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

CHEMAINUS RIVER

WATER ALLOCATION PLAN

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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 many advantages include:

1. Making information regarding our position on water allocation decisions available to the public and future applicants;
2. Reducing our response time by having plans in place prior to applications;
3. Eliminating separate studies and reports on each application;
4. Improving the consistency of our approach and decisions;
5. Definition of specific allocation directions and decisions;
6. Plans are more comprehensive than present reports;
7. Eliminates the need for referrals on individual applications.

The following regional policy was developed to provide 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 Chemainus River Water Allocation Plan area (Figure 1) is located in the southern region of Vancouver Island, approximately one fifth of the way up the eastern coast. It spans between the municipalities of Crofton to the south and Chemainus to the north. The plan covers land stretching inland to the west with an average width of 35 km.. El Capitan mountain and Mount Landale define the western boundary of the plan area and contain the headwaters for the Chemainus River. Most of the drainage flows in an easterly direction on its way to Stuart Channel and the Strait of Georgia, the eastern boundary of the plan area. The overall size of the plan area was determined to approximate 440 square kilometres.

Mount Landale, at 1,520 metres, is the highest point found within the allocation plan area and defines the natural divide which separates those streams flowing eastward, through the plan area, from those which flow south-westerly into Cowichan Lake and River system and from those streams which flow north into the Nanaimo River system. Distribution of lakes within the plan area is sparse with only a few small bodies of water located in the Mount Brenton area as well as those lakes located in the lower elevations near the town of Chemainus.

2.2 Climate

The Chemainus River Water Allocation Plan area is classified as a temperate climate, characterized by warm, relatively dry summers and mild wet winters. Climatic normals have been derived using information from an Environment Canada, Atmospheric Environment Science (AES) station. The information from two AES stations was used; the first station is located in the town of Chemainus, for the years between 1951-80, and the other is located just outside of the plan area at Duncan forestry station for the years 1951-80 (Appendix A). The mean annual daily temperature is 9.4^{o}C.

Precipitation in the region is low during the summer months and high throughout the winter months. Further information on this subject is available in the Precipitation segment of the Hydrology section, as well as in Appendix A. The low precipitation during the summer months, coupled with high evaporation rates causes the plan area to experience a moisture deficit in the summer.

2.3 Geology and Groundwater

The geological history of the Chemainus River Water Allocation Plan area has been shaped by the occurrences of structural, erosional, and depositional processes. The physiographic features of this portion of Vancouver Island are the result of repeated glaciation and marine tidal fluctuations which have influenced the present landscape. The majority of the surficial deposits found within the plan area are the result of the Fraser Glaciation of the Late Pleistocene Period (Ronneseth, 1985).

Unconsolidated sands, gravels, and tills (boulder clays) are commonly found within the area and are hydrogeologically significant in terms of their potential for groundwater. Ronneseth (1985) identifies the fluvial deposits of the Salish sediments found in the valley of the Chemainus River as the primary target for groundwater exploration within the plan area.

2.4 History and Development

The sheltered coastal water and abundance of wildlife within the Chemainus River Water Allocation Plan area once provided excellent hunting and fishing grounds for the Salish Indian Nation. During the mid 1800's to early 1900's, the plan area witnessed the growth of a community which has thrived on the prosperous forestry industry since 1858. The deep sea port at Chemainus Bay has been used over the years as a connection to the international trade market.

Today the town of Chemainus is home to 3,800 people. The community has expanded throughout its history to diversify into a vibrant tourist attraction and a thriving business community; the historical murals of Chemainus have attracted world wide attention and have contributed to the town's popularity.

2.5 Significant Drainage Areas

For the purpose of assessing water supplies for allocation demands, the Chemainus River watershed has been divided according to the identification of significant drainage areas. These areas were digitized using 1:50,000 NTS maps. The following table and Figure 2 illustrate these watershed areas.

Chemainus River Drainage Areas	
Drainage	**Area (km^2)**
Chemainus River	359.53
Bonsall Creek	34.04
Matthew Creek	4.29
Askew Creek	5.18
Other Areas	36.40
Total Plan Area	**439.44**

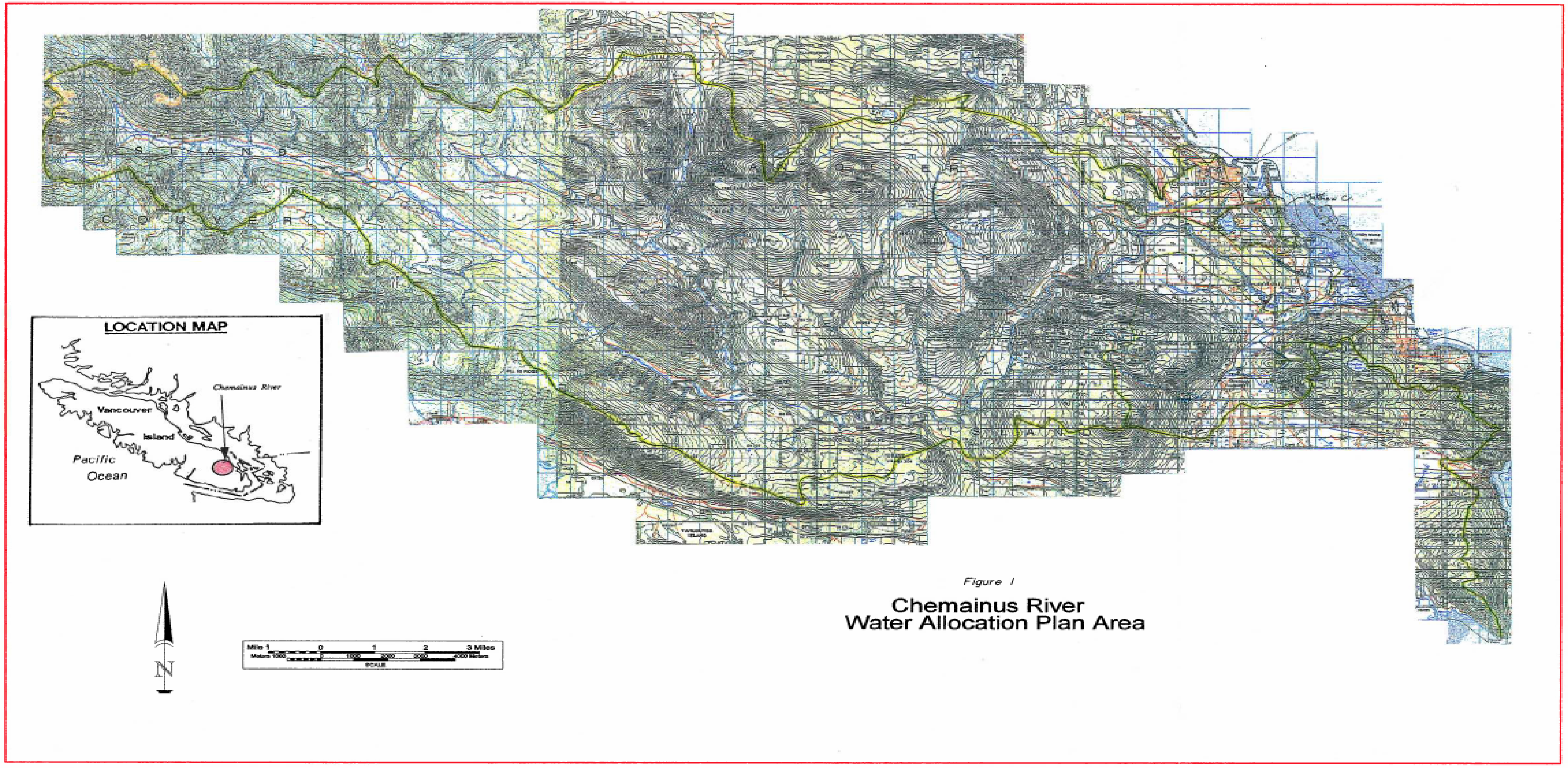


Figure 1
Chemainus River
Water Allocation Plan Area

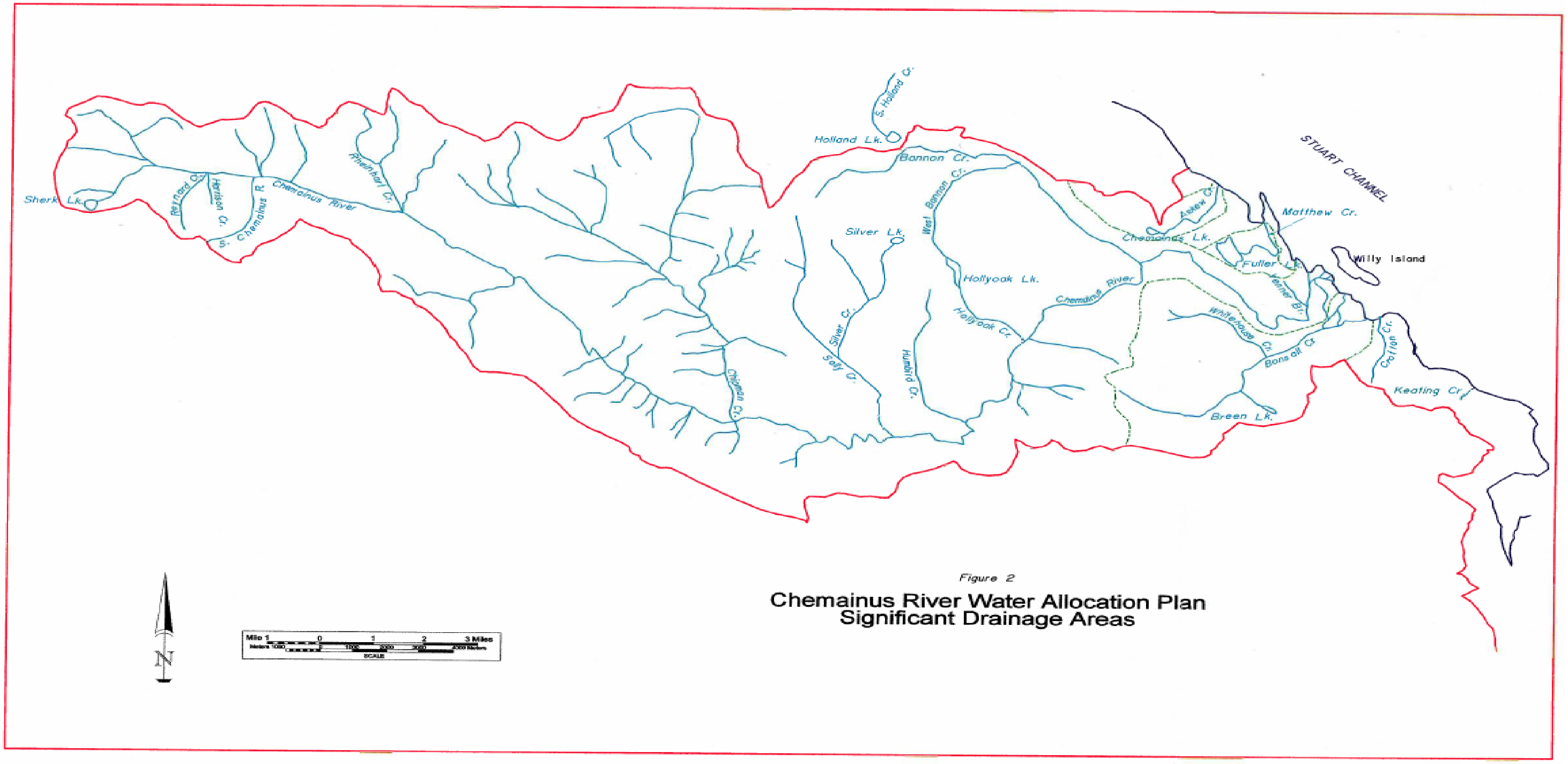


Figure 2
Chemainus River Water Allocation Plan
Significant Drainage Areas

3.0 HYDROLOGY

3.1 Precipitation

Using data collected from 1951-1980 at the Chemainus Atmospheric Environment Service (AES) station (48°56' N 123°44'W), the climatic normals for the Water Allocation Plan area were determined. The monthly precipitation normals are displayed in the following bar graph (Figure3).

The mean total annual precipitation for the area is 1,262.6 mm (50 inches). The minimum mean monthly precipitation is 22.9 mm (0.9 inch) and occurs in July, while the mean maximum monthly precipitation occurs in December with a value of 237.1 mm (9 inches). The mean number of days of the year with measurable precipitation is 155; with 148 mean days of rain and 11 mean days of snow.

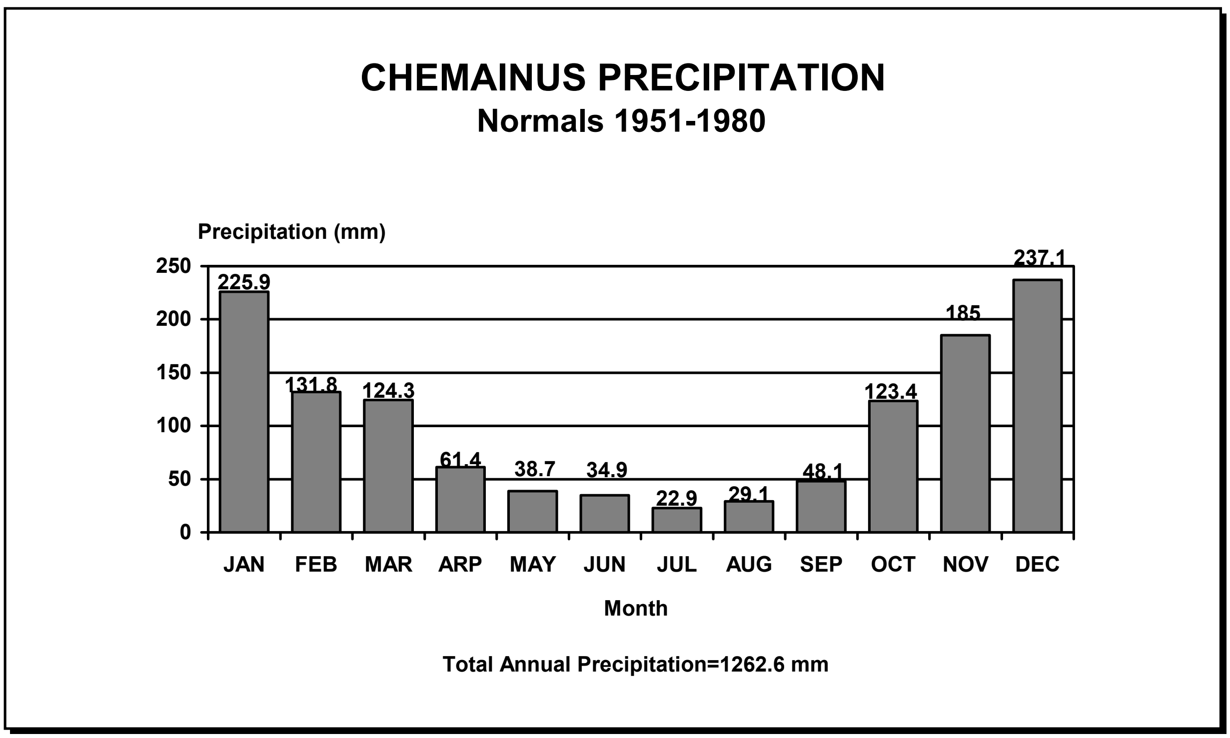


Figure 3

3.2 Hydrometric Information

There are many streams within the Chemainus River Water Allocation Plan area that have limited or no streamflow records. The hydrology of these streams must therefore be inferred from regionalized information obtained from Water Survey of Canada (WSC) hydrometric stations. There are two WSC stations within the Chemainus River Water Allocation area. One station is on the Chemainus River near Westholme; it has discharge records for the years 1914 to 1917 and 1952 to 1994. The second hydrometric station is on Bonsall Creek above Whitehouse Creek; data collected at this station are for the year 1968 only. These stations are both located on the south west coast of Vancouver Island in the same bio-climatic zone and have similar stream profile and aspect. The following table lists the WSC stations within the Chemainus River Water Allocation Plan area and their period of record, drainage area, mean annual discharge and mean 7-day average low flow.

Water Survey of Canada Stations					
Station Number	Station Name	Period of Record	Drainage Area (km^2)	Mean Annual Discharge (m^3/sec)	Mean 7-Day Average Low Flow (m^3/sec)
08HA001	Chemainus River near Westholme	1914-1994	355	18.8	0.512
08HA022	Bonsall Creek above Whitehouse Creek	Jun-Sep 1968	13	_	0.005

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

The locations of the hydrometric stations within the plan area, as well as the Chemainus and Duncan Forestry AES climatic stations are illustrated in Figure 4.

In addition there are miscellaneous stream flow records available from Regional Engineer's Reports related to water licences. The locations at which these miscellaneous stream flow measurements were taken are also illustrated in Figure 4, and are further summarized in Appendix C.

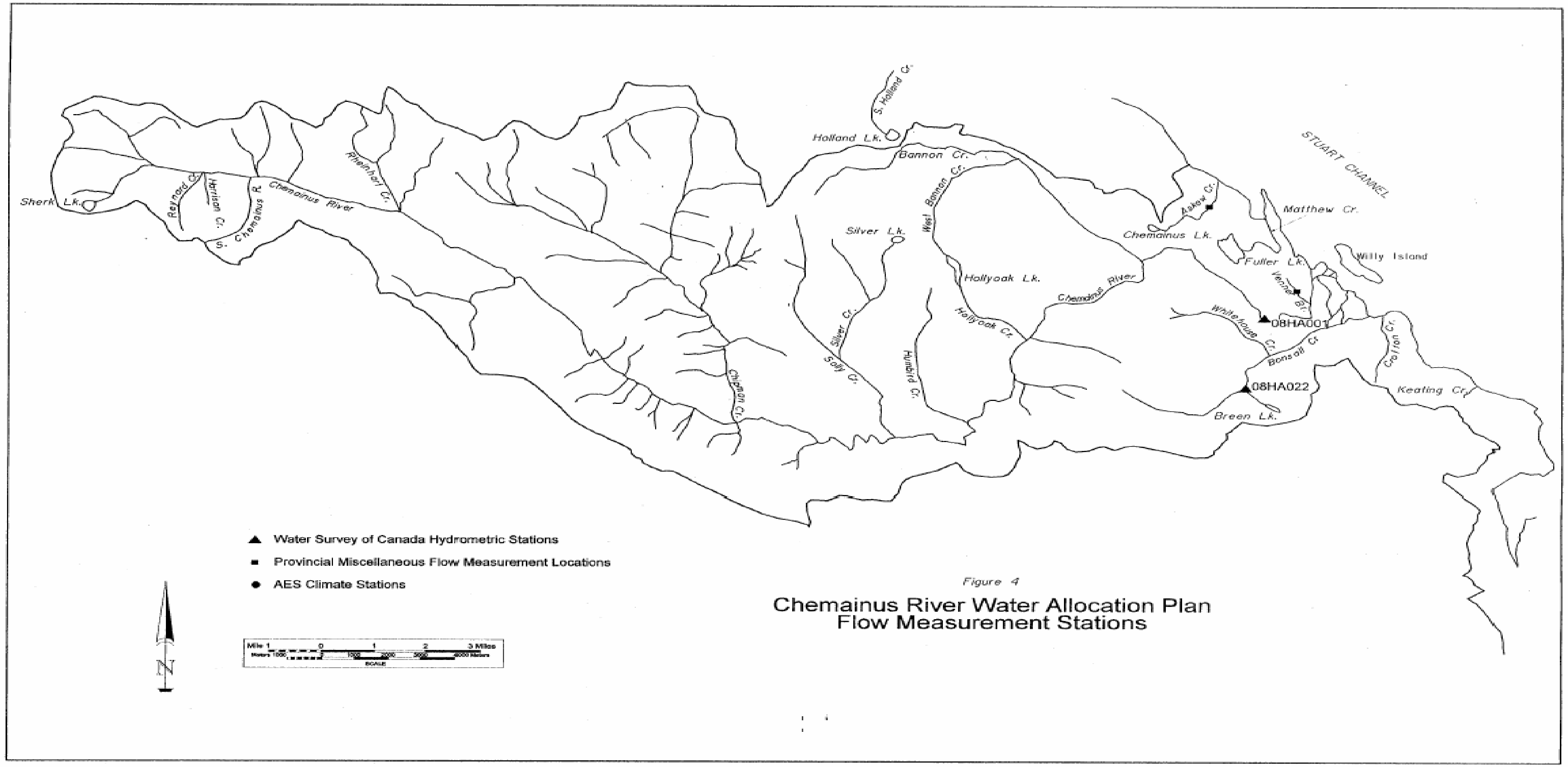


Figure 4
Chemainus River Water Allocation Plan
Flow Measurement Stations

The discharge runoff per square kilometre was estimated from the mean monthly and mean annual records at the WSC hydrometric station at Chemainus River near Westholme (08HA001) for its period of record. The average annual discharge runoff and average monthly discharges per square kilometre were used to estimate the mean monthly discharges (MMD) and mean annual discharge (MAD) in all identified significant drainage areas within the Chemainus River Water Allocation Plan Area. These estimated discharge runoffs per square kilometre are in the following table.

Chemainus River Discharge Runoff per Square Kilometre (litres/second/km^2)													
Station Number	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MAD
08HA001	96	89	70	64	43	19	7	3	5	35	96	117	53
%MAD	181	168	132	121	81	36	13	6	9	66	181	220	100

For each identified significant watershed without annual discharge records, the average discharge runoffs per square kilometre noted in the above table were multiplied by the drainage area to obtain an estimate of the mean monthly discharge (MMD) and mean annual discharge (MAD). The seasonal Water Survey of Canada (WSC) hydrometric record for 1968 on Bonsall Creek was used to modify all estimated mean monthly discharges, except the Chemainus River.

3.2.1 Chemainus River Drainage

The planimetered area of the Chemainus River drainage basin is 359.53 square kilometres (138.81 $miles^2$) making this drainage the largest within the plan. Spanning the width of the plan area, the Chemainus River flows for 53 kilometres (33 miles) with its headwaters in the western mountainous region at Mount Landale. The Chemainus River is fed by numerous tributaries as it runs eastward towards Stuart Channel. The Chemainus River drainage basin has hydrometric station 08HA001, located on the Chemainus River, near Westholme. This station has the longest history of streamflow measurements on Vancouver Island, with discharge records from 1914 to 1917 and 1952 to 1994. The accumulated data used in this Allocation plan is from a total of 47 years.

Venner Brook is tributary to the Chemainus River. The estimated watershed area of Venner Brook is 80 ha (200 acres). This brook has been observed to go dry at the end of a arid summer. Four streamflow measurements have been made on Venner Brook (Appendix C). Thomas Brook is tributary to Venner Brook. The estimated watershed area of Thomas Brook is 6 ha (15 acres). The headwaters of Thomas Brook are supported by two springs which have been ditched to flow into Thomas Brook.

Banon (Miller), Solly and House Creeks have no available streamflow records. The estimated watershed areas of these streams are 21.6 km^2 (5340 acres), 23.9 km^2 (5900 acres), and 6.25 km^2 (1544 acres), respectively.

Using the flow records of WSC station 08HA001 on Chemainus River near Westholme, the Mean Annual Discharge (MAD) and Mean Monthly Discharges (MMD) are in the following table.

Chemainus River Mean Monthly and Mean Annual Discharge (m^3/second)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
34.2	31.7	25.0	22.7	15.2	6.9	2.6	1.2	1.9	12.4	33.9	41.4	18.8

The following figure illustrates the mean monthly flow of Chemainus River at the Water Survey of Canada hydrometric station near Westholme (08HA001).

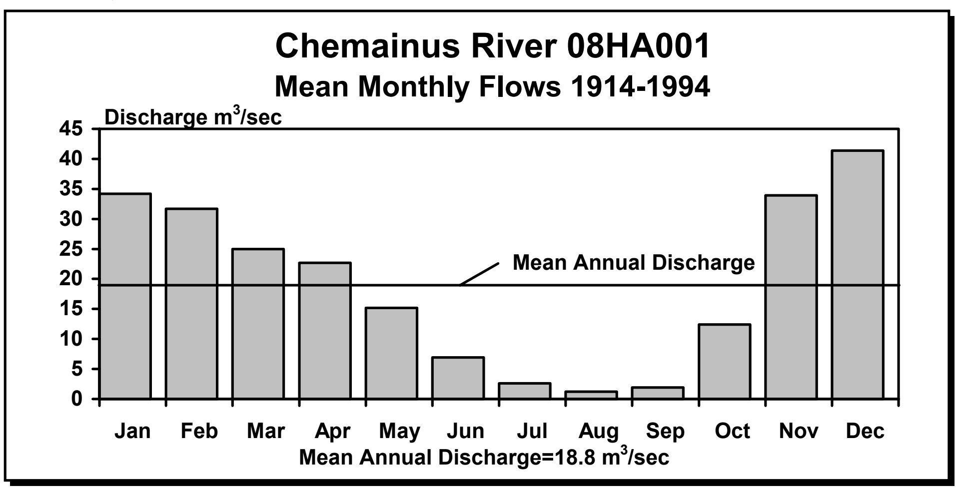


Figure 5: Chemainus River Mean Monthly Flow

3.2.2 Bonsall Creek Drainage

The Bonsall Creek drainage area includes Bonsall Creek, Whitehouse Creek, and other smaller tributaries. The total area of the Bonsall Creek drainage is 34.04 km^2 (13.14 miles^2) derived from planimetered 1:50000 topographic maps.

The Bonsall Creek Water Survey Canada (WSC) hydrometric station, 08HA022, is located approximately 1.25 km below the Trans Canada Highway crossing. Records are available for a 19 day period in May and for the period of June through September for the year 1968.

The discharge runoff per square kilometre of the May to September flows on Bonsall Creek is between 5% and 23% of the discharge runoff per square kilometre recorded on the Chemainus River for the same period. Therefore, the Bonsall Creek discharge runoff per square kilometre during the low flow months of May to September were reduced to 5% to 23% of the Chemainus River discharge runoff per square kilometre. The mean annual discharge, which is estimated from the average annual WSC hydrometric station discharge runoff per square kilometre, is assumed to be reliable. Therefore, the mean monthly discharge flows of October through April were adjusted approximately 9% higher to compensate for the lower mean monthly May to September discharge flow. This assumes a rapid runoff and greater flow during the wetter months of October through June, and lower flows during the dryer months of July, August and September than originally estimated using the average monthly discharge runoff per square kilometre of the Chemainus River.

The estimated Mean Annual Discharge (MAD) and Mean Monthly Discharge (MMD) for Bonsall Creek are in the following table.

Bonsall Creek Mean Monthly and Mean Annual Discharge (litres/second)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
3,600	3,300	2,700	2,500	240	140	70	30	10	1,500	3,600	4,300	1,800

3.2.3 Matthew Creek Drainage

The total area of the Matthew Creek watershed based on 1:50000 planimetered topographic maps is 4.29 km^2 (1060 acres). Fuller Lake, at an elevation of 46 m (150 ft.) above sea level, is tributary to Matthew Creek. The lake's watershed area is approximately 81.4 ha (201 acres); the surface area of Fuller Lake is approximately 24 ha (60 acres), based upon a study done by MELP, investigating Fuller Lake's water quality (Nordin, 1981). Nordin states that the estimated volume of Fuller Lake is 1,200 dam^3. The maximum depth of the lake is 17 m (57 ft) and the average depth is 8.5 m (28 ft).

There are no streamflow measurements for Matthew Creek. The watershed of Matthew Creek is at a relatively lower elevation than the Chemainus River; therefore, the modified mean monthly flows per square kilometre as described above in the Bonsall Creek drainage were used to estimate the Mean Annual Discharge (MAD) and the Mean Monthly Discharge (MMD) for Matthew Creek. The following table displays the estimated Mean Annual Discharge (MAD) and Mean Monthly Discharge (MMD) for Matthew Creek.

Matthew Creek Mean Monthly and Annual Discharge (litres/second)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
450	420	340	310	30	20	10	4	0	190	450	540	230

3.2.4 Askew Creek Drainage

The Askew drainage basin has a planimetered area of 5.18 km^2 (1280 acres). Chemainus Lake, located at an elevation of 90 m (300 ft.) above sea level is tributary to Askew Creek. Askew Creek flows in an easterly direction from a maximum elevation of approximately 200 m (650 ft.) above sea level. There is one streamflow measurement of 3.1 litres/second on Askew Creek on September 26, 1985 (Appendix C).

A survey of Chemainus Lake conducted on September 9, 1958 determined that the lake's maximum depth is 7.9 m (26 ft) and the mean depth is 5.3 m (17 ft). The area of Chemainus Lake is 5.2 ha (12.9 acres), with a volume of 276 dam^3.

The watershed of Askew Creek is at a relatively lower elevation than the Chemainus River; therefore, the modified mean monthly flows per square kilometre as described for the Bonsall Creek drainage were used to estimate the Mean Annual Discharge (MAD) and the Mean Monthly Discharge (MMD) for Askew Creek. The following table displays the estimated Mean Annual Discharge (MAD) and Mean Monthly Discharge (MMD) for Askew Creek.

Askew Creek Mean Monthly and Annual Discharge (litres/second)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
540	510	410	380	40	20	10	5	0	230	540	650	280

3.2.5 Other Small Drainages

The discharge runoff per square kilometre was used for other small watershed areas outside of the identified significant drainage areas. The estimated Mean Annual Discharge (MAD) and the Mean Monthly Discharge (MMD) per square kilometre are in the following table.

Discharge Runoff per Square Kilometre (litres/second/km^2)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
110	100	80	70	10	0	0	0	0	40	110	120	53

3.3 Low Flows

The lowest mean monthly discharge flows occur from May through October, a six month period, for all watersheds within the plan area; higher flows (above the Mean Annual Discharge) occur from November through April. The minimum mean monthly discharge (MMD) occurs in August.

The 7-day average low flows occur predominately in August or September. There are rarer occurrences of 7-day average low flows in July or October. The mean 7-day average low flow is 512 litres/second, and the 1 in 5 year, 7-day average low flow is 2.49 litres/second. The 7-day average low flows for Chemainus River near Westholme (08HA001) are listed in Appendix B.

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/second)				
Drainage Area	**Area (km^2)**	**MAD**	**Min. MMD**	**7-Day Avg. Low**
Chemainus River	359.53	18,800	1,100	512
Bonsall Creek	34.04	1,800	10	5
Matthew Creek	4.29	230	0	0
Askew Creek	5.18	280	0	0
Other Small Drainages	1.0	230	0	0

3.4 Lake and Evaporation

The following table summarizes information on lakes within the plan area.

Lakes					
Lake	**Drainage**	**Surface Area (ha)**	**Maximum Depth (m)**	**Mean Depth (m)**	**Volume (dam^3)**
Holyoak Lake	Chemainus	20.7	10	5	1,030
Chemainus Lake	Askew	5.2	7.9	5.3	276
Fuller Lake	Matthew	24	17	8.5	1,200
Silver Lake	Chemainus	8.6	5.6	3.3	86.4
Brenton Lakes	Chemainus	7.4*	N/A	N/A	N/A
Sherk Lake	Chemainus	7.5*	N/A	N/A	N/A

* Planimetered area from 1:50,000 topographic map.
N/A = No information Available

Approximately 0.3 m (1 ft) of water may be lost over the surface of the water body due to evaporation.

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, wildlife, 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. The following table outlines the modified version used within the Chemainus River Water Allocation Plan.

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 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 6 illustrates fish habitat within the Chemainus River Water Allocation Plan area.

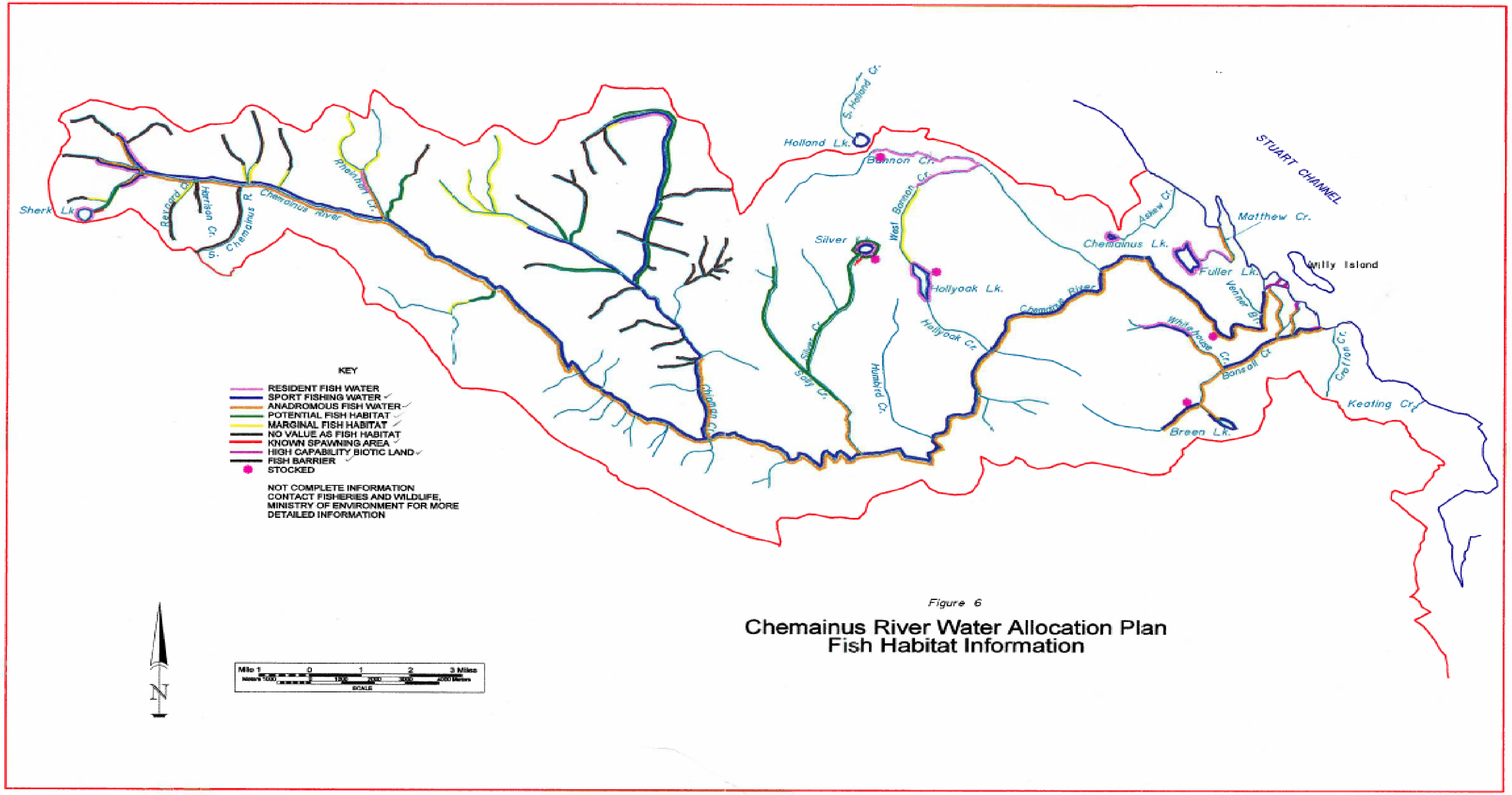


Figure 6

Chemainus River Water Allocation Plan
Fish Habitat Information

4.1 Chemainus River Instream Requirements

The Chemainus River drainage has been identified as an important fish habitat. Numerous tributaries are spawning and rearing habitat for Coho, Chum and Chinook salmon. As well, many of the streams within the Chemainus River drainage are home to resident Rainbow and Cutthroat trout populations.

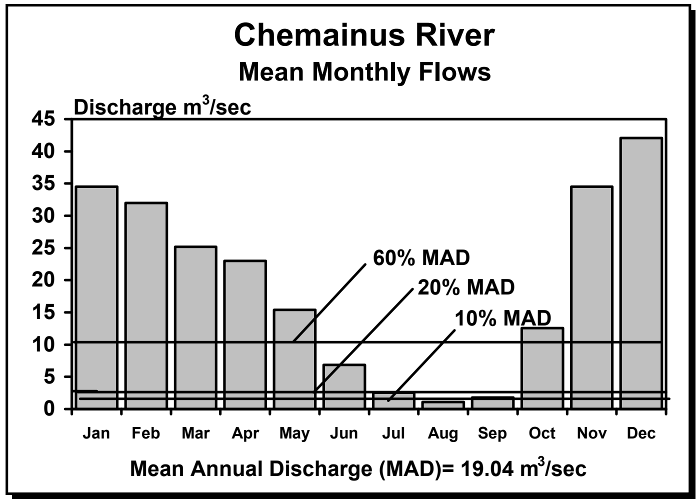


Figure 7

The Mean Monthly Discharge (MMD) to maintain the fish resources is 1.9 m^3/sec (10% MAD). Figure 7 illustrates that the estimated mean monthly flow falls below 10% of the mean annual discharge during the months of August and September. Therefore, water is only available for extractive use during the months of October through May when the mean monthly discharge is above 60% MAD. No water is available from Chemainus River when the flow is below 60% MAD or 11.3 m^3/sec (398 ft.^{3}/second). Thus, the estimated volume of water available from October through May is 334,000 dam^3.

4.2 Bonsall Creek Instream Requirements

The Bonsall Creek drainage basin supports a variety of fish species; sea-run and resident Cutthroat and Rainbow trout, Coho and Chum salmon utilize these waterways.

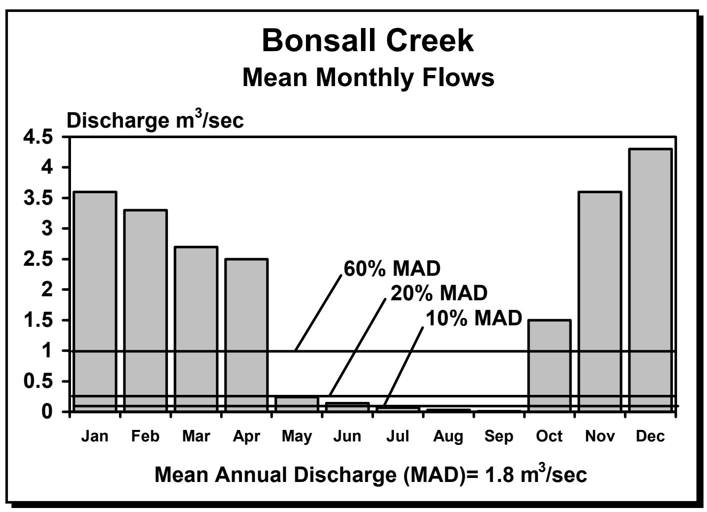


Figure 8

Figure 8 illustrates that the mean monthly flow in Bonsall Creek falls below 10% of the mean annual discharge (MAD) during the months of June, July, August and September. Therefore, water is only available for extractive uses during the months of October through April when the mean monthly discharge is above 60% MAD . No water is available from Bonsall Creek when the flow is below 60% MAD or 1,080 litres/second (38.1 ft^3/sec). Thus, the estimated volume of water available from October through April is 36,000 dam^3.

4.3 Matthew Creek Instream Requirements

The Matthew Creek drainage supports Coho salmon, sea-run and resident Cutthroat and Rainbow trout, Smallmouth Bass, and Brown Bullhead fish species.

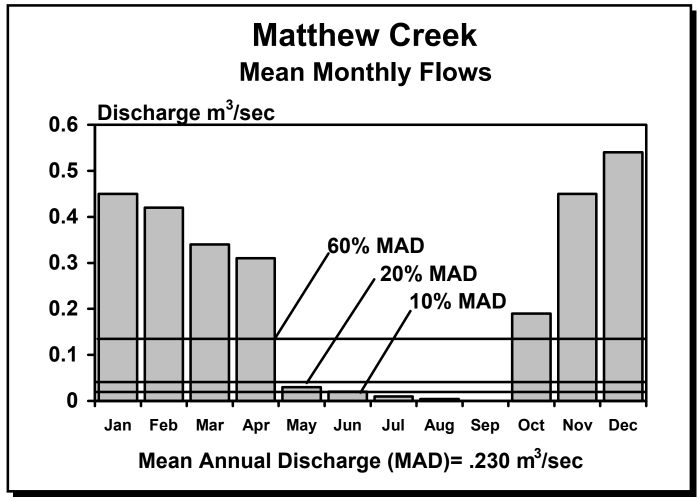


Figure 9

Figure 9 illustrates that the estimated mean monthly flow in Matthew Creek falls below 10% of the mean annual discharge (MAD) during the period of June through September. Therefore, water is only available for extractive use during the months of October through April when the mean monthly discharge is above 60% MAD. No water is available from Matthew Creek when the flow is below 60% MAD or 138 litres/second (4.9 ft^3/second). Thus, the estimated volume of water available from October through May is 4,700 dam^3.

4.4 Askew Creek Instream Requirements

The Askew Creek drainage contains Chemainus Lake which supports resident Cutthroat and Rainbow trout. Askew Creek has been identified as potential fish habitat.

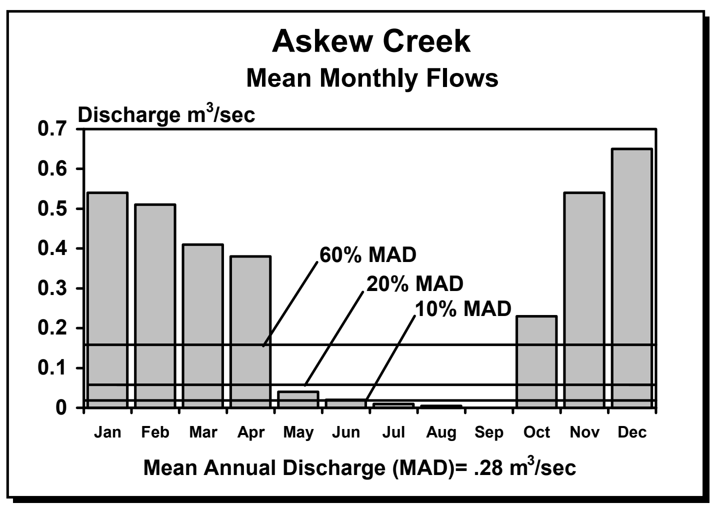


Figure 10

Figure 10 illustrates that the estimated mean monthly flow in Askew Creek falls below 10% of the mean annual discharge (MAD) during the months of June, July, August and September. Therefore, water is only available for extractive use during the months of October through April when the mean monthly discharge is above

60% MAD. No water is available from Askew Creek when the flow is below 60% MAD or 168 litres/second (5.9 ft^3/second). Thus, the estimated volume of water available from October through May is 5,400 dam^3.

4.5 Other Streams Instream Requirements

Various small watersheds may support small populations of fish. Where fish are identified, water will only be available from those drainages during the period of October through April when the mean monthly flow is greater than 60% MAD.

5.0 WATER DEMAND

5.1 Licensed Demand

There are 158 water licences currently (April 1996) within the Chemainus River Water Allocation Plan area. Figure 11 illustrates the number of water licences issued for each purpose for the water within the plan area. The largest number of water licences support rural residential domestic demands (83 water licences) and irrigation demands (40 water licences). There are 22 water licences for storage purposes, 7 water licences for industrial uses, 4 water licences for waterworks purposes, 1 water licence for land improvement purposes, and 1 water licence for conservation purposes.

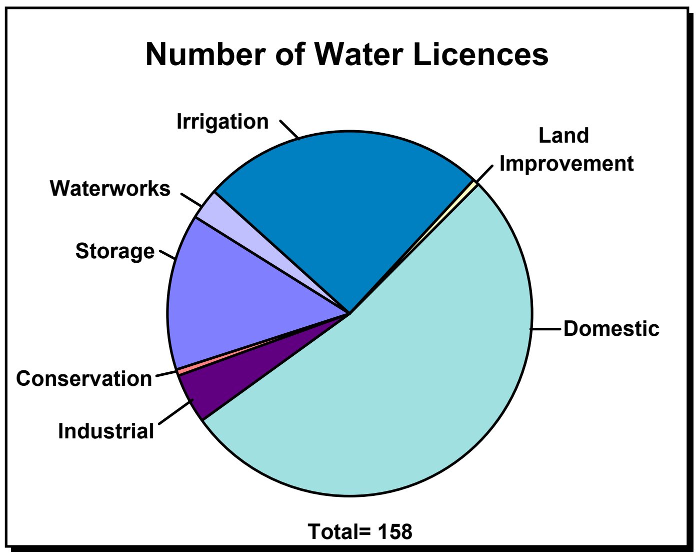


Figure 11

Of greater significance for water management is the estimated average annual licensed water demand. The total estimated average annual licensed water demand for the plan area is 7,202 dam^3. Figure 12 illustrates the estimated average annual licensed water demand for each purpose under which water licences have been issued. At 41% of the total annual water demand, storage purposes support the largest annual water demand in the plan area. The second largest demand is for municipal waterworks purpose (38%), followed by industrial purpose (11%), irrigation purpose (9%), domestic purpose (0.6%), and finally land improvement purpose (0.1%).

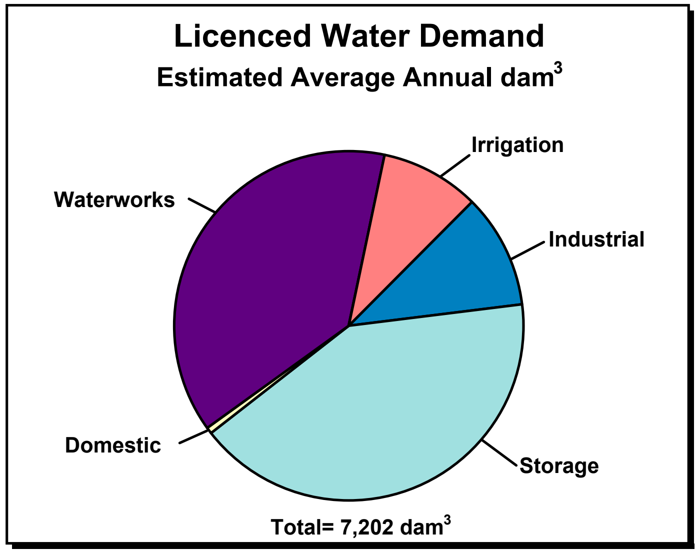


Figure 12

The following table summarizes the annual water demands for each purpose for the Chemainus River Water Allocation Plan area (also see Appendix D).

Estimated Average Annual Licensed Water Demand			
PURPOSE	**NUMBER OF LICENCES**	**QUANTITY LICENSED**	**ANNUAL DEMAND (dam^3)***
Municipal Waterworks	4	3,310,000 gpd	2,746.12
Domestic	83	51,700 gpd	42.93
Industrial			
(Enterprise)	2	3,000 gpd	2.07
(Fire Protection)	1	8,000 gpd	13.28
(Ponds)	1	8.25 acft	10.18
(Processing)	1	425,000 gpd	705.2
(Stockwatering)	1	9,000 gpd	7.47
(Watering)	1	25 acft	30.85
Sub-total	7	445,000 gpd 33.25 acft	728.02 41.03
Irrigation	40	537.11 acft	662.79
Storage	22	2,410.63	2,974.72
Land Improvement	1	4.9 acft	6.05
Conservation	1	0	0
Total	**158**	**-**	**7,201.66**

* Assumes that waterworks and domestic demands are the authorized maximum daily licensed amount divided by 2 to estimate the average daily demand, then multiplied by 365 days to determine the annual demand. Industrial (processing), conservation and land improvement demands are assumed to be uniform demands over the year and licensed volume is the total annual demand. Industrial (enterprise, fire protection, ponds, stockwatering and watering) , irrigation and storage licensed demands are the total annual licensed volumes.

The low flow licensed water demand may be critical between competing water uses and instream flow requirements to maintain the fish resources. The estimated low flow licensed demand for each identified drainage area and for other drainages in the Chemainus River Water Allocation Plan area are summarized in the following table (also see Appendix E).

Low Flow Licensed (Consumptive) Water Demand per Drainage Area		
DRAINAGE AREA	**LOW FLOW WATER DEMAND***	
	litres/second	**dam^3**
Chemainus River	119.89	438.34
Bonsall Creek	20.60	164.01
Matthew Creek	-36.68	-285.21
Askew Creek	5.87	45.65
Other	1.79	13.97
Total	**111.47**	**376.76**

* Based on an estimated licensed water demand assuming that: irrigation and industrial demands are totally withdrawn over a 90 day period; domestic and municipal waterworks demands are the authorized licensed maximum daily amount for 90 days; authorized storage balances demand and, therefore, is a negative demand over 90 days; land improvement and conservation are non-consumptive and, therefore, have no demand.

5.2 Projected Demand

There are 5 water licence applications pending as of January 1996. The potential annual water demand of these existing applications totals 801 dam^3, and includes 796 dam^3 (480,000 gpd max.) for industrial purpose and 5 dam^3 (6000 gpd max.) for domestic purpose. The water licence applications within the plan area are summarized in the following table (also see Appendix F).

Water Licence Applications			
Purpose	**No. of Licences**	**Quantity**	**Average Annual Demand (dam3)**
Domestic	3	6000 gpd	4.98
Industrial (Fire Protection)	1	0	0
(Processing)	1	480,000 gpd	796.46
Total	**5**	**486,000 gpd**	**801.44**

Most future water demands are anticipated to be similar to existing licensed water demands. Waterworks, domestic, industrial, irrigation, and land improvement licences will increase in number as the population of the plan area expands. Conservation purpose demands will increase as groups/agencies attempt to preserve and protect fish and wildlife habitat from urban encroachment and habitat destruction. Storage of winter high flows will be required to support water requirements during the summer low flow period.

The conclusions and recommendations found in the following sections outline the requirements, limitations and acceptance criteria necessary for approval of the applications discussed above.

6.0 CONCLUSIONS and RECOMMENDATIONS

The Chemainus River drainage has a four month low flow period from June through September, while all of the other significant drainage areas within the Chemainus River Water Allocation Plan area experience a five month low flow period from May through September in which water is unavailable for extractive purposes. The minimum mean monthly flow occurs in August and ranges from 0 litres/second in Matthew Creek to 1,100 litres/second in Chemainus River.

High flow periods, in which the mean monthly flows are greater than 60% of the mean annual discharge, occur from October through April. Therefore, there is considerable flow available for part of the year to develop supporting storage for water demands during the low flow months. The maximum mean monthly flow occurs in December and ranges from 540 litres/second in Matthew Creek to 41,400 litres/second in Chemainus River.

All significant drainage areas within the plan area support the spawning and rearing of anadromous fish such as salmon and sea-run Cutthroat trout. As well, there are resident fish such as Rainbow and Cutthroat trout in many of the streams and lakes within the plan area.

Fish and debris screen shall be required on all intake or diversion works within identified fish habitat areas. Fish and debris screens are part of good intake design and should be encouraged on all intake or diversion works. Fish passage provisions for both juvenile and adult fish are required on all storage dams or diversion works constructed on sources frequented by fish. Appendix G contains information on fish screening requirements.

Instream works are to be constructed only during the period specified by the fisheries agencies to minimize impacts on the fish resources. Instream works will normally only be approved for construction during the low flow period from June through September.

The licensed water demand within the Chemainus River Water Allocation Plan area consists of Domestic, Waterworks, Industrial, Irrigation, Storage, Land Improvement and Conservation purpose licences. Domestic purposes hold the majority of the water licences within the area; yet these demands do not significantly impact other water interests, except where there is a local competing water demand conflict. The largest existing annual licensed water demands are for storage purposes and community waterworks purpose.

The following table summarizes the water available for the identified significant drainage areas, not accounting for existing water demand.

CHEMAINUS RIVER -WATER AVAILABILITY			
DRAINAGE	DRAINAGE AREA (km^2)	WATER VOLUME AVAILABLE (dam^3)	
		HIGH FLOW*	LOW FLOW**
Chemainus River	359.53	334,000	0
Bonsall Creek	34.04	36,000	0
Matthew Creek	4.29	4,700	0
Askew Creek	5.18	5,400	0

* High Flow is the quantity of water available above 60% MAD during the period from October through April.
** Low Flow is the minimum mean monthly quantity of water available above 10% MAD during the low flow period from June through September.

6.1 Domestic

A domestic water licence shall be 2,300 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 licences for the maintenance of green lawns and gardens.

Domestic water licences 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 to develop a community water system of their own.

To ensure an adequate domestic water supply for household uses, applicants shall be required to develop storage or to use naturally stored water from lakes or marshes. For the average daily demand of 1,100 litres/day (250 gpd) for a five month period (150 days) a volume of 170 m^3 (6,000 ft^3) is required. This requires a reservoir or dugout approximately 9 metres (30 feet) long by 6 metres (20 feet) wide, with an average depth of 3.5 metres (11 feet), allowing 0.3 metres (1 foot) for evaporation loss over the surface of the reservoir.

A spring that is tributary to the ground shall be licensed for an individual domestic water demand provided that it is 30 metres (100 feet) away from any existing licensed springs. Multiple domestic water licences 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 (i.e. pump test in August or September) and by satisfying any written concerns and objections of any existing water licensees. Springs with surface overflow during the low flow period shall be required to develop storage.

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

6.2 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 increase in the coming years, as the Chemainus River Water Allocation Plan area is further developed and the population expands.

Applicants for a waterworks licence shall be required to assess the supply for a ten year projected demand and provide evidence that the projected demand is not excessive in comparison with adjoining community demands, that water conservation is being promoted (i.e. residential meters, pricing practices, education) and that adequate system balancing storage (i.e. volume difference between maximum hour and maximum daily demands) will be constructed or is available for peek hour 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. Licensed allocations will be limited to a 10 year projected demand except where the applicant can provide satisfactory evidence that a longer projection period is required (i.e. because the cost of construction of works must be amortised over a longer period).

The licensee shall be required to meter and record the water diverted from the source stream. The licensee shall be required to treat the water supply in accordance with the Ministry of Health requirements. All waterworks licences will require storage at the source stream.

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

6.3 Irrigation

The soil type, crop rooting depth and climatic characteristics determine the water requirements for irrigation. The irrigation demands for different crops and their rooting depths along with the water availability coefficient are classified into two categories, shallow (0.5 metre) and deep (1.0 metre) effective rooting depths. The available water storage capacity (AWSC) was estimated for shallow and deep root zone depth for the soil types present within the plan area. Where composites of two or three soil associations are intermixed or occupy such small areas that they cannot be separated at the scale of mapping, only the predominant soil association was considered. Areas identified as predominately rock outcrop, coastal beach or tidal flats were assumed to have no potential irrigation demand.

Figure 13 indicates the annual irrigation water requirements for various soil groups within the plan area. The following table was made using the climatic information for Duncan and the AWSC of irrigation requirements for different crop effective rooting depth classes and soil classes.

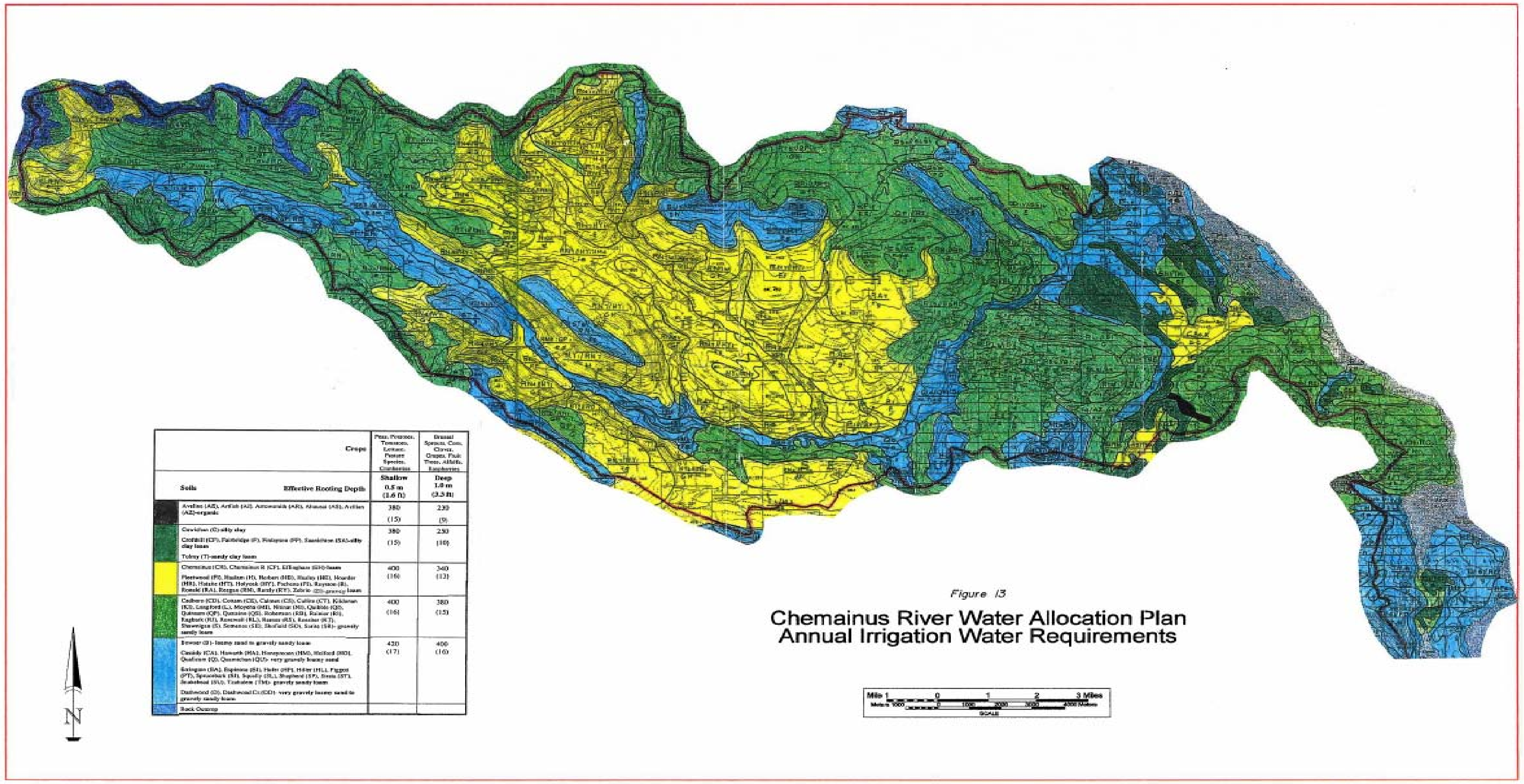


Figure 13

Chemainus River Water Allocation Plan
Annual Irrigation Water Requirements

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), Azilian (AZ)-**organic**	380 (15)	230 (9)
Cowichan (C)-**silty clay** Crofthill (CF), Fairbridge (F), Finlayson (FF), Saanichton (SA)-**silty clay loam** Tolmy (T)-**sandy clay loam**	380 (15)	250 (10)
Chemainus (CH), Chemainus R (CP), Effingham (EH)-**loam** Fleetwood (Fl), Haslam (H), Herbert (HB), Healey (HE), Hoarder (HR), Hatzite (HT), Holyoak (HY), Pachena (PI), Royston (R), Ronald (RA), Reegan (RN), Rutely (RY), Zebrio (ZI)-**gravely loam**	530 (21)	330 (13)
Cadboro (CD), Cottam (CE), Calmus (CS), Cullite (CT), Kildonan (KI), Langford (L), Moyeha (MI), Nitinat (NI), Quibble (QI), Quinsam (QP), Quatsino (QS), Robertson (RB), Rainier (RI), Ragbark (RJ), Rosewall (RL), Reeses (RS), Rossiter (RT), Shawnigan (S), Somenos (SE), Shofield (SO), Sarita (SR)-**gravely sandy loam**	530 (21)	380 (15)
Bowser (B)- **loamy sand to gravely sandy loam** Cassidy (CA), Hawarth (HA), Honeymoon (HM), Holford (HO), Qualicum (Q), Quamichan (QU)- **very gravely loamy sand** Errington (EA), Espinosa (EI), Hufer (HF), Hiller (HL), Piggott (PT), Sprucebark (SJ), Squally (SL), Shepherd (SP), Strata (ST), Snakehead (SU), Tzuhalem (TM)- **gravely sandy loam** Dashwood (D), Dashwood Cr.(DD)- **very gravely loamy sand to gravely sandy loam**	530 (21)	400 (16)

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. In the case where irrigation gun or flood irrigation 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 or 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 off-stream storage development. 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. Diversion into storage will be authorized from November 1 to April 30 provided that the available streamflow is in excess of 60% MAD.

The maximum irrigation system flow rate shall not exceed 19.1 litres/minute (4.2 imperial gallons/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.

6.4 Industrial

The industrial water licences and water licence applications within the plan area are demands associated with fire protection, fish culture, golf course maintenance, lumber processing, enterprise (restaurant and camp facilities) and stock watering.

Commercial fish hatcheries and/or rearing purposes shall require an industrial water licence. Use of water by government and non-profit organizations will be licensed 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.

Golf course watering is essentially an irrigation water demand except that the watering is not limited to the irrigation period of April to September. The quantity of water required should be determined as previously stated in the irrigation section. Except for the period of water withdrawal, which shall be the whole year, the same requirements and conditions as irrigation demands shall apply. Off-stream storage is required to support these demands; diversion into storage will be authorized from November 1 to April 30 provided that the available stream flow is in excess of 60% MAD.

Cattle or livestock watering requiring more than 450 litres/day (100 gpd) are to be considered an Industrial (Agricultural/ Stockwatering) demand. Cattle or livestock requiring 450 litres/day (100 gpd) or less will be considered a Domestic (Livestock) demand. Estimated amounts of water required for livestock watering demands are listed in the following table.

Recommended Livestock Water Requirements

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

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

6.5 Storage

Storage purpose is the impoundment of water, either on-stream or off-stream in a dugout or behind a dam. In the unlikely event that a large storage development to support a major water demand (eg. BC Hydro power, pulp and paper, large waterworks) is proposed, a more specific supply versus demand and environmental impact assessment will be required.

The storage quantity required to support the smaller water demands of domestic, industrial and irrigation uses shall be the five month low flow period volume of the water demand plus an additional allowance of 0.3 metres (1 foot) depth over the surface area of the storage reservoir for evaporation and other losses. Off-stream storage in a dugout will be required for these demands in most cases. Storage in swamps or natural depressions may be considered where fish and wildlife are not adversely impacted or where the natural habitat is enhanced.

The applicant will be required to complete an adequate report for “Dam and Reservoir Information Required in Support of a Water Licence Application for Storage Purpose (Schedule 2)”. If the required report is not provided the application will be refused.

Diversion of water into off-stream storage will be during the period from November through April during the high flows. All in-stream storage water licensees will be required to release at the outflow the estimated mean monthly inflow to the reservoir during the low flow period of June through September.

The applicant must obtain written agreement, right of way easement for works or flooding of 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 to maintain fish passage where required. Loss of spawning areas and modification of fish habitat due to storage development may require mitigation work in the affected stream.

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

6.6 Land Improvement

Land improvement purpose is the impoundment of water on a stream or the diversion of water form 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 resources.

Water used to facilitate the development of a park is usually maintained in a dammed lake for recreation (i.e. boating, fishing, swimming, golf course water traps) and aesthetics. The dammed lake 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 to control the volume of water in small ponds for water traps and aesthetics. Property owners may acquire a water licence to construct and maintain dugouts or to control the volume of small ponds for aesthetics and to increase the property value. 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. The water quantity required to facilitate the development of a park or to 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 the 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.

6.7 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 or wildlife for non-profit purposes.

Salmon enhancement proposals that would increase fish stocks in stream channels or side channels may require the development of supporting storage to maintain required low flow.

6.8 Allocation Plan Revision

The Chemainus River Water Allocation Plan should be reviewed and updated on or before January 1, 2001.

References

Nordin, Fuller Lake Water Quality Investigation. Ministry of Environment, Lands and Parks. 1981.

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

Wallis, C.H. APD Technical Paper 10: Calculating Irrigation Requirements for Eastern Vancouver Island. Ministry of Environment. 1982.

APPENDIX A

Chemainus & Duncan Forestry
Canadian Climatic Normals
1951-1980
1961-1990

Environment Canada
Atmospheric Environment Service

BRITISH COLUMBIA/COLOMBIE–BRITANNIQUE

CHEMAINUS 48° 56'N 123° 44'W 53 m	JAN JAN	FEB FEV	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														
Daily Minimum Temperature														
Daily Temperature														
Standard Deviation, Daily Temperature														
Extreme Maximum Temperature														
Years of Record														
Extreme Minimum Temperature														
Years of Record														
Rainfall	195.1	123.7	113.1	61.3	38.7	34.9	22.9	29.1	48.1	123.4	181.3	215.7	1187.3	2
Snowfall	30.8	8.1	11.3	T	0.0	0.0	0.0	0.0	0.0	0.0	3.7	21.4	75.3	2
Total Precipitation	**225.9**	**131.8**	**124.3**	**61.4**	**38.7**	**34.9**	**22.9**	**29.1**	**48.1**	**123.4**	**185.0**	**237.1**	**1262.6**	**2**
Standard Deviation, Total Precipitation	94.6	62.9	55.0	34.1	20.8	19.6	18.4	26.1	27.8	74.3	75.1	85.4	166.7	2
Greatest Rainfall in 24 hours	95.8	81.3	79.0	51.8	61.5	31.5	39.1	60.7	65.0	66.0	72.4	78.2	95.8	
Years of Record	57	58	55	57	57	58	55	53	53	53	55	56		
Greatest Snowfall in 24 hours	45.7	69.9	27.9	0.8	0.0	0.0	0.0	0.0	0.0	0.0	21.6	35.6	69.9	
Years of Record	56	58	56	57	58	59	59	56	56	56	55	55		
Greatest Precipitation in 24 hours	95.8	81.3	79.0	51.8	61.5	31.5	39.1	60.7	65.0	66.0	72.4	80.8	95.8	
Years of Record	56	58	55	57	57	58	55	53	53	53	55	55		
Days with Rain	17	14	15	12	9	9	6	7	9	15	17	18	148	2
Days with Snow	4	1	2	*	0	0	0	0	0	0	1	3	11	2
Days with Precipitation	20	15	18	12	9	9	6	7	9	15	17	20	155	2

BRITISH COLUMBIA/COLOMBIE–BRITANNIQUE

	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
DUNCAN FORESTRY 48° 47'N 123° 41'W 6 m														
Daily Maximum Temperature	5.5	8.6	10.3	13.5	17.3	20.5	23.7	23.1	20.0	14.7	9.1	6.5	14.4	3
Daily Minimum Temperature	−1.4	0.3	0.8	3.0	5.8	9.1	10.6	10.3	7.3	4.3	1.4	0.2	4.3	3
Daily Temperature	2.1	4.5	5.6	8.3	11.6	14.9	17.1	16.7	13.7	9.5	5.3	3.3	9.4	3
Standard Deviation, Daily Temperature	1.8	1.2	0.9	0.8	0.9	1.2	1.1	1.1	1.1	0.8	1.0	1.7	0.3	3
Extreme Maximum Temperature	15.0	19.4	21.1	25.6	30.6	31.7	37.2	35.6	31.1	25.0	18.9	17.0	37.2	
Years of Record	22	22	22	22	22	22	23	23	23	23	23	23		
Extreme Minimum Temperature	−21.1	−13.3	−7.8	−3.9	−2.2	1.7	3.3	2.2	−2.2	−6.7	−9.4	−21.7	−21.7	
Years of Record	22	22	22	22	22	22	23	23	23	23	23	23		
Rainfall	143.2	111.9	90.8	50.1	36.0	28.3	20.1	27.8	47.1	91.6	158.3	180.5	985.7	3
Snowfall	26.0	4.4	4.8	T	0.0	0.0	0.0	0.0	0.0	0.0	1.8	19.7	56.7	3
Total Precipitation	169.2	116.4	95.6	50.1	36.0	28.3	20.1	27.8	47.1	91.6	160.0	200.1	1042.3	3
Standard Deviation, Total Precipitation	79.2	55.5	39.7	28.2	15.4	22.0	14.3	22.9	31.2	62.7	66.9	75.5	160.1	3
Greatest Rainfall in 24 hours	73.9	45.0	37.3	45.0	22.9	26.6	23.9	49.8	37.6	54.6	54.0	72.0	73.9	
Years of Record	21	22	22	22	22	22	23	22	23	23	23	23		
Greatest Snowfall in 24 hours	32.3	20.8	21.8	1.0	0.0	0.0	0.0	0.0	0.0	0.0	8.6	33.0	33.0	
Years of Record	21	22	22	22	22	22	23	23	23	23	23	23		
Greatest Precipitation in 24 hours	73.9	45.0	37.3	45.0	22.9	26.6	23.9	49.8	37.6	54.6	54.0	72.0	73.9	
Years of Record	21	22	22	22	22	22	23	22	23	23	23	23		
Days with Rain	15	15	15	12	10	7	5	7	9	14	18	19	146	3
Days with Snow	5	1	1	*	0	0	0	0	0	0	1	3	11	3
Days with Precipitation	18	16	15	12	10	7	5	7	9	14	18	21	152	3

APPENDIX B

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

Chemainus River
Bonsall Creek

CHEMAINUS RIVER NEAR WESTHOLME (08HA001) m^3/sec													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC	Mean Annual
1914						5.74	2.17	0.705	3.07	37.6	62.2	12.3	
1915	25.9	20.2	23.8	26.4	7.17	4.18	1.63	0.68	0.425	22.5	25.4	51.3	17.5
1916	7.84	38.8	39.6	36.7	33.5	27.5	9.7	1.54	0.569	1.74	13.5	12.2	18.5
1917	19.1	17.1	9.18										
1952												28	
1953	73.9	31.7	16.1	18.5	16.9	6.6	2.34	0.785	3.41	14.9	46.9	50.2	23.5
1954	39.9	76.2	35.2				9.56	1.74	6.5	11.6	57.6	38.7	
1955	20.2	14.7	10.5	24.9	18.9	11	4.83	2.71	0.705	18.1	33.2	23.3	15.2
1956	24.3	5.57	20.4	30	31.2	21.2	4.13	0.636	1.79	20.7	14	39.7	17.9
1957	19.9	23.6	36.4	19.3	9.08	2.43	2.8	4.22	2.58	5.14	6.32	25.4	13.1
1958	42.8	36.6	17.5	23.8	7.4	2.8	0.664	0.344	1.89	12.3	26.5	70.2	20.2
1959	53.3	13.7	18.6	38.4	17.2	5.77	2.29	1.38	3.38	9.78	29.5	30.1	18.6
1960	24.6	37.4	17.5	31.1	16.4	6.43	1.38	0.76	0.869	10.1	26.8	31.2	17
1961	61.4	65.6	35.1	17.7	16.4	4.2	1.22	0.41	1.09	13.8	25.6	41	23.4
1962	36.4	14.7	10.7	26.9	15.7	6.9	1.69	2.18	1.3	19.2	63.1	63.2	21.8
1963	18.5	37.9	21.3	19.2	11.5	1.84	1.48	0.678	0.367	24.4	34.9	36.4	17.2
1964	41.1	24.3	19	19.4	15.8	11.9	4.03	1.61	2.19	7.39	13.8	18.5	14.9
1965	19.7	38.9	14.9	15.6	10.6	2.67	0.698	0.469	0.381	18.8	31.8	45.7	16.5
1966	41.7	25	34.5	28.2	15	6.18	2.71	0.682	0.792	9.81	33.5	72.5	22.6
1967	54.3	29.8	28.8	16	18.8	7.13	1.11	0.351	0.393	22.5	23.2	46.3	20.7
1968	99.2	50.3	33.8	13.6	10.3	4.93	1.41	1.29	4.55	27	31.9	26.6	25.4
1969	12.9	12	23.5	39.7	28.1	8.04	1.68	1.08	5.24	6.93	18.2	44.6	16.9
1970	25.9	26.6	23.4	23.3	8.8	2.8	0.759	0.222	0.816	8.66	18	42.1	15.1
1971	49.3	50.4	29	33.1	42.5	15.4	5.59	1.31	1.46	8.74	24.9	17.5	23.1
1972												74	
1973	44.1	17.7	12.8	7.89	8.68	5.47	1.92	0.531	0.631	6.92			
1974		32.8	67.1	32.7	25.9	16.2	7.75	1.27	0.692	0.867			
1975	22.5	13.6	24.7	21	29.3	9.64	2.17	3.52	2.32	36.8	74.4	65.1	25.5

CHEMAINUS RIVER NEAR WESTHOLME (08HA001) m^3/sec													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC	Mean Annual
1976	46.1	24	19.8	31.5	24.9	12.5	3.9	3.02	2.39	2.73	11.6	30.3	17.7
1977	12.3	25	23.1	18.2	7.09	3.21	0.945	0.303	1.83	8.73	77.1	25.2	16.8
1978	18.3	22.7	25.8	11.6	7.22	3.76	0.751	1.13	8.29	4.09	10.6	15.6	10.7
1979	5.43	30.3	42.3	16.6	12.8	2.56	0.986	0.407	4.75	16	10.4	125	22.4
1980	24.1	61.7	21.8	21.3	6.9	5.07	4.97	0.909	1.68	1.87	102	145	32.9
1981	23.7	45	12.1	24.8	8.39	8.96	2.31	0.829	1.71	44.4	60.5	52.3	23.6
1982	37.5	43.9	18.5	21.2	16.9	7.37	2.49	0.749	0.622	27	26.6	54.7	21.4
1983	50.2	75.6	34.3	15.4	6.39	1.99	6.28	1.01	3.18	2.9	86.8	35.4	26.2
1984	31.2	33.5	36.5	23.1	30.3	7.01	1.48	0.76	1.06	13.8	43.7	25.8	20.6
1985	9.43	11.4	11.9	29	14.7	4.31	0.479	0.25	0.361	14.7	13.9	13.4	10.3
1986	58.1	38.6	34.1	10.6	16.9	3.85	1.46	0.736	0.971	1.32	30.7	29.9	18.8
1987	40.8	29.9	33.7	12.3	7.78	4.71	1.08	0.422	0.224	0.327	10.6	34.4	14.7
1988	26.6	20.5	22.9	25.7	14.7	7.64	1.59	0.409	0.516	1.69	41	22.7	15.4
1989	29.1	17.7	24.7	28.3	9.34	2.2	1.33	0.601	0.334	4.87	17.5	23.1	13.2
1990	29.7	25.7	24.5	23.6	7.67	10.3	1.44	0.479	0.46	13.3	69.7	38.6	20.4
1991	29.7	60.3	11	21.2	5.61	2.22	1.23	7.41	4.03	0.961	32	32.5	17
1992	69.3	32.3	7.96	9.11	5.31	1.09	1.23	0.74	1.03	5.11	20.9	16	14.1
1993	18.6	14.2	31.6	25	13.9	6.62	1.9	0.845	0.317	1.07	4.1	39.8	13.2
1994	32	28	40.5	19.7	5.06	3.46	1.04	0.313	0.537	3.28	19.9	56.8	17.5
MEAN	34.2	31.7	25.0	22.7	15.2	6.9	2.6	1.2	1.9	12.4	33.9	41.4	18.8
% of MAD	182%	169%	133%	121%	80.7%	36.6%	13.6%	6.3%	9.9%	65.9%	181%	220%	

CHEMAINUS RIVER NEAR WESTHOLME (08HA001) 7-Day average Low Flow (m^3/sec)				
	Period: Apr 1 to Sep 30		Period: Jan 1 to Dec 31	
YEAR	Date of Occurrence	7-Day Average m^3/sec	Date of Occurrence	7-Day Average m^3/sec
1914	09/03/14	0.408	09/03/14	0.408
1915	09/04/15	0.332	09/04/15	0.332
1916	09/24/16	0.437	09/24/16	0.437
1953	09/22/53	0.398	09/22/53	0.398
1954	08/14/54	1.090	08/14/54	1.090
1955	09/09/55	0.311	09/09/55	0.311
1956	09/04/56	0.182	09/04/56	0.182
1957	07/05/57	0.972	07/07/57	0.972
1958	08/25/58	0.271	08/25/58	0.271
1959	09/01/59	1.130	09/01/59	1.130
1960	08/13/60	0.566	08/13/60	0.566
1961	08/26/61	0.249	08/26/61	0.249
1962	07/30/62	0.459	07/30/62	0.459
1963	09/10/63	0.287	09/10/63	0.287
1964	09/11/64	0.940	09/11/64	0.940
1965	09/27/65	0.322	09/28/65	0.315
1966	08/23/66	0.437	08/23/66	0.437
1967	08/31/67	0.242	08/31/67	0.242
1968	08/08/68	0.570	08/08/68	0.570
1969	08/21/69	1.030	08/21/69	1.030
1970	08/28/70	0.138	08/28/70	0.138
1971	08/15/71	1.060	08/15/71	1.060
1972				
1973	09/15/73	0.394	09/15/73	0.394
1974	09/27/74	0.492	09/27/74	0.492
1975	08/16/75	0.566	08/16/75	0.566
1976	09/27/76	1.380	10/20/76	1.300
1977	08/18/77	0.218	08/18/77	0.218
1978	08/08/78	0.596	08/08/78	0.596
1979	08/14/79	0.377	08/14/79	0.377
1980	08/25/80	0.661	08/25/80	0.661
1981	08/22/81	0.676	08/22/81	0.676
1982	09/06/82	0.496	09/06/82	0.496
1983	08/24/83	0.527	08/24/83	0.527
1984	08/20/84	0.712	08/20/84	0.712
1985	08/26/85	0.218	08/26/85	0.218
1986	08/06/86	0.633	08/06/86	0.633

CHEMAINUS RIVER NEAR WESTHOLME (08HA001) 7-Day average Low Flow (m^3/sec)				
	Period: Apr 1 to Sep 30		Period: Jan 1 to Dec 31	
YEAR	Date of Occurrence	7-Day Average m^3/sec	Date of Occurrence	7-Day Average m^3/sec
1987	09/09/87	0.196	09/09/87	0.196
1988	09/06/88	0.191	09/06/88	0.191
1989	09/26/89	0.283	10/01/89	0.282
1990	09/27/90	0.337	09/29/90	0.330
1991	08/23/91	0.749	08/23/91	0.749
1992	08/21/92	0.619	08/21/92	0.619
1993	09/27/93	0.274	10/02/93	0.264
1994	08/28/94	0.214	08/28/94	0.214
	MEAN	0.515	MEAN	0.512

BONSALL CREEK ABOVE WHITEHOUSE CREEK (08HA022) (m^3/sec)													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC	Mean Annual
1968						0.037	0.012	0.008	0.014				
MEAN						0.037	0.012	0.008	0.014				

BONSALL CREEK ABOVE WHITEHOUSE (08HA022) 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
1968	08/10/68	0.005	08/10/68	0.005
	MEAN	0.005	MEAN	0.005

APPENDIX C

Miscellaneous Flow Measurements

Miscellaneous Flow Measurements- Estimates & Measurements					
Stream	**Location**	**Date**	**Method***	**Flow**	**Litres/ sec**
Askew Creek	Oak St. culvert	09/26/85	BS	0.11 cfs	3.1
Francis Spring	Trib. to Francis Brook	08/17/34	VN	0.01 cfs	0.28
Venner Brook	0.4 km d/s of Chemainus Rd. culvert	11/12/87	-	0.00 cfs	0
Venner Brook	“	07/06/89	BS	0.13 cfs	3.68
Venner Brook	“	08/04/89	BS	0.05 cfs	1.42
Venner Brook	“	08/15/89	BS	0.05 cfs	1.42

* VN=V-Notch Weir
  BS= Bucket & Stopwatch

APPENDIX D

Licensed Water Demand by Purpose

(January 1996)

LICENCE NUMBER	FILE NUMBER	SOURCE	QUANTITY/ UNITS	LITRES/ SECOND	DEMAND (dam^3/year)
Domestic Purpose[o]					
C046477	0329640	Ariosto Spring	500 gpd	0.03	
C059040	0317295	Askew Creek	2,000 gpd	0.11	
F003453	0265155	Askew Creek	500 gpd	0.03	
F003454	0265156	Askew Creek	500 gpd	0.03	
F004005	0265009	Baker Creek	1,000 gpd	0.05	
F008364	0090085	Barkley Springs	1,000 gpd	0.05	
F044520	0242500	Barnes Spring	1,000 gpd	0.05	
C047886	0340570	Beaumont Spring	500 gpd	0.03	
F047766	0140398	Beaumont Spring	500 gpd	0.03	
F011122	0116288	Berridge Creek	1,000 gpd	0.05	
C037979	0305498	Bonsall Creek	500 gpd	0.03	
C042921	0317983	Bonsall Creek	500 gpd	0.03	
C043133	0322041	Bonsall Creek	1,000 gpd	0.05	
C044824	0328100	Bonsall Creek	500 gpd	0.03	
F012410	0143222	Brown Spring	500 gpd	0.03	
C049244	0340627	Buchman Creek	500 gpd	0.03	
F003967	0265011	Calcutta Creek	1,000 gpd	0.05	
C040616	0310704	Chemainus River	500 gpd	0.03	
C040931	0316086	Chemainus River	500 gpd	0.03	
C041931	0317069	Chemainus River	1,000 gpd	0.05	
C043138	0322602	Chemainus River	500 gpd	0.03	
C107767	0310703	Chemainus River	1,000 gpd	0.05	
F020110	0227903	Cox Spring	500 gpd	0.03	
F020815	0285005	Cox Spring	500 gpd	0.03	
F014806	0147825	Coyne Spring	500 gpd	0.03	
C040850	0310856	Diane Brook	1,000 gpd	0.05	
C100956	1001263	Dobie Brook	1,500 gpd	0.08	
C053046	0364823	Eggleston Spring	1,000 gpd	0.05	
C064080	1000626	Elverson Brook	500 gpd	0.03	
F015783	0194914	Elverson Brook	500 gpd	0.03	
C046946	0330182	Frances Brook	500 gpd	0.03	
C030233	0261494	Frances Spring	500 gpd	0.03	
F017609	0213161	Fuller Lake	500 gpd	0.03	
C063920	1000491	Gionet Spring	500 gpd	0.03	
C104590	1001561	Gionet Spring	500 gpd	0.03	
C055040	0366172	Gissing Creek	500 gpd	0.03	
C055041	0366174	Gissing Creek	500 gpd	0.03	
C101981	1001404	Goodall Creek	500 gpd	0.03	
F014959	0346158	Gore-Langton Spring	100 gpd	0.005	
F014960	0155010	Gore-Langton Spring	100 gpd	0.005	

LICENCE NUMBER	FILE NUMBER	SOURCE	QUANTITY/ UNITS	LITRES/ SECOND	DEMAND (dam^3/year)
F014961	1001217	Gore-Langton Spring	100 gpd	0.005	
F014962	1001218	Gore-Langton Spring	100 gpd	0.005	
F014963	1001219	Gore-Langton Spring	500 gpd	0.03	
F014462	0172036	Gowan Spring	500 gpd	0.03	
F017753	0217716	Groves Creek	500 gpd	0.03	
C107434	0340591	Hamilton Spring	500 gpd	0.03	
F047764	0202042	Hamilton Spring	500 gpd	0.03	
C043578	0323214	Haslam Spring	500 gpd	0.03	
F014953	0151470	Highmoor Spring	500 gpd	0.03	
C057296	0366709	Holman Spring	1,000 gpd	0.05	
C032905	0273730	Horace Brook	2,000 gpd	0.11	
C107780	1001296	House Creek	500 gpd	0.03	
F012409	0143106	Jeffery Spring	500 gpd	0.03	
C061348	0265007	Keating Creek	1,000 gpd	0.05	
F007380	0057146	Keating Creek	500 gpd	0.03	
F011254	0142069	Keating Creek	400 gpd	0.02	
F015835	0191294	Keating Creek	500 gpd	0.03	
F110082	0265010	Keating Creek	500 gpd	0.03	
C057294	0367106	Khenipsen Spring	600 gpd	0.032	
C105786	0328966	Kow-Tas Springs	500 gpd	0.03	
C058579	0368542	Larry Spring	1,000 gpd	0.05	
F017424	0215604	Lodge Spring No. 2	500 gpd	0.03	
F011187	0115843	Matthew Creek	500 gpd	0.03	
C063967	1000517	Moffat Spring	500 gpd	0.03	
F044523	0300911	Omdal Spring	500 gpd	0.03	
F041039	0316081	Pressey Spring	500 gpd	0.03	
F044340	0300257	Punnett Spring	500 gpd	0.03	
F047032	0300036	Purgavie Spring	500 gpd	0.03	
C022503	0206655	Richardson Brook	500 gpd	0.03	
C033259	0277386	Rodd Spring	500 gpd	0.03	
F012408	0143063	Savage Spring	500 gpd	0.03	
C020083	0188379	Stroulger Spring	500 gpd	0.03	
F012769	0155086	Stroulger Spring	100 gpd	0.005	
F018261	0227179	Taylor Spring	500 gpd	0.03	
F018425	0227575	Taylor Spring	500 gpd	0.03	
C100950	1001181	Thomas Brook	100 gpd	0.005	
C048548	0341588	Venner Brook	500 gpd	0.03	
C026751	0234978	Watkins Spring	1,000 gpd	0.05	

LICENCE NUMBER	FILE NUMBER	SOURCE	QUANTITY/ UNITS	LITRES/ SECOND	DEMAND (dam^3/year)
C027603	0244960	Way Brook	500 gpd	0.03	
C045745	0323723	Way Swamp	100 gpd	0.005	
C045302	0328451	Whitehouse Creek	500 gpd	0.03	
F010788	0128598	Whitehouse Creek	2,000 gpd	0.11	
F016307	0197300	Whitehouse Creek	1,000 gpd	0.05	
		Sub-total	**51,700 gpd**	**2.90**	**42.93**
Industrial Purpose (Enterprise) [oo]					
C047543	0254760	Mt Prevost Spring	1,000 gpd	0.05	
C057297	0355912	Keating Creek	2,000 gpd	0.11	
		Sub-total	**3,000 gpd**	**0.16**	**2.07**
Industrial Purpose (Fire Protection) [oo]					
C036917	0300245	Chemainus River	8,000 gpd	0.42	
		Sub-total	**8,000 gpd**	**0.42**	**13.28**
Industrial Purpose (Ponds) [oo]					
C100957	1001279	Emerald Springs	8.25 acft	1.31	
		Sub-total	**8.25 acft**	**1.31**	**10.18**
Industrial Purpose (Processing)					
C065772	0242620	Fuller Lake	425,000 gpd	22.4	
		Sub-total	**425,000 gpd**	**22.4**	**705.20**
Industrial Purpose (Stockwatering) [oo]					
C100956	1001263	Dobie Brook	9,000 gpd	0.47	
		Sub-total	**9,000 gpd**	**0.47**	**7.47**
Industrial Purpose (Watering) [oo]					
C065774	1000267	Fuller Lake	25 acft	3.97	
		Sub-total	**25 acft**	**3.97**	**30.85**
Irrigation Purpose[oo]					
C056793	0365615	Andee Spring No. 1	0.3 acft	0.05	
C058796	0366821	Askew Creek	20 acft	3.17	
C061472	1000360	Askew Creek	4 acft	0.64	
C070371	1000850	Askew Creek	30 acft	4.76	
C025964	0230815	Bonsall Creek	40 acft	6.35	
F020109	0226258	Bonsall Creek	18.2 acft	2.89	
F020428	0202909	Bonsall Creek	27.2 acft	4.32	
F044521	0270916	Bonsall Creek	7 acft	1.11	
C059716	1000009	Chemainus Lake	36 acft	5.71	
C027028	0238779	Chemainus River	30 acft	4.76	
C039882	0309668	Chemainus River	80 acft	12.7	
C043579	0323101	Chemainus River	60 acft	9.52	

LICENCE NUMBER	FILE NUMBER	SOURCE	QUANTITY/ UNITS	LITRES/ SECOND	DEMAND (dam^3/year)
C051451	0340713	Chemainus River	15 acft	2.38	
F052084	0211960	Chemainus River	36.5 acft	5.8	
C050694	0341101	Clement Creek	0.75 acft	0.12	
C100956	1001263	Dobie Brook	10 acft	1.59	
C102957	0322690	Dunne Brook	1 acft	0.16	
C056003	0190136	Fuller Lake	0.33 acft	0.05	
C034948	0285679	Goodall Creek	0.25 acft	0.04	
C056794	0355237	Holcomb Creek	3 acft	0.48	
C032905	0273730	Horace Brook	20 acft	3.17	
C061348	0265007	Keating Creek	1 acft	0.16	
C045111	0328249	Keith Creek	0.75 acft	0.12	
C106436	1001649	Kenyon Spring	0.1 acft	0.62	
C028562	0251108	Matthew Creek	2 acft	0.32	
F020108	0250758	Matthew Creek	0.3 acft	0.05	
C063970	1000549	Moffat Creek	3 acft	0.48	
C063976	1000550	Moffat Creek	7 acft	1.11	
C041664	0316676	Quist Brook	10 acft	1.59	
C100950	1001181	Thomas Brook	0.25 acft	0.04	
C048548	0341588	Venner Brook	9.3 acft	1.48	
C048549	0341589	Venner Brook	0.3 acft	0.05	
C052156	0190668	Venner Brook	5.9 acft	0.94	
C053208	0323954	Venner Brook	4.43 acft	0.7	
C053210	0346606	Venner Brook	3.83 acft	0.61	
C053212	0346607	Venner Brook	3.27 acft	0.52	
C070376	1000959	Venner Brook	0.25 acft	0.04	
C102987	0341590	Venner Brook	28.4 acft	4.51	
F017483	0229902	Venner Brook	7.5 acft	1.19	
C045745	0323723	Way Swamp	10 acft	1.59	
		Sub-total	**537.11 acft**	**85.24**	**662.79**
Storage Purpose[oo]					
C058797	0366821	Askew Creek	20 acft	3.17	
C061473	1000360	Askew Creek	4 acft	0.64	
C070371	1000850	Askew Creek	30 acft	4.76	
C023493	0213906	Banon Creek	44 acft	7.0	
C067480	0341103	Banon Creek	850 acft	134.89	
F011416	0265355	Banon Creek	300 acft	47.6	
C043580	0323101	Chemainus River	4 acft	0.64	
C050695	0341101	Clement Creek	0.75 acft	0.12	

LICENCE NUMBER	FILE NUMBER	SOURCE	QUANTITY/ UNITS	LITRES/ SECOND	DEMAND (dam^3/year)
C065773	0242620	Fuller Lake	75 acft	11.9	
C065774	1000267	Fuller Lake	25 acft	4.0	
C056795	0355237	Holcomb Creek	3 acft	0.48	
C022721	0194486	Holyoak Lake[ooo]	1,000 acft	95.19	
C032906	0273730	Horace Brook	20 acft	3.17	
C045112	0328249	Keith Creek	0.75 acft	0.12	
C106436	1001649	Kenyon Spring	0.1 acft	0.02	
C063971	1000549	Moffat Creek	3 acft	0.48	
C063977	1000550	Moffat Creek	7 acft	1.11	
C041665	0316676	Quist Brook	2.5 acft	0.4	
C053209	0323954	Venner Brook	4.43 acft	0.7	
C053211	0346606	Venner Brook	3.83 acft	0.61	
C053213	0346607	Venner Brook	3.27 acft	1.52	
C045746	0323723	Way Swamp	10 acft	1.59	
		Sub-total	**2,410.63 acft**	**-320.11**	**2,974.72**
Land Improvement Purpose					
C106436	1001649	Kenyon Spring	4.9 acft	0.78	
		Sub-total	**4.9 acft**	**0.78**	**6.05**
Conservation Purpose					
C070383	1001106	Matthew Creek	0 total flow	0	
		Sub-total	**0 total flow**	**0**	**0**
Waterworks Purpose[o]					
C022463	0265355	Banon Creek	1,500,000 gpd	78.92	
C067480	0341103	Banon Creek	800,000 gpd	42.09	
C044023	0243969	Genoa Spring	10,000 gpd	0.53	
C022720	0194486	Holyoak Lake	2,000,000 gpd	105.22	
		Sub-total	**3,310,000 gpd**	**226.76**	**2,746.12**
			Total Demand	**24.30**	**7,201.66**

[O] Based on the assumption that the demand is the authorized maximum daily licensed divided by 2 to estimate the average daily demand and multiplied by 365 days to determine the annual demand.

[OO] The rate (litres/second) is based on an estimated 90 day period demand assuming that storage, industrial and irrigation demands are totally withdrawn over the 90 day period.

[ooo] The rate (litres/second) for Holyoak Lake is based on an estimated 150 day period demand assuming that this storage is totally withdrawn over the 150 day period.

APPENDIX E

Low Flow Licensed Water Demand by Drainage Area
(April 1996)

DRAINAGE/ PURPOSE	LICENSED QUANTITY	LOW FLOW WATER DEMAND (litres/second)[o]	LOW FLOW WATER DEMAND (dam^3)
Chemainus River			
Domestic	3,500 gpd (max. day)	0.18	1.43
Industrial	8,000 gpd (max. day)	0.42	3.27
Irrigation	285.23 acft	45.27	352.0
Storage	1,000 acft[oo]	-95.19	-1,234.0
	359.53 acft	-57.04	-443.66
Waterworks	4,300,000 gpd (max. day)	226.25	1,759.3
	Total Consumption	**119.89**	**438.34**
Bonsall Creek			
Domestic	24,500 gpd (max. day)	1.29	10.02
Industrial	10,000 gpd (max. day)	0.52	7.88
	8.25 acft	1.31	10.18
Irrigation	147.25 acft	23.37	181.71
Storage	37.1 acft	-5.89	-45.78
Land Improvement	4.9 acft	**Non-consumptive**	
	Total Consumption	**20.6**	**164.01**
Matthew Creek			
Domestic	1,000 gpd (max. day)	0.05	0.41
Industrial	425,000 gpd (max. day)	22.36	173.88
	25 acft	3.97	30.85
Irrigation	2.63 acft	0.42	3.25
Storage	400 acft	-63.48	-493.6
	Total Consumption	**-36.68**	**-285.21**
Askew Creek			
Domestic	3,000 gpd (max. day)	0.16	1.23
Irrigation	90 acft	14.28	111.06
Storage	54 acft	-8.57	-66.64
Conservation	0	0	0
	Total Consumption	**5.87**	**45.65**
Other Areas			
Domestic	16,100 gpd (max. day)	0.84	6.59
Industrial	2,000 gpd (max. day)	0.11	0.82
Irrigation	12 acft	1.9	14.81
Storage	10 acft	-1.59	-12.34
Waterworks	10,000 gpd (max. day)	0.53	4.09
	Total Consumption	**1.79**	**13.97**

O Based on an estimated 90 day period demand assuming that: irrigation and industrial demands are totally withdrawn over the 90 day period; domestic and municipal waterworks demand are the authorized licensed maximum daily for 90 days; storage balances demand, and therefore, is a negative demand over the 90 days; land improvement is non-consumptive and, therefore, has no demand.
oo The storage demand on Holyoak Lake is based upon an estimated 150 day period.

APPENDIX F

Pending Water Licence Applications
(January 1996)

LICENCE NUMBER	FILE NUMBER	SOURCE	QUANTITY/ UNITS	LITRES/ SECOND	DEMAND (dam^3/year)
Domestic Purpose[o]					
Z108028	1001773	Gore-Langton Spring	500 gpd	0.03	
Z100942	1000706	Solly Creek	5,000 gpd	0.26	
Z109547	1001842	ZZ Spring (70788)	500 gpd	0.03	
		Sub-total	**6,000 gpd**	**0.32**	**4.98**
Industrial Purpose (Fire Protection) [oo]					
Z100942	1000706	Solly Creek	0 total flow		
		Sub-total	**0**	**0**	**0**
Industrial Purpose (Processing)					
Z100942	1000706	Solly Creek	480,000 gpd	25.25	
		Sub-total	**480,000 gpd**	**25.25**	**796.46**
			Total Demand	**25.57**	**801.44**

[O] Based on the assumption that the demand is the authorized maximum daily licensed divided by 2 to estimate the average daily demand and multiplied by 365 days to determine the annual demand.

[OO] The rate (litres/second) is based on an estimated 90 day period demand assuming that storage, industrial and irrigation demands are totally withdrawn over the 90 day period.

APPENDIX G

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.

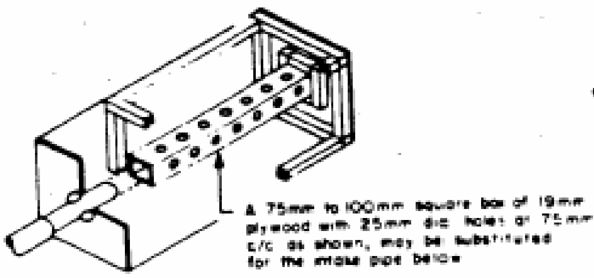
3. B.C. Ministry of Environment
   Water Management.

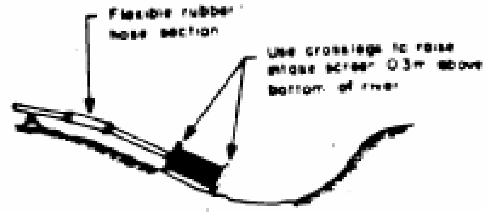
4. B.C. Ministry of Agriculture and Food.

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

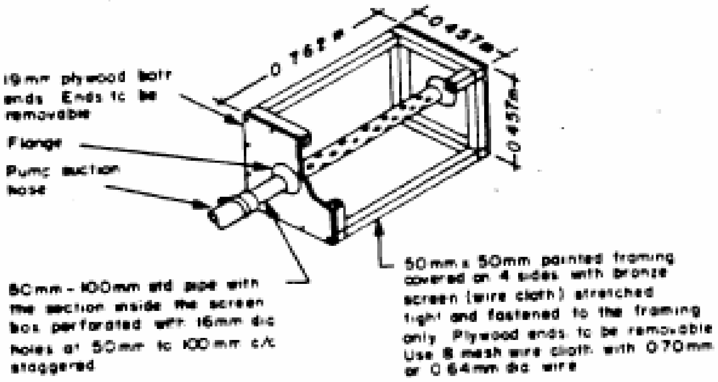
It may be necessary that several or all these agencies also be solicited for approvals prior to the installation of a water intake.

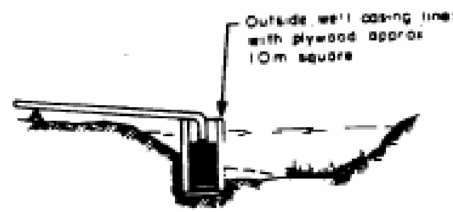
Revised January, 1986



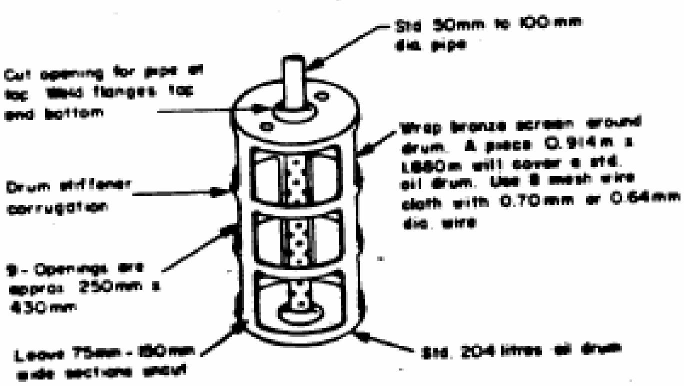


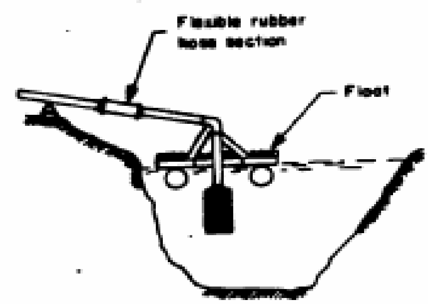
STANDARD INSTALLATION





INSTALLATION IN SHALLOW WATER MUDDY OVERGROWN BOTTOM





INSTALLATION IN DEEP WATER

NOTE

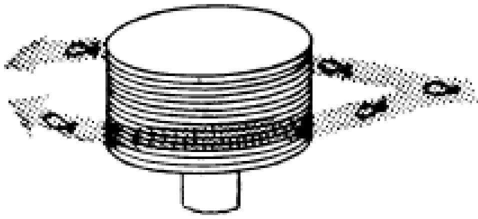
1. Oil drum shall be thoroughly washed out or steam cleaned before cutting openings.
2. All loose rust shall be removed and the drum coated with metal primer. Two coats of machinery enamel or expoxy paint shall be applied before covering with wire cloth

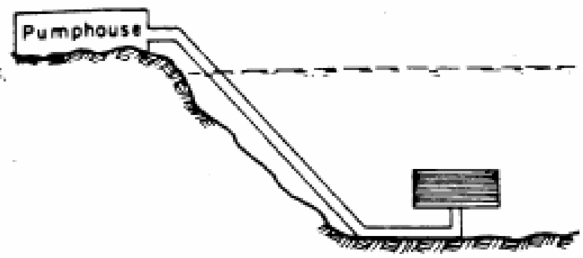
NOTE

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

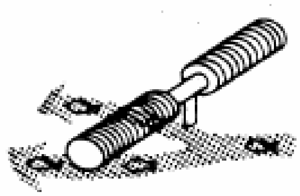
(For pumps of a capacity less than 28.3 L/sec [1cfs, 449 U.S. or 374 Igpm])

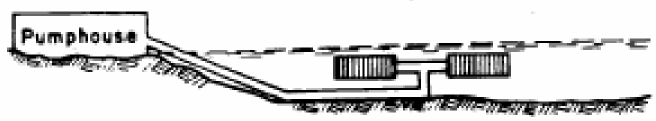




DEEP WATER WELL SCREEN

May be installed in lakes and the ocean.





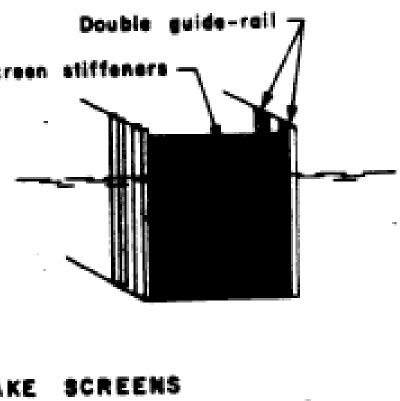
SHALLOW WATER WELL SCREEN

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).

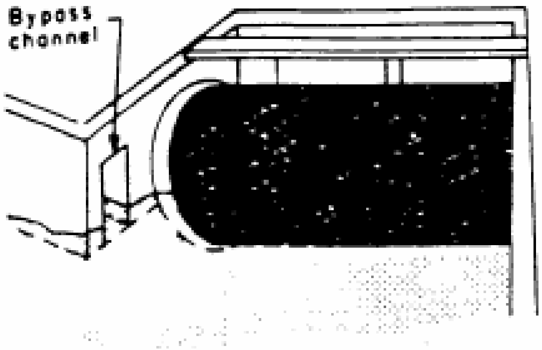
VERTICAL PANEL SCREENS

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.



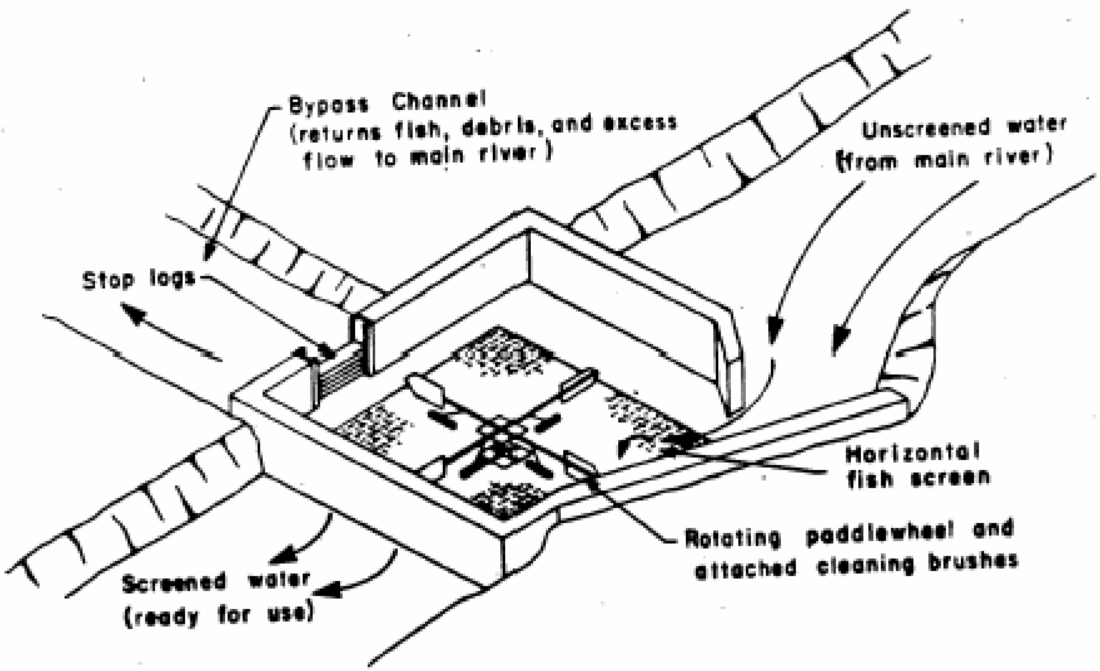
LARGE STATIONARY WATER INTAKE SCREENS

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



REVOLVING DRUM SCREEN, HORIZONTAL AXIS

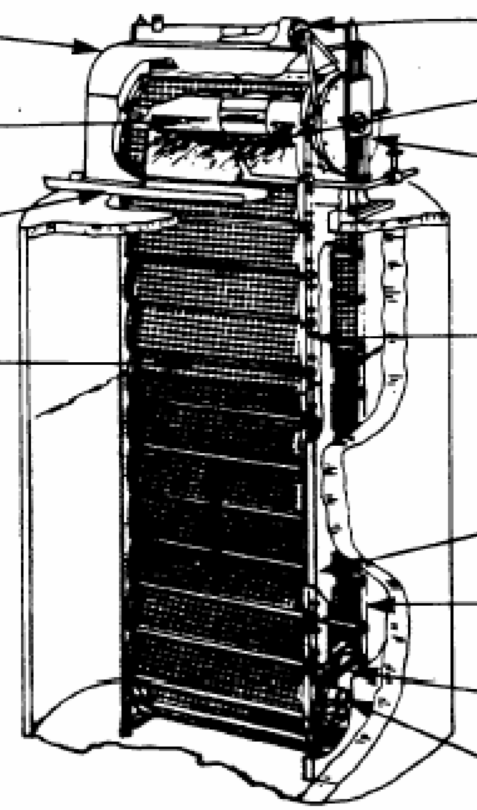
Generally, installed to divert fish from irrigation canals. Can be driven by a small motor or by a paddle wheel. To avoid juvenile fish impingement, a bypass channel is required near the front of the screen. Rubber seals are necessary along the base and sides.



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