PROVINCE OF BRITISH COLUMBIA
MINISTRY OF ENVIRONMENT, LANDS AND PARKS
VANCOUVER ISLAND REGION

Courtenay River

WATER ALLOCATION PLAN

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COURTENAY RIVER WATER ALLOCATION PLAN

1.0 INTRODUCTION

The Water Management Program's goals are to sustain a healthy water resource through anticipating and planning for water uses. Water Allocation Plans are a means of identifying water demands and ensuring that water use is compatible with the goals of a sustainable environment. The advantages include:

1. Making information regarding Water Management's position on water allocation decisions available to future applicants and the public.

2. Reducing application response time.

3. Eliminating the need for individual studies and reports on each application.

4. Improving the consistency of Water Management's approach and decisions.

5. The definition of specific allocation directions and decisions.

6. Plans are more comprehensive than present reports.

7. Eliminating the need for referrals on individual applications.

The Vancouver Island Region developed the following policy to provide water allocation direction:

Regional Policy:
The region shall be subdivided into watershed areas and a water allocation plan shall be prepared for each watershed area. Water licence decisions will be made in accordance with approved plans.

Assessments undertaken as part of the water allocation planning process include identifying the surface water resources available, the instream requirements for fish, the existing and potential licensable water demands and providing direction regarding further water licence allocations.

Input may be sought from other agencies. Referrals go to Federal & Provincial Fisheries agencies and to Water Management in Victoria.

2.0 GENERAL WATERSHED INFORMATION

2.1 Geography and Morphology

The Courtenay River Water Allocation Plan area (Figure 1) is located almost half way up the eastern coast of Vancouver Island. The size of the plan area is approximately 900 square kilometres. The Courtenay River Plan area extends from Royston in the south to Merville in the north and from Forbidden Plateau in the west to the Strait of Georgia in the east. Water flows generally in a west to east direction in the plan area (see Figure 1 - Courtenay River Water Allocation Plan Area). Mount George V is the highest peak in the allocation plan area at 1883 metres. The largest lake is Comox Lake with a surface area of approximately 16.2 square kilometres.

2.2 History and Development

Population centres within the plan area are mostly situated on or near the coastline. Courtenay is the main population centre with a population of 17,700 as of 1995. Other communities within the plan area are Cumberland, Royston, Sandwick, Merville and part of Comox.

At one time the Cumberland/Royston section of the Courtenay River Allocation Plan area was a prosperous coal mining region. Cumberland was established by the coal mining industry, as were Puntledge and Bevan. Present employment is primarily from resource based activities such as forestry, fishing, mining, agriculture, tourism and recreation.

2.3 Climate

The Courtenay River Water Allocation Plan area is situated in a region that is characterised by wet, mild winters and warm, dry summers; however, the higher elevations do receive a fair amount of snow. The mean daily temperature is 8.7 °C. The minimum mean daily temperature of -2.5 °C is in January and the maximum mean daily temperature of 23.6 °C is in July according to the climatic normals from 1951 to 1980 of the Atmospheric Environmental Science (AES) station near Cumberland (Appendix A).

2.4 Geology and Groundwater

The Courtenay River Allocation Plan area has been influenced by various geological processes. The allocation plan area has been shaped by fluvial, alluvial, colluvial, marine and glacial processes. Glacial processes, during and since the Pleistocene ice age, have had a significant impact on the hydrogeology of the region. Surficial deposits such as silts, sand, gravel and till affect the occurrence and behaviour of groundwater (Atwater, 1994). The most significant unconsolidated deposits for potential groundwater development are primarily composed of sand and gravel. In this plan area, the largest groundwater reserves are most likely contained in alluvial, deltaic, fluvial, terraced fluvial and glaciofluvial deposits (Ronneseth, 1985).

There is evidence that potential for groundwater development in the Allocation Plan area does exist. It is likely that a major aquifer exists in a large glaciofluvial deposit near the outlet at the north-east end of Comox Lake; the presence of springs east of this deposit indicates that there is a groundwater flow probably originating from Comox Lake (Zubel, 1979). There is also excellent groundwater potential in a small delta where the Cruickshank River enters Comox Lake. The Tsolum River floodplain has some potential for groundwater development between Dove Creek and Puntledge River (Zubel, 1979).

2.5 Significant Drainage Areas

For the purpose of assessing water supplies for allocation demands significant drainage areas were identified and defined on 1:50,000 NTS maps. The following table lists the significant drainage areas and they are illustrated in Figure 2.

Significant Drainage Areas

Drainage	Area (km^2)
Roy Creek	13.4
Millard Creek	7.8
Bonner Creek	9.0
Perseverance Creek	26.8
Comox Lake	441
Morrison Creek	14.1
Browns River	98.0
Puntledge River	607.6
Tsolum River	248
Courtenay River	859

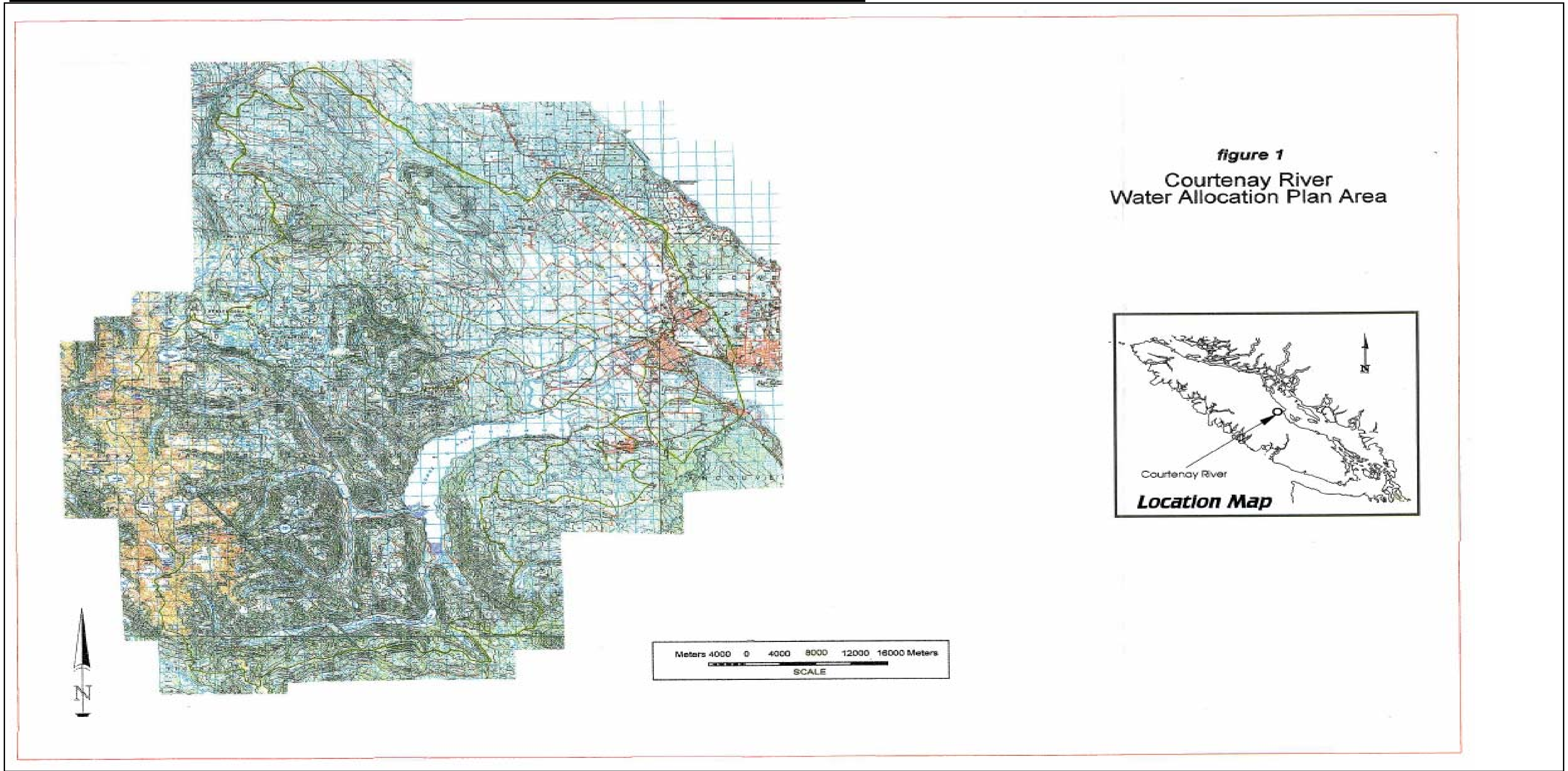


Figure 1 COURTENAY RIVER WATER ALLOCATION PLAN AREA

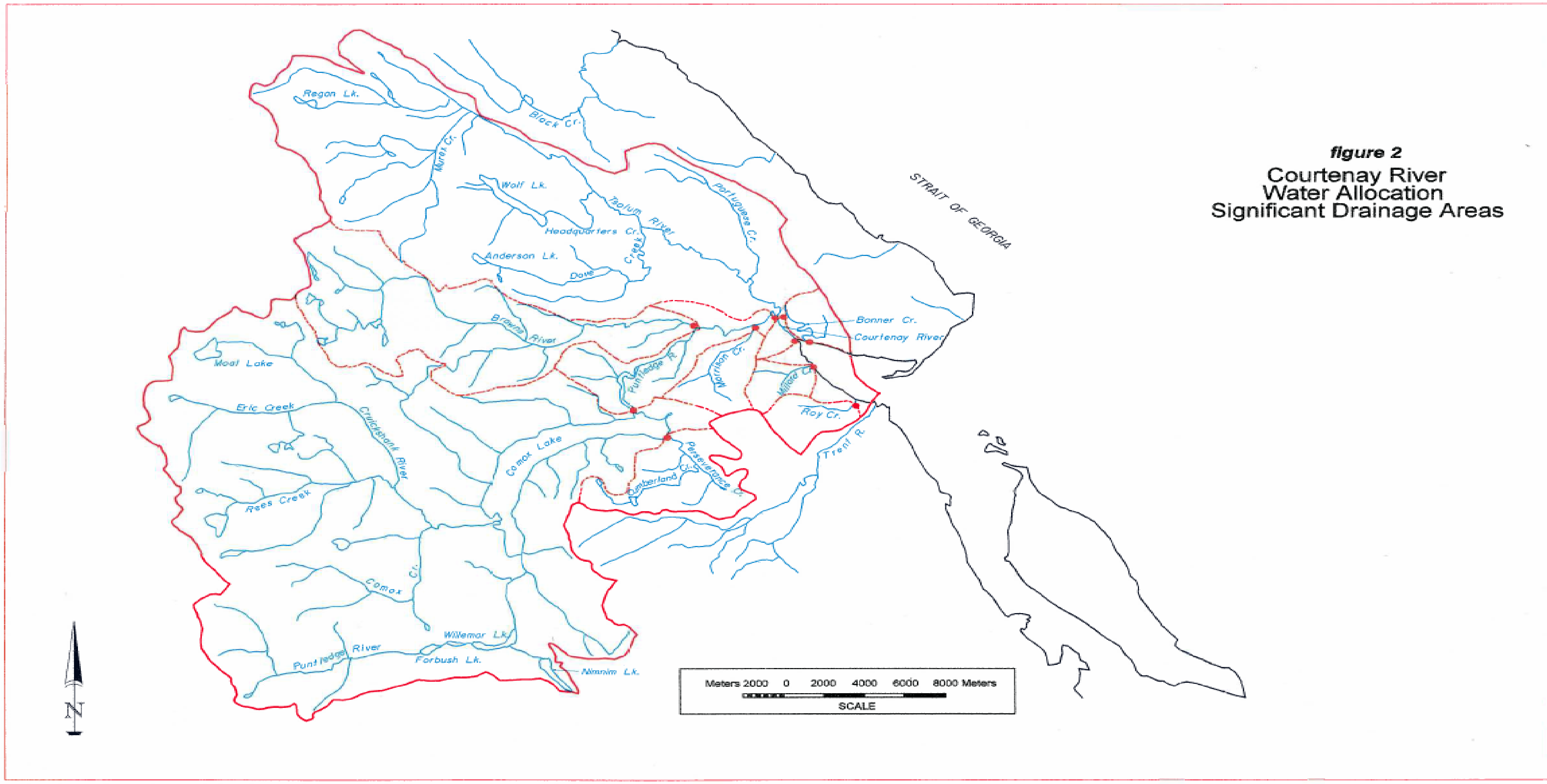


Figure 2 COURTENAY RIVER WATER ALLOCATION PLAN SIGNIFICANT DRAINAGE AREAS

3.0 HYDROLOGY

3.1 Precipitation

Using the Cumberland Atmospheric Environment Service station data from 1951 to 1980 the following bar graph (Figure 3) was constructed to illustrate the monthly precipitation normals. Appendix A provides the Canadian Climatic Normals for this area.

The mean total annual precipitation is 1569.6 mm. The minimum mean monthly precipitation of 35.5 mm occurs in July and the maximum mean monthly precipitation of 291.1 mm occurs in December . The mean number of days with measurable precipitation is 153; 141 mean days with rain and 18 mean days with snow.

Precipitation in this region is high in the winter months and low in the summer months. The lack of precipitation in the summer months creates an annual moisture deficit in the plan area.

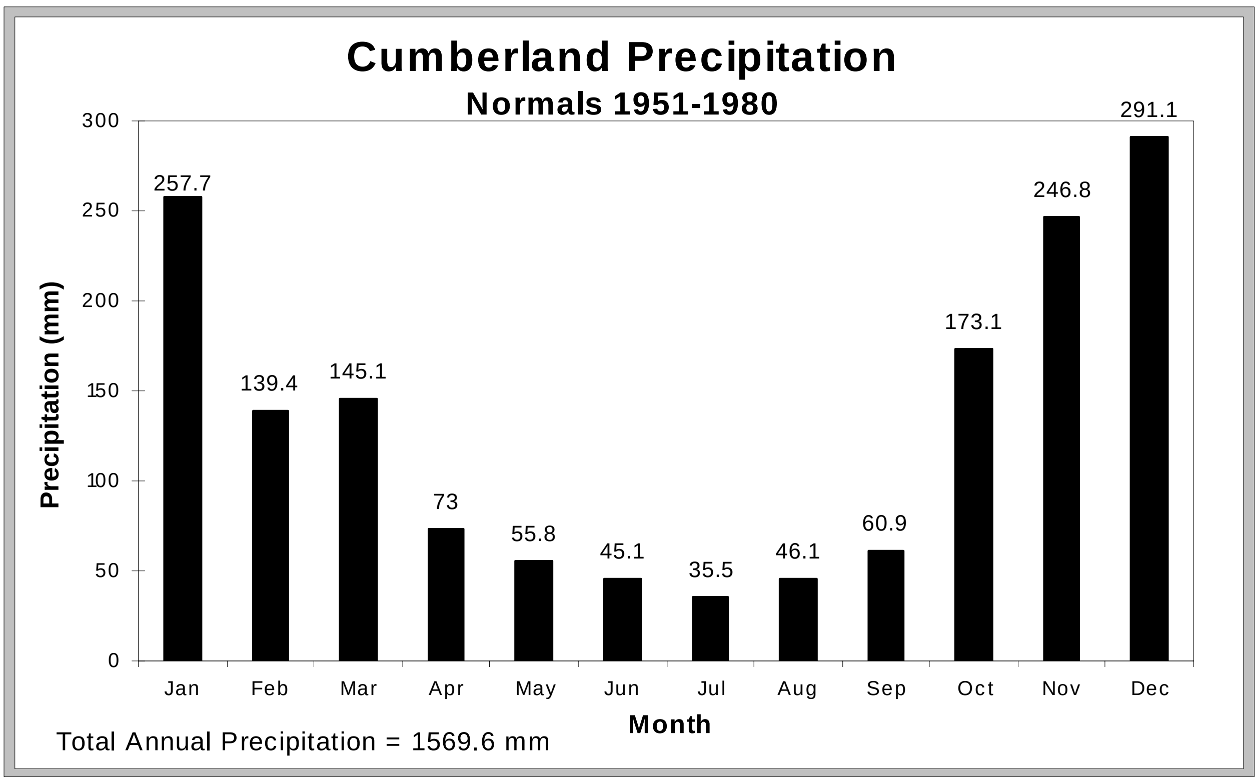


Figure 3 CUMBERLAND PRECIPITATION

3.2 Hydrometric Information

There is streamflow information from seven Water Survey of Canada (WSC) hydrometric stations within the Courtenay River Water Allocation Plan area. Five hydrometric stations were still in operation as of 1993: Puntledge River at Courtenay (08HB006), Tsolum River near Courtenay (08HB011), Browns River near Courtenay (08HB025), Cruickshank River near the mouth (08HB074) and Dove Creek near the mouth (08HB075). The WSC station located on the Puntledge River near Cumberland (08HB007) quit operating in 1953 and the station on Roy Creek at Cumberland Road (08HB042) only operated in 1971.

Two additional WSC hydrometric stations that were used to estimate streamflow are not within the plan area: Trent River near Royston (08HB044) and Black Creek at Sturgess Road (08HD014). The Trent River station operated seasonally from April through September for the years 1971 to 1976. The Black Creek station also operated seasonally from 1980 to 1989. The following table illustrates the years of operation, drainage area, mean annual discharge and the lowest mean monthly discharge and month for each WSC station.

Water Survey of Canada Hydrometric Stations

Station Name	Station Number	Period of Record	Drainage Area (km^2)	Mean Annual Discharge (m^3/sec)	Minimum Mean Monthly Discharge and Month (m^3/sec)
Puntledge River at Courtenay	08HB006	1914 - 20 1955 - 57 1964 - 93	593	41.0	22.3 August
Puntledge River near Cumberland	08HB007	1914 - 53	453	30.6	13.4 September
Tsolum River near Courtenay	08HB011	1914 - 17 1955 - 57 1964 - 93	235	10.3	0.9 August
Browns River near Courtenay	08HB025	1960 - 93	86	5.14	0.65 September
Roy Creek at Cumberland Road	08HB042	1971 April-Sept.	12.1	_	0.0006 August

Water Survey of Canada Hydrometric Stations					
Station Name	Station Number	Period of Record	Drainage Area (km^2)	Mean Annual Discharge (m^3/sec)	Minimum Mean Monthly Discharge and Month (m^3/sec)
Cruickshank River near the mouth	08HB074	1982 - 93	214	17.1	4.8 September
Dove Creek near the mouth	08HB075	1985-93	41.1	1.59	0.09 September
Trent River near Royston	08HB044	1971-1976 April-Sept.	72	-	0.199 August
Black Creek at Sturgess Road	08HD014	1980-1989 April-Sept.	71.7	-	0.005 September

The Water Survey Canada hydrometric station discharge records are summarized in Appendix B.

Miscellaneous streamflow measurements are available from Regional Engineer's Reports related to water licences and provincial low flow monitoring studies.

Figure 4, on the following page, illustrates the location of the WSC hydrometric stations, the Cumberland AES station and the locations of the miscellaneous stream flow measurement sites.

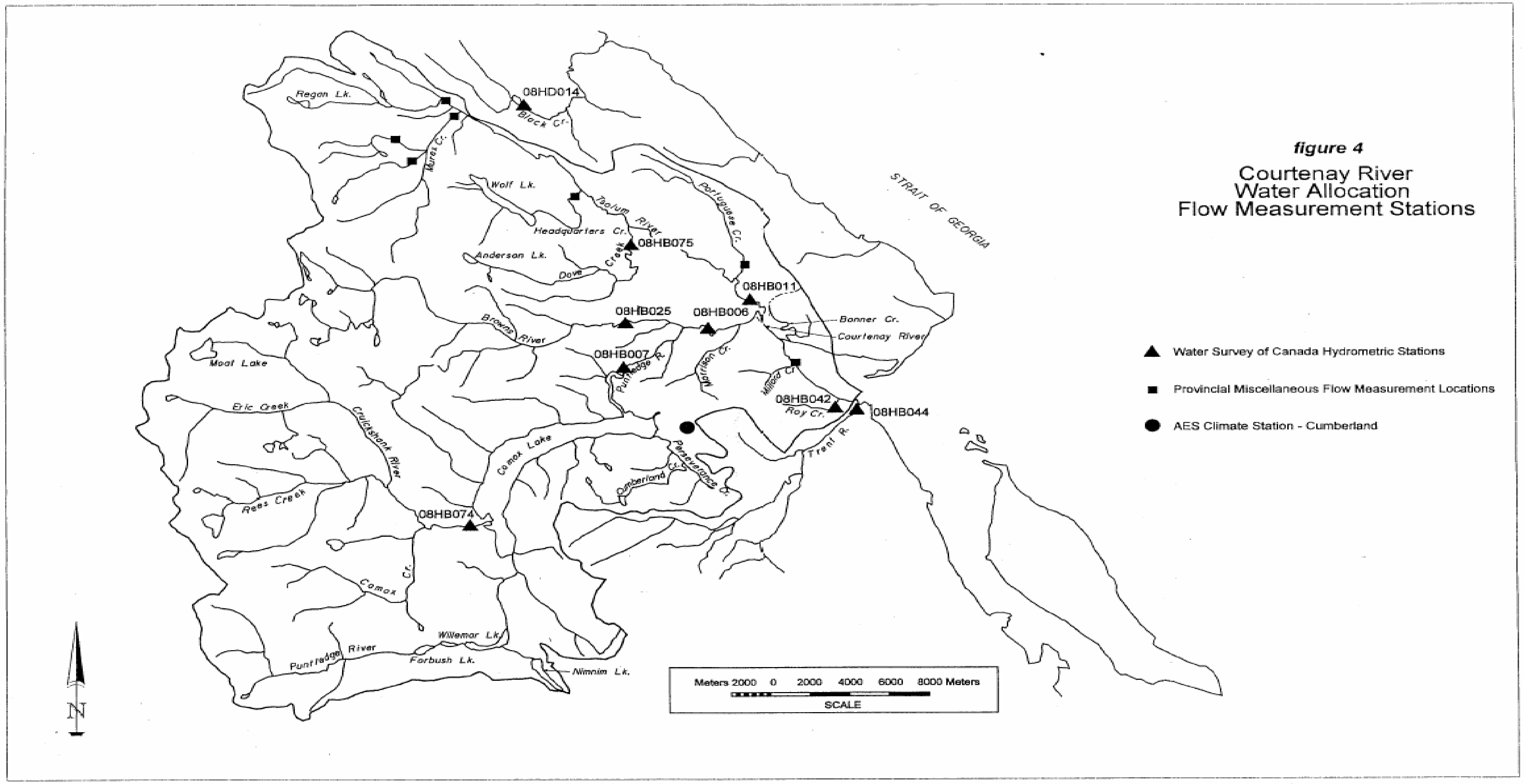


Figure 4 DISCHARGE MEASUREMENT STATIONS

To estimate the discharge of ungauged streams, runoff per square kilometre was estimated from the mean monthly and mean annual discharge at selected WSC hydrometric stations. The stations chosen (shown in the table below) were most indicative of the identified sub-drainage basins lacking annual discharge records within the Courtenay River Water Allocation Plan area. The following table indicates the discharge runoff per square kilometre of selected watersheds and the average discharge runoff per square kilometre and its % MAD.

Discharge Runoff per Square Kilometre (litres/second/Km^2)													
Station Number	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MAD
08HB011 Tsolum River	71.9	71.1	65.1	47.7	31.1	17.9	7.7	3.8	6.8	31.9	76.6	88.1	43.8
08HB044 Trent River				48.3	51.8	19.6	5.8	2.8	4.5				
08HD014 Black Creek				11.0	4.31	1.06	1.05	0.13	0.07				
08HB042 Roy Creek				20.66	4.79	1.82	0.50	0.05	0.07				
08HB075 Dove Creek	86.6	72.5	57.9	50.1	22.4	14.4	4.9	2.7	1.7	21.4	67.2	82.2	38.7
Average	79.3	71.8	61.5	35.5	22.9	10.9	4.0	1.9	2.6	26.7	71.9	85.2	39.5
%MAD	200.7	181.7	155.7	90.0	57.9	27.7	10.1	4.8	6.7	67.5	182.0	215.6	100

For significant drainage areas the average monthly discharge and average annual discharge runoff per square kilometre were used to estimate the mean monthly discharge (MMD) and mean annual discharge (MAD).

The Courtenay River Water Allocation Plan area is divided into ten significant drainage areas. Three are Roy Creek, Millard Creek and Bonner Creek, which flow into Comox Harbour. Perseverance Creek flows into Comox Lake and is included in the Comox Lake watershed. Comox Lake, Browns River and Morrison Creek watersheds flows into the Puntledge River drainage basin. The Courtenay River watershed is composed of both the Puntledge River and Tsolum River drainage areas.

3.2.1 Roy Creek

The estimated drainage area of Roy Creek to the Water Survey of Canada hydrometric station (08HB042) is 12.1 km^2 . The total drainage area of Roy Creek at the mouth is 13.4 km^2. Roy Creek ranges from an approximate elevation of 140 metres to sea level and, therefore, is a low elevation watershed with relatively flat terrain. Roy Creek flows into Comox Harbour just north of Gartley Point.

There are WSC (08HB042) flow measurements from April through September 1971 for Roy Creek. These flow measurements were used to estimate the mean monthly flows for April through September for the drainage area. The previously estimated average discharge per square kilometre was used to estimate the mean annual discharge (MAD) and the mean monthly discharges (MMD) for October through March. The October through March mean monthly discharges were adjusted for MAD. The discharges were adjusted for the additional flows to the mouth of Roy Creek.

The following table summarizes the mean monthly and mean annual discharge for Roy Creek.

Roy Creek Mean Monthly and Mean Annual Discharge at Mouth (Litres/sec)													
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
08HB042				250	58	22	6	0.6	0.8				
Discharge	1174	1073	935	277	64	24	6.7	0.7	0.9	469	1075	1253	529
%MAD	222	203	177	52	12	4.6	1.3	0.13	0.18	89	203	237	100

The following figure illustrates the mean monthly discharge for Roy Creek at its mouth.

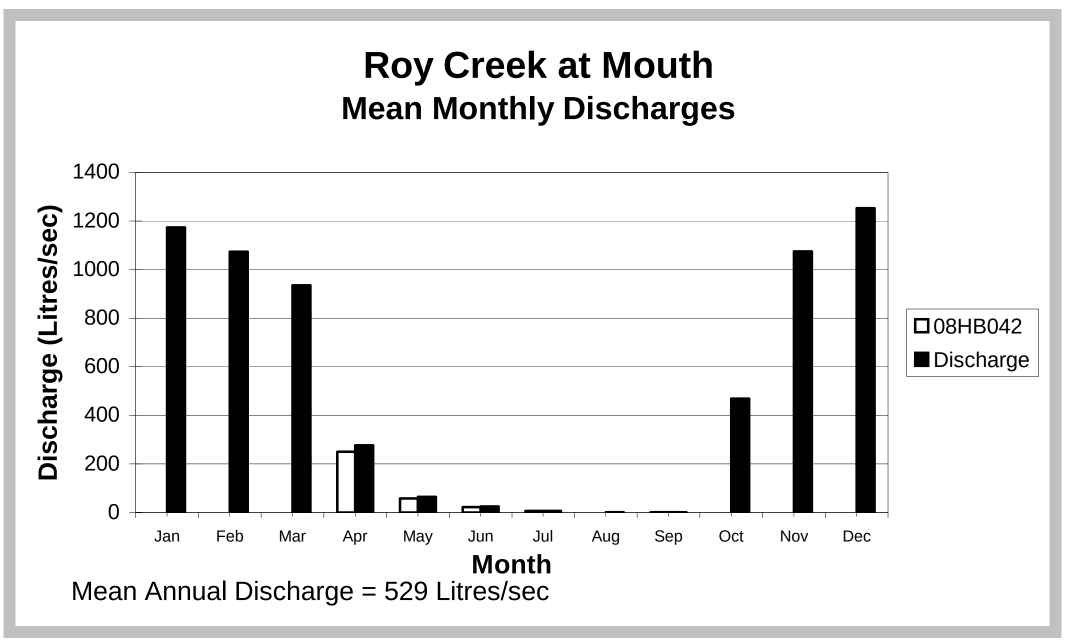


Figure 5 ROY CREEK AT THE MOUTH MEAN MONTHLY DISCHARGE

3.2.2 Millard Creek

The estimated drainage area of the Millard Creek watershed is 7.8 km^2, making it the smallest identified significant watershed in the plan area. Picket Spring is in the headwaters of Millard Creek. Millard Creek is a low elevation watershed, as most of it is below 100 metres, with relatively flat terrain.

There are miscellaneous streamflow records for Millard Creek for September 6 and 10 1985. The previously estimated average discharge per square kilometre was used to estimate the mean monthly and mean annual discharges for Millard Creek.

The mean monthly and mean annual discharge estimates for Millard Creek are summarized in the following table.

Millard Creek Mean Monthly and Mean Annual Discharge (Litres/sec)													
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
Discharge	619	524	480	277	179	85	31	15	20	208	561	665	308
% MAD	201	170	156	90	58	28	10	4.8	6.6	68	182	216	100

3.2.3 Bonner Creek

Bonner Creek's drainage area is approximately 9 km^2. The drainage area of Bonner Creek is below 100 metres elevation and, therefore, is a low elevation watershed with flat terrain. Bonner Creek flows into Lloyd Slough and into Comox Harbour directly below Courtenay River's mouth.

There are no streamflow measurements for Bonner Creek. Since it is a low elevation watershed, similar to Millard Creek and Roy Creek, the previously estimated average discharge per square kilometre was used to estimate its streamflow.

The following table summarizes the estimated mean monthly and mean annual discharges for Bonner Creek.

Bonner Creek Mean Monthly and Mean Annual Discharge (Litres/sec)													
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
Discharge	714	646	554	320	206	98	36	17	23	240	647	767	326
% MAD	201	182	156	90	58	28	10	4.8	6.6	68	182	216	100

3.2.4 Perseverance Creek

The drainage area of Perseverance Creek was estimated to be 26.8 km^2. Perseverance Creek drains from an elevation of approximately 240 metres passing through Allen Lake, which has an approximate surface area of 89,000 m^2 (8.9 ha), and flowing into Comox Lake. Cumberland Creek is tributary to Perseverance Creek and drains from a maximum elevation of approximately 900 metres. It flows through Cumberland Lake #1 (6.2 ha), Hamilton Lake (7 ha), Cumberland Lake #2 (2.2 ha), and Henderson Lake (0.3 ha) before reaching Perseverance Creek. Compared to other watersheds in the plan area, Perseverance Creek is a relatively low elevation watershed.

There are no streamflow records for Cumberland Creek or Perseverance Creek. Although the Perseverance Creek watershed does have higher elevations than the Millard Creek and Bonner Creek watersheds, the mean monthly discharge flows per square kilometre were assumed to be the same. Therefore, the average discharge per unit area hydrograph was used to estimate streamflow on Perseverance Creek, as was done for both Millard Creek and Bonner Creek.

The following table summarizes the estimated mean monthly and mean annual discharges for the Perseverance Creek watershed.

Perseverance Creek Mean Monthly and Mean Annual Discharge (Litres/sec)													
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
Discharge	2125	1924	1648	951	614	292	107	51	70	716	1927	2283	1059
%MAD	201	182	156	155	58	28	10	4.8	6.6	68	182	216	100

3.2.5 Comox Lake

Comox Lake watershed area is 441 km^2. It is part of the Puntledge River watershed. Cruickshank River, the upper Puntledge River, Perseverance Creek and a number of other streams flow into Comox Lake.

Comox Lake is the largest lake in the plan area with a surface area of approximately 16.2 km^2 (1620 ha) and a mean depth of 61 metres. The estimated volume of Comox Lake is therefore, approximating 988,200 dam^3. It is situated approximately 138 metres (453 feet) above sea level and has a maximum depth of about 109 metres (358 feet).

There are also a number of smaller lakes in this watershed, including, Moat Lake (95 ha), Memory Lake (90 ha), Willemar Lake (82 ha), Forbush Lake (47 ha), and Nimnim Lake (45 ha).

There is one WSC hydrometric station within the drainage area; namely Cruickshank River near the Mouth (08HB074). The estimated drainage area of the Cruickshank River WSC hydrometric station is 214 km^2. There is twelve years of discharge records at this station.

The Puntledge River near Cumberland (08HB007) WSC hydrometric station is near the outlet to Comox Lake and provides an estimate of the discharge from Comox Lake as regulated by the dam at the outlet. An estimate of the natural outflow from Comox Lake can be obtained using the discharge per unit area of the Cruickshank River near the Mouth (08HB074).

The following table summarizes the mean monthly and mean annual discharges for Cruickshank River near the Mouth (08HB074), the regulated outflow from Comox Lake as represented by the Puntledge River near Cumberland (08HB007) and the estimated natural outflow from Comox Lake.

Comox Lake Natural Mean Monthly Outflow (m^3/sec)													
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
Cruickshank 08HB074	17.7	20	17.9	17.4	26.3	26.2	13.8	9.4	4.9	17.2	23.5	16.3	17.1
Puntledge 08HB007	36.5	32.4	25	32.4	42.6	39.9	22.5	14.4	13.4	26.8	39.3	43.3	30.6
Comox Lake Natural Outflow	36.5	41.2	36.9	35.9	54.2	54	28.4	19.4	10.1	35.4	48.4	33.6	35.2
% MAD	103.7	117.0	104.8	102.0	154.0	153.4	80.7	55.1	28.7	100.6	137.5	95.5	100

The following figure illustrates the mean monthly discharges for the Cruickshank River near the Mouth (08HB074), the regulated outflow from Comox Lake as represented by the Puntledge River near Cumberland (08HB007) and the estimated natural outflow from Comox Lake.

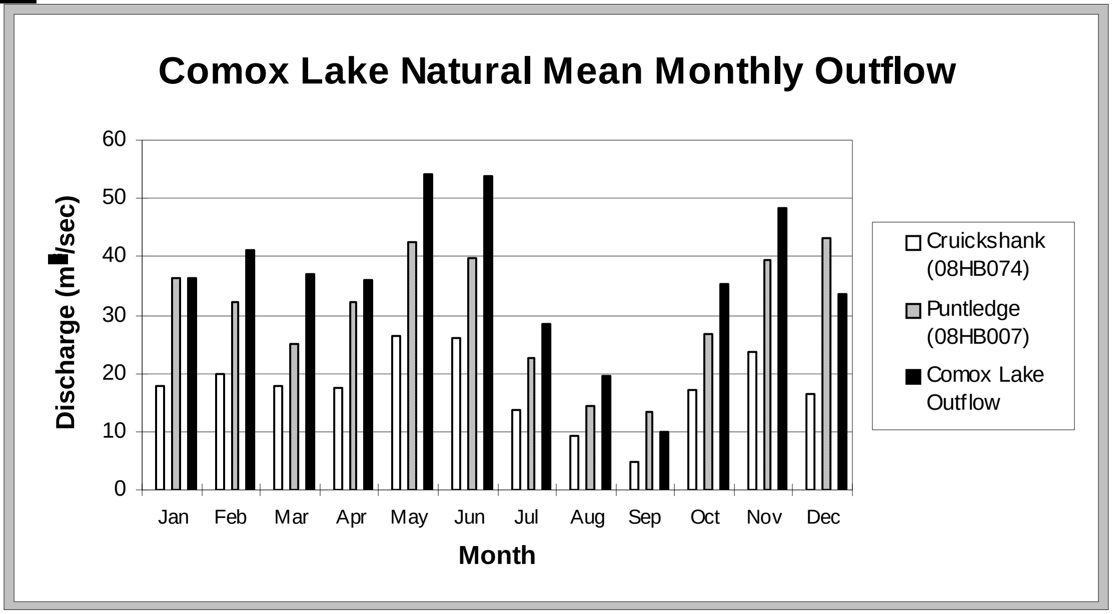


Figure 6 COMOX LAKE NATURAL MEAN MONTHLY OUTFLOW

3.2.6 Morrison Creek

The estimated drainage area of Morrison Creek is 14.1 km^2. Most of the drainage area of Morrison Creek is below 150 metres and, therefore, is a low elevation watershed with relatively flat terrain. A number of small streams, such as First Supply Creek, Nellie Creek, Willemar Creek and Arden Creek, are tributary to Morrison Creek. Morrison Creek flows through Courtenay and into the Puntledge River.

As this is a low elevation watershed, the mean monthly discharge per square kilometre is assumed to be the same as Millard Creek, Bonner Creek and Perseverance Creek; therefore, the previously estimated average discharge per square kilometre was used to estimate streamflow on Morrison Creek. The drainage area of Morrison Creek was multiplied by the average discharge per square kilometre.

The mean monthly and mean annual discharge estimates are summarized in the following table.

Morrison Creek Mean Monthly and Mean Annual Discharge (Litres/sec)													
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
Discharge	1118	1012	867	501	323	154	56	27	37	376	1014	1201	557
% MAD	201	182	156	90	58	28	10	4.8	6.6	68	182	216	100

3.2.7 Browns River

The total drainage area of Browns River at the mouth is 98 km^2. The estimated drainage area of Browns River to the Water Survey of Canada hydrometric station (08HB025) is 86 km^2. This station provides 34 years of streamflow records for this watershed. Browns River is a high elevation watershed with some steep terrain. Most of its area has elevations greater than 200 metres and its highest point being Mount Washington with an elevation of 1590 metres. Other high elevation points include Mount Elma at approximately 1400 metres, Mount Drabble at 1363 metres and Indianhead Mountain at 1282 metres.

Many small lakes and swamps are in the headwaters for this river system, along with a significant swamp called Paradise Meadows. Snow melt contributes to Browns River's streamflow during the months April, May and June. A number of creeks, including Ramparts Creek, Paradise Creek and Wattaway Creek, are tributary to Browns River. Browns River flows predominantly south-west entering the Puntledge River near Courtenay.

The following table summarizes the mean monthly discharge and mean annual discharge measurements for Browns River.

Browns River Mean Monthly and Mean Annual Discharge (08HB025) (Litres/sec)													
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
Discharge	6940	6500	5020	6850	9680	7030	1830	840	650	5670	7480	7270	5140
% MAD	135	126	98	133	188	137	36	16	13	110	146	141	100

The following figure illustrates the mean monthly discharges for Browns River.

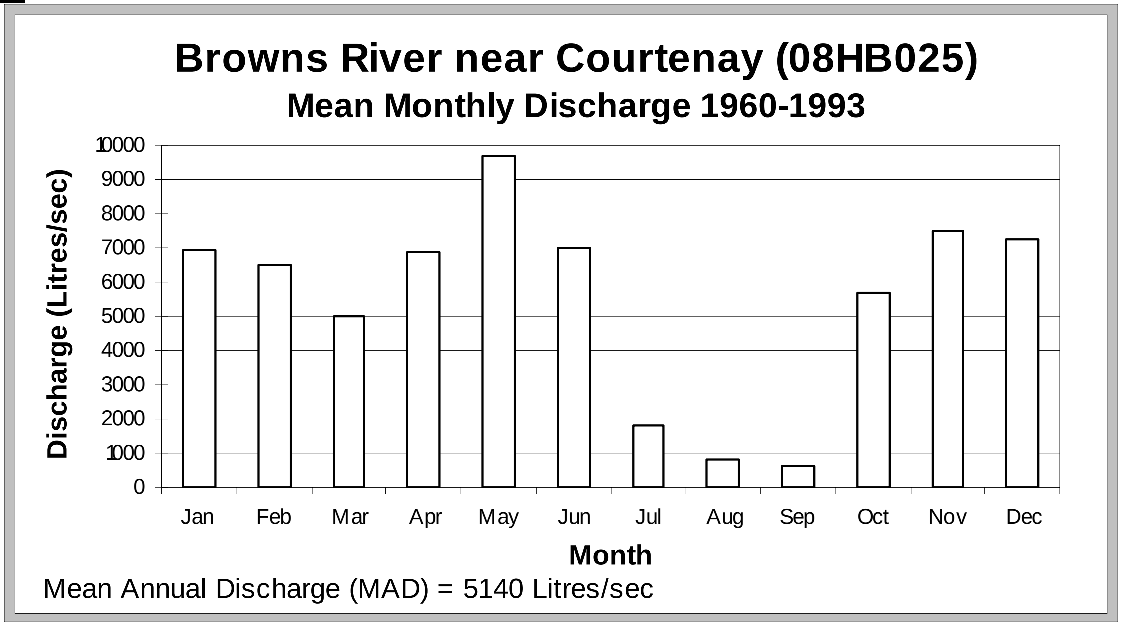


Figure 7 BROWNS RIVER (08HB025) MEAN MONTHLY DISCHARGE

3.2.8 Puntledge River

The estimated drainage area of the Puntledge River watershed is 607.6 km^2. This watershed includes the previously identified significant drainage areas of Perseverance Creek, Comox Lake, Browns River and Morrison Creek.

The Puntledge River watershed area is a relatively high elevation watershed with most of its elevation above 200 metres and reaching almost 2000 metres along its western boundary. The western boundary of this watershed is defined by a mountain range that contains a number of glaciers and lakes in the headwaters. Puntledge River flows predominantly north-east to join with the Tsolum River to form the Courtenay River. The flow on the Puntledge River is regulated by a dam at Comox Lake.

There is a Water Survey of Canada hydrometric station on the Puntledge River above the confluence with the Tsolum River; namely the Puntledge River at Courtenay (08HB006). The drainage area of the Puntledge River at Courtenay (08HB006) hydrometric station is 593 km^2. This hydrometric station has forty years of discharge records from 1914-1920, 1955-1957 and 1964-1993.

The following table summarizes the mean monthly and mean annual discharges for the Puntledge River using the Puntledge River at Courtenay (08HB006) hydrometric station.

Puntledge River at Courtenay Mean Monthly and Mean Annual Discharge (08HB006) (m^3/sec)												
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
Discharge	47.3	43.8	40	40.3	50.4	48.8	31	22.4	23.5	35.6	53.5	54.9	41
%MAD	115	107	98	98	123	119	76	55	57	87	130	134	100

The following figure illustrates the mean monthly discharges for the Puntledge River.

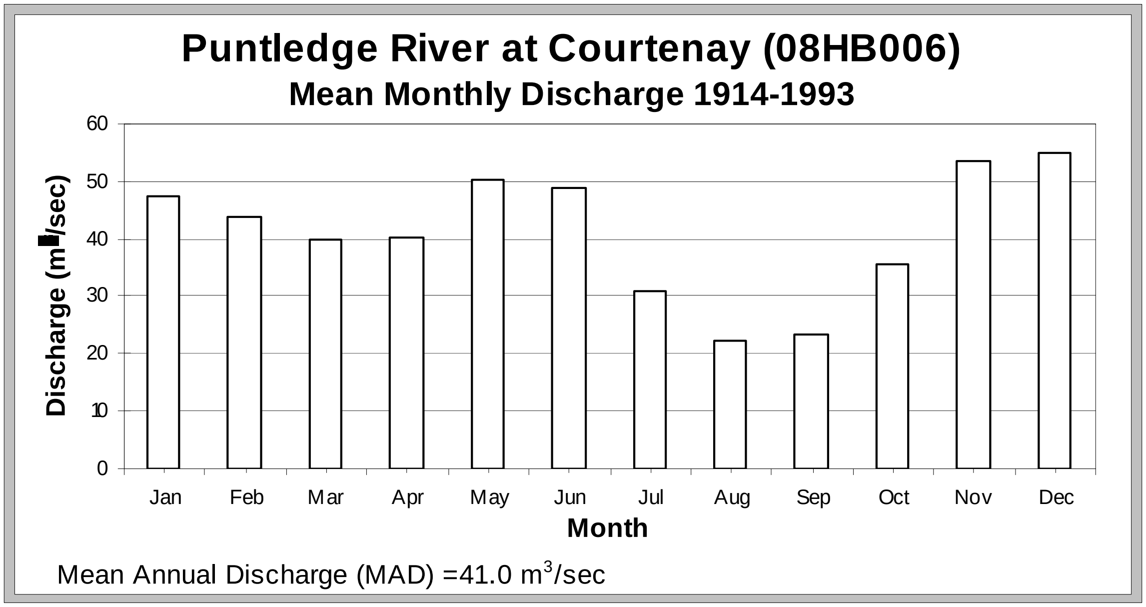


Figure 8 PUNTLEDGE RIVER (08HB006) MEAN MONTHLY DISCHARGE

The natural or non-regulated flow of the Puntledge River was estimated using the average of the discharge runoff per square kilometre for the Cruickshank River and Browns River .

The following table shows the regulated mean monthly and mean annual discharges for the Puntledge River at Courtenay (08HB006) and the estimated natural discharge.

Puntledge River Mean Monthly and Mean Annual Discharge (m^3/sec)													
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
Regulated (08HB006)	47.3	43.8	40	40.3	50.4	48.8	31	22.4	23.5	35.6	53.5	54.9	41
Natural	48.4	50.1	42.1	47.7	69.8	60.5	25.4	15.9	9.0	43.4	58.4	47.7	41.4

The following figure illustrates the mean monthly discharges of the Puntledge River at Courtenay (08HB006) compared to the estimated natural discharge.

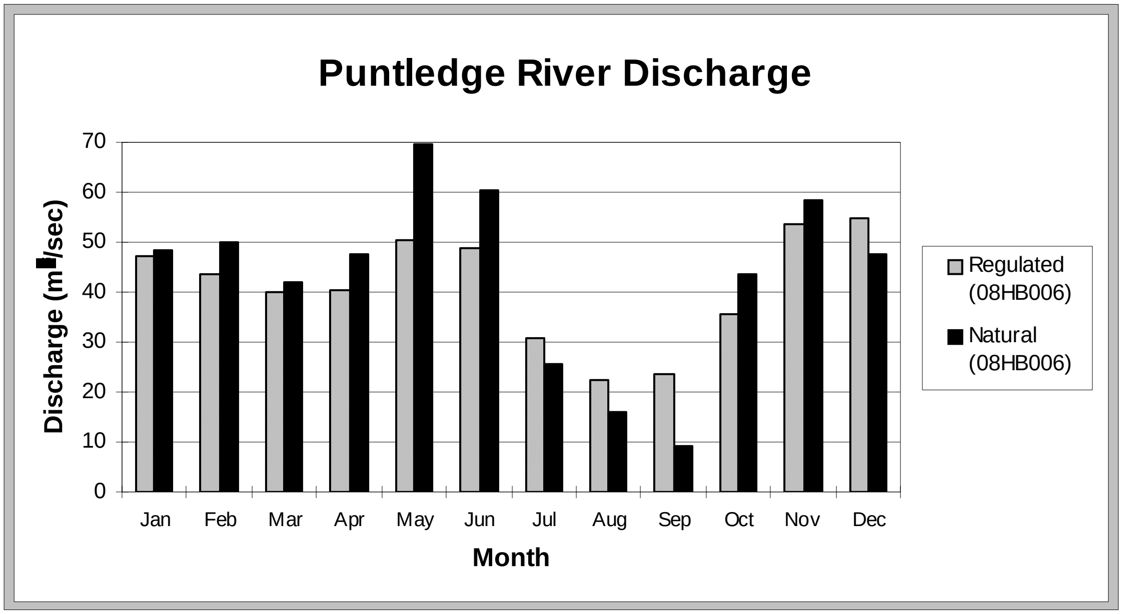


Figure 9 PUNTLEDGE RIVER DISCHARGE

Regulated streamflow is lower during the months of October, November and January through June and is higher during the months of July through September.

3.2.9 Tsolum River

The drainage area of the Tsolum River at the confluence with the Puntledge River is 248 km^2. The watershed is relatively flat and half of the watershed area is below an elevation of 300 metres. Elevations reach 580 metres at Constitution Hill and 1590 metres at Mount Washington. Tsolum River flows predominantly south-east to join with the Puntledge River to form the Courtenay River.

The largest lake in the watershed area is Wolf Lake at an elevation of 215 metres above sea level. Wolf Lake has a surface area of approximately 156 hectares. Headquarters Creek flows from Wolf Lake into the Tsolum River.

Anderson Lake, south-west of Wolf Lake, is at an elevation of 541 metres above sea level. Anderson Lake has a surface area of approximately 23 hectares. Dove Creek flows from Anderson Lake into the Tsolum River.

A number of small lakes such as Hell Diver Lake, Little Lost Lake, Lost Lake, Regan Lake and McKay Lake are in the headwaters for the Tsolum River. There are also large swamp areas in the north-east part of the headwaters of the Tsolum River.

Portuguese Creek is another significant tributary which flows south from Merville through developed farm lands. It flows parallel to the Island Highway (Highway 19) into the Tsolum River above the confluence with Puntledge River.

There are two Water Survey of Canada hydrometric stations within the Tsolum River watershed; namely the Tsolum River near Courtenay (08HB011) and Dove Creek near the Mouth (08HB075). There are 37 years of flow records available from 1914 to 1917, 1955 to 1957 and 1964 to 1993 on the Tsolum River near Courtenay (08HB011). There are 9 years of flow records available from 1985 to 1993 on Dove Creek near the Mouth (08HB075). The drainage area of the Tsolum River near Courtenay (08HB011) is 235 km^2.

There are also miscellaneous discharge records available for Portuguese Creek, Headquarters Creek, Murex Creek and the upper Tsolum River.

The following table summarizes the mean monthly and mean annual discharge for the Tsolum River.

Tsolum River Mean Monthly and Mean Annual Discharge (08HB011) (m^3/sec)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
Discharge	16.9	16.7	15.3	11.2	7.3	4.2	1.8	0.90	1.6	7.5	18.0	20.7	10.3
%MAD	164	162	149	109	71	41	17	8.7	16	73	175	201	100

The following figure illustrates the mean monthly discharges for the Tsolum River.

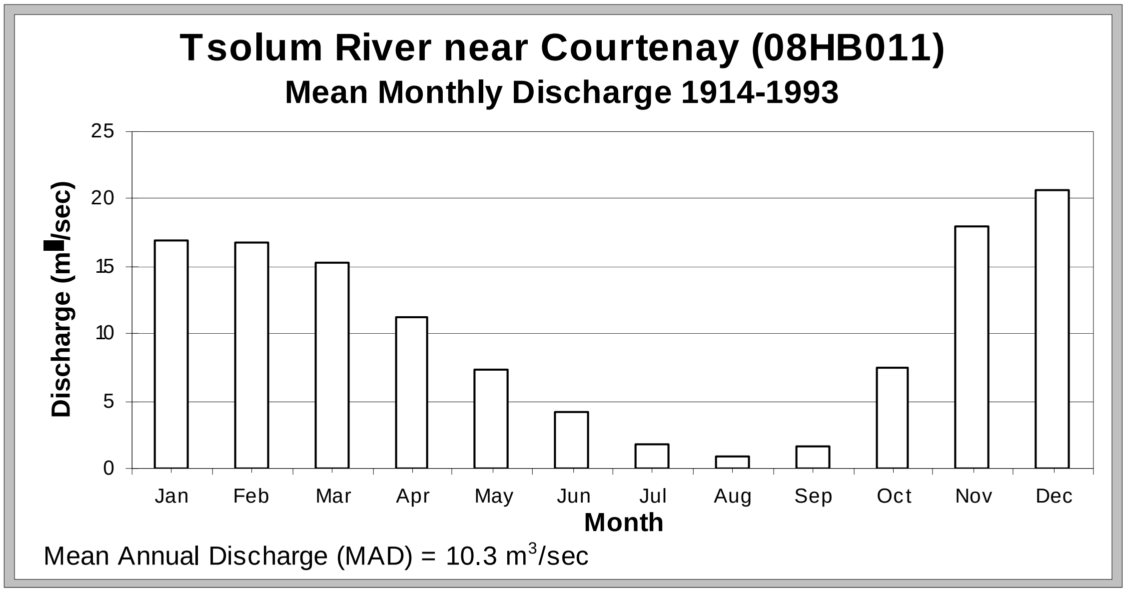


Figure 10 TSOLUM RIVER (08HB011) MEAN MONTHLY DISCHARGE

3.2.10 Courtenay River

The Courtenay River is formed by the confluence of the Tsolum and Puntledge Rivers and flows about 2.6 kilometres from the confluence to the ocean. The estimated drainage area of the Courtenay River is 859 km^2. The Courtenay River drainage area includes the previously identified significant drainage of Perseverance Creek, Comox Lake, Browns River, Morrison Creek, Puntledge River and Tsolum River.

Courtenay River's discharge was estimated by calculating the sum of the discharges from the Puntledge River at Courtenay (08HB006) and the Tsolum River near Courtenay (08HB011).

The following table summarizes the regulated mean monthly and mean annual discharge for the Courtenay River and the streamflow used to estimate its discharge.

Courtenay River Regulated Mean Monthly and Mean Annual Discharge													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**MAD**
Puntledge (08HB006)	47.3	43.8	40.0	40.3	50.4	48.8	31.0	22.4	23.5	35.6	53.5	54.9	41.0
Tsolum (08HB011)	16.9	16.7	15.3	11.2	7.3	4.2	1.8	0.9	1.6	7.5	18.0	20.7	10.3
Courtenay River	64.2	60.5	55.3	51.5	57.7	53	32.8	23.3	25.1	43.1	71.5	75.6	51.3
% MAD	125	118	108	100	113	103	64	45	49	84	139	147	100

The following table summarizes the estimated natural mean monthly and mean annual discharge for the Courtenay River and the streamflow used to estimate its discharge.

Courtenay River
Natural Mean Monthly and Mean Annual Discharge

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
Puntledge (Natural)	48.4	50.1	42.1	47.7	69.8	60.5	25.4	15.9	9.0	43.4	58.4	47.7	41.4
Tsolum (08HB011)	16.9	16.7	15.3	11.2	7.3	4.2	1.8	0.9	1.6	7.5	18.0	20.7	10.3
Courtenay River	65.3	66.8	57.4	58.9	77.1	64.7	27.2	16.8	10.6	50.9	76.4	68.4	51.7
% MAD	126	129	111	114	149	125	53	32	21	98	148	132	100

The following figure illustrates the regulated and natural mean monthly flows for the Courtenay River.

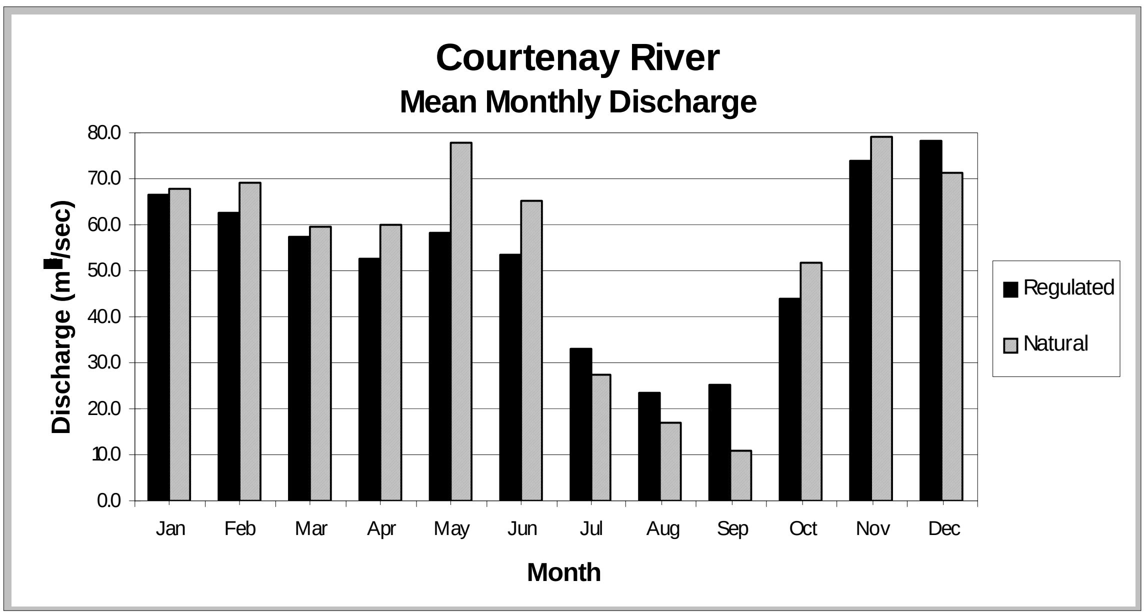


Figure 11 COURTENAY RIVER MEAN MONTHLY DISCHARGE

3.3 Low Flows

In the Courtenay River Water Allocation Plan area the minimum monthly flows occur in April, May, June, July, August and September. The minimum mean monthly discharge (MMD) occurs in August and September.

The 7-day average low flows occur predominantly in September or August. There are rarer occurrences of 7-day average low flows in July, June and April.

A summary of the mean annual discharge (MAD), minimum mean monthly discharge (Min MMD) and mean 7-day average low flow is in the following table.

MAD, Min MMD and 7-Day Average Low Flow (Litres/sec)			
Drainage Area	**MAD**	**Min MMD**	**7-Day Avg Low**
Roy Creek	529	0.7	0
Millard Creek	308	15	
Bonner Creek	356	17	
Perseverance Creek	1,059	51	
Comox Lake	29,800	13,100	
Morrison Creek	557	27	
Browns River	5,857	741	136
Puntledge River (08HB006)	41,000	22,400	16175
Tsolum River	10,870	950	190
Courtenay River	52,600	23,400	

4.0 INSTREAM FLOW REQUIREMENTS

Maintaining the natural stream environment and instream uses is of paramount importance for present and future generations. Maintaining water for the fisheries resource is a key factor in maintaining instream flow requirements for water quality, recreational, aesthetic and cultural values. The Ministry of Environment Provincial policy is:

> **In situations where a water allocation decision will significantly impact instream uses of water, the comptroller or regional water manager may refuse the application or include water licence conditions to protect the instream use.**

Instream fisheries flow requirements are based on a Provincially modified version of the Tennant (Montana) Method.

Modified Tennant (Montana) Method Instream Flow Requirements	
Flows	**Description**
30-60% MAD	Excellent spawning/rearing
20-30% MAD	Good spawning/rearing
10-20% MAD	Fair spawning/rearing
5-10% MAD	Poor spawning/rearing
>5% MAD	Severely degraded spawning/rearing

In drainages where fish are present, the minimum flow required to sustain the fisheries resource for fair spawning and rearing habitat is 10% of the Mean Annual Discharge (MAD). Therefore, the Regional policies to implement the Provincial policy are:

> **The minimum flow required to sustain the fisheries resources for spawning and rearing is 10% of the Mean Annual Discharge (MAD); unless a more rigorous analysis indicates a different minimum flow requirement.**
>
> **For streams where the natural mean monthly flow falls below 10% of the MAD, extractive licensed demands should only be allowed for the period of months when the mean monthly flow is above 60% of the MAD**
>
> **For streams where the mean 7-day average low flow falls below 10% of the MAD, extractive demands should only be allowed for the period of months when the mean monthly flow is above 60% of the MAD. Where the mean 7-day average low flow remains above 10%, then the 7-day low flow amount above 10% MAD is available**.
>
> **Withdrawals from natural water bodies (lakes, ponds, swamps and marshes) supporting natural fisheries resources shall not reduce the shoal area more than 10%.**

Figure 13, on the following page, illustrates fish habitat within the plan area.

4.1 Roy Creek

Coho salmon, Chum salmon and sea-run Cutthroat trout have been identified in Roy Creek.

The following figure illustrates that the mean monthly flow in Roy Creek falls below 10% of the mean annual discharge (MAD) during the four months of June, July, August and September. Therefore, no water is available from Roy Creek when the monthly flow is below 60% MAD or 317 litres/second. Water is only available for extractive use during the months of October through March when the mean monthly discharge is above 60% MAD.. Thus, the estimated volume of water available from October through March is 9,500 dam^3.

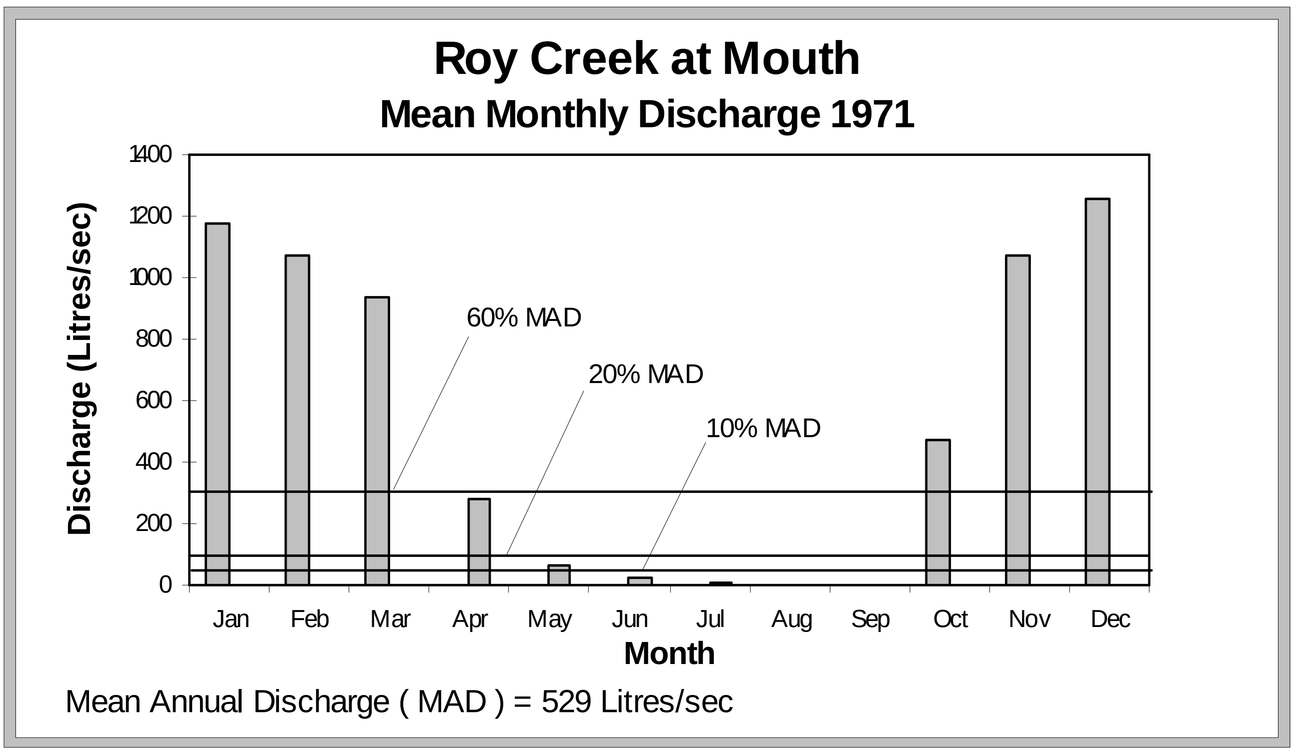


Figure 12 ROY CREEK MEAN MONTHLY DISCHARGE

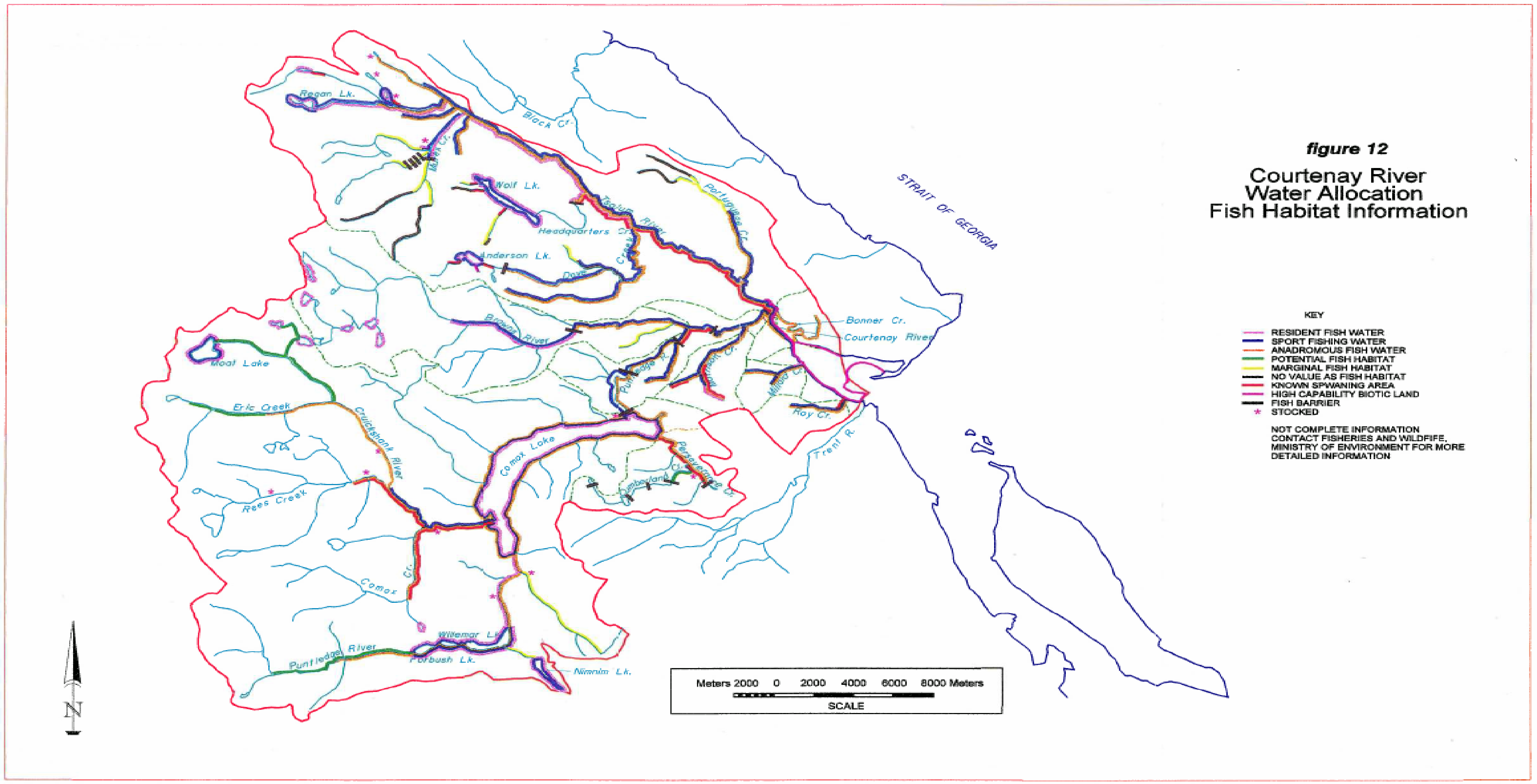


Figure 13 FISH HABITAT INFORMATION

4.2 Millard Creek

Anadromous fish such as Coho, Chum and Pink salmon utilize Millard Creek for spawning and rearing. This stream is also inhabited by Steelhead and sea-run Cutthroat trout. Piercy Creek, which is tributary to Millard Creek, is utilized by Coho salmon.

The following figure illustrates that the estimated mean monthly discharge in Millard Creek falls below 10% of the mean annual discharge (MAD) during the months of August and September. Therefore, no water is available from Millard Creek when the flow is below 60% MAD or 185 litres/second. Water is only available during the months of October through April when the mean monthly discharge is above 60% MAD. Thus, the estimated volume of water available from October through April is 5,300 dam^3.

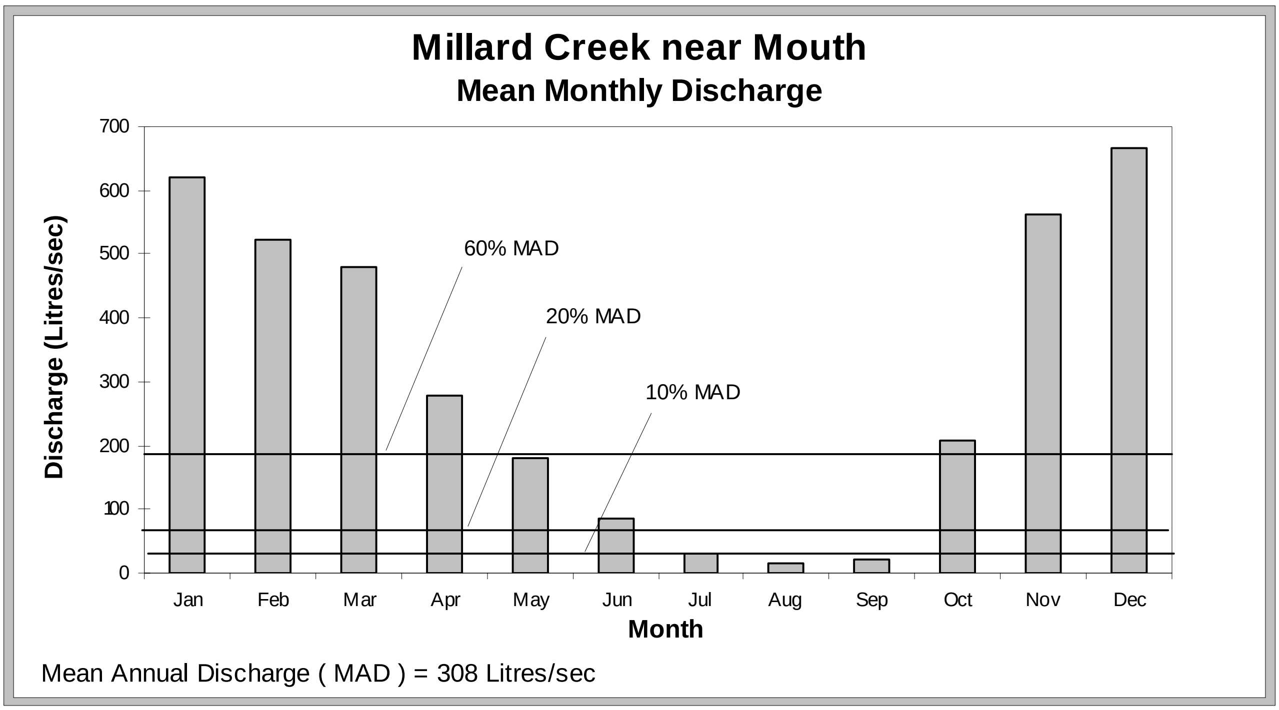


Figure 14 MILLARD CREEK MEAN MONTHLY DISCHARGE

4.3 Bonner Creek

Both Coho salmon and sea-run Cutthroat trout and possibly resident Cutthroat trout utilize Bonner Creek.

The following figure illustrates that the estimated mean monthly discharge in Bonner Creek falls below 10% of the mean annual discharge (MAD) during the months of August and September. Therefore, no water is available from Bonner Creek when the flow is below 60% MAD or 214 litres/second. Water is only available for extractive use during the months of October through April when the mean monthly discharge is above 60% MAD. Thus, the estimated volume of water available form October through April is 7,600 dam^3.

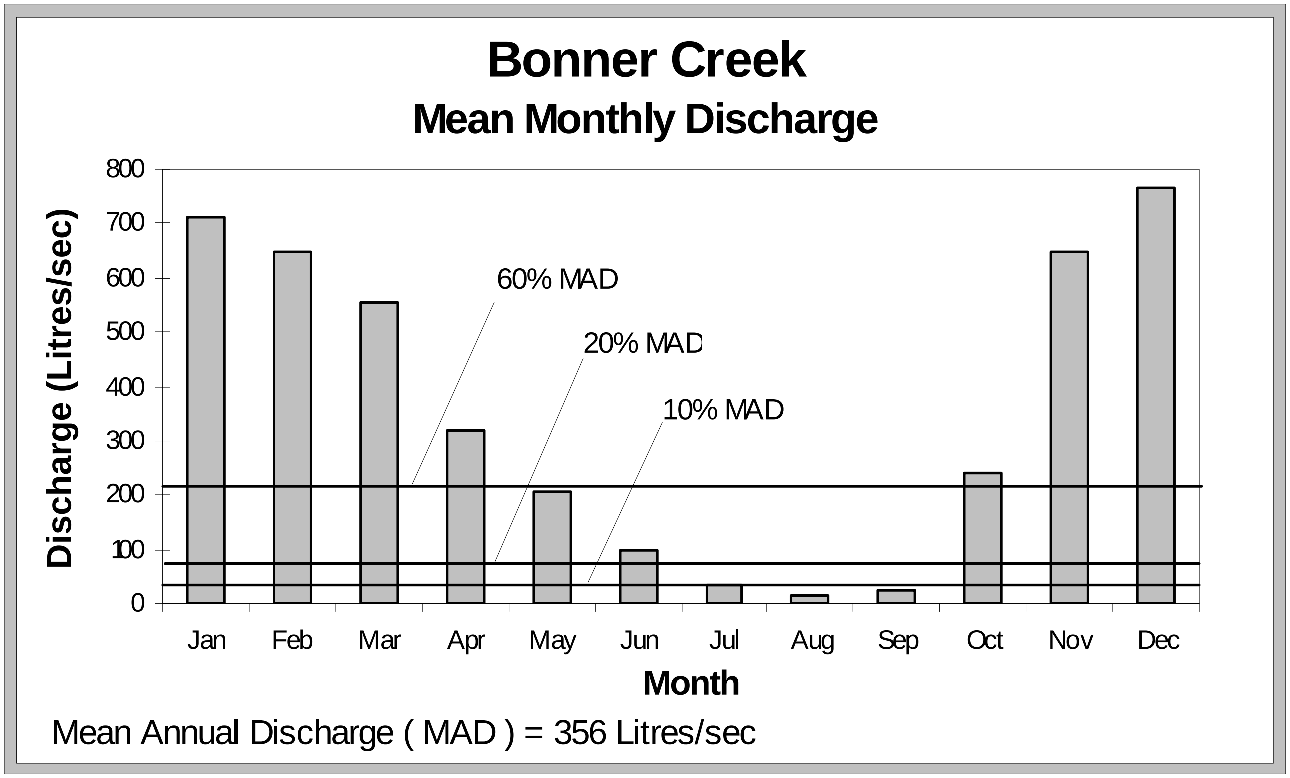


Figure 15 BONNER CREEK MEAN MONTHLY DISCHARGE

4.4 Perseverance Creek

Perseverance Creek is stocked with Coho salmon and is, therefore, utilized by anadromous fish. Coho salmon may also occupy the lower portion of Cumberland Creek, which is tributary to Perseverance Creek.

The following figure illustrates that the estimated mean monthly flow in Perseverance Creek falls below 10% of the mean annual discharge (MAD) during the months of August and September. Therefore, no water is available from Perseverance Creek when the flow is below 60% MAD or 635 litres/second. Water is only available for extractive use during the months of October through April when the mean monthly discharge is above 60% MAD. Thus, the estimated volume of water available for extraction from October through April is 18,600 dam^3.

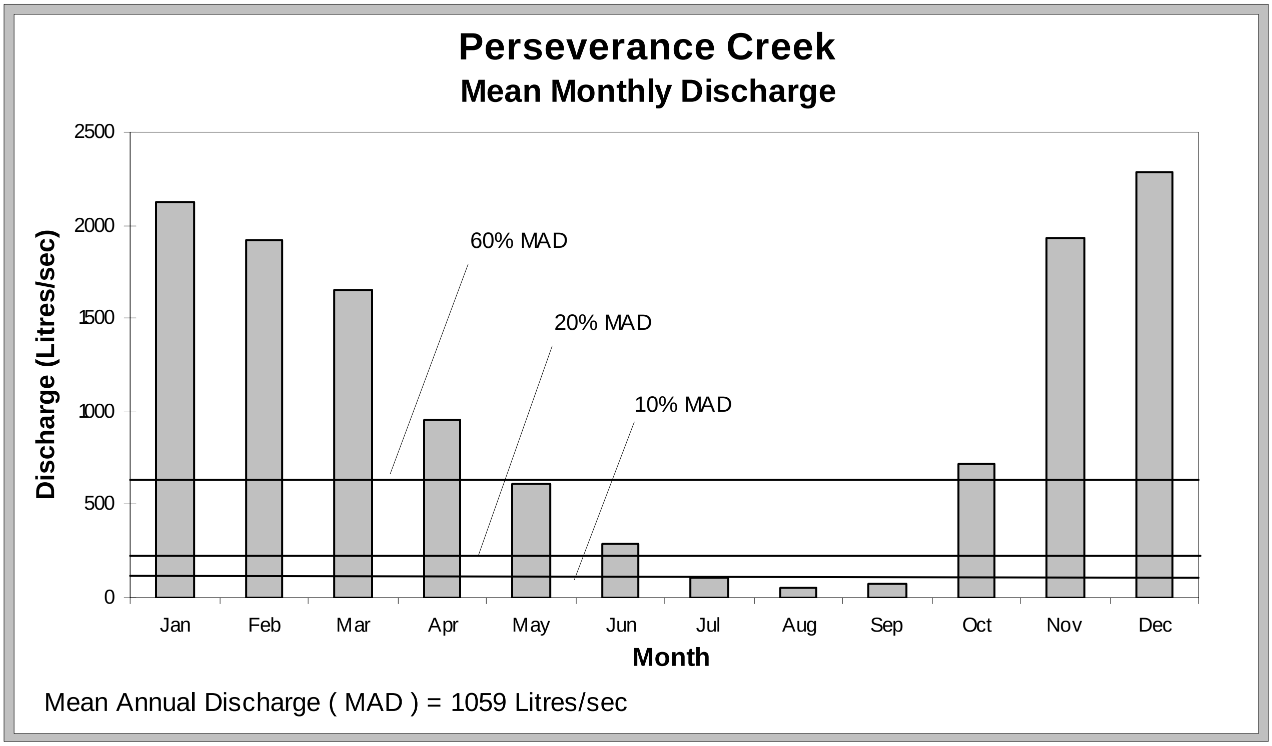


Figure 16 PERSERVERANCE CREEK MEAN MONTHLY DISCHARGE

4.5 Comox Lake

Resident fish such as Cutthroat and Rainbow trout , Kokanee salmon and Dolly Varden inhabit Comox Lake. Also both the Cruickshank River and the upper Puntledge River have fish values and are stocked. Comox Lake is stocked with Coho salmon fry.

Direct water extractions from Comox Lake should not reduce the shoal area of the lake by more than 10% to maintain fish values in the lake. The estimated shoal area of Comox Lake is the top 6 metres of the lake. Therefore the maximum quantity of water available from Comox Lake, without supporting storage development, is 9,700 dam^3.

The natural outflow from Comox Lake is approximately equal to the inflow to the lake over the long term. Therefore the following figure illustrates that all mean monthly discharges (MMD) exceed the 20% MAD criteria used to protect the instream fish resources. Therefore extractive water demands from streams that flow into Comox Lake and at the outflow from Comox Lake are not restricted during the low flow months due to instream fish flow requirements (except

Perserverance Creek - see above). Therefore some water is available for extractive use from streams that flow into Comox Lake and at the outlet to Comox Lake all year round.

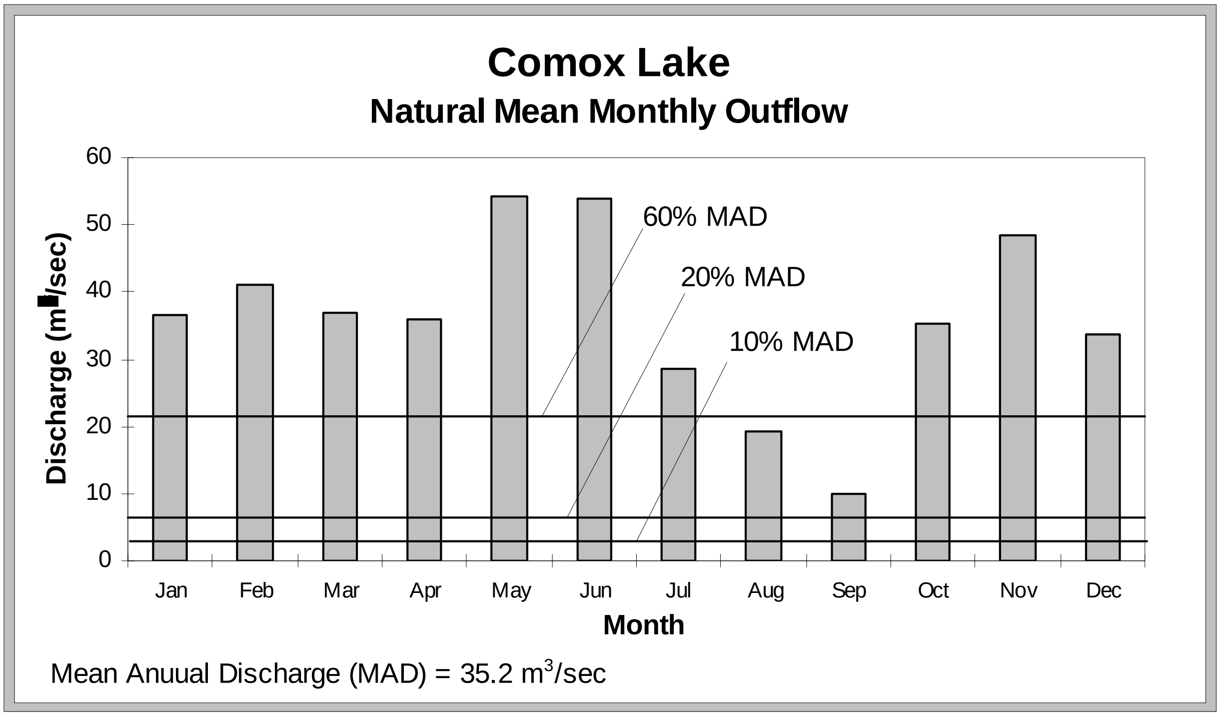


Figure 17 COMOX LAKE NATUREAL MEAN MONTHLY OUTFLOW

4.6 Morrison Creek

Anadromous fish such as Steelhead trout, sea-run Cutthroat trout, Coho salmon and Pink salmon utilize Morrison Creek; Coho and Pink salmon use this creek for spawning. Resident Cutthroat trout inhabit some of the upper portion of Morrison Creek.

The following figure illustrates that the estimated mean monthly flow in Morrison Creek falls below 10% of the mean annual discharge (MAD) during the months of August and September. Therefore, no water is available from Morrison Creek when the discharge is below 60% MAD or 334 litres/second. Water is only available for extractive use during the months of October through April when the mean monthly discharge is above 60% MAD. Thus, the estimated volume of water available from October through April is 9,800 dam^3.

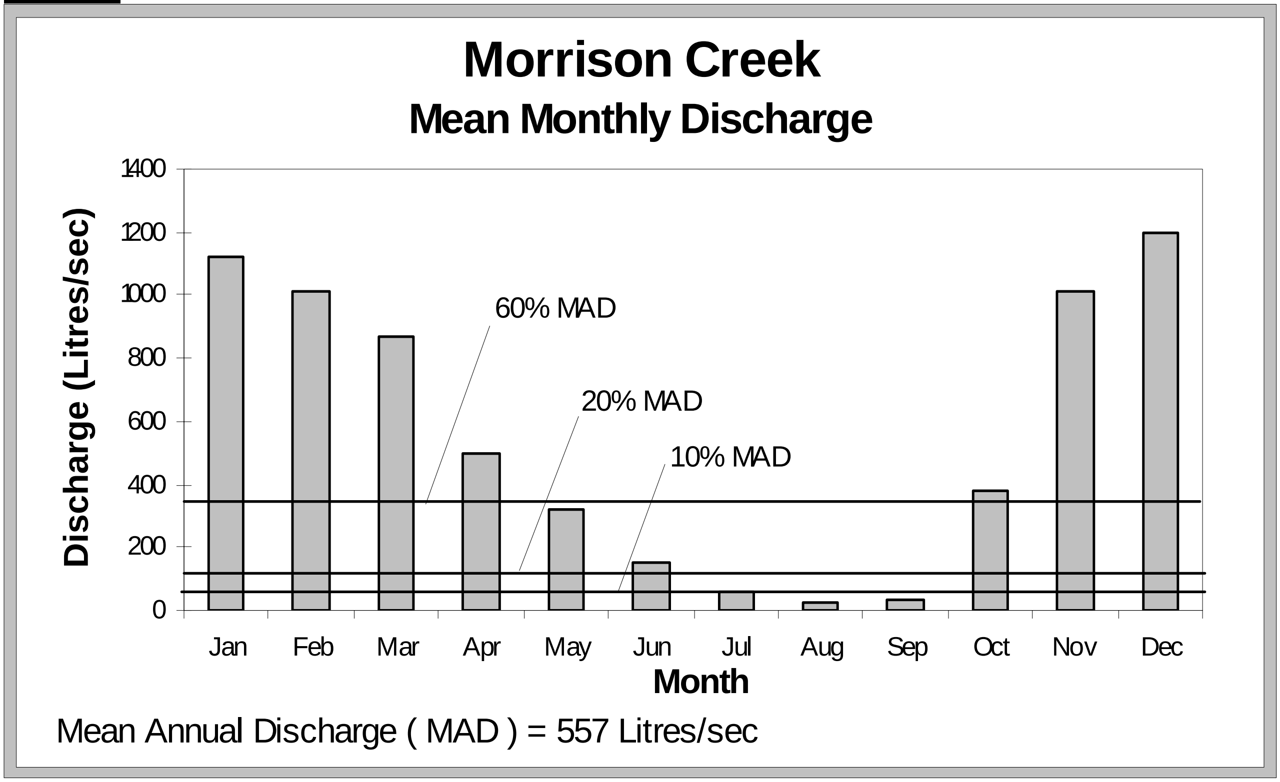


Figure 18 MORRISON CREEK MEAN MONTHLY DISCHARGE

4.7 Browns River

Sea-going fish such as Coho salmon and Steelhead are found in Browns River along with resident Rainbow trout. Lakes in the upper watershed are also inhabited by Rainbow trout. A waterfall, approximately 7 kilometres upstream from the mouth of Browns River, marks the upper limit of the anadromous fish habitat.

The following figure illustrates that the mean monthly flow in the Browns River falls between 10% and 20% of MAD during the months of August and September. The mean 7-day average low flow for the Browns River of 136 litres/second is less than the 10% MAD (514 litres/second) criteria. Therefore, no extractive water demands may be made when the mean monthly flows are below 60% MAD (3,084 litres/second). July, August and September fall into this non-extractive period. Thus, the estimated quantity of water available from Browns River during the months of October through June is 90,000 dam^3.

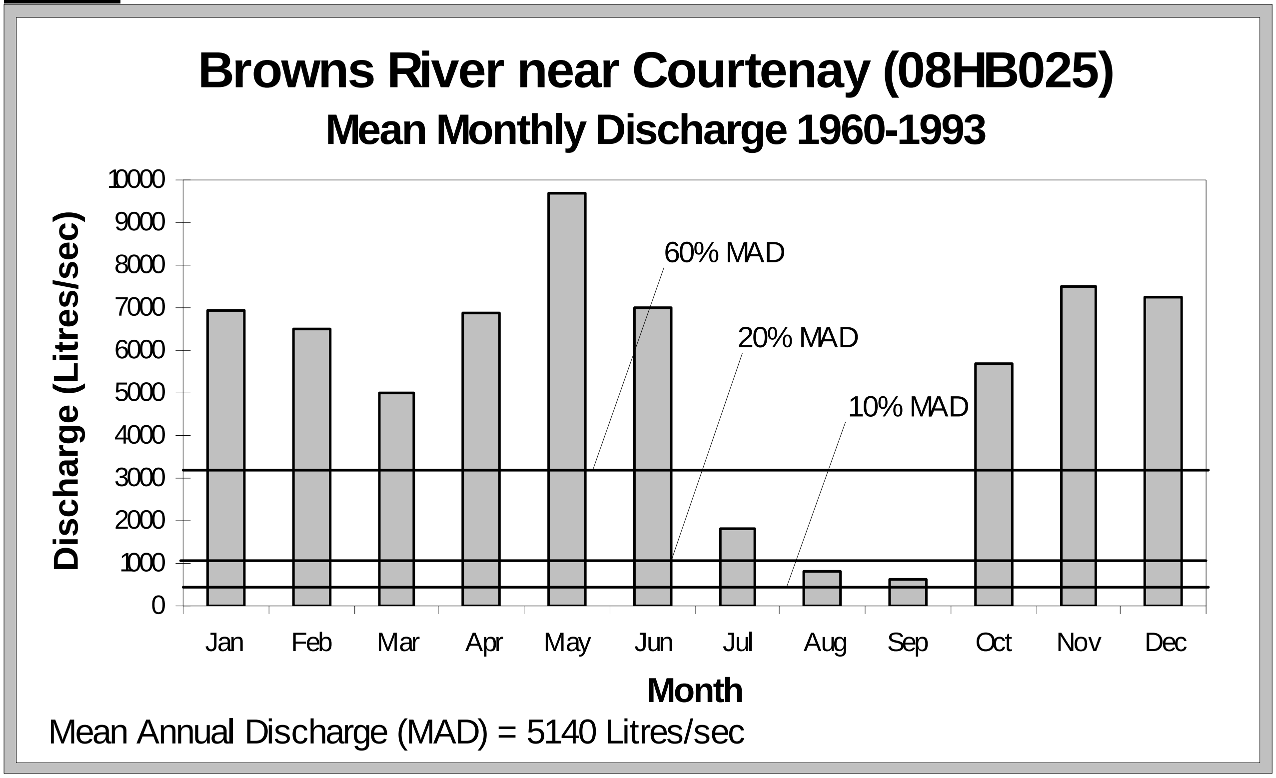


Figure 19 BROWNS RIVER (08HB025) MEAN MONTHLY DISCHARGE

4.8 Puntledge River

Anadromous fish such as Coho, Chum, Chinook and Pink salmon utilize the Puntledge River for spawning and rearing. Steelhead trout also utilize the Puntledge River. The Puntledge River is stocked with salmon and trout. Toma Creek, which is tributary to Puntledge River, is also stocked with Coho. Forbush, Willemar and Nimnim Lakes are inhabited by resident Cutthroat trout, Kokanee salmon and Dolly Varden.

The Federal Department of Fisheries and Oceans (Fed Fish) operates two hatcheries on the Puntledge for the production of Coho, Chum, Chinook and Pink salmon as well as Steelhead and Cutthroat trout. There are also a number of spawning channel and fish passage developments on the Puntledge River.

A number of studies have been conducted by Fed Fish and the Provincial Ministry of Environment to determine the instream fish flow requirements to mitigate the impact on fish by the storage development on Comox Lake and flow regulation in the Puntledge River by BC Hydro. Agreement has been reached and an operation order issued to required a minimum flow in the Puntledge River to maintain the fisheries resource. The desirable minimum flow in the Puntledge River below the penstock's outfall and above the confluence with the Tsolum River is 20.5 m^3/sec

(725 cfs). Also a minimum flow of 5.7 m^3/sec (200 cfs) from June 10 to September 30 and 2.8 m^3/sec (100 cfs) from October to June 9 is required in the Puntledge River between the B.C. Hydro's intake and the penstock's outfall (see Provisional Operation Rule on licence file 0265017). BC Hydro endeavors to maintain these minimum desirable flows whenever inflow to and storage in Comox Lake is adequate to maintain these flows in the Puntledge River. However inflow to Comox Lake is commonly not sufficient to maintain the 20.5 m^3/sec (725 cfs). A minimum flow of 15.6 m^3/sec (550 cfs) is maintained when inflows to Comox Lake are not sufficient.

The following figure illustrates that mean monthly flows in the Puntledge River below the penstock for the period of record and the 20.5 m^3/sec (725 cfs) minimum flow desired to maintain the fish resource.

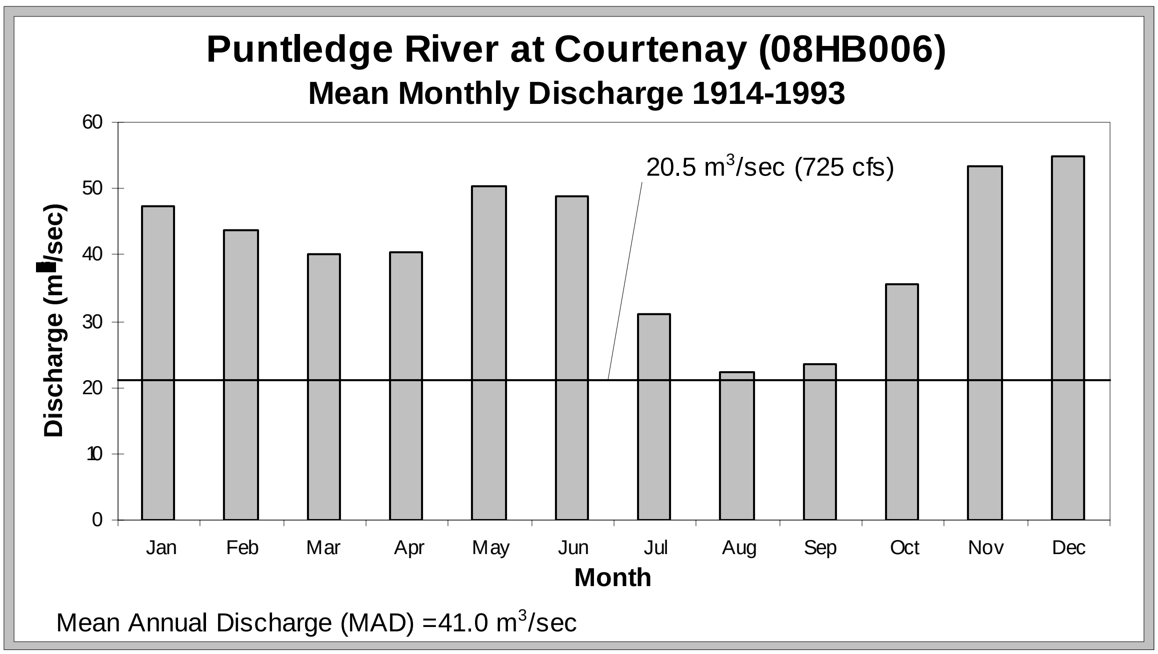


Figure 20 PUNTLEDGE RIVER (08HB006) MEAN MONTHLY DISCHARGE

The minimum mean monthly flow, for the period of record, is 22.4 m^3/sec (790 cfs) in August. Although the minimum mean monthly flow for the period of record is 1.9 m^3/sec (65 cfs) above the desirable minimum flow for fish, the annual minimum mean monthly flows are below the desirable minimum flow for fish in approximately 7 out of 10 years and below 15.6 m^3/sec (550 cfs) approximately 3 out of 10 years, for the period of record.

However a flow of 0.11 m^3/sec (4 cfs) has in the past been reserved for other use in the main stem of the Puntledge River below the penstock's outfall .

4.9 Tsolum River

The Tsolum and its tributaries have been utilized by anadromous fish such as Coho, Chum and Pink salmon, and Steelhead trout. Resident Cutthroat trout inhabit the Tsolum River and some of its tributaries

The following figure illustrates that the mean monthly flow in Tsolum River falls below 10% of the mean annual discharge (MAD) during the month of August. Therefore, no water is available from Tsolum River when the flow is below 60% MAD or 6,180. Water is only available for extractive use during the months of October through May when the mean monthly discharge is above 60% MAD. Thus, the estimated volume of water available from October through May is 211,000 dam^3.

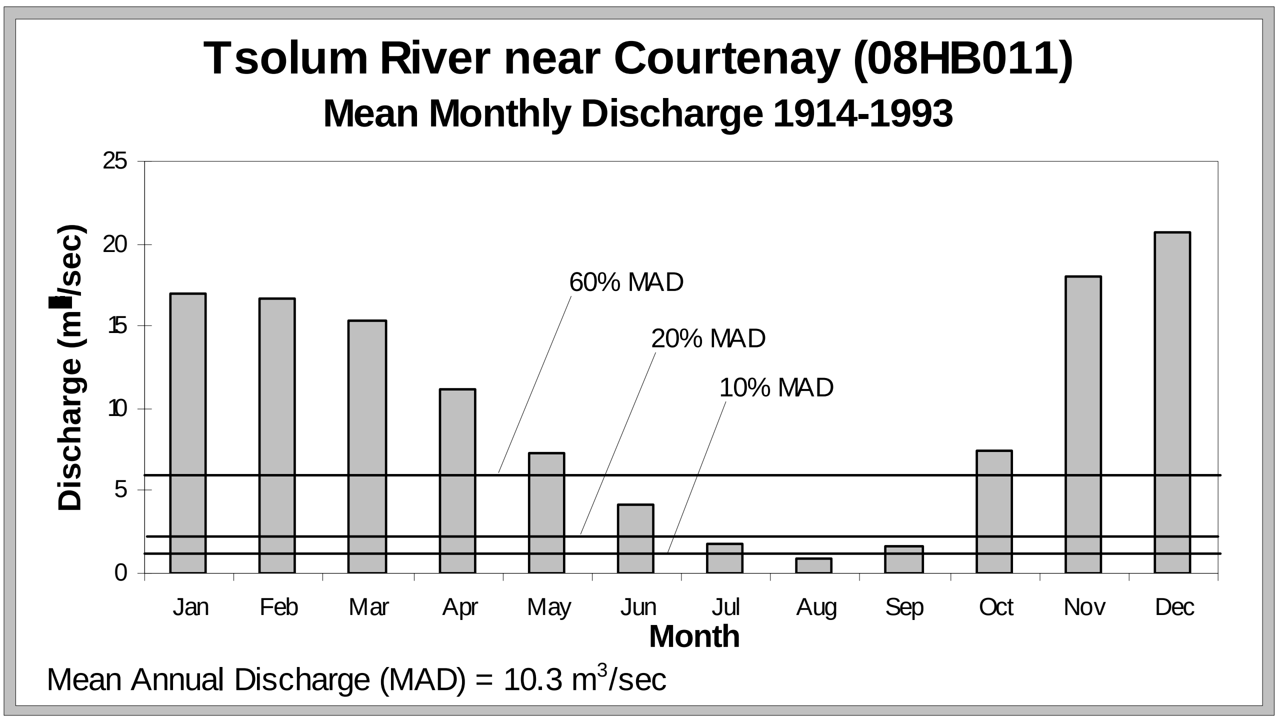


Figure 21 TSOLUM RIVER (08HB011) MEAN MONTHLY DISCHARGE

4.10 Courtenay River

The Courtenay River, being the confluence of the Puntledge River and Tsolum River, has the same anadromous fish such as Sockeye, Coho, Chum and Pink salmon, Steelhead trout and Cutthroat trout and resident fish such as Cutthroat trout, Kokanee salmon and Dolly Varden utilizing the lakes and rivers in this watershed.

COURTENAY RIVER WATER ALLOCATION PLAN

The Courtenay River, being an extension of the Puntledge River (and Tsolum River), would have same limitations for instream flow requirements for fish. Therefore the flow reserved for other uses of 0.11 m^3/sec (4 cfs) is also available from the main stem of either the Puntledge River or Courtenay River.

5.0 WATER DEMAND

5.1 Licenced Demand

There are 166 water licenses currently (January 1996) within the Courtenay River Water Allocation Plan area. Figure 29 illustrates the number of water licenses issued for each purpose for streams within the plan area. Almost half of these water licenses (80) are for domestic purposes for residential demands. There are 45 water licenses for irrigation purposes, 15 licenses for storage, 8 licenses for conservation purposes, another 8 water licenses for waterworks, 5 water licenses for land improvement, 4 more water licenses for industrial purposes and 1 water licence for the purpose of hydro-electric power generation.

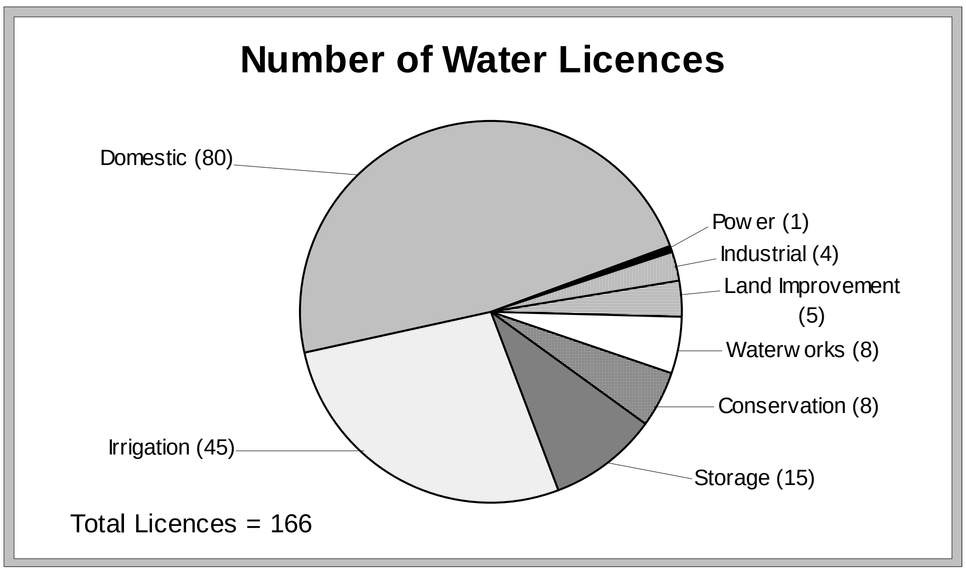


Figure 22 NUMBER OF WATER LICENCES

Of greater importance for water management is the estimated average annual licenced water demand and low flow water demand. The total estimated average annual licenced water demand for the plan area is 1,269,300 dam^3. The following figures illustrate the estimated average annual licenced water demand for each purpose under the issued water licences for the plan area.

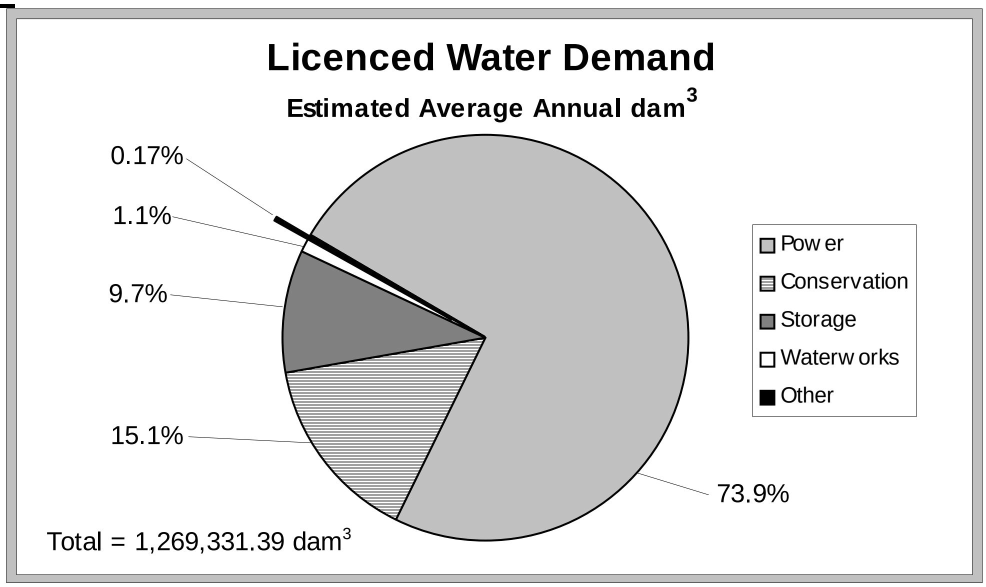


Figure 23 LICENCED WATER DEMAND

Other licenced water demand includes irrigation, industrial, domestic and land improvement purposes and is further illustrated in the following figure.

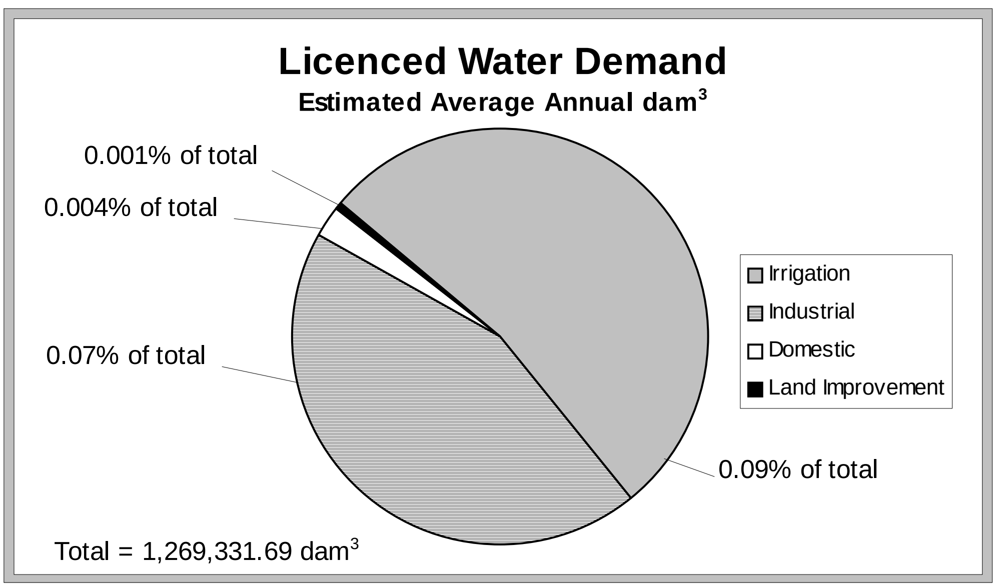


Figure 24 LICENCED WATER DEMAND

Power purpose constitutes the largest annual water demand in the plan area at 937,810 dam^3 and 74% of the total annual water demand. The second largest annual water demand is for conservation purpose consisting of approximately 15% of the total water demand. Next is storage purpose (9.7%), then waterworks purpose (1.1%), irrigation purpose (0.09%), industrial purpose

(0.07%), domestic purpose (0.004%) and finally land improvement purpose (0.001%). The following table and Appendix C summarize these annual water demands.

Estimated Average Annual Licenced Water Demand			
Purpose	**Number Of Licences**	**Quantity Licenced**	**Annual Demand (dams^3)**
Waterworks	8	17,179,500 GD	14,251.43
Domestic	80	61,150 GD	50.77
Industrial			
Ponds (Fish Culture)	2	13.74 AF	17.03
Enterprise (Ski Lodge)	2	3,500 GD	2.84
Processing (Concrete)	1	538,454 GD	893.36
Subtotal	4		913.23
Power (hydro-electric)	1	1,050 cfs	937,809.68
Irrigation	45	892.14 AF	1,100.62
Conservation	8	215.15 cfs	192,161.78
Land Improvement	5	8,500 GD	14.19
Storage	15	99,724.80 AF	123,029.69
Total	**166**	-	**1,269,331.39**

* Assumes that waterworks demand, domestic demand and industrial enterprise demand are the authorized maximum daily licenced divided by 2 to estimate the average daily demand and multiplied by 365 days to determine the annual demand. Power demands, industrial processing demands, conservation demand and land improvement demand are assumed to be uniform demands over the year and the licenced volume is the total annual demand. Industrial ponds (fish culture), irrigation and storage licenced demands are the total annual licenced volumes.

5.2 Projected Demand

There were 21 water licence applications pending as of January 1996. The potential annual water demand of these applications totals 189.67 dam^3 . These potential water demands include 165.88 dam^3 (200,000 gpd max.) for waterworks purpose, 7.1 dam^3 (8,699 gpd max.) for domestic purpose, 16.17 dam^3 (13.125 AF) for irrigation purpose, 0.2 dam^3 (250.001 gpd max.) for industrial purpose (livestock watering) and 0.32 dam^3 (200 gpd max.) for land improvement purpose. The water licence applications within the Courtenay River Allocation Plan area are summarized in Appendix D.

Most future water demands are anticipated to be similar to existing licenced demands. The number of waterworks, domestic, industrial, irrigation and land improvement licenses will increase as the population in the plan area grows. Conservation purpose demands will likely increase as groups and agencies take measures to preserve and protect fish and wildlife habitat from urban encroachment. Storage of winter high flows will be required to support water requirements during the summer low flow period in most parts of the plan area.

6.0 CONCLUSIONS and RECOMMENDATIONS

Roy Creek has a six month low flow period, form April through September. Millard Creek, Bonner Creek, Perseverance Creek and Morrison Creek all experience five month low flow periods, from May through September. Tsolum River has a four month low flow period from June through September. Browns River experiences a three month low flow period, from July through September. The minimum mean monthly flow occurs in August and September. The maximum mean monthly flow occurs in December.

All significant streams within the Courtenay River Water Allocation Plan area support an important and varied fish resource. Most of the streams within the Courtenay River Water Allocation Plan area experience low flow periods in which water is naturally limiting to fish. Therefore water is not available for extractive demands during the period when the flow is less than 60% MAD. Storage development, preferably off-stream, will be required to divert higher flows into storage for low flow season use. There is considerable flow available to develop storage in order to support water demands during the low flow months. Some water is available for extractive purposes year round without supporting storage from Comox Lake watershed, Puntledge River main stem below the penstock outfall and Courtenay River.

Fish and debris screens shall be required on all intake or diversion works within the identified fish habitat areas. Fish and debris screens are part of a good intake design and should be encouraged on all intakes or diversion works. Fish passage provisions for both juvenile and adult fish shall be required on all storage dams or diversion works constructed on sources frequented by fish. Information on fish screening requirements is in Appendix E.

Instream works are to be constructed only during the period specified by the fisheries agencies to minimize impacts on the fish resources. Instream work will normally only be allowed during the low flow period.

The licenced water demand within the Courtenay River Water Allocation Plan area consists of waterworks, domestic, industrial, power, irrigation, conservation, land improvement and storage purposes. Although the largest number of water licenses issued are for domestic purposes, the licenced domestic demand does not significantly impact other water interests except where there is a local competing water demand conflict. The largest annual licenced water demand is for power generation purposes. Conservation purposes account for the next largest annual licenced water demand. Irrigation water demands have the largest impact on the low flow period of the smaller streams and the instream flow requirements for fish because the demand occurrence is coincidental.

All further extractive licence demands in all identified watersheds, except Comox Lake and the main stem of the Puntledge and Courtenay River, will require storage if the instream fish resource is to be maintained. Storage shall be required for all existing and proposed licenced water demand when applications for increased licenced water demands are received from an existing licensee on sources in Roy Creek, Millard Creek, Bonner Creek, Perseverance Creek, Morrison Creek, Browns River and Tsolum River watersheds.

A flow of 0.11 m^3/sec (4 cfs) is reserved for extractive water demands in the main stem of either the Puntledge River or Courtenay River below the penstock outfall.

The following table summarizes the water available for the identified significant drainage areas.

COURTENAY RIVER - WATER AVAILABILITY

DRAINAGE	DRAINAGE AREA (km^2)	WATER VOLUME AVAILABLE (DAM^3)	
		HIGH FLOW*	LOW FLOW**
Roy Creek	13.4	9,400	0
Millard Creek	7.8	5,300	0
Bonner Creek	9	7,600	0
Perseverance Creek	26.8	18,600	0
Comox Lake	441	506,600	9,700
Morrison Creek	14.1	9,800	0
Browns River	98	90,000	0
Puntledge River (08HB006)	607.6	513,000	285
Tsolum River	248	211,000	0
Courtenay River	859	691,000	285

* High flow is the quantity of water available above 60% MAD during the period starting in October through to March, April, May, June or July.

**Low flow is the quantity of water available during the months of July, August and September for Comox Lake, Puntledge River and Courtenay River.

6.1 Waterworks

Waterworks purpose in the Water Act is the carriage or supply of water by a municipality, improvement district, regional district or private utility for the purpose of providing water to a residential area.

The demand for waterworks will greatly increase in the coming years as land in the Courtenay River Water Allocation Plan area are further subdivided and developed.

Applicants for a waterworks demand will be required to assess the supply for a ten year projected demand and provide evidence that a projected demand is not excessive in comparison with adjoining community demands. Water Utilities will also have to provide evidence that the appropriate requirements for a Certificate of Public Convenience and Necessity (CPCN) have been met and a CPCN will be obtained. Licenced allocations will be limited to a ten year projected demand except where the applicant can provide satisfactory evidence that a longer projection period is required (ie. because the cost of construction of works must be amortised over a longer period). Licenced demand shall not exceed a 25 year projection period.

The licensee shall be required to meter or measure and record the water diverted from the source stream. The licensee shall be required to treat the water supply in accordance with Ministry of Health requirements. All waterworks licenses will require storage at the source stream except in the Comox Lake and Puntledge River watersheds.

Adequate system balancing storage will be required to ensure that the rate of withdrawal from the source during short term or maximum hour demand does not exceed the maximum daily demand. Good conservation techniques must be practiced at all times and no increase in the amount of water in existing community waterworks licenses will be allowed unless meters and other conservation measures have been used.

Storage and diversion structures must be capable of maintaining or improving existing low flows during the three month low flow period and maintaining fish passage where required.

6.2 Domestic

A domestic water licence shall be 2,270 litres/day (500 gpd) for each rural dwelling as indicated on the plan attached to the water licence application. This amount will allow for the maintenance of 0.10 hectares (0.25 acres) of garden associated with the dwelling. It is not appropriate, where the primary source of domestic water supply is insufficient, to issue additional water licenses for the maintenance of green lawns and gardens.

Domestic water licenses shall not be issued to provide evidence to subdivision approval authorities of an “adequate potable water supply” for subdivision development. Residential land subdivisions shall be encouraged to connect to existing community water supply systems or develop a community water system of their own.

To ensure an adequate domestic water supply for household uses, applicants shall be encouraged to develop storage or use naturally stored water from lakes or marshes. For the average daily demand of 1,136 litres/day (250 gpd) for a three month period (92 days) a volume of 0.1 dam^3 (4,000 ft^3) is required. This requires a reservoir or dugout approximately 7 metres (23 feet) long by 5 metres (16 feet) wide, with an average depth of 3.5 metres (12 feet); allowing 0.3 metres (1 foot) for evaporation loss.

A spring shall be licenced for an individual domestic water demand provided that it is 30 metres away from any existing licenced springs. Multiple domestic water licenses on a spring will only be allowed if the applicant can provide assurances that adequate water is available by determining the safe flow yield near the end of the low flow period (ie. pump test in August or September) and by satisfying any written concerns and objections of any existing water licensees.

A water licence for domestic use shall not be issued to a residence within a community water supply area unless written leave to do so is obtained from the community water supply agency.

Measuring or regulating (ie. metering) is not usually required with domestic water usage. An adequate screen shall be installed on the intake to prevent fish or debris from entering the works

6.3 Industrial

The industrial water licenses within the plan area are demands associated with fish culture, a ski lodge and gravel processing. The industrial water licence applications are demands associated with livestock watering.

Commercial fish hatcheries shall require an industrial water licence. Use of water by government and non-profit organizations will be licenced as conservation purpose. Information on fish species and size, water temperature requirements and operating methods will be required in support of an application for a water licence. Fish Farm and Waste Management Permits will also be required. Off-stream storage is required for fish ponds associated with commercial fish farming.

Industrial demands related to commercial and resort development should be handled similar to multiple domestic demands with the same requirements.

Concrete companies that require the diversion and use of water for washing sand and gravel shall require an industrial water licence. The industrial water requirements for washing sand and gravel are 130 litres/ton/day (8 hours). Recycled water may reduce this demand and satisfactory recycling will be required.

Cattle or livestock watering requiring more than 450 l/day (100 Igpd) are to be considered an Industrial (Agricultural) demand. Cattle or livestock requiring 450 l/day (100 Igpd) or less will be considered a Domestic (livestock) demand. Estimated livestock demands are:

Recommended Livestock Water Requirements

	Water Requirements	
Livestock	l/day	Igpd
Cattle (beef) per animal	45	10
Cattle (dairy) per animal	132	29
Chickens per 100 animals	27	6
Turkeys per 100 animals	55	12

6.4 Power

There is one existing power purpose water licence for the generation of hydro-electric power within the Courtenay River Plan area. The licensee is B.C. Hydro and the maximum diversion is 29.7 m^3/sec (1,050 cfs) of water from Puntledge River. Water is stored in Comox Lake and released into the Puntledge River. Downstream of the diversion dam on the Puntledge River, B.C. Hydro is required to maintain the flows of 5.7 m^3/sec (200 cfs) from June 10 to September 30. From October 1 to June 9 the flows must be at or above 2.8 m^3/sec (100 cfs). The flows below the outfall of the penstock must be maintained at or above 15.6 m^3/sec (550 cfs) from June 10 to September 30 and 20.5 m^3/sec (725 cfs) from October 1 to June 9.

No further significant power demands in the plan area are anticipated at this time.

6.5 Irrigation

The crop rooting depth, soil type and climatic characteristics determine the water requirements for irrigation. The following figure indicates the annual irrigation water requirements for various crops and soil groups in the plan area.

If the applicant for a water licence can provide more specific soil assessment information for a given area, that soil assessment may be used to assess irrigation demands.

It should be noted that these annual irrigation water requirements are for sprinkler irrigation systems only.

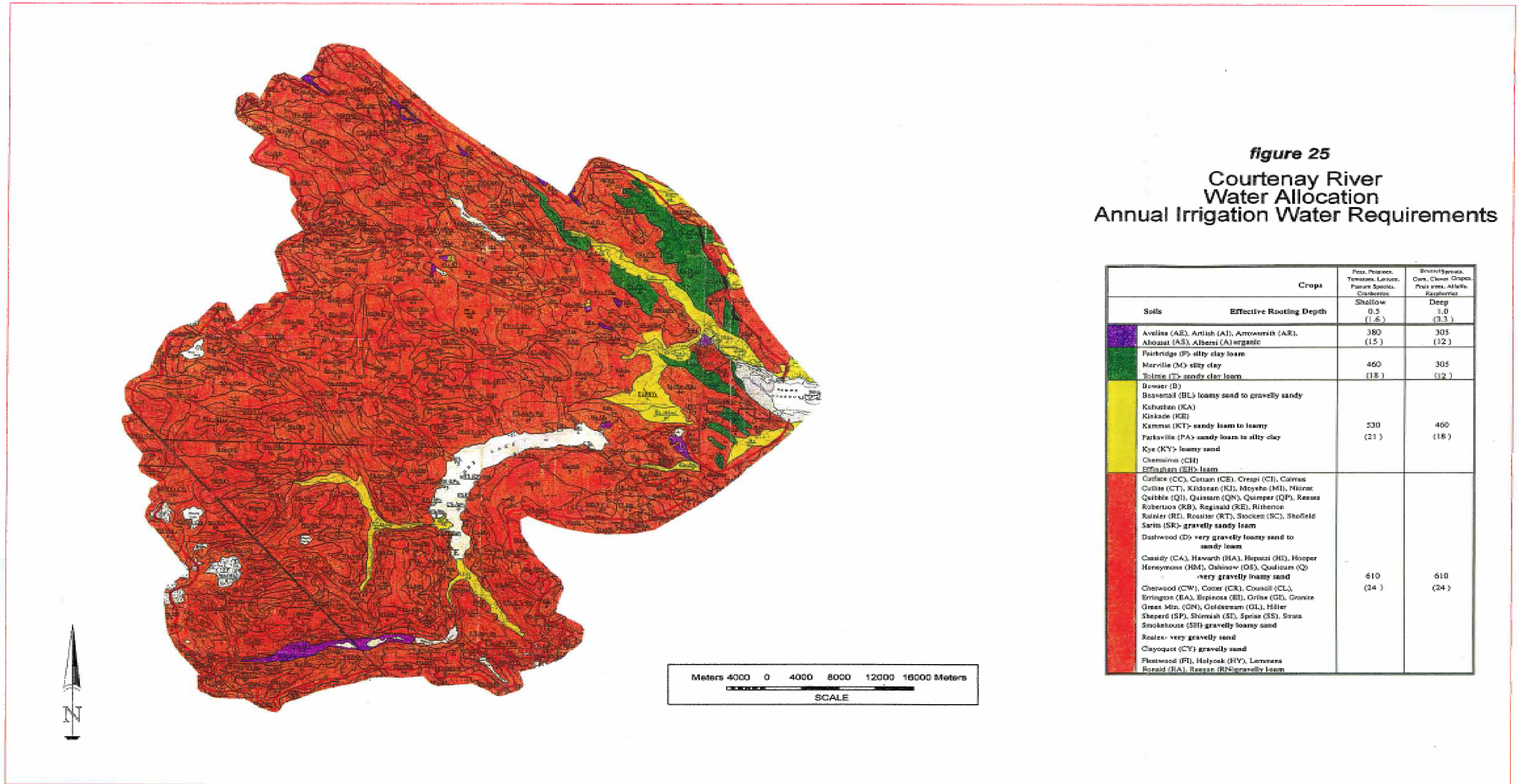
Irrigation gun or flood irrigation systems require greater irrigation quantities and should be discouraged. If irrigation gun and flood practices are to be used, suitable meters shall be installed and water withdrawals limited to the equivalent annual irrigation requirements for sprinkler systems. As the equivalent annual irrigation water requirements for sprinkler systems may not be adequate to sustain crops using these less efficient methods of irrigation, the applicant may be required to reduce crops, limit the acreage irrigated to convert to a more efficient sprinkler irrigation system. Trickle irrigation can reduce water requirements by 35% and should be encouraged where practical.

All irrigation water demands must be supported by storage development except in the Comox Lake and Puntledge River watersheds. Storage required to support irrigation demands is the total required amount as per crop and soils, plus an additional allowance for evaporation and other losses from the storage reservoir.

The maximum irrigation system flow rate shall not exceed 19.1 litres/sec (4.2 imperial gallons per minute) per 0.4 hectare (1 acre), and users must be encouraged to employ good agricultural practices (field size, system selection and farm management) to conserve water. The authorized period of use for irrigation shall be from April 1 to September 30.

As noted above, all intake works in fish bearing waters shall be screened to prevent fish and debris from entering the intake.

Annual Irrigation Water Requirements millimetres (inches)		
Crops	Peas, Potatoes, Tomatoes, Lettuce, Pasture Species, Cranberries	Brussel Sprouts, Corn, Clover Grapes, Fruit trees, Alfalfa, Raspberries
Effective Rooting Depth	Shallow 0.5 m (1.6 ft)	Deep 1.0 m (3.3 ft)
Aveline (AE) Artlish (AI) Arrowsmith (AR) Ahousat (AS) Alberni (A) **- organic**	380 (15)	305 (12)
Fairbridge (F) **- silty clay loam** Merville (M) **- silty clay** Tolmie (T) **- sandy clay loam**	460 (18)	305 (12)
Bowser (B) Beavertail (BL) **- loamy sand to gravelly sandy** Kuhushan (KA) Kinkade (KE) Kammat (KT) **- sandy loam to loamy** Parksville (PA) **- sandy loam to silty clay** Kye (KY) **- loamy sand** Chemainus (CH) Effingham (EH) **- loam**	530 (21)	460 (18)
Catface (CC), Cottam (CE), Crespi (CI), Calmus Cullite (CT), Kildonan (KI), Moyeha (MI), Nitinat Quibble (QI), Quinsam (QN), Quimper (QP), Reeses Robertson (RB), Reginald (RE), Ritherton Rainier (RI), Rossiter (RT), Stockett (SC), Shofield Sarita (SR) **- gravelly sandy loam** Dashwood (D) **- very gravelly loamy sand to sandy loam** Cassidy (CA), Hawarth (HA), Hepatzi (HI), Hooper Honeymonn (HM), Oshinow (OS), Qualicum (Q) **-very gravelly loamy sand** Chetwood (CW), Cotter (CR), Council (CL), Errington (EA), Espinosa (EI), Grilse (GI), Granite Green Mtn. (GN), Goldstream (GL), Hiller Sheperd (SP), Shirmish (SI), Sprise (SS), Strata Smokehouse (SH) **- gravelly loamy sand** Realex **- very gravelly sand** Clayoquot (CY) **- gravelly sand** Fleetwood (FI), Holyoak (HY), Lemmens Ronald (RA), Reegan (RN) **- gravelly loam**	610 (24)	610 (24)



Soils / Effective Rooting Depth	Crops: Peas, Potatoes, Tomatoes, Lettuce, Pasture Species, Cranberries — Shallow 0.5 (1.6)	Crops: Brussel Sprouts, Corn, Clover, Grapes, Fruit trees, Alfalfa, Raspberries — Deep 1.0 (3.3)
Aveline (AE), Artlish (AI), Arrowsmith (AR), Ahousat (AS), Alberni (A) organic	380 (15)	305 (12)
Fairbridge (F)- silty clay loam; Marville (M)- silty clay; Tolmie (T)- sandy clay loam	460 (18)	305 (12)
Bowser (B); Beaverdell (BL) loamy sand to gravelly sandy; Kahushan (KA); Kinkade (KE); Kammat (KT)- sandy loam to loamy; Parksville (PA)- sandy loam to silty clay; Kye (KY)- loamy sand; Chemainus (CH); Effingham (EH)- loam	530 (21)	460 (18)
Cutface (CC), Cottam (CE), Crespi (CI), Calmus; Cullite (CT), Kildonan (KI), Moyeha (MI), Nitinat; Quibble (QI), Quinsam (QN), Quimper (QP), Reeses; Robertson (RB), Reginald (RE), Ritherdon; Rainier (RI), Rossiter (RT), Stockett (SC), Shofield; Sarita (SR)- gravelly sandy loam; Dashwood (D)- very gravelly loamy sand to sandy loam; Cassidy (CA), Haworth (HA), Hepatti (HI), Hooper; Honeymoon (HM), Oshinow (OS), Qualicum (Q) -very gravelly loamy sand; Cherwood (CW), Cotter (CR), Council (CL), Errington (EA), Espinosa (EI), Grilse (GI), Granite; Green Mtn. (GN), Goldstream (GL), Hiller; Shepard (SP), Shirmish (SI), Sprise (SS), Strata; Smokehouse (SH)-gravelly loamy sand; Reales- very gravelly sand; Clayoquot (CY)- gravelly sand; Fleetwood (FI), Holyoak (HY), Lemmens; Ronald (RA), Reegan (RN)-gravelly loam	610 (24)	610 (24)

Figure 25 ANNUAL IRRIGATION WATER REQUIREMENTS

6.6 Conservation

Conservation purpose is the use and storage of water or the construction of works in and about a stream for the enhancement of fish and wildlife for non-profit purposes.

Salmon enhancement proposals that would significantly increase fish stocks in the stream channels will require the development of supporting storage to maintain required low flows. All requirements noted for storage development shall be required for conservation development where applicable

6.7 Land Improvement

Land improvement purpose is the impoundment of water on a stream or the diversion of water from a stream to facilitate the development of a park, to construct and maintain an aesthetic pond, to protect property from erosion or to drain and reclaim land. No significant water quantity is removed from the stream. Land improvement water demands are non-consumptive uses of the water resource.

Water used to facilitate the development of a park is usually maintained in a dammed lake or reservoir for recreation (ie. boating, fishing, swimming, golf course water traps) and aesthetics. The dammed lake or reservoir is usually filled during the high flow period and the water levels maintained or gradually lowered during the low flow period. Golf courses also acquire water licences to construct and maintain dugouts or control the volume of water in small ponds for water traps and aesthetics. Property owners may likewise acquire a water licence to construct and maintain dugouts or control the volume of water in small ponds for aesthetics and to increase property values. These water demands are essentially storage developments that do not support an extractive use. Therefore, all the requirements noted for storage development shall be required for land improvement development where applicable. No supporting storage is required. The water quantity required to facilitate the development of a park or create an aesthetic pond shall be the volume of the impoundment.

Constructing ditches to drain swamps or marshes, confining or straightening the meandering of stream channels and relocating a stream channel adjacent to a property line is sometimes proposed to accommodate subdivision or building development. Streams should not be relocated to accommodate development. Post-development flow conditions should be maintained as near as possible to pre-development flow conditions. The development of land improvement detention dugouts or the control of water in natural ponds, swamps and marshes to reduce flood flow and increase low flow releases will be encouraged. Proposed construction of works on streams that drain swamps or marshes or increase high flow conditions and reduce low flow conditions will not be authorized.

6.8 Storage

Storage purpose is the impoundment of water, either on-stream of off-stream in a dugout or behind a dam.

The storage quantity required to support the smaller water demands anticipated to support domestic, industrial, commercial and irrigation uses shall be the volume of the water demand during the low flow period as noted above plus an additional allowance of 0.3 metres (1.0 foot) depth over the surface area of the storage reservoir for evaporation and other losses.

The water licence applicant shall be required to submit a completed report form entitled "Dam and Reservoir Information Required in Support of a Water Licence Application for Storage Purpose (Schedule 2)" before the application is considered.

Total storage (dead and live) will be licenced. Dead storage should be licenced as it will in most cases have some intrinsic value such as providing conservation of water for wildlife or aesthetic value.

Diversion of water into off-stream storage will be during the high flow period of October through March. All instream storage will be required to pass any inflow to the reservoir down stream during the low flow period from April through September.

The applicant shall obtain written agreement, right-of-way or easement for works or flooding affecting other lands.

Fish passage is required for both juvenile and adult fish at all dams in fish bearing streams. Design of storage dams must consider fish ladders and provide adequate flow release and maintain fish passage where required. Instream storage works are to be constructed only during the period specified by the fisheries agencies to minimize impacts on the fish resource. Instream work will normally be allowed only during the low flow period. Mitigation work will be required for loss of spawning areas in the creeks affected by any storage.

Design plans must be submitted and accepted in writing before construction commences on any proposed dam over 3 metres (10 feet) in height or on storage of 12 dam^3 (10 acft) or more.

All water licensees that develop storage greater than 100 dam^3 (80 AF) shall be required to record and report the water level of the reservoir and flows from the reservoir as directed by the "Engineer" as defined in the Water Act of B.C.

Off-stream storage dugouts that are outside the high water winter wetted perimeter of any watercourse, are not accessible by fish and do not adversely impact on flows in any watercourse during the low flow period are encouraged.

6.9 Allocation Plan Revision

COURTENAY RIVER WATER ALLOCATION PLAN

The Courtenay River Water Allocation Plan should be reviewed and updated on of before December 2001.

References

Atwater, J et al. Groundwater Resources of British Columbia. Ministry of Environment, Lands and Parks. 1994.

Jungen, J.R. MoE Technical Report 17: Soils of Southern Vancouver Island. MoE, Surveys and Resource Mapping Branch, Victoria. 1985.

Ronneseth, K.D. Regional Groundwater Potential for Supplying Irrigation Water: 1985 Union Bay to Oyster River. Ministry of Agriculture and Food. 1985.

Zubel, Marc. Proposed Vancouver Island Fish Hatchery Groundwater Supply (Fanny Bay to Campbell River). MoE, Inventory and Engineering Branch, Victoria. 1979.

APPENDIX A

Cumberland
Canadian Climatic Normals
1951 - 1980

BRITISH COLUMBIA/COLOMBIE–BRITANNIQUE

CUMBERLAND
49° 37'N 125° 2'W 159 m

	JAN JAN	FEB FÉV	MAR MAR	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEP SEPT	OCT OCT	NOV NOV	DEC DÉC	YEAR ANNÉE	CODE CODE
Daily Maximum Temperature	4.4	7.5	9.3	13.8	17.7	20.2	23.6	22.9	20.4	13.9	8.3	5.5	14.0	2
Daily Minimum Temperature	–2.5	–1.3	–0.7	1.4	4.6	7.8	10.0	9.9	7.3	4.0	0.8	–1.1	3.4	2
Daily Temperature	**0.9**	**3.1**	**4.3**	**7.6**	**11.2**	**14.0**	**16.9**	**16.4**	**13.9**	**9.0**	**4.6**	**2.2**	**8.7**	**2**
Standard Deviation, Daily Temperature	1.9	1.7	1.0	1.1	1.5	1.8	1.7	1.5	1.5	1.0	1.4	1.8	0.7	2
Extreme Maximum Temperature	16.1	20.6	26.7	28.9	36.1	40.6	43.9	37.8	34.4	28.3	21.1	16.7	43.9	
Years of Record	53	52	51	51	54	55	53	53	54	53	53	50		
Extreme Minimum Temperature	–20.6	–14.4	–14.4	–7.8	–3.3	–1.1	2.2	2.2	–2.2	–8.3	–13.9	–18.9	–20.6	
Years of Record	53	52	51	50	53	55	53	54	54	53	51	51		
Rainfall	183.4	111.0	130.7	72.3	55.8	45.1	35.5	46.1	60.9	172.3	233.6	246.0	1392.7	3
Snowfall	74.2	27.5	14.4	0.7	0.0	0.0	0.0	0.0	0.0	0.8	9.7	43.4	170.7	3
Total Precipitation	**257.7**	**139.4**	**145.1**	**73.0**	**55.8**	**45.1**	**35.5**	**46.1**	**60.9**	**173.1**	**246.8**	**291.1**	**1569.6**	**3**
Standard Deviation, Total Precipitation	113.0	59.4	59.8	49.9	27.9	22.0	30.2	37.5	36.8	110.3	112.0	91.2	306.9	3
Greatest Rainfall in 24 hours	105.9	78.2	68.6	83.6	47.0	49.3	51.8	73.4	67.1	115.6	92.7	111.8	115.6	
Years of Record	56	57	57	54	59	61	58	60	60	61	59	57		
Greatest Snowfall in 24 hours	96.5	63.5	40.6	9.7	0.0	0.0	0.0	0.0	0.0	12.7	38.1	50.8	96.5	
Years of Record	55	58	57	55	61	61	60	61	61	61	61	58		
Greatest Precipitation in 24 hours	105.9	78.2	68.6	83.6	47.0	49.3	51.8	73.4	67.1	115.6	92.7	111.8	115.6	
Years of Record	56	57	57	54	59	61	58	60	60	61	59	57		
Days with Rain	14	11	14	11	10	10	7	8	8	15	17	16	141	8
Days with Snow	7	3	3	*	0	0	0	0	0	*	1	4	18	3
Days with Precipitation	19	14	15	11	10	10	7	8	8	15	17	19	153	8

APPENDIX B

Water Survey of Canada
Monthly and Annual Mean Discharges
and
7-day Low Flows

Puntledge River
Tsolum River
Browns River
Roy Creek
Cruickshank River
Dove Creek
Black Creek
Trent River

Puntledge River Near Cumberland (08HB007)													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	Mean Annual
1914	52.9	15.8	30	67	48.3	64.9	24.9	9.48	14.8	81	78.9	30.2	43.3
1915	18.8	20.4	40	47.4	31.5	31.5	16.1	5.98	6.01	35.7	42.7	41.2	28.1
1916	18.2	33.4	51.6	39.8	57.7	61	37.3	20.1	12.5	10.1	11.8	13.4	30.5
1917	11.8	16.1	15.4	20.9	50.2	52.6	26.3	11.4	12.7	21.8	46.2	30.9	26.4
1918	80.1	63.9	37.6	39.3	40	36.3	18.8	17.3	12.3	20.4	43.6	36.2	37
1919	50.3	32.5	17.8	49.6	51.3	54.2	51.5	26.5	13.3	10.7	35.2	51.3	37
1920	35.6	28.5	15.9	13.8	9.03	25.8	19.8	13.7	43.6	56.3	52.3	70.7	32.1
1921	42.5	34.1	30.2	29.6	51.1	72.7	42.1	25.5	30.4	77.4	53.3	47.2	44.7
1922	15.5	9.59	10	18	49.3	51.9	13	17.2	29	29.2	21.9	42.7	25.7
1923	49	20.2	17.8	36.5	43.3	34.4	13.4	13.3	12.7	12.9	35.7	91.2	31.8
1924	33.1	83.1	27.8	15.1	39.4	24.3	13.4	13.3	13.5	63	64.9	45.7	36.2
1925	26.6	43	26.3	38	50.2	35.1	17.1	16.2	14.5	11.7	24.3	70.4	31
1926	24.5	50	16.3	26.7	18.3	20.6	11.5	11.1	10	52.5	35.3	40.5	26.3
1927	64.1	25.2	26.1	24.1	51.7	60.1	28.5	17	22.4	57	49.2	25.1	37.6
1928	64	31.2	30.7	24.7	46.6	27.5	15.7	11.3	9.8	29.7	56.1	33.5	31.7
1929	17.7	8.5	11.3	28.7	44.5	38.3	18.5	14.2	10.4	26	9.75	26.6	21.3
1930	31	52.1	23.8	48.7	21.9	24.9	11	9.04	9.68	13.4	27.4	30.3	25
1931	52.3	33.4	37.7	34.4	38	40.6	21.5	11.1	10.5	37.3	42.3	29.9	32.4
1932	27.5	20.5	42.4	41.6	48.6	36.4	26.3	16.8	11.2	9.75	54.8	36.7	31
1933	23.5	14.3	22.8	33.4	47.8	49.3	44.4	21	24.3	35.8	31.1	35.5	32
1934	69	51.2	32.6	37.1	36	20.5	13.6	27.5	11.4	15.6	85.2	29.4	35.6
1935	68.3	64.8	28.8	14.9	22.9	33.2	18	14.1	10.2	10.2	9.89	26.7	26.6

Puntledge River Near Cumberland (08HB007)													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Mean Annual
1936	22.1	8.94	16.5	25.3	50.6	41.9	22.5	16	10.8	8.5	8.57	22.5	21.2
1937	16.8	34.5	35.9	41	61.1	59.7	24.5	9.95	10.5	37.6	55.2	44.1	35.8
1938	33.5	27.1	37.4	33.2	40.6	40.5	16.7	10.4	10.3	14.5	33.3	34.4	27.6
1939	62.8	16	10.9	29.1	44.9	27.4	20.4	14.4	10.3	9.89	100	126	39.5
1940	47.3	46.5	42.1	29.1	38.9	18.3	12.9	12.9	11.2	40.8	43	66.5	34.2
1941	53.6	78.6	26.4	31.4	31.9	28.3	22.2	12.6	9.4	23.3	38.3	84.5	36.5
1942	22.3	24.1	16.4	17.4	27	28.6	17.7	12.3	8.66	12.3	28.2	38.7	21.1
1943	19.6	15	18.7	59.4	24.8	31	18	11.3	9.14	23.1	25.9	19.1	22.9
1944	57.2	22.6	12	18.6	25.2	23.4	9.4	8.38	8.68	10.6	53.3	31.2	23.4
1945	37.7	41	16.6	26.6	57.4	35.7	22.5	11	9.65	9.58	20.9	37.8	27.1
1946	39.9	21.8	32.4	32.8	75	54.1	38.7	19.4	10.9	13	12.1	34.5	32.2
1947	23.2	44.6	23.6	30.5	31.9	22.6	20.4	12.7	9.35	28.5	29.1	36.4	25.9
1948	28.5	18.4	16	27.5	56.5	69.9	22.9	13.8	15.5	27.9	32.6	23.2	29.4
1949	10.8	11.4	23.4	33.1	57.6	32.1	13.8	13.5	12.3	12.5	38.5	51.7	26
1950	12.8	20.3	29.4	28.5	40	65.8	33.5	13.7	11.2	33.1	46	74.9	34.2
1951	27.4	29.5	12.2	32	42	31.7	18.5	9.82	8.46	11.8	27.5	30	23.3
1952	10.5	44.4	15.5	39.6	58.3	48.8	41.7	16.6	11.4	10.5	26.8	47.4	30.9
1953	57.5	41.3	20.9										
Mean	36.5	32.4	25.0	32.4	42.6	39.9	22.5	14.4	13.4	26.8	39.3	43.3	30.6
%MAD	119%	106%	82%	106%	139%	130%	73.6%	47.0%	43.8%	87.5%	128%	141%	100%

Puntledge River Near Courtenay (08HB006)													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	Mean Annual
1914						52.1	39.7	17.3	21.3	112	91.3	39.2	
1915	25.5	31.9	57.4	69.9	35.5	29.1	17.1	9.95	9.73	39.5	50.1	56	36
1916	19.9	37.2	66.5	47.3	78.8	92.3	64.8	24.4	15.3	12.8	16.4	17.8	41.1
1917	15.3	19.6	19.2	30.6	66	63.7	28.5	12.7	17.7	51.3	62.4	39.7	35.6
1918	100	101	50.8	56.5	56.7	43.9	20.6	19.6	16.7	23.7	70.1	88.3	53.7
1919	74.3	56.5	43.4	79.1	55.9	66.3	50	27.9	19	27.2	56	108	55.3
1920	87.3	33.8	42.5	21.3	22.2	38.5	28.6	16.6	77.4				
1955			7.96	35.3	41.7	M	35.4	30.4	20.6	38.2			
1956	38.4	28.9	27.5	40.4	82.7	81.5	45.5	24.7	17.5	26.5	55.2	54.3	43.6
1957	30.7	24.6	32.1	39.4	42.8	25.7	16	29.2	32.7				
1964										25.3	32.1	37.6	
1965	28.4	36.4	23.2	24.9	32.5	27.2	21.9	19.4	13.7	47.9	71.9	52.9	33.3
1966	49.1	37.8	37.6	50.7	50.8	53.9	35.5	25.8	27.5	28.5	62.6	121	48.4
1967	45.8	41.3	35.9	34.1	44.1	68.9	26	24.5	21.7	78.2	47.8	51.8	43.4
1968	117	45.6	53.5	32.3	42.9	38.3	21.8	22.6	30.3	77.6	84.5	47.4	51.2
1969	30.8	25.8	26.3	43.1	109	97.1	40.8	25.2	28.4	35.9	53.2	53.2	47.5
1970	33.6	35.6	36.1	37.6	37.8	33.2	25.4	26.1	14.9	19.6	31.8	28.1	29.9
1971	29.6	53.1	34.8	37.5	72.4	77.3	44.5	33.6	30.8	27.6	54.9	30.7	43.8
1972	19	22.2	65.5	45.8	57.6	61.7	40.1	23.7	22.4	20.8	26.4	54	38.3
1973	64.5	32.9	33.8	26.7	49.7	49.7	29.1	25.2	19.3	21.8	33.3	71.6	38.3
1974	54.5	37.7	51.9	63	66.2	69.2	56.8	32.6	23.8	23	30.8	60.9	47.6
1975	31.9	23.3	29.5	27.4	50.3	47.2	28.5	25.3	32.3	60	140	52.7	45.7

Puntledge River Near Courtenay (08HB006)													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Mean Annual
1976	41.5	37.8	35.7	39.3	46.9	54.2	48.6	28	26.8	22.5	27.4	33.4	36.8
1977	33.7	40.8	40.3	41.3	40.8	41.2	19.6	16.1	22.9	42.5	68.1	59.4	38.8
1978	38.7	41.2	43	40.9	43.7	43.8	29.7						
1979						39.5	26.9	19.9	45	45.1	38.3	81.4	
1980	41.2	49.5	43.7	44.7	50.1	42.4	40	24.3	22.1	21.8	68.6	113	46.8
1981	71.5	52.2	30.4	30.5	35.4	25	20.4	20.9	23.3	46.1	97.2	50.9	41.9
1982	27.7	35.7	35.4	36.5	57.3	65.6	27.7	15.3	14.7	71.7	40.6	54.5	40.3
1983	83	95.3	63	37	53.2	52.3	38.4	26.6	22.7	20.7	98.4	28.6	51.2
1984	42.7	50.9	48.5	37.6	46.5	51.3	33.2	24		66.3	40.6	33.1	
1985	23.5	20.7	20.2	31.1	32.1	29.1	16.1	15.4	15.2	24.2	26.4	21.2	22.9
1986	58.8	49.2	64.7	34.6	47.3	43.6	27.3	19.2	13.8	11.2	24.3	78.6	39.4
1987	72.1	80.1	76.9	37.9	56.8	56.8	35.5	21.8	16.4	9.87	23.2	56.5	45.2
1988	29.6	32.9	34.1	44.4	60.3	45	26.7	25.3	18.7	14	46.3	40.9	34.8
1989	32.8	24.6	27.5	39.2	40.4	35.8	25.3	16.8	15.8	24.4	33.3	46.6	30.2
1990	36.9	31	33.4	36.4	20.4	34.6	17.4	15.3	15.7	30.1	126	66.8	38.5
1991	34	90.6	34.6	30	22.6	17.7	17.1	27	44.8	22.8	31.7	67.8	36.3
1992	111	91.5	38.5	38	36.1	20.7	19.4	19	19	29	50.2	34.9	42.1
1993	26.7	28.9	33.1	50.4	78.1	39.1	22.1	19.1	19.3	16.4	14	42	32.5
Mean	47.3	43.8	40.0	40.3	50.4	48.8	31.0	22.4	23.5	35.6	53.5	54.9	41.0
%MAD	115%	107%	97.6%	98.5%	123%	119%	75.6%	54.7%	57.4%	86.9%	131%	134%	100%

Tsolum River Near Courtenay (08HB011)													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	Mean Annual
1914						6.53	1.79	0.323	8.82		24.8	10.6	
1915	21.3	19.6	18.2	12.5	4.84	1.3	0.537	0.12	0.182	12.6	13.2	28	11
1916	1.49	6.21	23.6	21.1	19.5	13	8.21	1.16	0.094	1.58	8.25	9.44	9.48
1917	5.26	9.35	8.26										
1955			5.03	9.99			2.72	1.72	1.8	8.62			
1956	28.1	6.03	14.5	16.1	15.2	10	2.44	0.23	0.744	8.68	9.7	21.3	11.1
1957	8.28	10.4	21	16.3	6.51								
1964				7.25	4.55	5.07	3.87	1.9	0.957	1.74	6.89	13.8	
1965	10.5	17.1	7.49	10.8	3.6	0.889	0.169	0.922	0.892	13.3	24.3	29.9	9.94
1966	33.6	17	21.6	8.72	4.79	3.07	1.4	0.741	1.55	3.38	24.5	51.4	14.3
1967	19.9	10.3	21.1	6.91	6.79	3.58	0.386	0.21	0.687	15.3	8.53	17.3	9.29
1968	42.1	19.6	22.6	4.62	4.95	2.15	0.513	1.5	1.62	25.3	31	29	15.4
1969	5.94	22.6	19.5	30.6						5.45	22.8	29.3	
1970	10.2	10.8	9.16	6.21	3.36	1.86	0.709	0.406	0.245	8.47	10.9	26.5	7.4
1971	17.9	14.7	12.7	11.3	16.1	7.1	2.57	0.556	1.59	4.63	29	11.5	10.8
1972	5.35	17.4					1.88	0.496	2.27	1.55	15.2	23.3	
1973	34	7.76	14.7	5.94	8.57	3.9	1.74	0.498	1.11	6.24	16.8	42.4	12.1
1974	19.6	19.9	29.5	19.5	8.04	5.39	3.65	0.478	0.763	0.666			
1975	9.01	7.92	15.9	11.5	13.7	3.54	0.784	1.15	1	20.1	44.6	18.9	12.3
1976	15.8	10.2				4.16	2.5	0.654			5.02	10.1	
1977	5.66	19	17.1	8.28	5.34	4.65	0.719	0.203	2.34	13.2	25.3	18.6	9.96
1978	14	18.7	15	11.4	4.7	2.4	0.747	4.9	7.99	1.63	5.13	8.02	7.81

Tsolum River Near Courtenay (08HB011)													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Mean Annual
1979	4.03	24.7	14.5	11.2	7.35	1.42	1.61	0.423	6.09	12.8	7.82	28.9	9.99
1980	12.2	25.3	14.1	12.1	4.35	4.69	4.47	0.43	0.847	1.16	22.8	30.9	11.1
1981	20.4	17.5	5.47	7.42	6.72	3.49	1.8	1.09	3.77	14.4	29.9	23.6	11.3
1982	13.8	21.6	15.7	10.8	9.68	4.34	1	0.263	0.672	20.3	10.1	25.2	11.1
1983	30.7	43.2	26.7	8.02	5.13	2.81	2.56	0.682	1.5	3.53	44.9	6.81	14.5
1984	14.3	25.5	17.9	10.4	11.2	3.18	0.986	0.332	0.49	13.9	27.1	10.6	11.3
1985	3.46	6.76	8.3	11.5	6.5	1.76	0.135	0.039	0.871	6.52	4.17	8.26	4.85
1986	36.5	13.5	16	7.23	8.7	3.88	1.08	0.119	0.104	0.859	11.8	30.1	10.9
1987	28.1	23.7	23.2	6.27	5.71	2.4	1.04	0.214	0.156	0.229	6.94	24	10.1
1988	17.2	8.23	10.7	11.6	6.08	3.49	0.776	0.263	0.252	0.578	29.5	15.3	8.64
1989	9.1	8.32	14	14	4.01	1.49	2.51	0.625	0.206	5.55	6.77	13.5	6.67
1990	15.6	11.3	11.1	6.02	3.8	9.47	1.03	0.087	0.155	7.66	26.4	11.1	8.6
1991	9.86	39.5	6.82	10.6	2.43	1.42	0.815	6.18	2.02	0.331	21.1	22	10
1992	42.8	27.7	5.43	6.2	2.41	1.1	0.767	0.088	0.302	7.59	17.9	9.75	10.1
1993	9.96	7.43	17.8	17.7	11.3	9.39	2.94	1.24	0.232	0.962	2.21	24.9	8.86
Mean	16.9	16.7	15.3	11.2	7.3	4.2	1.8	0.9	1.6	7.5	18.0	20.7	10.3
%MAD	164%	162%	148%	109%	70.6%	40.3%	17.3%	8.6%	15.4%	73.1%	175%	201%	100%

Browns River Near Courtenay (08HB025)													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	Mean Annual
1960		5.75	3.67	8.08	11.6	11	2.21	0.476	0.461	5.18	4.64	6.54	
1961	14	9.64	6.82	7.88	15.6	11.2	1.72	0.151	0.307		4.98		
1962			1.37	6.58	5.27	4.77	1.24	1.25	0.718				
1963		16.6	6.01	5.59	5.59	2.52	2.41				10.5	9.38	
1964	4.24	3.75	2.2	3.9	8.48	14.4	9.06						
1965													
1966											11.9	20.6	
1967	5.26	3.45	5.65	2.64	12.4	14.2	1.32	0.178	0.176	11.8	4.75	8.29	5.87
1968	16.4	8.35	7.5	3.07	10.6	6.47	1.19	2.27	1.05	17.8	9.41	4.88	7.44
1969	M	M	3.59	9.23	15.8	15.4	2.27	0.307	3.88	2.21	14.5	6.99	
1970	5.07	3.95	2.87	5.01	9.72	4.87	0.707	0.272	0.3	3.94			
1971													
1985	1.43	1.26					0.231	0.051	0.575	4.69	1.75	2.3	
1986	12	8.01	8.64	4.25	10.7	4.43	0.879						
1987	7.55	9.89	11.9	7.03							6.73	5.1	
1988	4.42	3.82	4.22	9.83	12.2	6.76	1.27	0.293	0.317	0.937	10.2	5.87	5
1989	2.74	2.31	2.77	10.6	9.59	4.17	2.46	0.627	0.264	6.46	3.5	6.33	4.33
1990	4.4	2.32	3.99	7.06	5.9	5.47	0.819	0.094	0.075	6.99	14.5	5.45	4.75
1991	2.43	12.2	1.57	5.37	5	1.35	0.407	4.63	0.573	0.216	6.87	10.4	4.19
1992	14.3	9.73	4.84	7.41	2.76	0.851	0.633	0.153	0.097	6.82	5.48	1.54	4.53
1993	2.93	2.98	7.79	13	13.6	4.63	2.33	1.03	0.253	1.04	2.5	8.04	5.03
Mean	6.94	6.50	5.02	6.85	9.68	7.03	1.83	0.84	0.65	5.67	7.48	7.27	5.14
%MAD	135%	126%	98%	133%	188%	137%	35.6%	16.4%	12.6%	110%	145%	141%	100%

Browns River Near Courtenay (08HB025)
7-Day Average Low Flow (m^3/sec)

YEAR	Period: Apr 1 to Sep 30		Period: Jan 1 to Dec 31	
	Date of Occurrence	7-Day Average m^3/sec	Date of Occurrence	7-Day Average m^3/sec
1960	10-Aug-60	0.253	10-Aug-60	0.253
1961	18-Aug-61	0.019	18-Aug-61	0.019
1962	22-Sep-62	0.196	22-Sep-62	0.196
1963				
1964				
1965				
1966				
1967	29-Aug-67	0.101	29-Aug-67	0.101
1968	8-Aug-68	0.213	8-Aug-68	0.213
1969	16-Aug-69	0.214	16-Aug-69	0.214
1970	12-Sep-70	0.161	12-Oct-70	0.085
1971				
1985	27-Aug-85	0.013	27-Aug-85	0.013
1986				
1987				
1988	14-Sep-88	0.124	14-Sep-88	0.124
1989	22-Sep-89	0.198	7-Oct-89	0.128
1990	27-Sep-90	0.071	27-Sep-90	0.071
1991	3-Aug-91	0.206	28-Oct-91	0.178
1992	18-Sep-92	0.051	18-Sep-92	0.051
1993	27-Sep-93	0.091	10-Oct-93	0.079
	Mean	0.136	Mean	0.123

Roy Creek at Cumberland Road (08HB042)													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	Mean Annual
1971				0.25	0.058	0.022	0.006	0.0006	0.0008				
Mean				0.25	0.058	0.022	0.006	0.0006	0.0008				

Cruickshank River Near the Mouth (08HB074)													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	Mean Annual
1982					26.2	48	18.4	6.91	4.76	59.6	13.1	15.2	
1983	25.4	39.5	34.2	15.5	35.7	33.1	21	9.12	6.49	13.2	49.6	4.05	23.7
1984	23.3	19.5	20	14.2	19.3	28.9	21	8.93	5.16	36.5	15.8	10.5	18.6
1985	5.59	4.65	5.16	16.9	24	19.2	10.5	4.97	4.22	12.9	7.45	7.76	10.3
1986	27.8	25.1	27	13.1	31.5	28.1	12.7	5.98	3.6	6.95	17.4	26.9	18.8
1987	24.3	26.6	37.2	19.1	32	27.9	13	7.3	5.43	2.63	23.8	15.3	19.5
1988	11.8	12.6	12.8	23.4	31.4	29.5	20.7	10.3	4.65	6.74	29.8	19.6	17.8
1989	8.33	7.5	8.03	23.5	25.9	23.7	13.3	5.93	3.07	16	17.1	21	14.5
1990	12.5	7.37	10.7	17.3	18.9	21.7	8.58	4.24	2.9	24.8	55.6	19.6	17
1991	7.8	35.2	7.17	11.4	17.2	14.1	8.61	38.6	10.5	2.73	18.8	22.6	16.1
1992	33.5	28.2	14.3	18.9	16.4	14.4	7.89	4.3	3.97	20.1	26	11	16.5
1993	14.8	13.7	20	17.9	37.5	25.3	10	6.78	3.54	4.75	7.7	21.7	15.3
Mean	17.7	20.0	17.9	17.4	26.3	26.2	13.8	9.4	4.9	17.2	23.5	16.3	17.1
%MAD	104%	117%	104%	102%	154%	153%	80.7%	55.2%	28.4%	101%	138%	95.1%	100%

Cruickshank River Near the Mouth (08HB074)													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	Mean Annual
1982					26.2	48	18.4	6.91	4.76	59.6	13.1	15.2	
1983	25.4	39.5	34.2	15.5	35.7	33.1	21	9.12	6.49	13.2	49.6	4.05	23.7
1984	23.3	19.5	20	14.2	19.3	28.9	21	8.93	5.16	36.5	15.8	10.5	18.6
1985	5.59	4.65	5.16	16.9	24	19.2	10.5	4.97	4.22	12.9	7.45	7.76	10.3
1986	27.8	25.1	27	13.1	31.5	28.1	12.7	5.98	3.6	6.95	17.4	26.9	18.8
1987	24.3	26.6	37.2	19.1	32	27.9	13	7.3	5.43	2.63	23.8	15.3	19.5
1988	11.8	12.6	12.8	23.4	31.4	29.5	20.7	10.3	4.65	6.74	29.8	19.6	17.8
1989	8.33	7.5	8.03	23.5	25.9	23.7	13.3	5.93	3.07	16	17.1	21	14.5
1990	12.5	7.37	10.7	17.3	18.9	21.7	8.58	4.24	2.9	24.8	55.6	19.6	17
1991	7.8	35.2	7.17	11.4	17.2	14.1	8.61	38.6	10.5	2.73	18.8	22.6	16.1
1992	33.5	28.2	14.3	18.9	16.4	14.4	7.89	4.3	3.97	20.1	26	11	16.5
1993	14.8	13.7	20	17.9	37.5	25.3	10	6.78	3.54	4.75	7.7	21.7	15.3
Mean	17.7	20.0	17.9	17.4	26.3	26.2	13.8	9.4	4.9	17.2	23.5	16.3	17.1
%MAD	104%	117%	104%	102%	154%	153%	80.7%	55.2%	28.4%	101%	138%	95.1%	100%

Black Creek at Sturgess Road (08HD014)													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	Mean Annual
1980				0.862	0.144	0.186	0.335	0.004	0.02				
1981				0.791	0.624								
1982				0.859	0.14	0.001	0	0	0				
1983				0.731	0.053	0.074	0.068	0.026	0				
1984				0.911	0.814	0.155	0.001	0	0				
1985				0.547	0.225	0.038	0	0	0				
1986					0.553		0.061	0.003	0				
1987				0.354	0.298	0.048	0.03	0.037	0				
1988				1.05	0.167	0.103	0	0	0				
1989				0.969	0.072	0.005	0.181	0.012	0.027				
Mean				0.786	0.309	0.076	0.075	0.009	0.005				

Trent River Near Mouth (08HB044)													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	Mean Annual
1971					5.44	2.05	0.481	0.063	0.569				
1972					3.16	1.04	0.277	0.04	0.68				
1973				2.01	2.33	0.86	0.148	0.024	0.077				
1974					3.31	1.96	1.07	0.053	0.018				
1975				4.05	5.1	0.955	0.061	0.784	0.288				
1976				4.37	3.02	1.57	0.484	0.231	0.311				
Mean				3.48	3.73	1.41	0.420	0.199	0.324				

APPENDIX C

Licenced Water Demand by Purpose
(January 1996)

LICENCE NUMBER	FILE NUMBER	SOURCE	QUANTITY/ UNITS	LITRES/ SECOND	DEMAND (dam3/year)
Waterworks Purpose					
C019538E	0265498	Perseverance Creek	500,000 GD		
C0244185	0217424	Picket Spring	50,000 GD		
C0528369	0365696	Duckinfield Creek	85,500 GD		
C054745E	0366325	Washington Spring	44,000 GD		
C0590977	0366014	Puntledge River	15,500,000 GD		
C0593332	1000129	Courtenay River	192,000 GD		
C1057616	1001630	Courtenay River	58,000 GD		
F0138725	0265498	Cumberland Creek	750,000 GD		
		Sub-total	**17,179,500 GD**	**903.82**	**14,251.43***
Domestic Purpose					
C0173929	0161753	Lodge Creek	1000 GD		
C0321549	0270516	Hein Spring	1000 GD		
C0352828	0285583	Portuguese Creek	500 GD		
C0357748	0285660	Portuguese Creek	500 GD		
C0387459	0305530	Carwithen Swamp	500 GD		
C0404158	0310641	Walker Creek	500 GD		
C0407783	0300950	Walker Creek	500 GD		
C0428035	0322282	Supply Spring	500 GD		
C0438269	0249724	Tsolum River	500 GD		
C045310A	0328031	Tsolum River	500 GD		
C0475359	0328173	Morrison Creek	500 GD		
C048188E	0329314	Morrison Creek	500 GD		
C048362E	0330998	Morrison Creek	500 GD		
C0499992	0341044	Cannon Creek	500 GD		
C0501548	0341412	Tsolum River	500 GD		
C0512523	0342204	Roy Creek	250 GD		
C0544279	0364293	Galbraith Spring	500 GD		
C0552623	0364328	Puntledge River	500 GD		
C0553249	0364216	Puntledge River	500 GD		
C0565293	0367363	Puntledge River	3000 GD		
C0580418	0368112	Browns River	500 GD		
C0587679	1000069	Tsolum River	500 GD		
C0587998	0227056	Happy Creek	1000 GD		
C0589721	0369339	Puntledge River	500 GD		
C0596891	1000228	Puntledge River	500 GD		
C0640492	0209976	Millard Creek	500 GD		
C0640894	1000552	Puntledge River	500 GD		
C0657481	1000589	Linda Spring	1200 GD		
C0657819	1000681	Japanese Swamp	500 GD		
C065792E	1000717	Japanese Swamp	500 GD		
C0657937	1000718	Japanese Swamp	500 GD		

LICENCE NUMBER	FILE NUMBER	SOURCE	QUANTITY/ UNITS	LITRES/ SECOND	DEMAND (dam^3/year)
C0703454	1000978	Poncelet Spring	500 GD		
C070346E	1000979	Poncelet Spring	500 GD		
C0703477	1000980	Poncelet Spring	500 GD		
C0703483	1000981	Poncelet Spring	500 GD		
C1074514	0265897	Robertson Spring	1000 GD		
F0083277	0073333	Piercy Creek	2000 GD		
F0084839	0090954	Piercy Creek	2000 GD		
F0084845	0091014	Piercy Creek	2000 GD		
F0098089	0105902	Mathewson Spring	2000GD		
F0106866	0120526	Vessey Spring	500 GD		
F0127638	0079614	Millard Creek	2000 GD		
F0135939	0171649	Cliffe Spring	1000 GD		
F0148296	0182693	Turnbull Spring	500 GD		
F0160535	0190626	Millard Creek	1000 GD		
F0165521	0196977	Morrison Creek	1000 GD		
F0170918	0212089	Reimer Spring	1000 GD		
F0176016	0218119	Hurford Creek	1000 GD		
F0183482	0226675	Morrison Creek	500 GD		
F0183499	0227900	Winger Spring No. 2	500 GD		
F0183507	0227901	Winger Spring No. 2	500 GD		
F0188864	0226667	Mortimer Spring	1000 GD		
F0206887	0249267	Tsolum River	500 GD		
F020751E	0281213	Tsolum River	500 GD		
F0213723	0219734	Winger Spring	500 GD		
F0399496	0265969	Pearson Spring	500 GD		
F0401934	0277466	Mattoon Spring	1000 GD		
F041013A	0226008	Tsolum River	3000 GD		
F0441336	0285680	Tsolum River	500 GD		
F0445185	0281685	Morrison Creek	500 GD		
F0490381	0300893	Supply Spring	500 GD		
F0490398	0322275	Supply Spring	500 GD		
F0490406	0322276	Supply Spring	500 GD		
F0490412	0322277	Supply Spring	500 GD		
F0490429	0322278	Supply Spring	500 GD		
F0490435	0322279	Supply Spring	500 GD		
F0490441	0322280	Supply Spring	500 GD		
F0490458	0322281	Supply Spring	1000GD		
F0490464	0322283	Supply Spring	500 GD		
F049267E	0340802	Supply Spring	500 GD		
F0505574	0227057	Happy Creek	1000 GD		
F0515101	0330179	Puntledge River	500 GD		
F0515118	0328272	Tsolum River	500 GD		
LICENCE	**FILE**	**SOURCE**	**QUANTITY/**	**LITRES/**	**DEMAND**

NUMBER	NUMBER		UNITS	SECOND	(dam^3/year)
F0515992	0310974	Roy Creek	500 GD		
F051600E	0340104	Puntledge River	500 GD		
F0519234	0316893	Roy Creek	500 GD		
F0520786	0328196	Roy Creek	1000 GD		
F0520792	0317643	Tsolum River	500 GD		
F059168E	0216374	Tsolum River	1000 GD		
CO657481	10000589	Linda Spring	1200 GD		
		Sub-total	**61,150 GD**	**3.22**	**50.77***
Industrial Purpose (Ponds)					
C0517733	0340728	Keith Brook	11.43 AF		
C0657481	1000589	Linda Spring	2.31 AF		
		Sub-total	**13.74 AF**	**0.54**	**17.03*****
Industrial Purpose (Enterprise)					
C0545385	0365880	Lodge Creek	**3,500 GD**		
		Sub-total	**3,500 GD**	**0.18**	**2.84***
Industrial Purpose (Processing)					
C0186168	0173309	Picket Spring	**538,454 GD**		
		Sub-total	**538,454 GD**	**28.33**	**893.36**
Power Purpose					
C1067968	0265017	Puntledge River	**1,050 cfs**		
		Sub-total	**1,050 cfs**	**29,737.75**	**937,809.68**
Irrigation Purpose					
C0326676	0273220	Tsolum River	30 AF		
C0387459	0305530	Carwithen Swamp	12 AF		
C0407783	0300950	Walker Creek	0.5 AF		
C0423428	0317041	Roy Creek	15 AF		
C0428087	0316754	Tsolum River	35 AF		
C0433757	0322772	Cliffe Spring	0.5 AF		
C0460369	0161227	Tsolum River	0.5 AF		
C0460375	0328546	Tsolum River	0.5 AF		
C0473389	0330024	Mattoon Spring	6 AF		
C0541111	0193979	Tsolum River	25 AF		
C0545267	0355099	Forsyth Creek	30 AF		
C0546545	0364437	Garrick Spring	2 AF		
C058440A	0369639	Millard Creek	4 AF		
C058764A	1000006	Turner Swamp	0.5 AF		
C0587998	0227056	Happy Creek	5 AF		
C0589744	0367464	Puntledge River	45 AF		
C0592137	1000056	Courtenay River	180 AF		
C1009215	1001259	Puntledge River	3 AF		
C1055907	0368111	Smit Creek	0.5 AF		
C1081738	0198817	Tsolum River	60 AF		
LICENCE	**FILE**	**SOURCE**	**QUANTITY/**	**LITRES/**	**DEMAND**
NUMBER	**NUMBER**		**UNITS**	**SECOND**	**(dam^3/year)**

F0083277	0073333	Piercy Creek	11 AF		
F0135017	0157766	Millard Creek	0.84 AF		
F0135767	0156088	Tsolum River	14 AF		
F0158685	0187717	Oland Creek	18 AF		
F0160535	0190626	Millard Creek	19.5 AF		
F016578E	0198424	Tsolum River	10 AF		
F0166733	0198849	Lloyd Slough	60 AF		
F0170924	0194155	Tsolum River	6.3 AF		
F0183424	0198873	Tsolum River	2 AF		
F018343E	0226672	Tsolum River	10 AF		
F0401928	0273750	Tsolum River	22 AF		
F0406966	0268306	Tsolum River	10 AF		
F040863A	0240174	Tsolum River	20 AF		
F041013A	0226008	Tsolum River	30 AF		
F0429921	0264767	Puntledge River	68 AF		
F0445185	0281685	Morrison Creek	0.5 AF		
F0445191	0190339	Tsolum River	45 AF		
F0458561	0273360	Tsolum River	14.1 AF		
F0480968	0204999	Morrison Creek	3 AF		
F0505574	0227057	Happy Creek	5 AF		
F051924E	0317530	Tsolum River	7 AF		
F0521188	0200931	Tsolum River	27.9 AF		
F0525631	0179633	Tsolum River	5 AF		
F0525648	0317431	Tsolum River	20 AF		
F059168E	0216374	Tsolum River	8 AF		
		Sub-total	**892.14 AF**	**141.54**	**1,100.62****
Conservation Purpose					
C0343918	0281323	Headquarters Creek	0 TF		
C029827E	0257769	Headquarters Creek	35 cfs		
C055167E	0366410	Headquarters Creek	5 cfs		
C0560456	0342611	Puntledge River	30 cfs		
C0566565	0355613	Supply Spring	0.15 cfs		
C0703827	1001266	Puntledge River	30 cfs		
C1011502	1001374	Puntledge River	15 cfs		
C1067974	1001701	Puntledge River	100 cfs		
		Sub-total	**215.15 cfs**	**6,093.41**	**192,161.78**
Land Improvement Purpose					
C0352774	0277513	Arden Creek	0 TF		
C0352774	0277513	Willemar Creek	0 TF		
C0352774	0277513	Morrison Creek	0 TF		
C051774A	0340661	Keith Spring	8,500 GD		
C0726107	1000876	Lloyd Slough	0 TF		

LICENCE NUMBER	FILE NUMBER	SOURCE	QUANTITY/ UNITS	LITRES/ SECOND	DEMAND (dam^3/year)
		Sub-total	**8,500 GD**	**0.45**	**14.19**
Storage Purpose					
C0195397	0265498	Perseverance Creek	150 AF		
C0219336	0201930	Vanwest Lakes	100 AF		
C0298287	0257769	Headquarters Creek	3,200 AF		
C034616A	0281141	Perseverance Creek	150 AF		
C034616A	0281141	West Perseverance Creek	150 AF		
C0387465	0305530	Carwithen Swamp	4.5 AF		
C0423434	0317041	Roy Creek	15 AF		
C0473395	0330024	Mattoon Spring	1.5 AF		
C0545273	0355099	Forsyth Creek	30 AF		
C0545391	0365880	Lodge Creek	0.8 AF		
C0584416	0369639	Millard Creek	4 AF		
C0585605	0368563	Happy Creek	3.5 AF		
C0587656	1000006	Turner Swamp	0.5 AF		
F0138731	0265498	Cumberland Creek	435 AF		
C106798E	0265017	Puntledge River	95,480 AF		
		Sub-total	**99,724.8 AF**	**- 15,821.72**	**123,029.69****
			Total Demand	**21,087.52**	**1,269,331.39**

* Based on the assumption that the demand is the authorized maximum daily licenced divided by 2
to estimate the average daily demand and multiplied by 365 days to determine the annual demand.
** The rate (litres/sec.) is based on an estimated 90 day period demand assuming that storage and irrigation demands are totally withdrawn over a 90 day period.
*** The rate (litres/sec.) is based on an annual (365 day) period demand assuming that industrial pond demands are withdrawn over a one year period.

APPENDIX D

Pending Water Licence Applications
(January 1996)

LICENCE NUMBER	FILE NUMBER	SOURCE	QUANTITY/ UNITS	LITRES/ SECOND	DEMAND (dam^3/year)
Waterworks Purpose					
Z108175	1001781	Washington Spring	100,000 GD		
Z105091	1001595	ZZ Spring (66208)	100,000 GD		
		Sub-total	**200,000 GD**	**10.52**	**165.88***
Domestic Purpose					
Z100914	1000972	Dove Creek	500 GD		
Z100992	1001261	ZZ Creek (61286)	500 GD		
Z101009	1001303	Morrison Creek	2500 GD		
Z101010	1001306	ZZ Creek (61717)	500 GD		
Z101551	1001440	Piercy Creek	500 GD		
Z101664	1001397	ZZ Creek (63070)	500 GD		
Z102079	1001462	Tsolum River	500 GD		
Z103171	1001502	ZZ Spring (64339)	500 GD		
Z104529	1001560	Roy Creek	600 GD		
Z105342	1001610	Cannon Creek	500 GD		
Z105605	1001625	Puntledge River	1000 GD		
Z107170	1001724	Tsolum River	500 GD		
		Sub-total	**8,600 GD**	**0.45**	**7.1***
Irrigation Purpose					
Z100911	1000842	Millard Creek	1 AF		
Z101989	1001461	Tsolum River	0.125 AF		
Z105605	1001625	Puntledge River	6 AF		
Z106700	1001676	ZZ Spring (67857)	6 AF		
		Sub-total	**13.125 AF**	**2.08**	**16.17****
Industrial Purpose (Stock Watering)					
Z100914	1000972	Dove Creek	250 GD		
Z103171	1001502	ZZ Spring (64339)	0.001 GD		
		Sub-total	**250.001 GD**	**0.013**	**0.2***
Land Improvement Purpose					
Z100911	1000842	Millard Creek	**200 GD**	**0.01**	**0.32**
			Total Demand	**13.073**	**189.67*****

* Based on the assumption that the demand is the authorized maximum daily licenced divided by 2 to estimate the average daily demand and multiplied by 365 days to determine the annual demand.

** The rate (litres/sec.) is based on an estimated 90 day period demand assuming that the licenced quantities are totally withdrawn over the 90 day period.

*** Non-consumptive demand.

APPENDIX E

Fish Screening Requirements

FISH SCREENING DIRECTIVE

Government of Canada
Department of Fisheries and Oceans

WATER INTAKE FISH PROTECTION FACILITIES

The Department of Fisheries and Oceans has prepared this document as a guide to assist in the design and installation of water intakes and fish screening in British Columbia and the Yukon Territory to avoid conflicts with anadromous fish. Additional precautions must be taken at marine intake locations where entrainment of fish larvae, such as eulachon and herring larvae, is a possibility. The screening criteria constitutes the Department's policy regarding the design and construction requirements pursuant to Section 28 of the Fisheries Act.

PROVISIONS OF THE FISHERIES ACT - SECTION 28

Every water intake, ditch, channel or canal in Canada constructed or adapted for conducting water from any Canadian fisheries waters for irrigating, manufacturing, power generation, domestic or other purposes, shall, if the Minister deems it neccessary in the public interest, be provided at its entrance or intake with a fish guard or a screen, covering or netting, so fixed as to prevent the passage of fish from any Canadian fisheries waters into such water intake, ditch, channel or canal.

The fish guard, screen, covering or netting shall have meshes or holes of such dimensions as the Minister may prescribe, and shall be built and maintained by the owner or occupier of the water intake, ditch, channel or canal subject to the approval of the Minister or such officer as the Minister may appoint to examine it.

The owner or occupier of the water intake, ditch, channel or canal shall maintain the fish guard, screen, covering or netting in a good and efficient state of repair and shall not permit its removal except for renewal or repair, and during the time such renewal or repair is being effected, the sluice or gate at the intake or entrance of the water intake, ditch, channel or canal shall be closed in order to prevent the passage of fish into the water intake, ditch, channel or canal.

PROCEDURES FOR INSPECTION AND APPROVAL OF INTAKE STRUCTURES

Diversions less than 0.0283 cms (one cubic foot per second): The intake structure shall be constructed in accordance with specifications indicated herein. Upon completion of construction and prior to operation the owner shall contact a local representative of the Department of Fisheries and Oceans to arrange for on-site inspection and approval of the installation. Permanently submerged screens must be inspected prior to installation.

Diversons greater than 0.0283 cms (one cubic foot per second): The owner shall submit to the Department of Fisheries and Oceans 2 sets of detailed plans of the proposed installation for review and approval prior to fabrication. Design drawings are required whenever the diversion quantity exceeds 0.0283 cms (1.0 cfs) or 817,200 L/day (180,000 Igpd) for industrial diversions (calculated on the basis of 8 hours/day) or 123,350 cmy (100 ac.- ft./year) for irrigation diversions (calculated on the basis of 100 days/year and 12 hours/day). The plans shall contain the following information:

1. Intake structure location and dimensions.
2. Maximum discharge capacity of diversion.
3. Screen dimensions.
4. Mesh size.
5. Screen material.
6. Fabrication details.
7. Minimum and maximum water levels at the intake site.
8. Provision for bypassing fish.

The intake structure shall then be constructed in accordance with the approved plans. Upon completion of construction and prior to operation, the owner shall contact the local representative of the Department of Fisheries and Oceans to arrange for on-site inspection and approval of the installation. Permanently submerged screens must be inspected prior to installation.

SPECIFICATIONS FOR INTAKE STRUCTURES WITHOUT PROVISION FOR AUTOMATIC CLEANING

1. Screen Material: The screen material shall be either stainless steel, galvanized steel, aluminum, brass, bronze, or monel metal. Stainless steel is preferred since corrosion is greatly reduced.

2. Screen Mesh Size: Clear openings of the screen (the space between strands) shall not exceed 2.54 mm (0.10 inch). The open screen area shall not be less than 50% of the total screen area. The following square-mesh wire cloth screens are recommended:

   - 7 mesh, 1.025 mm (0.041 inch) wire, 51% open, 2.54 mm (0.10 inch) openings; or
   - 8 mesh, 0.875 mm (0.035 inch) wire, 52% open, 2.25 mm (0.09 inch) openings; or
   - 8 mesh, 0.700 mm (0.028 inch) wire, 60% open, 2.54 mm (0.10 inch) openings.

3. Screen Area: A minimum unobstructed screen area (gross area) of 0.93 square metre (10 square feet) shall be provided for each 0.0283 cms (1cfs) of water entering the intake. The required screen area shall be installed below minimum water level. Screen area lost by framing shall not be included as part of the unobstructed screen area.

4. Screen Support: The screen shall be adequately supported with stiffeners or back-up material to prevent excessive sagging.

5. Screen Protection: The intake structure shall, where necessary, be equipped with a trash rack or similar device to prevent damage to the screen from floating debris, ice, etc.

6. Screen Accessibility: The screen shall be readily accessible for cleaning and inspection. Screen panels or screen assemblies must be removable for cleaning, inspection and repairs.

7. Allowable Openings: The portion of the intake structure which is submerged at maximum water level shall be designed and assembled such that no openings exceed 2.54 mm (0.10 inch) in width.

8. Design and Location: The design and location of the intake structure shall be such that a uniform flow distribution is maintained through the total screen area.

9. Fish Bypass: The intake shall be designed to provide a transverse velocity (the component of the velocity parallel and adjacent to the screen face) to lead fish to a bypass or past the screens before they become fatigued. In no case should the transverse velocity be less than double the velocity through the screen.

SPECIFICATIONS FOR INTAKE STRUCTURES WITH PROVISIONS FOR AUTOMATIC CLEANING

The specifications are identical to those for intake structures without provisions for automatic cleaning except that the minimum unobstructed screen area (gross area) of 0.23 square metre (2.5 square feet) need only be provided for each 0.0283 cms (1 cfs) of water entering the intake. However, a regular cleaning and maintenance schedule is required to ensure seals and screen panels remain in good repair preventing impingement and entrainment of fish and debris.

For these self-cleaning intake structures, the location, design and juvenile fish avoidance system all affect operating characteristics. The final design, therefore, may incorporate modifications reflecting the best current technology available for minimizing adverse impact upon the fisheries resource.

ALTERNATE FISH PROTECTION FACILITIES

Enquiries concerning the Department's requirements for indirect intakes, such as infiltration galleries and wells, for salt water ocean intakes, and for new methods or devices for screening intake structures should be directed to the Department of Fisheries and Oceans, Senior Habitat Management Biologist.

Conversion Factors:

1 cubic foot per second (cfs) = 449 U.S. gallons per minute (U.S. gpm).
= 374 Imperial gallons per minute (Igpm).
= 1.98 acre feet per day (Ac.-Ft./day).
= 28.3 litres per second (L/sec.).
= 0.0283 cubic metres per second (cms)

0.10 inch = 3/32" (approx.) = 2.54 millimetres

Addresses for Correspondence and Approvals

1. Senior Habitat Management Biologist
   Fraser River, Northern B.C. and Yukon Division
   Department of Fisheries and Oceans
   Room 330, 80 - 6th Street
   New Westminster, B.C. V3L 5B3 Phone: 666-6479

2. Senior Habitat Management Biologist
   South Coast Division
   Department of Fisheries and Oceans
   3225 Stephenson Point Road
   Nanaimo, B.C. V9T 1K3 Phone: 756-7270

3. Senior Habitat Management Biologist
   North Coast Division
   Department of Fisheries and Oceans
   Room 109, 417 - 2nd Avenue West
   Prince Rupert, B.C. V6J 1G8 Phone: 624-9385

Other Federal and Provincial agencies having jurisdiction in water withdrawals and construction pertaining to watercourses in British Columbia include:

1. Transport Canada
   Canadian Coast Guard.

2. B.C. Ministry of Environment
   Fish and Wildlife Management.

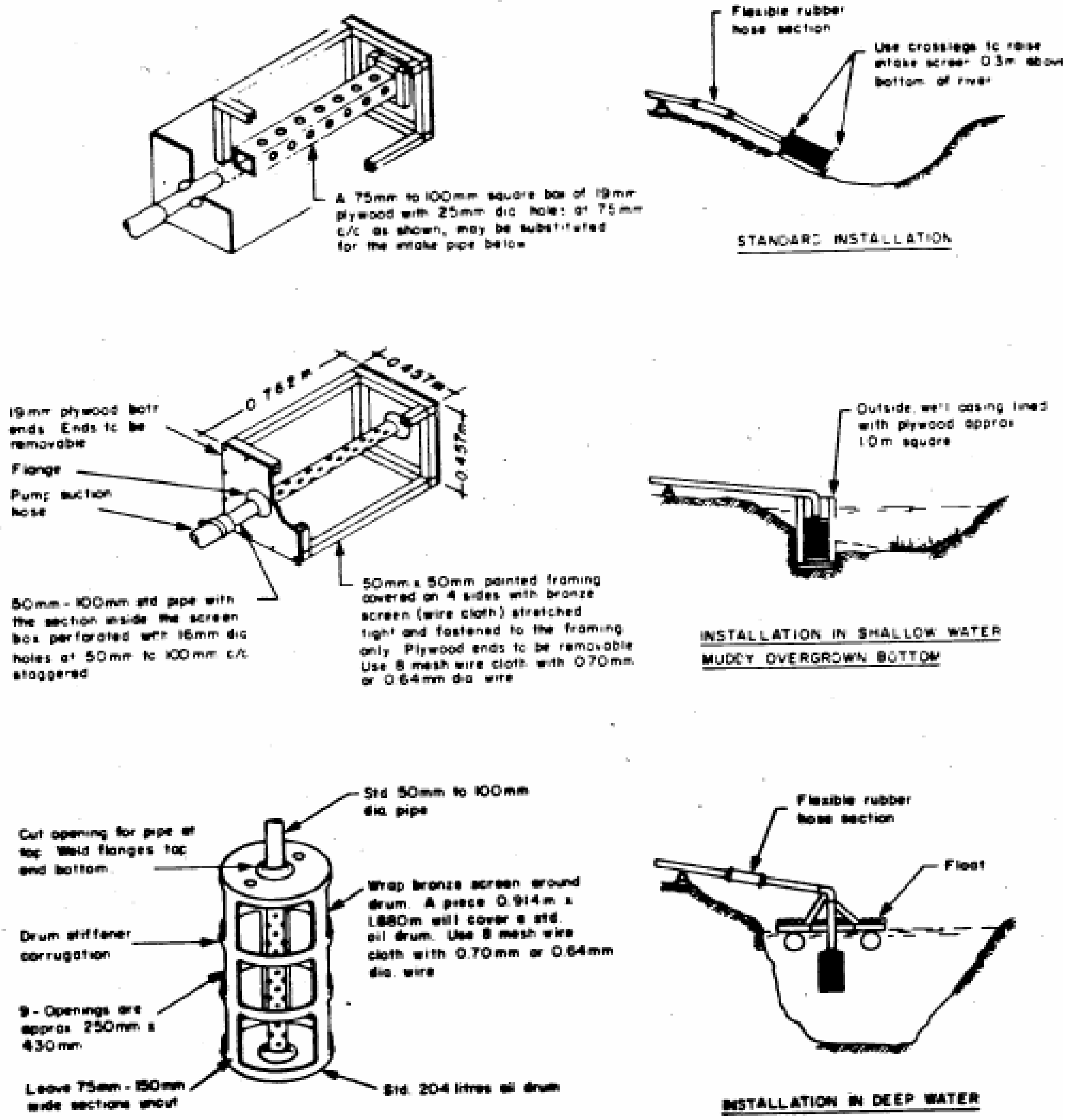
3. B.C. Ministry of Environment
   Water Management.

4. B.C. Ministry of Agriculture and Food.

5. B.C. Ministry of Lands, Parks and Housing.

It may be necessary that several or all these agencies also be solicited for approvals prior to the installation of a water intake.

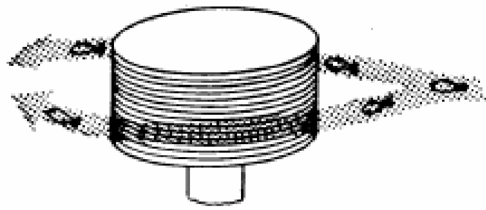
Revised January, 1986

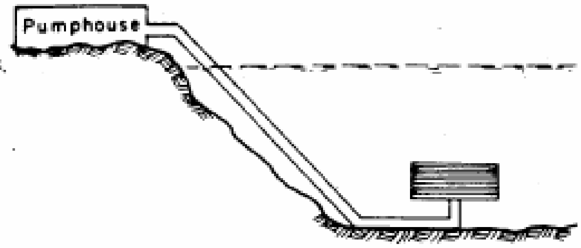


NOTE
1. Oil drum shall be thoroughly washed out or steam cleaned before cutting openings.
2. All loose rust shall be removed and the drum coated with metal primer. Two coats of machinery enamel or epoxy paint shall be applied before covering with wire cloth.

NOTE
All screens shall be installed below minimum water level, shall be easily accessible for cleaning, and shall be cleared of debris at regular intervals.

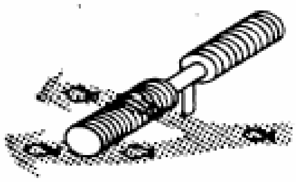
SMALL STATIONARY WATER INTAKE SCREENS
(For pumps of a capacity less than 28.3 L/sec [1 cfs, 449 U.S. or 374 Igpm])

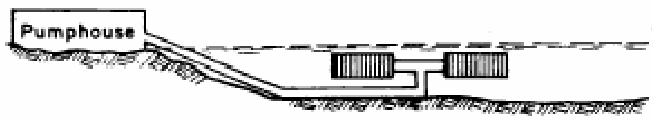




DEEP WATER WELL SCREEN

May be installed in lakes and the ocean.





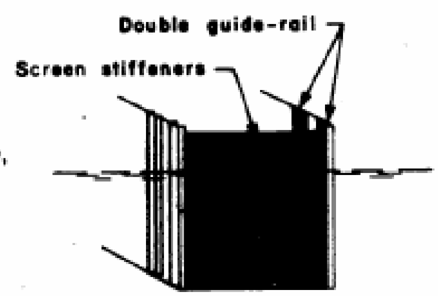
SHALLOW WATER WELL SCREEN

May be installed in lakes, pools, and stable areas in rivers.

Totally submerged cylindrical shaped stainless steel well screens provide for high intake capacity and large percentage of open area permitting water to enter at low velocities. Slot opening shall not exceed 2.54 mm (0.10 inch).

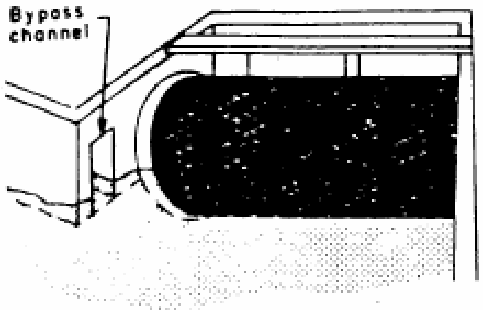
VERTICAL PANEL SCREENS

May be installed in rivers, lakes and the ocean. Generally, requires coarse trashracks, a sluice gate in river installations, double sets of guide-rails, and standby screen panels to allow for cleaning and repairs.



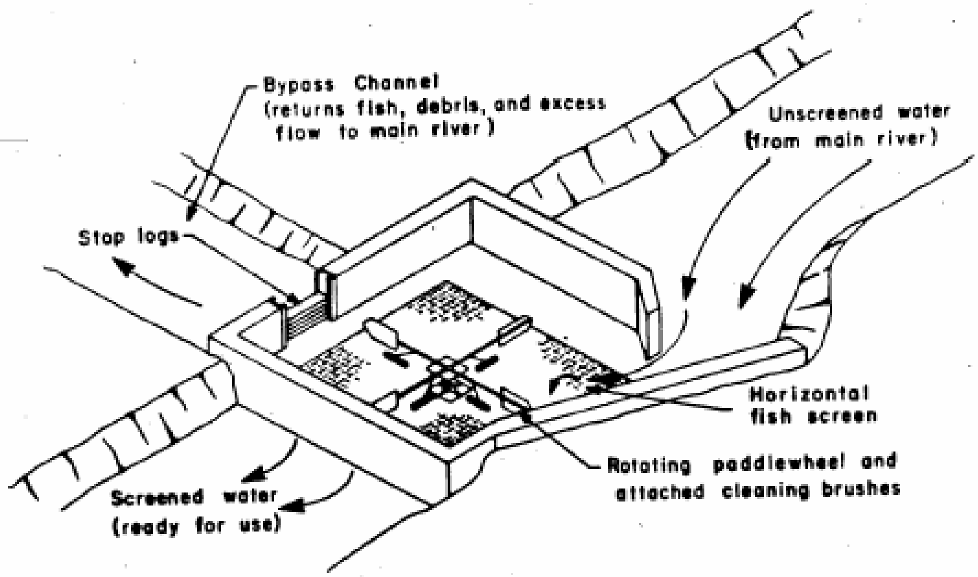
LARGE STATIONARY WATER INTAKE SCREENS

(For pumps of a capacity more than 28.3 L/sec [1 cfs, 449 U.S. or 374 Igpm])



REVOLVING DRUM SCREEN, HORIZONTAL AXIS

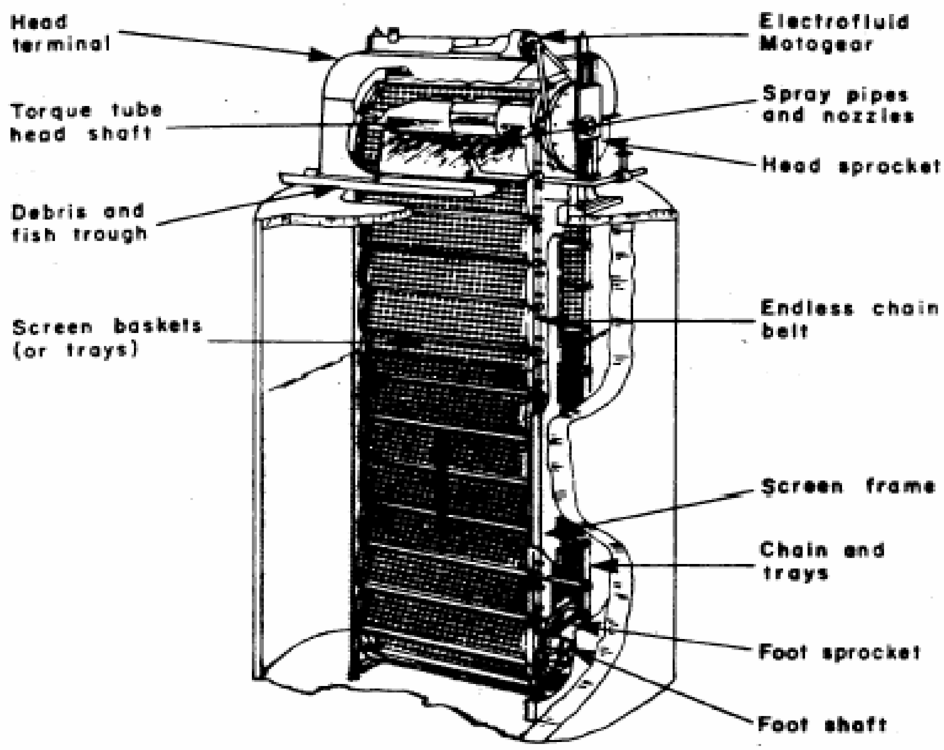
Generally, installed to divert fish from irrigation canals. Can be driven by a small motor or by a paddle wheel. To avoid juvenile fish impingement, a bypass channel is required near the front of the screen. Rubber seals are necessary along the base and sides.



FINNIGAN SCREEN

The horizontal, self-cleaning Finnigan Screen is another concept, generally installed to divert fish from irrigation or enhancement projects. The stationary horizontal screen is kept clean by a set of brushes attached to a revolving paddle wheel powered by the water current entering the structure. A portion of the flow, the suspended debris, and fish are directed to the bypass channel. The remainder of the flow passes through and below the screen for use as required.

IRRIGATION INTAKE SCREENS



CONVENTIONAL VERTICAL TRAVELLING SCREEN

May be installed in rivers, lakes and the ocean. A common screening method utilized by industry, these self-cleaning mechanical screens with modifications can prevent impact upon fish. Mounted flush to the stream bank (shoreline) or as pier intakes within streams and provided with an opening on the downstream end between the intake screens and trashracks, juvenile fish can generally escape entrapment. Rubber panel, side, and boot seals are required to prevent juvenile fish from gaining entry into the pumpwell. A safe bypass system is essential to return juvenile fish with debris back to the watercourse. Automatic controls are also necessary to ensure operation at a specific minimum head differential.

LARGE INDUSTRIAL AND DOMESTIC WATER INTAKE SCREEN