APPENDIX J – MEAN DAILY EXCEEDANCE DISCHARGES

1.0 Introduction

The mean daily exceedance discharges for any month can be calculated by methods in this Appendix. These discharges are used in temporary water management and fish passage design. The discharges most often used are the 5, 10, 25, 50, or 95 percent exceedances.

5 Percent Exceedance - The mean daily discharge, during an average year, is expected to exceed this flow on 5 percent of the days during the specified month. This is 1 or 2 days a month. This discharge is used to design temporary water management facilities providing a low risk of failure. An example would be a roadway detour culvert on a major highway, where there would be considerable cost and inconvenience if the pipe would wash out or the road overtopped. This is the largest of the five exceedance flows.

10 Percent Exceedance - The mean daily discharge during an average year is expected to exceed this flow on 10 percent of the days during the specified month. This is 3 days a month. This discharge is used as a high flow design discharge in fish passage design, as discussed in the Oregon Department of Fish and Wildlife (ODFW) “Guidelines and Criteria for Stream-Road Crossings.”

25 Percent Exceedance - The mean daily discharge, during an average year, is expected to exceed this flow on 25 percent of the days during the specified month. This is 7 or 8 days a month. This discharge is used to design temporary water management facilities having a normal risk of failure. An example would be a dam diverting water into a bypass pipe around a project. Occasional overtopping of the dam may be tolerable, and the riparian impacts of a larger structure may not be desired. This is also the typical discharge used to estimate facility sizes in engineer’s cost estimates.

50 Percent Exceedance - The mean daily discharge, during an average year, is expected to exceed this flow on half of the days during the specified month. This is about 15 days a month. This discharge is used in cost estimates more often than design. For example, a pump may be selected that is capable of conveying the 5 or 25 percent exceedance discharge, but its estimated monthly fuel costs may be based on conveying the 50 percent exceedance flow.

95 Percent Exceedance - The mean daily discharge during an average year is expected to exceed this flow on 95 percent of the days during the specified month. This is 29 days a month. This discharge is occasionally used in temporary water management. It is most often used as low flow design discharge in fish passage design, as discussed in the ODFW Guidelines. This is the smallest of the five exceedance flows.

The 95 percent exceedance is one of two low flow design discharges recommended in the Guidelines. The other is the 2-year, 7-consecutive day low flow. These two low flows are different in an important way. The 95 percent exceedance discharge can be calculated for any month of the year. The 2-year 7-consecutive day low flow represents discharges during the driest part of the year.

Exceedance discharges, both 10 and 95 percent, are often used for analysis of fish passage during migration because they can be calculated for specific months of the year. These are the only discharges that can be practically used to design installations on ephemeral streams with insufficient water for fish passage during the dry season.

2.0 Limitations of Method

Daily discharges are often extremely difficult to accurately predict using statistics from nearby watersheds. Local watershed characteristics can strongly influence the discharge magnitude, and these characteristics are often unique to the subject basin. In addition, there are often substantial differences in discharges from year-to-year due to variability in climate and water use. Some factors that influence daily flows are:

- 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.

A prediction method based on gage data can often overestimate daily flows in smaller watersheds. Almost all of these gages used to develop the statistics are on larger streams that flow throughout the year. As a consequence, discharge estimates based on gage statistics will often predict discharge throughout the year. This may not be the case in many smaller ephemeral 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 a lack of runoff or water percolating into the stream from the aquifer.

Water use information and parol evidence is used to determine if streamflow ceases during portions of the year. This evidence is used to supplement the calculation results.

3.0 Exceedance Discharge Statistics

Exceedance statistics for Oregon gaged basins are available from many sources. Statistics for many basins have been calculated by the United States Geological Survey (USGS). The information is presented in the 1990 USGS Open-File Report 90-118 titled "Statistical Summaries of Streamflow Data in Oregon: Volume 1 – Monthly and Annual Streamflow, and Flow-Duration Values."

Exceedance statistics for Washington gaged basins near the Oregon border are in the USGS Open-File Reports 84-145-A and 84-145 B. 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 includes the eastern half of the state.

Exceedance statistics for stations in Idaho near the Oregon border are in the USGS Water-Resources Investigations Report 01-4093 titled "Estimating Monthly and Annual Streamflow Statistics at Ungaged Sites in Idaho." This report was published in 2001.

Exceedance statistics are also available on the Water Availability Report System (WARS) section of the OWRD website: https://www.oregon.gov/owrd/Pages/index.aspx This is the most complete compilation of Oregon exceedance statistics.

Exceedance statistics selected specifically for ODOT low flow discharge estimates are summarized in publications on the ODOT Geo-Environmental Section's Engineering and Asset Management Unit website. These statistics were compiled by OWRD or ODOT using WARS. There are booklets for each of the eighteen OWRD administrative drainage basins in Oregon. Use of this data is recommended. Remarks are included to describe the utility of the data. It is essential to review the remarks to verify that the statistics for a gaged basin are suitable to estimate discharges in a nearby watershed. The Remarks also note if the statistics are based on natural or measured stream flows.

The distinction between these two discharges is discussed in the following sections.

3.1 Natural Stream Flow Exceedance Statistics

Natural stream exceedance flows are derived from statistical distributions of mean daily discharge measurements at gage sites. The initial distribution of the measured discharges is normalized to account for wet or dry climatic cycles that may have occurred during the gage period of record. Further adjustments are made to account for upstream consumptive water use, storage, or diversions. The resulting natural stream flows are intended to represent discharges from the watershed in its natural prehistoric or predevelopment conditions. They can also be used to estimate natural discharges in other similar nearby watersheds. These adjustments are made by the OWRD. This process is discussed in detail in the August 2002 OWRD Open File Report SW 02-002 by Richard M. Cooper, P.E. titled "Determining Surface Water Availability in Oregon."

Upstream diversions, storage, or consumptive use need to be added or subtracted from the natural discharges to calculate discharges expected at the site. The remarks on the data tables, OWRD water use information, and/or parol evidence is used to estimate these additions or reductions.

3.2 Measured Stream Flow Exceedance Statistics

Measured stream exceedance flows are also derived from statistical distributions of mean daily discharge measurements at gages. These distributions are not normalized or adjusted. This data can be used to estimate discharges from nearby watersheds if natural flow data is not available. Care should be used when this is done. Measured stream flow statistics in the ODOT Mean Daily Flow Data books include the following.

- Exceedance statistics for gages on large and extensively regulated rivers such as the Columbia and Lower Willamette. This data is intended for use on these rivers near the gage locations. In most cases these statistics are based on long periods of record and they give good estimates of expected future conditions.

- Exceedance statistics for gages in neighboring states near the Oregon border. The selected sites are on streams with little or no upstream regulation, diversion, or consumptive use. Statistical distributions from these gages may be useful when sites near the state border are analyzed.

- Miscellaneous sites throughout the state. These distributions should be used with care. In many locations they are the best available data.

Storage, diversions, or consumptive uses also need to be considered when using measured stream flow data. This is done in a slightly different way than the procedure for natural stream flows. The differences in water use between the subject and nearby basins need to be added or subtracted from the discharges estimated from measured flow statistics. The remarks on the data tables, OWRD water use information, and/or parol evidence can used to estimate these additions or reductions.

4.0 Procedure

There are four parts to the exceedance discharge calculation procedure, and all are discussed in detail in the following sections. The first part is to determine natural or measured flow discharges for the desired exceedances. The next part is to determine discharge additions or reductions due to diversions or storage, and losses due to consumptive use. The last part is to use parol evidence to verify the calculated discharge is realistic, or to adjust the results of the calculations. In many instances the parol evidence will also provide information to be used in the second part. The fourth part is to report the discharges.

4.1 Estimating Exceedance Discharges Based on Natural or Measured Flow Statistics

The first part of the procedure is to calculate exceedance statistics for the subject watershed based on gaged basin data.

Step 1 - Outline the subject watershed on a map and measure the drainage area. Look in the appropriate ODOT Mean Daily Flow Data book to find gaged basins in the vicinity with similar watershed and climatic characteristics. The statistics from a gage in the subject or a single nearby basin can be adjusted and used if the watershed and climate characteristics are very similar. This is done in the first example.

Often there are no very similar basins nearby. In these instances, the statistics from at least three or more basins should be used. The basins should be as similar as possible to the subject basin. This is illustrated in the second example.

Selecting appropriate “similar nearby” basins requires considerable judgment and knowledge of Oregon climate. A similar nearby basin may be a hundred or more miles away if climatic and watershed conditions are similar to the subject basin. This occurs at many locations in Oregon, such as the Willamette Valley, the east side of the Cascade Range, the grasslands in north central Oregon, and the desert in southeast Oregon. Conversely, a watershed which is quite close to the subject drainage may not be a “similar nearby” basin. Examples are the basins around Mount Hood and the Columbia River Gorge. Drainage basins as close as 20 to 50 miles apart can have greatly different climates, terrain, and land use. References to aid in the selection of similar nearby drainage basins are as follows.

- Drainage basin characteristics listed in the **Chapter 7** Appendices tables.
- Climatic conditions shown on the maps in the **Chapter 7** appendices.
- The “Oregon Atlas” published by the University of Oregon.
- Experience gained from observation while traveling around the state.

Step 2 - Read the "Remarks" for the gaged basin in the flow data book. The Remarks will mention if discharges from the gaged watershed are significantly affected by storage, diversions, or consumptive use. The remarks will also state if the statistics are based on natural or measured stream flows. Natural flow statistics are preferred.

Measured flow statistics can be used if natural statistics are not available. Measured flow statistics from basins with little upstream storage, diversions, or consumptive uses are preferred to estimate discharges in other similar basins. These basins most closely resemble basins in natural conditions. Measured flow statistics from streams with significant storage, diversions, or consumptive use should only be used for sites on those streams near the gages.

Step 3 - Calculate the exceedance discharges per square mile of drainage area from nearby similar 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 basin area 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 exceedance discharge by multiplying the estimated yield from Step 5 by the subject basin watershed area determined in Step 1, as follows:

Exceedance discharge in cubic feet per second = (exceedance discharge yield in cubic feet per second per square mile) x (basin area in square miles)

The exceedance flows calculated in this step may need to be adjusted to account for storage, diversions, or consumptive use. This is done by examining water use data and obtaining parol evidence, as shown in Parts 2 and 3.

4.2 Discharge Adjustments for Water Storage, Diversions, and Use

The second part of the procedure is to adjust the exceedance discharges calculated in the first part to account for storage, diversions, or consumptive use. The adjustments are based on remarks in the ODOT Mean Daily Flow Data publications and information from the Oregon Water Resources Department (OWRD). The steps are as follows.

Step 1 - Review remarks on data sheets in the ODOT Mean Daily Flow Data publications for the subject and adjacent basins, if available. These remarks are copied from USGS and OWRD publications containing gage data, and they address storage, regulation, and consumptive use. These remarks are an aid to the user, and they should not be considered as a definitive and comprehensive description of storage and water use.

The Remarks were collected during Step 2 of Part 1.

Step 2 - Review water availability information from the OWRD. The 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 OWRD printouts provide data about storage, diversions, and expected water use for each month at the outlet of the water availability basin. This information is in the Detailed Report on Water Availability. These reports are shown in the examples.

Step 3 - Review OWRD information about the locations of the water diversions or withdrawal. Diversions or withdrawals upstream from the site affect discharges through the site. Conversely, withdrawals or diversions downstream from the site do not influence discharges at the site. Diversion and withdrawal locations are listed in the Water Rights Point of Diversion Details table, along with information about the water source, maximum permitted withdrawal, and use. These tables are shown in the examples.

The Point of Diversion Details table lists the maximum diversions or water use allowed by existing permits. Estimates based on these maximum permitted flows are sufficient for most hydraulic design purposes. In reality, seldom are all of the permitted water diversions or withdrawals in full use at the same instant. A certified professional, such as a water rights examiner, should be consulted about actual water use. This professional should also be consulted if water rights and use are critical aspects of the project.

Step 4 - Estimate any adjustments to the flows determined in Part 1 based on information obtained in Part 2. Adjust discharges, if needed, using guidelines from Part 4.

4.3 Parol Evidence

The third part of the procedure is to consider parol evidence. Parol evidence is "word of mouth" testimony about the hydraulic history of the site. Often it is supported by other documentation such as written correspondence and photographic evidence. This information supplements the calculated discharges. 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 can also be the best source for information about storage, diversions, and consumptive use. This is illustrated in the second example.

Parol evidence is obtained by interviewing people familiar with the waterway, such as:

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

Typical questions to ask are:

- What are the usual discharges 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 various seasons? 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. A site visit is also useful to verify all needed information has been obtained and is correct.

4.4 Reporting Discharge Estimates

Exceedance discharges are reported in tables or narrative. The temporary water management discharges are reported as both the percent exceedance and the number of days a month the discharge is exceeded. The 10 and 95 percent exceedance flows for fish passage design are reported as percent exceedance discharges. This is shown in the examples. Exceedance discharges are usually reported to two significant figures. Further guidance about rounding figures is in **Chapter 4**.

Temporary Water Management – The 5, 25, and 50 percent exceedance discharges for temporary water management are reported on a table. The table lists natural discharges adjusted to account for storage, diversions, or consumptive use. These adjustments are based on storage, diversions, or uses that can be predicted with certainty in both timing and quantity. Adjustments are made for uses that significantly influence discharges. Minor uses are ignored.

The table notes mention storage, diversions, or withdrawals during the temporary water management period if their timing and quantity cannot be predicted. These items are mentioned if they significantly influence discharges. Minor uses are ignored.

High and Low Flows for Fish Passage Design – The 10 and 95 percent exceedance discharges for fish passage design are reported, if needed. The natural discharges are listed after they are adjusted to account for storage, diversions, or consumptive use. These adjustments are based on storage, diversions, or uses that can be predicted with certainty and will not vary throughout the project design life. Adjustments are made for uses that significantly influence discharges. Minor uses are ignored.

The narrative accompanying the fish passage exceedance discharge mentions storage, diversions, or withdrawals if they may fluctuate throughout the project design life. These items are mentioned if they significantly influence the discharge. Minor uses are ignored.

5.0 Example 1 – Exceedance Discharges Based on a Single Nearby Gaged Basin

Rock Creek is a small creek flowing northward in the Columbia River Gorge. It drains from the Cascade Mountains. The confluence of Rock Creek and the Columbia River is at the west side of the small town of Mosier. The total drainage area is 14.1 square miles.

Five, 25, and 50 percent exceedance discharges are needed for the months of July, August, and September. These are the months TWM will be in place. Fish are not expected to migrate during the TWM period, and they may migrate during the other months. The 10 percent discharge is needed for January, the wettest month. The 95 percent discharge is needed for October, the driest month outside of the TWM period.

Part 1 is to determine natural or measured flow exceedance statistics.

Step 1 - The subject basin is outlined on a 7.5 – minute USGS quadrangle map and measured with a planimeter. The drainage area for the site under investigation is 13.8 square miles. Nearby basins are identified in the ODOT Mean Daily Flow Data book for the Hood Basin. The adjacent Mosier Creek basin has similar climatic conditions and land use. It flows into the Columbia River at the east side of Mosier. The page in the ODOT Mean Daily Flow Data book for Mosier Creek is shown in Figure 1.

Step 2 - The Remarks for Mosier Creek in the ODOT data book say “No regulation. Several small pumping diversions for irrigation upstream from station.” The Remarks also say the exceedance statistics are natural flow data. It is assumed the exceedance statistics for Mosier Creek have been adjusted to account for storage, diversions, and consumptive use, since this is natural flow data. It is also assumed the natural flow data represents the similar Rock Creek watershed in pre-development conditions. The exceedance discharges from the 41.5 square mile Mosier Creek basin are:

Discharge from Mosier Creek basin in cubic feet per second

		Month			
Exceedance	January	July	August	September	October
5 percent		4.1	2.9	3.7	
10 percent	223				
25 percent		3.1	2.3	2.7	
50 percent		2.4	2.0	2.3	
95 percent					2.2

Step 3 – The yield from the Mosier Creek basin is calculated in this step. It is calculated by dividing each exceedance discharge by the 41.5 square mile drainage area, as follows:

Yield from Mosier Creek basin in cubic feet per second per square mile

		Month			
Exceedance	January	July	August	September	October
5 percent		0.099	0.070	0.089	
10 percent	5.4				
25 percent		0.075	0.055	0.065	
50 percent		0.058	0.048	0.055	
95 percent					0.053

Steps 4, 5, and 6 – The exceedance discharges for the subject stream are calculated by multiplying the yields from Step 3 by the 13.8 square mile Rock Creek drainage area, as follows:

Discharge from Rock Creek basin in cubic feet per second

	Month				
Exceedance	January	July	August	September	October
5 percent		1.3	0.96	1.2	
10 percent	75				
25 percent		1.0	0.76	0.90	
50 percent		0.80	0.67	0.76	
95 percent					0.73

OWRD BASIN: HOOD
COUNTY: WASCO

OWRD SUBBASIN: HOOD
AREA: 41.50 SQ MI

GAGE NUMBER: 14113200
DATUM: 425 FT

GAGE NAME: MOSIER CR NR MOSIER
STATUS: DISCONTINUED

OWNER: USGS
LATITUDE: 45 DEG 38 MIN 55 SEC

SOURCE: STREAM
LONGITUDE: 121 DEG 22 MIN 35 SEC

FLOW TYPE: RUNOFF
INDEX GAGE: ☐ YES ☑ NO ☐ UNKNOWN

REGULATION: ☐ YES ☑ NO ☐ UNKNOWN
PLS: 2N TOWNSHIP 12E RANGE 19 SECTION

MEAN DAILY FLOWS

START DATE: 5/1/1963 MM/DD/YY
STOP DATE: 10/31/1981 MM/DD/YY

GAPS: ☑ YES ☐ NO ☐ UNKNOWN
COMPLETE WYS: 18

	JAN	FEB	MAR	APR	MAY	JUN
5% EXCEEDENCE	402.0	330.0	288.0	116.0	31.9	7.8
10% EXCEEDENCE	223.0	202.0	193.0	93.5	22.3	7.0
25% EXCEEDENCE	86.6	94.9	105.0	57.7	14.4	6.1
50% EXCEEDENCE	36.2	58.9	55.4	35.9	11.2	5.0
95% EXCEEDENCE	6.0	12.6	12.0	6.1	4.5	2.6

	JUL	AUG	SEPT	OCT	NOV	DEC
5% EXCEEDENCE	4.1	2.9	3.7	7.2	29.1	109.0
10% EXCEEDENCE	3.5	2.6	3.2	5.5	20.0	66.2
25% EXCEEDENCE	3.1	2.3	2.7	4.1	10.4	32.8
50% EXCEEDENCE	2.4	2.0	2.3	3.3	5.8	14.0
95% EXCEEDENCE	1.4	1.1	1.5	2.2	3.1	3.9

COMMENTS: 1) Gage datum is 1929 NGVD. 2) These are natural stream flows. They are adjusted to a common base period and nearby index gages. They represent discharges that would occur if there are no out of stream consumptive uses, reservoir storage or diversions. 3) No regulation. Several small pumping diversions for irrigation above station.

Figure 1 Page in ODOT Mean Daily Flow Data Book for Mosier Creek

Part 2 of the procedure is to adjust the natural flow exceedance discharges calculated in Part 1 to account for storage, diversions, and consumptive use.

Step 1 - The first step is to look at the remarks on the data sheet for the adjacent Mosier Creek basin. Diversions into or out of the Rock Creek basin will be investigated if they are mentioned in the Mosier Creek data. The remarks do not mention any diversions to or from the Mosier basin. The remarks are in the table shown on Figure 1.

Step 2 - The second step is to examine OWRD data to determine storage, diversions, or consumptive use. The OWRD has calculated water availability and consumptive use for the entire Rock Creek watershed upstream from the Columbia River. The Water Availability Table can be found on the interactive mapping section of the OWRD website. The table for the 50 percent exceedance discharge is shown in Figure 2. Consumptive uses of 0.00, 0.02, 0.01, 0.01, and 0.00 cubic feet per second are listed for January, July, August, September, and October, respectively. No storage or diversions are noted.

Note: The consumptive uses listed on the OWRD 80 percent exceedance table are identical, and they could also be used.

Step 3 - The point of withdrawal locations are determined during this step. This will help determine whether or not the consumptive uses reduce discharges at the project site. The project site is 0.35 miles upstream from the mouth of the creek on the Columbia River. It is possible the withdrawals could occur within the 0.35 mile reach downstream from the crossing, and they would not affect discharges at the site.

DETAILED REPORT ON THE WATER AVAILABILITY CALCULATION
Water Availability as of 11/14/2003 for
ROCK CR > COLUMBIA RIVER - AT MOUTH

Watershed ID #: 30410526 Basin: Hood Exceedance Level : 50
Time: 15:06 Date: 11/14/2003

Month	Natural Stream Flow	CU + Stor Prior 1/1/93	CU + Stor After 1/1/93	Expected Stream Flow	Reserved Stream Flow	Instream Water Rights	Net Water Available
1	5.07	0.00	0.00	5.07	0.00	0.00	5.07
2	10.50	0.00	0.00	10.50	0.00	0.00	10.50
3	13.20	0.00	0.00	13.20	0.00	0.00	13.20
4	3.07	0.03	0.00	3.04	0.00	0.00	3.04
5	0.71	0.09	0.00	0.63	0.00	0.00	0.63
6	0.16	0.07	0	0.09	0.00	0.00	0.09
7	0.06	0.02	[illegible]	0.04	0.00	0.00	0.04
8	0.04	0.01	0.00	[illegible]	0.00	0.00	0.03
9	0.02	0.01	0.00	[illegible]	0.00	0.00	0.01
10	0.03	0.00	0.00	0.03	0.00	0.00	0.03
11	0.17	0.00	0.00	0.17	0.00	0.00	0.17
12	3.20	0.00	0.00	3.20	0.00	0.00	3.20
Stor	2160	14	0	2150	0	0	2150

Permitted surface water uses.

Figure 2 Water Availability Table for Rock Creek

The points of withdrawal are determined from the "Water Rights Point of Diversion Details" table for the Rock Creek water availability basin. This table is obtained from the OWRD website. An abbreviated table is shown in Figure 3. These parameters are specified when the table is requested to assure all needed data is provided:

- "All Uses" as the water use to be printed, and
- a time period between 1 January 1800 and the present (14 November 2003).

The table lists two permitted surface water diversions in the Rock Creek basin, as follows.

- Permit # S 6322, surface water withdrawal from Rock Creek, up to 0.08 cubic feet per second, at any time of the year, for irrigation.

- Permit # S 3102, springwater withdrawal, up to 0.01 cubic feet per second, at any time of the year, for irrigation and domestic use.

The point of withdrawal locations are described in the detail table for both permitted uses. Both are in Township 2 North, Range 11 East, Section 11. These withdrawal points are within the watershed upstream from the project site. These consumptive uses, if utilized, will reduce discharges at the site.

STREAM NAME	APPL	PERMIT	LOCATION	USE	SEASON	SOURCE	RATE(CFS)	RATE(AFT)	P/S	STAT
ROCK CREEK > COLUMBIA RIVER	S 9567	S 6322	0.200N 11.00E 11 NENW	IR	1/1 - 12/31	ROCK CREEK	0.8 (EST)		P	NC
ROCK CREEK > COLUMBIA RIVER	G 13322	G 12690	0.200N 11.00E 02 SENE	GD	1/1 - 12/31	A WELL	0.09 (EST)		P	NC
ROCK CREEK > COLUMBIA RIVER	G 13322	G 12690	0.200N 11.00E 02 SENE	CM	1/1 - 12/31	A WELL	0.14 (EST)		P	NC
ROCK CREEK > COLUMBIA RIVER	[illegible]322	G 12690	0.200N 11.00E 02 SENE	IM	1/1 - 12/31	A WELL	0.14 (EST)		P	NC
UNN STR > ROCK CREEK	S 5149	G 3102	0.200N 11.00E 11 SENE	ID	1/1 - 12/31	SPRS	0.1 (EST)		P	NC
UNN STR > ROCK CRE[illegible]	R 75526		0.200N 11.00E 14 SWNW	LW	1/1 - 12/31	RUNOFF/RES 1	0.0 (EST)	0.5 (EST)	P	NC
UNN STR > RO[illegible]K	R 75526		0.200N 11.00E 14 SWNW	FP	1/1 - 12/31	RUNOFF/RES 1	0.0 (EST)	0.0 (EST)	P	NC
UNN STR[illegible]CK CREEK	R 75526		0.200N 11.00E 15 SENE	LW	1/1 - 12/31	RUNOFF/RES 3	0.0 (EST)	0.2 (EST)	P	NC
UNN STR > ROCK CREEK	R 75526		0.200N 11.00E 15 SENE	LW	1/1 - 12/31	RUNOFF/RES 2	0.0 (EST)	0.2 (EST)	P	NC
UNN STR > ROCK CREEK	R 75526		0.200N 11.00E 15 SENE	FP	1/1 - 12/31	RUNOFF/RES 3	0.0 (EST)	0.0 (EST)	P	NC
UNN STR > ROCK CREEK	R 75526		0.200N 11.00E 15 SENE	FP	1/1 - 12/31	RUNOFF/RES 2	0.0 (EST)	0.0 (EST)	P	NC
UNN STR > ROCK CREEK	G 14773	G 13633	0.200N 11.00E 11 NWSE	IR	1/1 - 12/31	A WELL	0.134 (EST)		P	NC

Permitted surface water uses.

Figure 3 OWRD Water Rights Points of Diversion Details Table

Part 3 – Parol evidence is collected and considered during this step. People are interviewed who have as much as 20 years of experience with the stream. They say the stream dries up during the spring, and it almost always dries up before late June. They also say the stream stays dry throughout the summer until the area receives heavy precipitation in the fall.

Part 4 – The discharges are reported during this step. The Temporary Water Management (TWM) Discharges are summarized in a table with notes. The fish passage design discharges are mentioned separately with associated notes.

Temporary Water Management Discharges – The temporary water management exceedance flows vary from 0.67 cubic feet per second (August 50 percent) to 1.3 cubic feet per second (July 5 percent). The expected consumptive uses vary from 0.01 cubic feet per second (August and September) to 0.02 cubic feet per second (July). The consumptive uses are a very small portion of the predicted discharges. They are considered “minor uses” and are not reported in the notes or used in any adjustments. The natural discharges calculated in Step 6 are reported in the table shown in Figure 4. Parol evidence indicates actual discharges are likely to be lower than those listed in the table. This is mentioned in the table notes.

Fish Passage Design Discharges - The 10 and 95 percent exceedance discharges for the wettest and driest months of the fish migration period are reported. The 10 percent exceedance discharge of 75 cubic feet per second is reported for January, and the 95 percent discharge of 0.73 cubic feet per second is listed for October. These flows are based on the natural discharges calculated in Step 6 of Part 1, and they are presented as follows:

"Fish are expected to migrate through the crossing during the months of the year outside of the TWM period. These are the months of October through June. The wettest month of this migration period is January, and the 10 percent average daily exceedance discharge for this month is 75 cubic feet per second. This is the high flow design discharge for fish passage. The driest month of the migration period is October. The 95 percent average daily exceedance discharge for October 0.73 cubic feet per second. This is the low flow design discharge for fish passage.

These calculated discharges are based on measured flow data from an adjacent gaged basin. Actual stream flows may be less than this discharge, and surface flow may cease for extended periods during the summer and early fall."

ROCK CREEK
ESTIMATED DISCHARGES FOR
TEMPORARY WATER MANAGEMENT

	AVERAGE DAILY DISCHARGE IN CUBIC FEET PER SECOND (GALLONS PER MINUTE)		
NOTE	**1**	**2**	**3**
JULY	1.3 (580)	1.0 (450)	0.80 (360)
AUGUST	0.96 (430)	0.76 (340)	0.67 (300)
SEPTEMBER	1.2 (540)	0.90 (400)	0.76 (340)

1) 5 Percent Exceedance Discharge (Average daily discharge expected to be exceeded 2 days each month.)
2) 25 Percent Exceedance Discharge (Average daily discharge expected to be exceeded 8 days each month.)
3) 50 Percent Exceedance Discharge (Average daily discharge expected to be exceeded 16 days each month.)

1.1.1

1.1.2 In-water work period extends from 1 July through 30 September. Temporary water management shown on plans recommended throughout in-water work period. Listed discharges are surface water from the upstream watershed. The estimated discharges are based on an adjacent gaged basin. Discharges in the subject watershed may differ.

Actual discharges are expected to be lower than estimated discharges. Surface water discharge may cease for extended periods.

Figure 4 Temporary Water Management Discharge Table for Rock Creek

6.0 Example 2 – Exceedance Discharges Based on Several Nearby Gaged Basins

Unnamed Creek is a small stream draining fruit orchards in the Columbia River Gorge. The confluence of the creek and the Hood River is north of the small town of Odell. 5, 25, and 50 percent exceedance discharges are needed for the months of July, August, and September. This is the TWM period. Fish passage is not needed so the 10 and 95 percent discharges will not be calculated.

Part 1 of the analysis is to determine natural or measured exceedance flow statistics.

Step 1 - The subject basin is outlined on a 7.5 – minute USGS quadrangle map. The small basin is difficult to accurately delineate using only the map. The drainage boundaries are verified by a field inspection. The drainage area is measured by a planimeter, and it is 0.108 square miles.

Nearby gaged basins are identified in the ODOT Mean Daily Flow Data book for Hood Basin. Unlike the first example, there is no basin in the immediate area with similar climatic conditions and land use. It is necessary to calculate discharge estimates with data from basins out of the immediate area. Usually at least three basins are used when this is done.

The subject basin is in the Hood River Valley on the north side of Mount Hood. Four gaged basins are in this valley or surrounding mountains, and natural discharge statistics are available for all. The basins are as follows.

Gage 14113400 Dog River near Parkdale, drainage area = 4.50 square miles, gage elevation = 4,347 feet. The basin is in the mountains south of the nearby Upper Hood River Valley.

Gage 14118000 Green Point Creek below North Fork near Dee, drainage area = 20.00 square miles, gage elevation = 1100 feet. The basin is in the mountains west of the Hood River Valley.

Gage 14118500 West Fork Hood River near Dee, drainage area = 95.6 square miles, gage elevation = 802 feet. The basin is in mountains to the southwest of Hood River Valley.

Gage 14120000 Hood River at Tucker Bridge near Hood River, drainage area = 279 square miles, gage elevation = 383 feet. The basin is in the mountains surrounding the Hood River Valley and Upper Hood River Valley.

Not all nearby gaged basins could be used. Several gaged basins are located to the east of Hood River Valley near the towns of Mosier, The Dalles and Dufur. The monthly discharge data was examined, and it appears these basins have distinctly different discharge characteristics than those around the Hood River Valley. The summer flows are much less compared to the winter discharges, and there is less discharge per square mile of drainage area. Data from these basins are not used.

Several gaged basins are located to the west of Hood River Valley in the Sandy River Basin. The monthly data indicates these basins also have different discharge characteristics. The September discharges, in particular, are considerably higher than those in the Hood River Valley. Data from these basins are not used.

Several gaged basins are north of Hood River Valley in Washington. These basins have significantly higher summer discharges than the Hood River Valley area basins. Statistics from these basins are not used.

Step 2 - The Remarks for the four basins in Hood River Valley area mention the following about storage, regulation, or diversion.

Gage 14113400 Dog River near Parkdale, No regulation or diversion above station.

Gage 14118000 Green Point Creek below North Fork near Dee, No regulation. Water is diverted above station in NW1/4 S10, T1N, R9E, and from North Fork in SE1/4 SW1/4 S30, T2N, R9E, and in SW1/4 S3, T1N, R9E, for irrigation near Oak Grove outside of Green Point Creek Basin.

Gage 14118500 West Fork Hood River near Dee, No regulation. Dee Irrigation District canal diverts from right bank about 6 miles upstream from station for irrigation upstream from station and in Middle Fork basin. Diversions from Green Point basin upstream from station for irrigation near Oak Grove: water from two of these diversions is carried in Hood River Irrigation District canal.

Gage 14120000 Hood River at Tucker Bridge near Hood River, Some daily fluctuation possibly caused by diversion dam upstream from station and Sawmill at Dee. Diversions for irrigation above station.

The Remarks for all four gages also mention: “These are natural stream flows. They are adjusted to a common base period. They represent discharges that would occur if there are no out of stream consumptive uses, reservoir storage or diversions.” This means the statistical distributions have been adjusted to account for the diversions, and they represent the watersheds in natural conditions prior to development. Discharges from similar nearby basins in their natural state can be directly estimated using these flows. The discharges are:

	Mean Daily Low Flows for Nearby Basins in cubic feet per second								
Month	July			August			September		
Percent Exceedance	5	25	50	5	25	50	5	25	50
Basin									
Dog R near Parkdale	32.2	11.0	7.7	7.5	5.1	4.0	5.1	3.8	3.1
Green Point Cr below North Fork near Dee	50.8	33.5	26.8	27.7	21.9	16.5	31.0	20.6	6.2
West Fork Hood R near Dee	413	291	242	269	213	183	325	204	175
Hood R at Tucker Br near Hood River	1080	729	599	701	538	455	660	489	423

Step 3 - The basin yields are calculated by dividing the exceedance discharges by the drainage areas, as follows:

		Basin Yield in cubic feet per second per square mile								
Month		July			August			September		
Percent Exceedance		5	25	50	5	25	50	5	25	50
Basin	**Drainage Area in Square Miles**									
Dog R near Parkdale	4.5	7.16	2.44	1.71	1.67	1.13	0.89	1.13	0.84	0.69
Green Point Cr below North Fork near Dee	20.0	2.54	1.68	1.34	1.39	1.10	0.83	1.55	1.03	0.81
West Fork Hood R near Dee	95.6	4.32	3.04	2.53	2.81	2.23	1.91	3.40	2.13	1.83
Hood R at Tucker Br near Hood River	279	3.87	2.61	2.15	2.51	1.93	1.63	2.37	1.75	1.52

Step 4 - The yield versus discharge curves are determined by linear interpolation. This was automatically done by a computer program. The printouts are shown in Figure 5.

Step 5 - The yields for the 0.108 square mile subject basin are calculated during this step. This is done automatically when using the program. The equations and yields are:

Month	**Exceedance**	**Equation**	**Mean Daily Low Flow Yield in cubic feet per second per square mile**
July	5 percent	-0.0044x + 4.9092	4.91
July	25 percent	0.0019x + 2.2573	2.26
July	50 percent	0.0022x + 1.7137	1.71
August	5 percent	0.0036x + 1.7395	1.74
August	25 percent	0.003x + 1.3006	1.30
August	50 percent	0.0028x + 1.0342	1.03
September	5 percent	0.0037x + 1.7385	1.74
September	25 percent	0.003x + 1.1412	1.14
September	50 percent	0.0028x + 0.9307	0.93

x = basin area in square miles

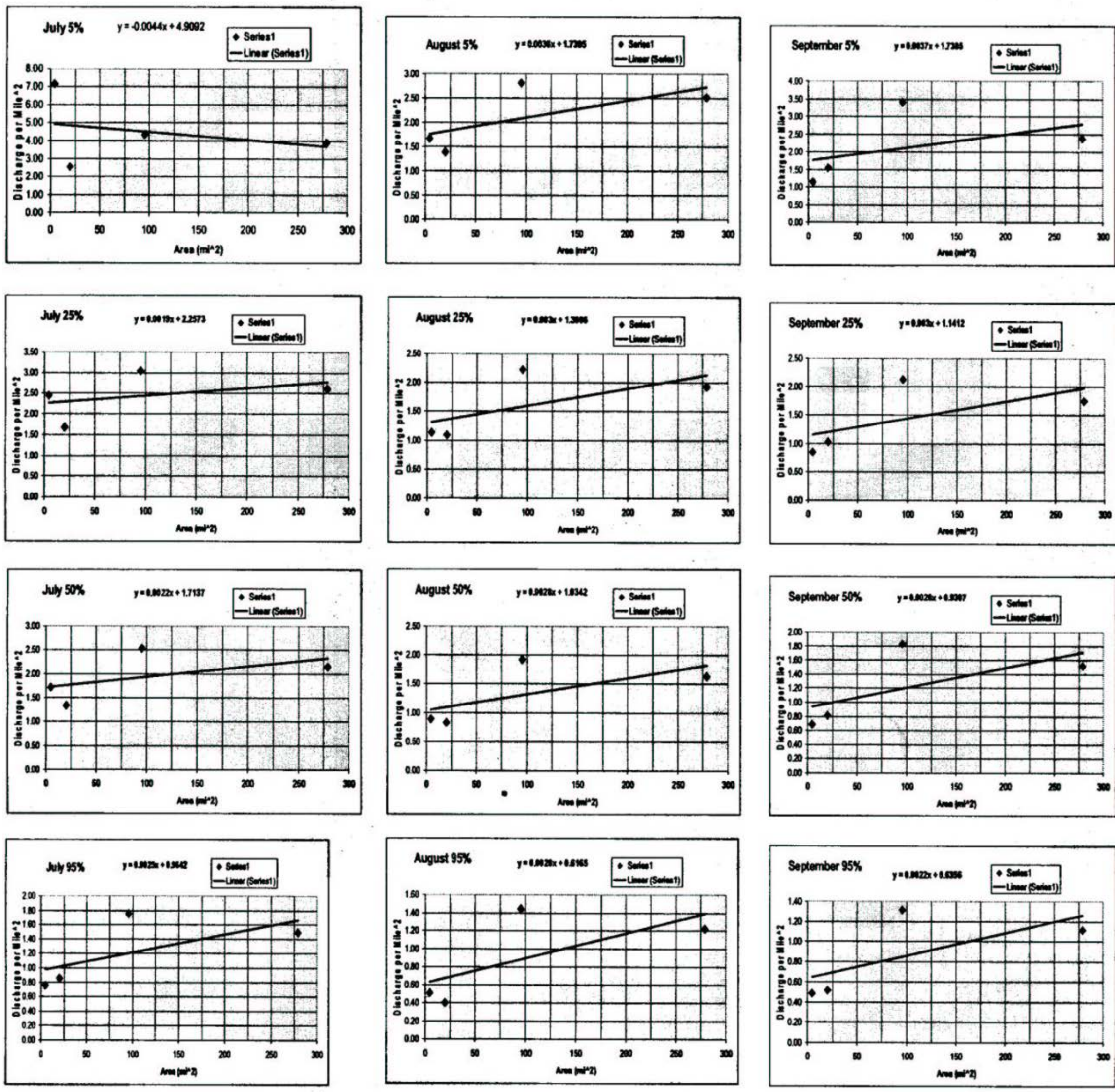

Figure 5 Linear Interpolation of Natural Flow Data from Nearby Basins

Step 6 - The exceedance discharges for the subject basin are calculated by multiplying the yields by the 0.108 square mile drainage area. The discharges are as follows:

	Mean Daily Low Flow in cubic feet per second								
Month	July			August			September		
Percent Exceedance	5	25	50	5	25	50	5	25	50
Basin									
Unnamed Creek	0.53	0.24	0.19	0.19	0.14	0.11	0.19	0.12	0.10

Note: The less frequent exceedance discharges should be greater than the more frequent discharges, for any given month. For example, during June the 5 percent discharge should be greater than the 25 percent discharge, and the 25 percent flow should be bigger than the 50 percent discharge, etc. Data from additional nearby stations may be needed if this does not occur.

Part 2 – The discharges calculated in Part 1 are natural flows. They represent runoff from the watershed in pre-development conditions when it was covered with forest and grasslands. Now the watershed has been developed into orchards with a few residences. This development can significantly alter discharges. OWRD data is reviewed in this step to determine water use.

Step 1 - The first step of Part 2 is to look at the Remarks in the ODOT mean daily flow data books for nearby gaged basins. None of the basins have any remarks pertaining to the subject basin.

Step 2 - Storage, diversions, or water uses are determined during this step using OWRD information. Unlike the first example, the subject drainage is part of a much larger OWRD Water Availability Basin, and it is difficult to determine water use from a "Detailed Report on the Water Availability Calculation." Water use will be determined from the OWRD website for the two public land survey sections containing the subject basin, Township 2 North, Range 10 East, Sections 15 and 22, Willamette Meridian. Details are listed in the "Water Rights Point of Diversion Details" tables for the sections. Abbreviated tables are shown in Figure 6.

Stream Name	Application	Permit	Location	Use	Season	Priority	Source	Rate (CFS)	Rate (AFT)	P/S	Status
HOOD R > COLUMBIA R			02.00N 10.00E 15 NENE	IL	1/1 ~ 12/31	12/31/1890	UNN STR	0.0 (est)		P	NC
HOOD R > COLUMBIA R			02.00N 10.00E 15 NENE	IL	1/1 ~ 12/31	12/31/1890	A SPR	0.125 (est)		S	NC
HOOD R > COLUMBIA R			02.00N 10.00E 15 NWSW	IS	1/1 ~ 12/31	12/31/1909	SMALL SEEPAGE STR	0.0 (est)		S	NC
HOOD R > COLUMBIA R	S 10821	S 7354	02.00N 10.00E 15 NWNE	IS	1/1 ~ 12/31	06/03/1926	A SPR	0.0 (est)		P	NC
HOOD R > COLUMBIA R	S 10821	S 7354	02.00N 10.00E 15 NENW	IS	1/1 ~ 12/31	06/03/1926	A SPR	0.25 (est)		S	NC
HOOD R > COLUMBIA R	S 16307	S 12120	02.00N 10.00E 15 NESW	ID	1/1 ~ 12/31	04/06/1936	SPR 1	0.035 (est)		S	NC
HOOD R > COLUMBIA R	S 16307	S 12120	02.00N 10.00E 15 NENW	ID	1/1 ~ 12/31	04/06/1936	SPR 2	0.015 (est)		S	NC
HOOD R > COLUMBIA R	S 56053	S 42328	02.00N 10.00E 15 SESW	IC	1/1 ~ 12/31	06/10/1977	UNN STR/RES	0.06 (est)		P	NC
HOOD R > COLUMBIA R	S 56053	S 42328	02.00N 10.00E 15 SESW	IC	1/1 ~ 12/31	10/25/1977	UNN STR/RES	0.11 (est)		P	NC
HOOD R > COLUMBIA R	R 56795	R 6702	02.00N 10.00E 15 SESW	IR	1/1 ~ 12/31	10/25/1977	UNN STR	0.0 (est)	0.29 (est)	P	NC
HOOD R > COLUMBIA R	S 61263	S 45643	02.00N 10.00E 15 SESW	IS	1/1 ~ 12/31	02/19/1981	RESERVOIR	0.45 (est)		S	NC
HOOD R > COLUMBIA R	S 61263	S 45643	02.00N 10.00E 15 SESW	LV	1/1 ~ 12/31	02/19/1981	RESERVOIR	0.0 (est)	0.05 (est)	P	NC
UNN STR > HOOD R	S 8528	S 5544	02.00N 10.00E 15 NENW	IS	1/1 ~ 12/31	07/24/1922	A SPR	0.18 (est)		S	NC
UNN STR > HOOD R	R 33118	R 2253	02.00N 10.00E 15 NENW	IS	1/1 ~ 12/31	05/21/1959	WW IN UNN SWALE	0.0 (est)	0.4 (est)	S	NC
UNN STR > HOOD R	S 10735	S 7284	02.00N 10.00E 15 NESW	IS	1/1 ~ 12/31	04/26/1926	UNN STR	0.11 (est)		S	NC
UNN STR > HOOD R	S 33119	S 26225	02.00N 10.00E 15 NENW	IS	1/1 ~ 12/31	05/21/1959	UNN STR	0.15 (est)		S	NC
UNN STR > HOOD R	G 1701	G 1561	02.00N 10.00E 15 NENW	IS	1/1 ~ 12/31	03/23/1960	A WELL	0.25 (est)		S	NC
UNN STR > HOOD R	R 61455	R 8252	02.00N 10.00E 15 SESW	LV	1/1 ~ 12/31	03/27/1981	UNN STR	0.0 (est)	0.005 (est)	P	NC
UNN STR > HOOD R	R 61455	R 8252	02.00N 10.00E 15 SESW	IS	1/1 ~ 12/31	03/27/1981	UNN STR	0.0 (est)	0.45 (est)	S	NC

SECTION 15

Stream Name	Application	Permit	Location	Use	Season	Priority	Source	Rate (CFS)	Rate (AFT)	P/S	Status
ODELL CR > HOOD R			02.00N 10.00E 22 NESE	IR	1/1 ~ 12/31	12/31/1885	ODELL CR	0.025 (est)		P	NC
ODELL CR > HOOD R			02.00N 10.00E 22 NENE	IR	1/1 ~ 12/31	12/31/1887	ODELL CR	0.125 (est)		P	NC
ODELL CR > HOOD R			02.00N 10.00E 22 NENE	IR	1/1 ~ 12/31	12/31/1887	ODELL CR	0.125 (est)		P	NC
UNN STR > ODELL CR	S 7483	S 4748	02.00N 10.00E 22 NESW	IS	1/1 ~ 12/31	08/20/1920	UNN STR	0.31 (est)		S	NC

SECTION 22

Figure 6 Water Rights Points of Diversion Details

Step 3 - The details table lists many permitted uses throughout the section. The uses within the subject watershed are determined during this step. The contour map in the "Interactive Mapping" section of the OWRD website covering the subject basin is examined. This is shown in Figure 7.

Note: The drainage basin boundaries are not shown on the map displayed by the OWRD. These basin boundaries are added by the author to make the map easier to understand.

Figure 7 Map Showing Diversion Points

Two points of diversion are shown by purple triangles on the OWRD basin map. Both are adjacent to small reservoirs. Two permitted surface water uses corresponding to these diversions are listed in details table shown in Figure 6. They are:

- Permit # S 42328, surface water withdrawal from the subject Unnamed Stream and a reservoir on the stream, up to 0.17 cubic feet per second, for irrigation.

- Permit # S 45643, surface water withdrawal from another reservoir on the subject stream, up to 0.45 cubic feet per second, for irrigation.

The total water use can be 0.62 cubic feet per second if all of these rights are fully used at the same time. The discharges in the creek due to natural runoff vary from 0.10 to 0.51 cubic feet per second, based on the various 50 percent exceedances determined in Part 1 Step 6. The total water rights for withdrawal from the reservoirs are greater than the discharge from the creek into the reservoirs. As a result, the creek at the project site, which is downstream from the reservoirs, may be dry during the months of June through September due to either upstream storage or water use.

Note: Public land survey locations for water storage, diversion, or use are listed on the various OWRD tables. This information can also be used to locate diversion points.

Part 3 – Parol evidence is considered during this step. Several people familiar with the drainage are interviewed. There is a system of irrigation canals, gates, pipes, and ditches in the area. Irrigation district personnel say the irrigation system is in operation throughout the summer to water the local pear orchards. They say the farmers turn off the flow of water to their fields immediately before the pear harvest. The canals overflow during the interval between the cessation of water use and the time when the irrigation district closes the canal headgates. During this interval a surge of overflow water up to 3 to 4 cubic feet per second is expected through the drainage at the crossing site.

A site visit was made to verify and supplement the parol evidence. An irrigation weir is noted in the immediate vicinity of the project, as shown in Figure 8. Water impounded by the weir during the summer is used to irrigate a small nearby orchard. Proposed construction will occur in this area. Care will be needed during the project temporary water management to allow the orchard to be irrigated.

Figure 8 Irrigation Weir on Project Site

Part 4 – The final part is to compile the discharge estimates. The natural discharges are reported in the table. They are expected to occur throughout the construction period due to storm runoff and discharge from the aquifer. The lack of water due to consumptive use, or the surge of water caused by irrigation system overflow may occur at unpredictable times throughout the project. These varying discharges are mentioned in the notes to the table. The table is shown in Figure 9. The need to provide access to water for irrigating the field where the gate may be removed is mentioned to the designer in correspondence.

UNNAMED CREEK
ESTIMATED DISCHARGES FOR
TEMPORARY WATER MANAGEMENT

	AVERAGE DAILY DISCHARGE IN CUBIC FEET PER SECOND (GALLONS PER MINUTE)		
NOTE	**1**	**2**	**3**
JULY	0.53 (240)	0.24 (110)	0.19 (85)
AUGUST	0.19 (85)	0.14 (63)	0.11 (49)
SEPTEMBER	0.19 (85)	0.12 (54)	0.10 (45)

1) 5 Percent Exceedance Discharge (Average daily discharge expected to be exceeded 2 days each month.)
2) 25 Percent Exceedance Discharge (Average daily discharge expected to be exceeded 8 days each month.)
3) 50 Percent Exceedance Discharge (Average daily discharge expected to be exceeded 16 days each month.)

1.1.3 In-water work period extends from 15 July through 31 August. Temporary water management shown on plans recommended throughout in-water work period. Listed discharges are surface water runoff from the upstream watershed. Irrigation discharges not included. The estimated discharges are based on nearby gaged basins. Discharges in the subject watershed may differ.

The creek could go dry during the in-water work period due to water use upstream or natural conditions. An additional 3 to 4 cubic feet per second irrigation flow can be expected during portions of the in-water work period. The dry periods and flow surges can occur without prior warning.

Figure 9 Temporary Water Management Discharge Table for Unnamed Creek