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METHODS USED TO DETERMINE WATER USE IN THE OKANAGAN RIVER BASIN IN 1980

PREPARED BY:

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MARCH 1985

Inland Waters Directorate
Pacific and Yukon Region
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ENVIRONMENT CANADA
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ABSTRACT

Water use estimates for the Okanagan River Basin were updated in 1980 during the Okanagan Basin Implementation Program. Water use was estimated for two general categories: (1) Agricultural water use and (2) Domestic, Commercial and Industrial use. This paper outlines the methods used in making the estimates and summarizes the results of the update.

Agricultural use was updated based on air photographs of the Basin and a survey of irrigation districts. Domestic, commercial and industrial use was updated using data from surveys of organized water districts and a separate population study. Methods for disaggregating the data into smaller drainage areas and monthly figures are discussed. Sources of error and methods for improving the estimates are presented.

RESUME

Les estimés de l'utilisation d'eau pour le bassin de la rivière Okanagan ont été revisés en 1980 durant la mise en oeuvre du programme, du bassin de la rivière Okanagan. L'utilisation d'eau fut estimé pour deux catégories générales: (1) la consommation d'eau par l'agriculture; et (2) l'utilisation d'eau à des fins domestique, commerciales et industrielles. Ce rapport souligne les méthodes utilisées pour produire les estimations et aussi résume les résultats de la révision.

L'utilisation d'eau par l'agriculture a été revisé en vérifiant des photos cériennes du bassin et d'un levé des districts d'irrigation. L'utilisation d'eau à des fins domestiques, commerciales et industrielles, a été revisé avec l'aide, de donné obtenu de léve des usagers organisés d'eau de surface et d'une étude de la population. Des méthodes pour désagréger les donnés entre des unitées de drainage plus petites et entre des valeurs mensuels sont presentées, toutes comme les sources d'erreurs et les méthodes pour eméliorer les estimations.

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I. INTRODUCTION

Estimates of water use in the Okanagan River Basin in 1980 were made during the Okanagan Basin Implementation Program (O.B.I.P.) and were summarized in the Final Report (1982). This paper describes the data sources and methods used in arriving at these estimates. Methods for disaggregating and improving the accuracy of these estimates so that they can be used in forecasting and optimization models are also discussed.

II. WATER USE CLASSIFICATIONS

The water use estimates made during the O.B.I.P. are classified into two general categories of water use:

1) agricultural water use;
2) domestic, commercial and industrial use.

These estimates are given for the Basin as a whole and for two sub-basin areas which are Okanagan Lake and Okanagan River. Table 1, reproduced from the Final Report of the O.B.I.P., shows the estimates of water use for the two categories.

The estimates given in Table 1 are in too aggregate a form to be useful in forecasting and optimization models. The aggregation does not allow us to examine several specific reaches or sub-basins in the Okanagan system where water use conflicts exist. However, the raw data used in arriving at the estimates in Table 1 is available in a very disaggregated form, and can be collated into more relevant geographical units and water use classifications. Problems encountered in undertaking this disaggregation are discussed in subsequent sections of this report.

TABLE 1
ESTIMATED WATER REQUIREMENTS IN THE OKANAGAN RIVER BASIN IN CANADA 1970, 1980 AND 1990

PURPOSE OR USE OF WATER	1970 BASED ON 1976 OPERATING CONDITIONS		1980 BASED ON IMPLEMENTED PLAN FOR WATER MANAGEMENT		1990 Projection BASED ON IMPLEMENTED PLAN FOR WATER MANAGEMENT	
	Millions of Cubic Metres					
	Diversion	Consumptive Use	Diversion	Consumptive Use	Diversion	Consumptive Use
1. Okanagan Lake						
Water Use from tributaries to Okanagan Lake and from Okanagan Lake for:						
(i) irrigation	140	70	132	66	132	66
(ii) municipal, domestic and industrial	60	15	36	9	51	13
Total Water Diverted and Estimated Consumption in Okanagan Lake Area	200	85	168	75	183	79
2. Okanagan River						
Water Use from Okanagan River and Valley Lakes south of Penticton						
(i) irrigation	78	39	68	17	70	18
(ii) municipal, domestic and industrial	4	1	16	4	21	5
Sub-Total	82	40	84	21	91	23
(iii) evaporation losses from Skaha, Vaseux and Osoyoos Lakes and from Okanagan River	60		60		60	
(iv) minimum in-channel needs for intake submergence and fishing	152		95		95	
(v) in-channel fishery requirements - additional to minimum flows shown in (iv)	48		68		68	
Total Water Requirements Okanagan River Area	342 to 300		307 to 244		314 to 246	
TOTAL BASIN REQUIREMENTS	542 to 385		475 to 319		497 to 325	

Note 1: Figures shown for estimated consumptive use assume the following return flows from diverted quantities: irrigation - 50%; municipal and domestic - 65%; industrial - 90%.

Source: Report on the Okanagan Basin Implementation Agreement, P. 80, Canada-British Columbia, 1982.

III. DOMESTIC, COMMERCIAL AND INDUSTRIAL USE

Domestic, commercial and industrial water uses are aggregated into a single category, since they account for only a minor portion of the total water use in the Basin. Aggregation of these uses into a single category also made the process of estimating water use much simpler. There were three basic steps in this process.

1) All municipal water systems in the Basin were surveyed for data on quantity of water used.

2) All irrigation districts were surveyed for domestic use. (The survey also obtained data on area irrigated.)

3) Estimates were made of domestic water use in areas of the Basin not served by either municipal water systems or irrigation districts.

An example of the municipal survey questionnaire is shown in Appendix 1. In most cases the municipalities were able to separate out irrigation water use from domestic, commercial and industrial water use. When this was not possible, the municipalities provided an estimate of the irrigated area supplied by their system. Using an estimate of per hectare water use (water duty), total agricultural water use for the system could then be calculated and separated from the domestic commercial and industrial water use.

A telephone survey of irrigation districts was conducted during 1980. The irrigation districts were not able to supply the actual amount of water supplied to domestic use, but data were available on the number of domestic connections serviced by each system. The number of connections was multiplied by the average household size[*1] to obtain population

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[*1] Average household size was taken from a study by Schultz International (1981)

serviced by each irrigation district. Domestic consumption was then estimated by multiplying population by a per capita consumption figure of 455 liters (100 gallons) per day. This figure, which was based on unspecified previous studies, was intended to account for all in-house uses and did not include lawn and garden watering. It was assumed that lawn and garden watering in rural areas would already be accounted for in the estimates of agricultural water use.

The study also included water consumption by the population residing outside of municipalities and organized irrigation districts. This population figure was determined by deducting the sum of municipal and irrigation district populations from the total basin population, as shown below:

Total Basin Population*2	185,073
Subtract:	
Municipal plus Irrigation District Population	131,130
Difference equal to:	
Population outside Municipalities and Irrigation Districts	53,943

Water use by the population outside of municipalities and irrigation districts was calculated on the basis of a per capita use of 455 liters per day. It was again assumed that this portion of the population was rural and that lawn and garden watering would be accounted for in the agricultural totals. It was also assumed that there were no commercial or industrial water users in these unorganized areas, with the exception of Hiram-Walker Distilleries.

Total domestic, commercial and industrial use was then tabulated for municipalities, irrigation districts and unorganized areas as shown in Table 2.

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*2 Total Basin population was taken from Schultz International (1981)

TABLE 2

OKANAGAN RIVER BASIN:

DOMESTIC, COMMERCIAL AND INDUSTRIAL WATER USE

Type of System	Water Use (Millions of Cubic Meters)
Irrigation Districts	8.201
Municipalities	30.641
Unorganized	8.952
Total:	47.794

A. Accuracy of the Estimates

Given the objectives of the update, the estimates of domestic, commercial and industrial water use are reasonably accurate. However, there are some possible sources of error which could be rectified, before utilizing the data for forecasting and optimization models. These sources of error are not expected to affect significantly the aggregate estimates of water use in the Basin, but they might result in significant inaccuracies when the data is disaggregated into smaller geographical units.

A source of error in the estimates is the use of the 455 liters per day per capita consumption in the unorganized areas. This figure was based on the assumption that unorganized areas were primarily rural and that lawn and garden watering was accounted for in agricultural water use. However, there are several residential suburbs in these unorganized areas which would have much higher consumption than the 455 liters per day per capita. Based on estimated consumption in municipal areas, a figure of at least 900 liters per day would be appropriate for these suburbs. It is therefore recommended that the suburban (non-agricultural) population in unorganized areas be estimated and a higher water-use consumption figure be applied to this population. Water licence records and field work could be utilized in making this estimate.

A second source of error is the omission of industries and commercial establishments which have private intakes. The estimates did include water use by Hiram-Walker Distilleries, a private licence, but there are some other industrial establishments with private intakes which should also be included. Brenda Mines is an example of such an establishment. There are also several motels and resorts in the Osoyoos region which have private intakes. In the summer tourist season these may account for significant water consumption.

It is recommended that estimates be made of water use by industries and commercial establishments with private intakes and that these be added to the total water use estimates for domestic, commercial and industrial. Industrial estimates can be made by using the questionnaires from the Industrial Water Use Survey*3, carried out by Inland Waters Directorate in conjunction with the 1976 and 1981 census. Estimates of water use by motels and resorts with private intakes can be made by utilizing accommodation directories and water licence records.

Finally, it should be noted that the water use estimates for the domestic, commercial and industrial category were made on the basis of only a single year's observation (1980). The problem with this procedure is that estimated water use will be affected by the particular weather variables which occurred in 1980.

It would be more useful to show annual water use for different weather scenarios. For example, in the Okanagan Basin Study (1974), water use was calculated on the basis of dry, average and wet years. The same calculations should be made for the 1980 update, utilizing the same pattern of variation observed in the Okanagan Basin Study.

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*3 A description of the survey and the data is given by Tate (1983)

B. Disaggregation of the Estimates

There are three types of disaggregation required in order for the data to be useful in forecasting and optimization models. First, the data will have to be disaggregated into finer geographical units, preferably into areas supplied by a common water source. The suggested breakdown consistent with optimization and forecasting model development is;

1) Kelowna Creek
2) Mission Creek
3) Equesis Creek
4) Powers Creek
5) Peachland Creek
6) Trout Creek
7) Penticton Creek
8) All other tributaries running into Okanagan Lake
9) Okanagan Lake
10) Skaha Lake
11) Okanagan River
12) Osoyoos Lake

This breakdown allows an examination of conflicting demands and shortages of water from specific tributaries and reaches of the mainstem system. These problems are masked when only aggregate data for the whole Basin is considered. The geographical breakdown can be achieved by matching survey data from each municipality and irrigation district to its water source. There will be some problems in determining the water supply source for some unorganized areas. Estimates can be made by using the population data in the study by Schultz International (1981) which contained population data by sub-basin and economic region of the Okanagan Basin.

The second disaggregation required is temporal; where the annual water use estimates are broken down into monthly or seasonal

estimates. This breakdown is important because there are usually only two or three months during the year when water is in short supply. The use of annual water use data would often mask the shortage in these critical periods. The breakdown can be fairly easily achieved by using coefficients developed during the Okanagan Basin Study (1974) which show the variation in domestic, commercial and industrial water use throughout the year.

Finally, the domestic, commercial and industrial water use should be disaggregated into (1) domestic-commercial use and (2) industrial use. The disaggregation is consistent with water use data which is being used for the forecasting models in other regions. It will allow different growth rates to be used for industry and domestic-commercial when making forecasts of water use. The industrial water use can be calculated and separated out of the current estimates by use of data from the Industrial Water Use Survey. The individual questionnaires are available for most of the industrial water users in the Basin. Any industrial establishments for which the data is not available can be identified from various directories and handbooks[*4]. Water use for these establishments can then be estimated on the basis of coefficients derived from the other industrial establishments for which water use data has been collected.

[*4] See "Manufacturers' Directory, 1982-83", Province of B.C. (1983) and "British Columbia Lumber Trade Directory and Year Book", Progress Publishing (1983)

IV. AGRICULTURAL WATER USE

Agricultural water use was calculated by estimating the hectares of land irrigaged and then multiplying this figure by a per hectare water duty. No estimates were made of water use for livestock as it was considered to be relatively insignificant. Two sources of data were used to determine the irrigated area in the Basin.

1) Agricultural areas were identified from 1977 coloured aerial photographs and a field reconnaissance was carried out to determine which areas were irrigated.

2) Irrigated area was obtained from irrigation district tax rolls and a telephone survey of irrigation districts in 1980.

The two data sources resulted in almost the same aggregate figure for irrigated area in the Basin: 24,524 hectares using the air photo approach and 24,894 hectares using the irrigation district figures. However, there were several discrepancies between irrigated area totals when smaller geographical areas were considered. Possible sources of error and discrepancies in the two data sources are discussed in subsequent sections.

A. Estimating Irrigated Area by Air Photography

Cultivated area was based on 1977 coloured air photos supplemented by the most recent black-and-white photos for the outlying areas not covered by the colour photographs. The interpretation of the photos was done by mapping technicians with the B.C. Ministry of Environment. Cultivated areas were transferred to 1:50,000 base maps for the Basin as a whole, and 1:10,000 for Mission Creek. Each parcel of land was given a reference number and the area measured by the digitizer entered against it. Each parcel of land measured by a digitizer from the 1:50,000 overlays was then grouped by drainage sub-basin and the totals computed.

The classification of crop types used in the estimates of cultivated land are as follows:

1) Improved pasture and forage crops
2) Orchards and Vineyards
3) Crop land
4) Golf courses.

In general, crop types were identified through air photo interpretation. Two problems were encountered in identifying crop types. First, it was difficult to differentiate between forage crops and cropland and, secondly, there was variation between these two types of crops from one year to the next. These problems were more serious in the northern part of the Okanagan Basin. Field surveys were made of the questionable areas in order to identify crop type and extent of irrigation.

Table 3 shows the cultivated land and irrigated area in the Okanagan based on the air photos and field surveys. Parcels of land cut by sub-basin boundaries were divided on a percentage basis into the appropriate basin. The total irrigated land based on this compilation is 24,524 hectares.

B. Estimating Irrigated Area by Irrigation District Survey

Each irrigation district manager was contacted and asked for an estimate of the irrigated area served by his irrigation district. The total acreage for all irrigation districts from this survey was calculated as 16,854 hectares; considerably less than the total irrigated acreage of 24,524 hectares calculated from the air photos. The reason for this discrepancy was the large number of private systems, most of which are supplied by the main valley lakes and rivers. An estimate of irrigated area served by private systems was then made using the air photo maps. Private systems area was identified as acreage outside irrigation district boundaries. The

TABLE 3

CULTIVATED LAND DISTRIBUTION & IRRIGATED AREA BY LAKE SUB-BASIN

OKANAGAN RIVER DRAINAGE BASIN, 1977

BASIN	SUBDIVISION DESCRIPTION	CULTIVATED AREA (Hectares)	IRRIGATED AREA (Hectares)
Ellison-Wood Lake	Vernon Creek - Clark Creek	-	-
	Winfield Area - Wood Lake	658	599
	Wood Lake - West	875	869
	Total	1,533	1,468
Kalamalka Lake	Oyama Creek	-	-
	Coldstream Creek	2,323	1,637
	Oyama	23	14
	Kalamalka Lake - West	170	170
	Kalamalka Lake - East	59	59
	Kalamalka Lake - North	-	-
	Total	2,575	1,881
Okanagan North	Vernon	1,343	1,135
	B.X. Creek - Lower	418	313
	B.X. Creek - Upper	470	397
	Greennow Creek	60	-
	Deep Creek	9,248	833
	Irish Creek	267	149
	Newport Creek	11	-
	Equesis Creek	195	80
	Nashwito Creek	21	-
	Whiteman Creek	6	-
	Shorts Creek	81	14
	Okanagan Lake - Ellison Park	15	-
	Okanagan Landing	202	135
	Okanagan Lake - Vernon West	514	154
	Swan Lake - West	481	377
	Swan Lake - East	759	290
	Okanagan Lake - North Tip	82	-
	Okanagan Lake - North Arm West	161	48
	Okanagan Lake - North Arm West	205	83
	Okanagan Lake - North Arm West	169	19
	Okanagan Lake - North Arm West	64	15
	Okanagan Lake - Ewing	31	2
	Okanagan Lake - Nahun	7	-
	Total	14,810	4,012

TABLE 3 (CONTINUED)
CULTIVATED LAND DISTRIBUTION & IRRIGATED AREA BY LAKE SUB-BASIN
OKANAGAN RIVER DRAINAGE BASIN, 1977

BASIN	SUBDIVISION DESCRIPTION	CULTIVATED AREA (Hectares)	IRRIGATED AREA (Hectares)
Okanagan Central	Kelowna Creek	2,602	2,524
	McDougal Creek	116	115
	West Bank Creek	349	328
	Mission Creek	2,317	2,085
	Trepanier Creek	58	44
	Bellevue Creek	25	25
	Peachland Creek	26	26
	Powers Creek	147	130
	Okanagan Centre	1,406	1,377
	Okanagan Lake Westside	407	382
	Okanagan Lake Kelowna South	371	323
	Okanagan Lake Mt. Boucherie S.	41	41
	Okanagan Lake O.K. Mission N.	277	277
	Okanagan Lake - Gettatly	76	76
	Okanagan Lake - Drought Creek	72	72
	Okanagan Lake - Peachland	88	88
	Terrace Creek - Lambly Creek	6	4
	Lebanon Creek - Deeper Creek	210	210
	Total	8,643	8,125
Okanagan South	Trout Creek	775	754
	Naramata Creek	976	97
	Penticton Creek	33	26
	Eneas Creek	875	848
	Okanagan Lake - Niggertoe Mtn.	67	67
	Okanagan Lake - Penticton N.	782	780
	Penticton Municipality	-	-
	Okanagan Lake - Okanagan Mt.	131	131
	Total	2,760	2,704
Skaha Lake	Ellis Creek	-	-
	Shingle Creek/Shafford Creek	250	250
	McLean Creek	125	125
	Skaha Lake - Mt. Christie	187	187
	Skaha Lake - Kaleden	314	314
	Skaha Lake - Okanagan Falls	66	66
	Penticton West	89	89
	Penticton South	36	36
	Total	1,067	1,067

TABLE 3 (CONTINUED)
CULTIVATED LAND DISTRIBUTION & IRRIGATED AREA BY LAKE SUB-BASIN
OKANAGAN RIVER DRAINAGE BASIN, 1977

BASIN	SUBDIVISION DESCRIPTION	CULTIVATED AREA (Hectares)	IRRIGATED AREA (Hectares)
Vaseux Lake	Shuttleworth Creek	36	36
	Vaseux Lake East	174	174
	Vaseux Lake West	74	74
	Total	284	284
Okanagan River	Park Rill	445	445
	Vaseux	14	14
	Testalinden	75	75
	Wolfcub Creek	65	65
	Okanagan River East	70	70
	Okanagan River West	331	331
	Tugulnuit Lake	286	286
	Oliver West	1,230	1,230
	Oliver East	259	259
	Total	2,775	2,775
Osoyoos	Inkaneep Creek	158	158
	Haynes Creek	79	79
	Nine Mile Creek	1,057	56
	Deadman Lake	410	410
	Osoyoos Lake North-East	8	8
	Osoyoos Lake West	302	302
	Osoyoos Lake - Mt. Kruger	1,186	1,138
	Anarchist Lookout	36	36
	Total	3,237	2,187
	GRAND TOTAL	37,681	24,524

total private irrigated area was estimated to be 8,041 hectares which, when added to the 16,854 hectares in irrigation districts, gives a total of 24,895 irrigated hectares in the Basin. The latter figure is very close to the estimate of 24,524 hectares made on the basis of the air photos.

C. Estimating Water Duties

With the exception of the Mission Creek area, the water duties used in the update were the same as those used in the 1974 Okanagan Basin Study. The 1974 estimates were based on recommendations of the B.C. Ministry of Agriculture which were derived from consultations between irrigation and soil specialists. These recommendations are conservative in that they would be sufficient to meet requirements in a dry year. They also include a 10 percent allowance for conveyance losses. In the case of Mission Creek, a more detailed soil mapping study was carried out in 1977-78. This study identified areas with different soil types in the Mission Creek Basin, and assigned water duties based on these soil types. The overall water duty for the Mission Creek area determined from this exercise was found to be lower than the 1974 study estimates. It is still considered as a dry year estimate; actual use in average and wet years would be lower.

D. Accuracy of the Estimates

Overall, the estimates are reasonably accurate and should be acceptable for use in forecasting and optimization models. One problem is that the water requirements are given only for a dry year (referring to an exceptionally dry and hot summer). According to the Okanagan Basin Study (1974), water use could be 30 percent less in a year where moister and cooler conditions prevailed during the irrigation season. It is therefore recommended that a range of agricultural water requirements be given, representing water use in dry, average and west years.

It is recommended that the water use estimates calculated from the air photos be used in the forecasting and optimization models. These estimates are based on a more consistent methodology than the estimates obtained from the irrigation district survey. A basic problem with the irrigation district survey is the variation in the responses given by the system managers because of different manners in which the term "irrigated area" can be interpreted. For example, one manager may have interpreted irrigated area to be all land that is irrigated in a dry year, while another manager might have interpreted it to be land irrigated in the most recent year. Others might consider irrigated land to be all agricultural land classified as improved land for taxation purposes. This variation could result in significant errors when the data is disaggregated by tributary source or sub-basin.

A small source of error in the estimates is the omission of livestock water requirements from the calculations. Livestock requirements are likely to be less than 1 percent of the total water required for irrigation so the omission is not significant. However, it may be desirable to estimate livestock water use in the Okanagan in order to be consistent with methodology used in other basins.

E. Disaggregation of the Estimates

The same geographical and temporal breakdowns will be required for agriculture as is required for domestic, commercial and industrial water use. (See Section III.B.) No disaggregation by product type is thought necessary at this point.

Disaggregation of annual water use into monthly water use is fairly straightforward since irrigation water is only applied five months of the year. Coefficients were developed in the Okanagan River Basin Study (1974) which show the percentage of water use occurring in each of these months. These coefficients can be applied to the updated data to obtain a monthly distribution of water use.

Some problems occur when disaggregating irrigation water use by source of water supply. Certain tributaries serve as the source of water for areas outside of their drainage sub-basin. For example, Mission Creek supplies water for large tracts of land within the Kelowna Creek drainage basin. The basic problem is to identify such tracts of land and match them to the tributary water source. This is possible for organized areas such as irrigation districts and municipalities for which the water supply source is known. However, there are approximately 8,100 hectares in unorganized areas supplied by private systems. Fortunately, it is known that much of the area is in the southern regions of the Basin and is supplied by water from Okanagan River. The remainder of the unorganized area is scattered in small pockets in other areas of the Basin. The only area where these pockets appear to be significant is the Kelowna area. Field work may be required in this area in order to specify the source of water supply for the unorganized areas.

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