Parol evidence is also needed to estimate low flow discharges. It often accurately describes when water is present, the sources of water, and how often flow occurs. Parol evidence can also be the best source for information about irrigation flows and other regulated discharges. Parol evidence is obtained by interviewing people familiar with the waterway, such as:

- ODOT maintenance personnel,
- local watermasters,
- Oregon Department of Fish and Wildlife personnel, and
- local residents.

Typical questions to ask are:

- What are the lowest summer flows during a typical year?
- What is the lowest flow that will occur for a week or so during a typical year?
- What flows through the site during the summer? Rainfall runoff? Irrigation flow? Springwater?
- Is there more or less water flowing through this site than other typical creeks with similar watershed sizes in the area?
- Are there upstream diversions into or out of the creek?

Parol evidence should be recorded along with information such as the contact's address, phone number, etc. It is good practice to obtain information from several sources. Parol evidence is often supported by correspondence, photographs, and in some cases, survey marks. This supporting evidence should be copied or retained as needed.

Parol evidence along with OWRD data should be used to determine if water is reserved during the dry season for in-stream uses such as navigation, scenic qualities, power generation, or fish habitat. Water is often reserved during the dry season for dilution of pollutants downstream from wastewater treatment facilities. This should be investigated when parol data is collected.

6.1. Example of Parol Evidence Method

People familiar with Miner Creek are asked about its summer flow characteristics. They state the creek does not normally dry up through the summer. In addition, they describe flows of less than one cubic feet per second when asked about the amount of low flow discharge during the summer.

7.0 Determining 2-Year 7-Consecutive Day Low Flow Discharge

The calculation methods sometimes produce similar results. In this case it is necessary to verify the results are reasonable. Often the two calculation methods provide different results. In these instances it is necessary to verify which result is realistic and reasonable. This is done during this step in the hydrology process. It is accomplished by comparing the results of the two calculation methods against each other, and against the estimate based on OWRD data and the parole evidence.

7.1. Example of Determining 2-Year 7-Consecutive Day Low Flow Discharge

The 2-year 7-day low flow discharges for Miner Creek based on the two calculation procedures are summarized as follows:

Nearby gage method: 0.01 cubic feet per second without consumptive use
No flow with consumptive use

Regression equation method: 0.54 cubic feet per second without consumptive use
0.53 cubic feet per second with consumptive use

The similar 80 percent exceedance flow based on OWRD data is:

Estimate based on OWRD data: 0.05 cubic feet per second without consumptive use
0.04 cubic feet per second with consumptive use

Parol evidence method: Typical discharge less than 1 cubic foot per second at highway crossing, no dry periods.

The results of all the methods do not contradict observed discharges. Selection of discharge value would have to consider the purpose for which the answer would be used.

8.0 Reporting Discharge Estimates

Two-year 7-consecutive day low flow estimates are reported in narrative. These discharges are usually reported to two significant figures. Further guidance about rounding figures is in **Chapter 4**.

The first item mentioned in the narrative is the natural discharge from the watershed. This discharge is adjusted to account for diversions into and out of the watershed and consumptive

uses if they will be occurring throughout the dry season and they are not intermittent.
In some instances there is discharge reserved from consumption or diversion for in-stream uses such as navigation, power generation, scenic qualities, or aquatic habitat. The narrative should mention this. The narrative should also mention whether or not the calculated discharges are lower than the flow reserved for in-stream uses. It is not uncommon for this to occur in Oregon streams during the dry season.

The narrative should mention intermittent changes to the 2-year 7-consecutive day low flow due to storage regulation, diversions, or consumption. Estimates of these changes should be noted.

Parol evidence should be mentioned if it is needed to supplement the calculated discharges.

8.1. Example of Reporting Discharge Estimates

The natural discharge is reported as the 2-year 7-consecutive day low flow for Miner Creek. It is not adjusted to account for consumptive use because these uses are intermittent. It is reported as follows:

"The 2-year 7-consecutive day low flow for an average year, during the driest period, is estimated to be 0.05 cubic feet per second."

The consumptive uses may reduce this discharge. The following sentences are added to mention this:

"Consumptive uses up to 0.01 cubic feet per second are permitted in the upstream watershed. As a result, 2-year 7-consecutive day low flows are estimated to fluctuate between 0.05 and 0.04 cubic feet per second during the typical year."

Parol evidence indicates discharge is almost always present. This is mentioned as follows:

"People familiar with the waterway recall that it does not normally dry up during the summer."