PART I

SURFACE WATER

CHAPTER 1

Introduction

1.1 PURPOSE

The purpose of this Technical Supplement is to assemble available water resource data in a summarized form for those involved in water resource studies and management. This information has been collected from a number of sources and where records are missing, data have been derived.

The ideal objective in water management in the Okanagan would be the supply of adequate water of good quality within the major tributaries and along the mainstem system to meet present and projected future water requirements. To approach this objective, intelligent planning and orderly development are necessary and these in turn require adequate Information about the water resources and how man's activities have affected it and are likely to affect it.

1.2 SCOPE

The Water Quantity Studies include summarization, analysis and extension of existing data on water resources of the basin. Data has been taken from public sources as well as computer analysis using, where possible, the standard 50 year study period (1921 to 1970). The discharges used throughout are either natural or modified by 1970 and projected 2020 conditions of development; that is the natural flows have been depleted and regulated for those anticipated levels of use. This Technical Supplement includes natural flows as well as regulated flows and resulting lake elevations based on present day water needs. In Technical Supplement 3- Alternatives and Water Quantity Data, a number of alternatives are discussed with respect to present and future (Year 2020) water use. In addition, all basic water quantity data have been collected in Technical Supplement No. 3 for easy reference.

Detailed data are presented in this Technical Supplement for eight selected tributaries, and in addition, for the mainstem of the river from Okanagan Lake to Oroville, Washington. The total quantity of water available at main use points under natural and regulated conditions in each of the selected tributaries is shown by months on graphs and in tables for dry, average and wet years.

Within the mainstem system a 50 year period of record at Penticton has been extended by correlations to provide equivalent records downstream. These mainstem records were analyzed and summarized as follows:

1. Median flow.
2. Maximum, minimum, mean, 80, 90 and 95 per cent frequencies of occurrence and maximum and minimum years.
3. Peak discharge frequency.
4. Low flow discharges for pre-selected periods of 1, 2 and 3 consecutive years.

The tributary reports also contain a general hydrologic description of the area, and discussions of water use, evaporation and stream management.

1.3 TYPES OF DATA

Through computer modelling in each of the selected tributaries natural flows have been developed at all major water use points and hydrometric stations for dry, average and wet years. These natural flow data have been used as input in a second group of models to provide regulated discharges under 1970 level of development.

For the mainstem model which terminates at hydrometric station 8NM-85, some four miles south of Oliver a more detailed analysis was possible because of some 50 years of inflow records available for Okanagan Lake. The mainstem model was based on the assumption that the Okanagan Flood Control Works constructed during 1950 to 1958 had been in operation over the standard study period.

In summary a natural flow data base is available to those Interested in future modelling and in addition a set of regulated flows have also been documented for use by those concerned with water management.

Because of the paucity of hydrometric and meteorological data in the tributaries the results obtained can only be considered as first approximations with a possible order of accuracy of ± 20% with respect to mean monthly flows. In contrast to this, the mainstem model supported by 50 years of records is estimated to have an accuracy of ±10%.

Hopefully, with the passage of time and assuming a continuation of the recommended monitoring contained in part 5 of this technical supplement the above described models can be improved particularly within the tributaries.

1.4 RELATIONSHIP TO OTHER PARTS OF REPORT

This report is one of seven Basic Data Technical Supplements as listed below:

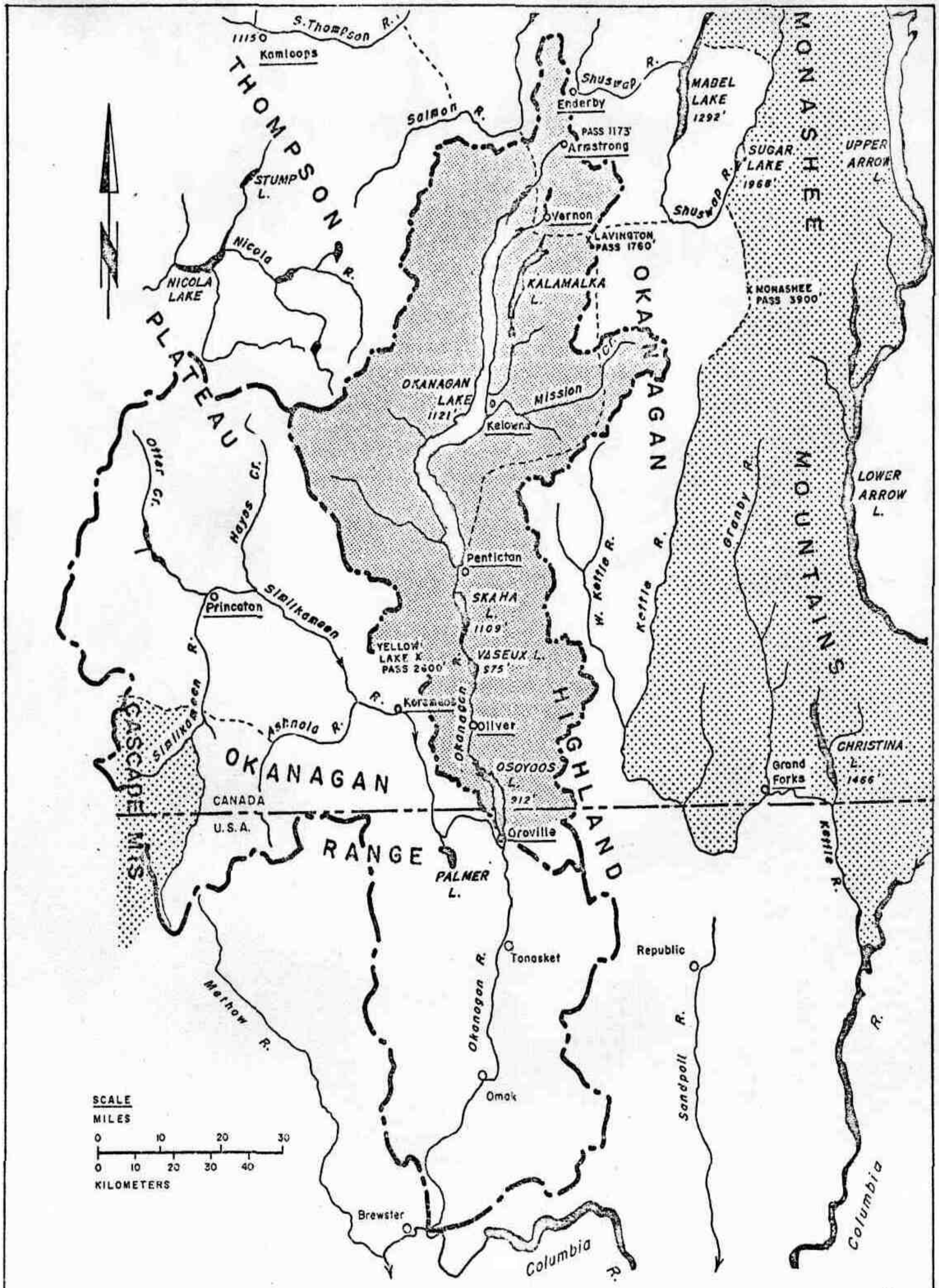
I Water Quantity in the Okanagan Basin
II Water Quantity Computer Models
III Water Quantity Alternatives and Supporting Water Quantity Data.
IV Water Quality and Waste Loadings in the Okanagan Basin.
V The Limnology of the Major Okanagan Basin Lakes.
VIII Water Based Recreation in the Okanagan Valley.
IX Fisheries and Wildlife in the Okanagan Basin.

It will be noted that all Water Quantity Data is contained in Technical Supplement 3 which also contains sufficient descriptive material to allow the water researcher or manager to use this information without reference to other volumes of the report. Technical Supplement 3 also contains the various water management alternatives investigated under this study. However, for those Interested in the overall hydrological and meteorlogical background as well as the computer modelling, reference should be made to Technical Supplements 1 and 2.

1.5 DESCRIPTION OF BASIN (Figure 1.1)

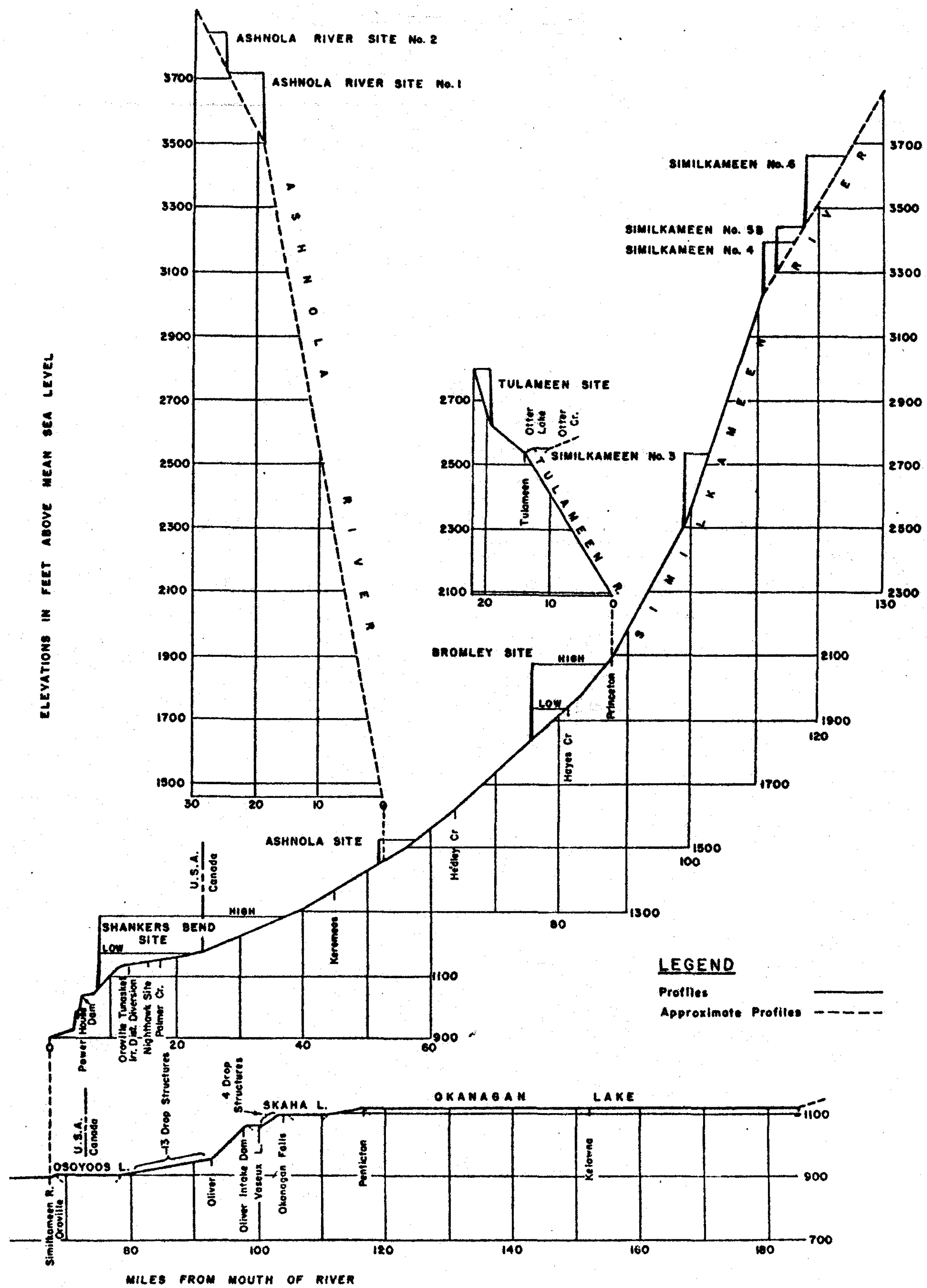
The Okanagan - Similkameen Basin, situated about 150 miles east of the Pacific Coast, drains an area of about 8,400 square miles; 6,000 square miles in south central British Columbia, and 2,400 square miles in north central Washington. It extends 180 miles from north to south and 85 miles from east to west. The basin is bounded on the north and west by the Shuswap, Thomson and Nicola basin, on the west by the Skagit River basin, on the southwest by the Methow River basin, and on the east by the Kettle and Sanpoil River basins. From its source, the Okanagan River flows south along the east side of the basin in a fairly narrow valley which is noted for its chain of lakes. It crosses the international boundary, near Osoyoos, about two-thirds of the distance from its headwaters to its junction with the Columbia River near Brewster, Washington. The major tributary of the Okanagan, the Similkameen rises In Washington near the boundary, flows north into British Columbia, then east, then south-easterly to recross the boundary about 24 miles above its confluence with the Okanagan River near Oroville. A map of the basin is shown in Figure 1.1 and stream profiles in Figure 1.2.

The Okanagan Basin in Canada exclusive of the Similkameen covers an area of 3165 square miles which represents slightly less than one percent of the total land area of British Columbia. While this portion of the basin is the subject of this report it has been necessary to extend the hydrological analysis southward to Oroville, Washington in order to include Osoyoos Lake which straddles the international border (Figure 1.3). Moreover, the effects of flood flows from the Similkameen on the high water levels of Osoyoos Lake has required some examination of the peak flows of the former.



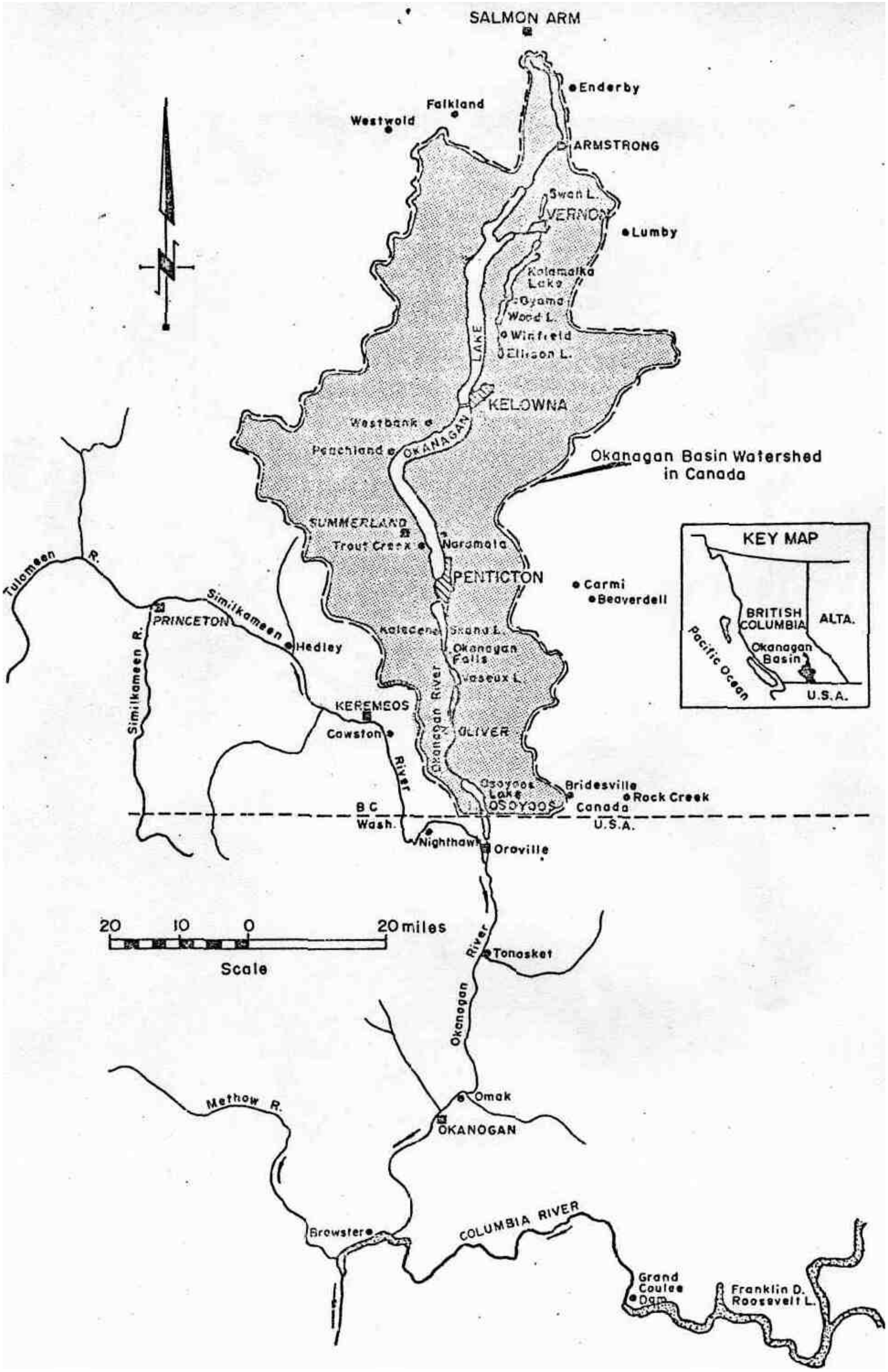
OKANAGAN BASIN
PHYSIOGRAPHIC MAP
CANADA – U.S.A.

Figure 1.1



OKANAGAN-SIMILKAMEEN
STREAM PROFILES

Figure 1.2



OKANAGAN DRAINAGE BASIN IN CANADA Figure 1.3

1.5.1 <u>Physiography</u> (Figure 1.4)

The Okanagan Basin upstream of Oroville as well as the surrounding basins (Kettle, Similkameen and Shuswap) consist for the most part of high plateau land with an average elevation of 5,000 feet in the south decreasing to 4,000 feet in the north. This plateau is sharply split by the Okanagan Trench, a wide deep valley, which has been eroded by stream and glacial action. The Monashee Mountains, some 20 to 40 miles to the east, have an average elevation of about 7,000 feet, but several peaks in the vicinity of Mabel and Sugar Lakes support glaciers at altitudes approaching 10,000 feet.

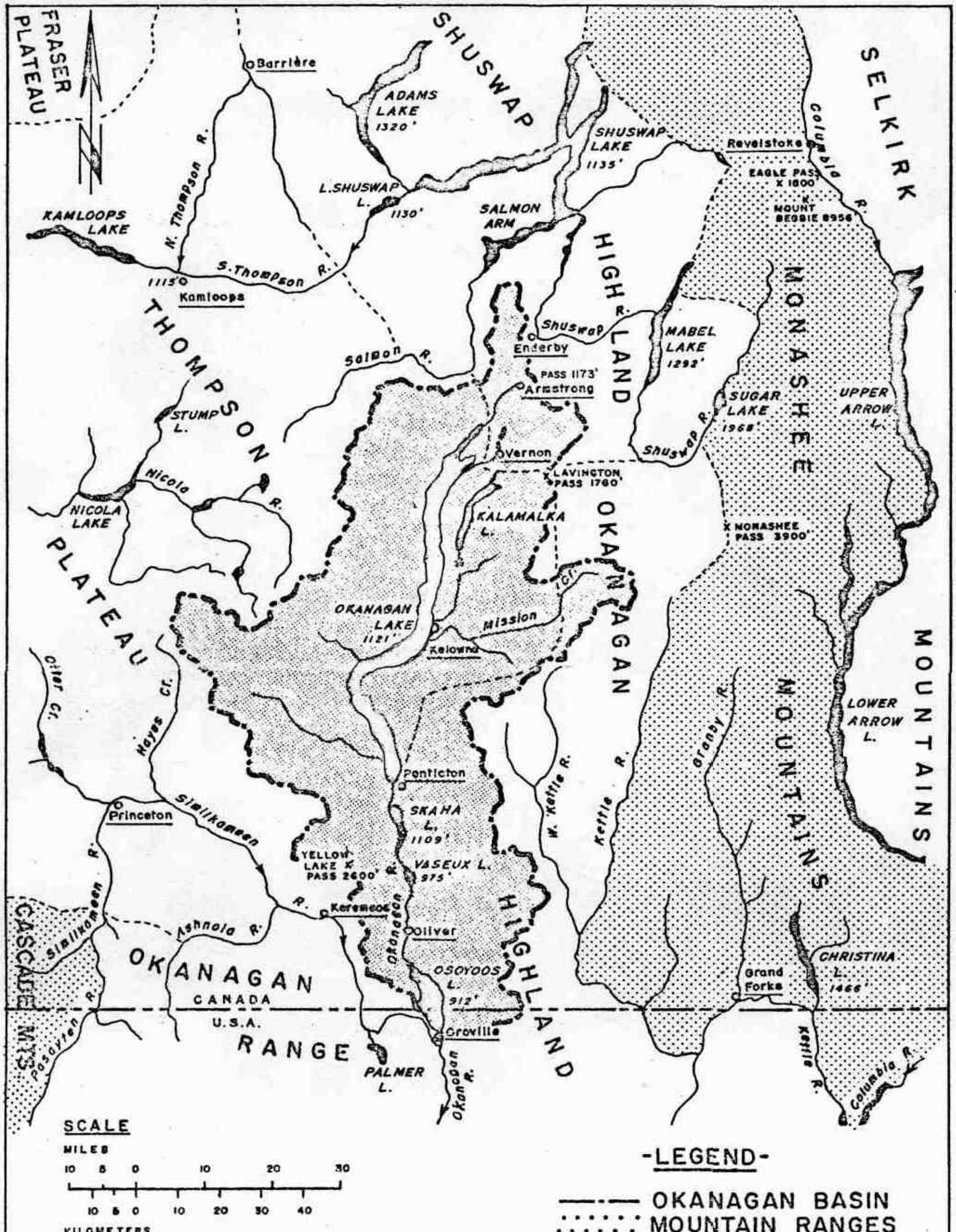
The trough in which the Okanagan River flows is one of several deep, north-south, parallel valleys developed in a complex of igneous and sedimentary rocks that are moderately to extensively metamorphosed. Extensive glaciation in the area between the Cascade Mountains on the west and the Rocky Mountains on the east has greatly modified the drainage and topography, and has largely obscured the bedrock geology.

The results of Pleistocene glaciation which ended about 10,000 years ago can be seen throughout the Okanagan Valley. A layer of ice, probably about 7,000 feet thick, chiselled mountain peaks and ridges and scoured north-south valleys into smooth troughs. The flow of ice from the centre of accumulation was generally northwest into the Yukon and southward into the United States.

The movement of great amounts of debris during each ice advance, and the subsequent reworking by meltwater, caused marked changes in the drainage of the area; and the present system, with only minor exceptions, is the result of processes which took place during the last ice advance and retreat. During melting of the glaciers, marginal streams between the ice and the valley walls produced terraces of the morainal material. Much of the valley floor south of Skaha Lake was covered with deep glacial drift, and at Okanagan Falls the river was forced along the valley wall. A few miles to the north the outlet of Okanagan Lake was dammed by the coalescing deltas and alluvial fans of Penticton, Ellis and Shingle Creeks.

As the ice receded, the terrain was left draped with a layer of mixed stones, silt and clay, called "glacial till". The depth of this material varies from two to 40 feet and has served as the parent material for most of the soils of the area.

During the melting of the huge ice sheet there was a superabundance of water. Rivers and streams were much larger than at present, and quickly



OKANAGAN BASIN
PHYSIOGRAPHIC MAP
CANADA

Figure 1.4

began the process of clearing valleys of much of their deep glacial debris. However, the ice did not melt uniformly and in the Okanagan Valley large remnant ice lakes remained. In order to by-pass these ice lakes, melting water flowed roughly parallel to the ice but at considerably higher elevations than the present valley floor. As the water from the valley sides with its load of glacial till met the glacial ice, its velocity was reduced and a considerable amount of this glacial material was sorted and deposited in places along the edge of the ice-lake. Gradually as the ice melted the glacial streams followed successively low channels until the drainage pattern became approximately the same as today. Along roost of the Okanagan Valley between Osoyoos Lake and Armstrong, discontinuous ribbons of material deposited from meltwater form gently sloping terraces along the valley sides. The well known silt terraces near the south end of Okanagan Lake are an outstanding feature of glacial-stream deposition. Smaller glacial fluvial terraces, often called "benches" may be found throughout most of the Valley.

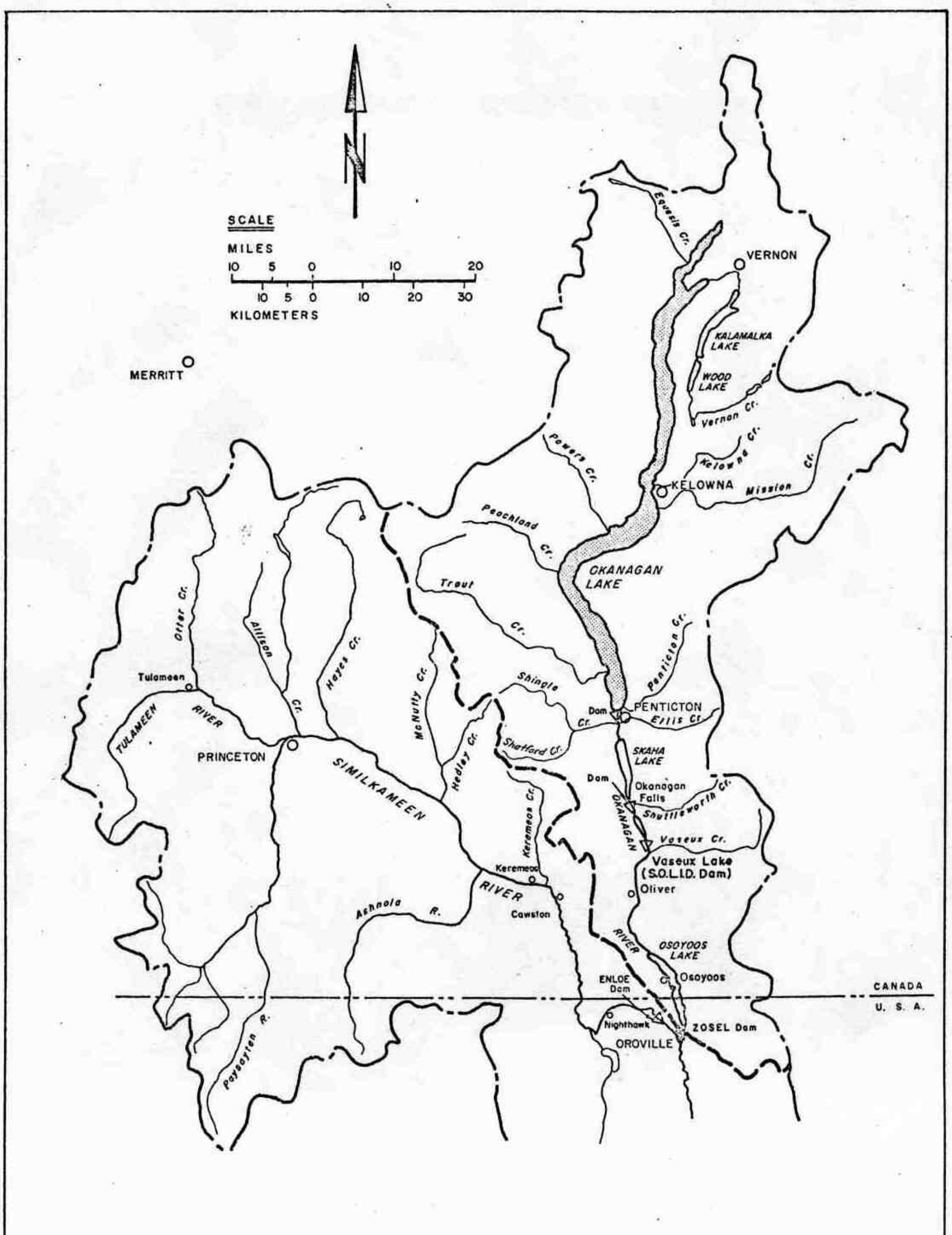
On the plateau surface, the retreating ice exposed shallow depressions many of which are not occupied by small lakes. The chain of Lakes along the Okanagan trench, as mentioned previously, is also a result of glacial action. In these cases, the ice-lakes scoured immense depressions in the valley bottoms. These "over deepened" sections later became filled with water as the ice melted. Further evidence of glacial action is the separation of lake bodies by narrow alluvial fans such as is evident at Penticton, and between Wood and Kalamalka Lakes near Vernon.

There are several relatively low passes between the Okanagan Basin and adjoining drainage systems including Spallumcheen Valley north of Armstrong (elevation 1173 feet), the Lavington Pass (elevation 1760 feet) west of Lumby and the divide between the Southern Okanagan and Similkameen near Yellow Lake (elevation 2600 feet). All three are the location for transportation routes and the first two have been studied with respect to possible water diversions into Okanagan Lake.

1.5.2 Drainage

From the Okanagan Basin divide near Armstrong, drainage is southward through the mainstem lakes including Okanagan, Skaha, Vaseux and Osoyoos Lakes (Figures 1.5 and 1.6).

Major tributaries of Okanagan Lake, listed in order of decreasing annual discharge are Mission, Vernon, Trout, Penticton, Equesis, Kelowna, Peachland and Powers Creeks. The Okanagan Lake Dam at Penticton and the improved four miles of Okanagan River Channel running south and discharging into Skaha Lake



OKANAGAN – SIMILKAMEEN BASIN   Figure 1.5

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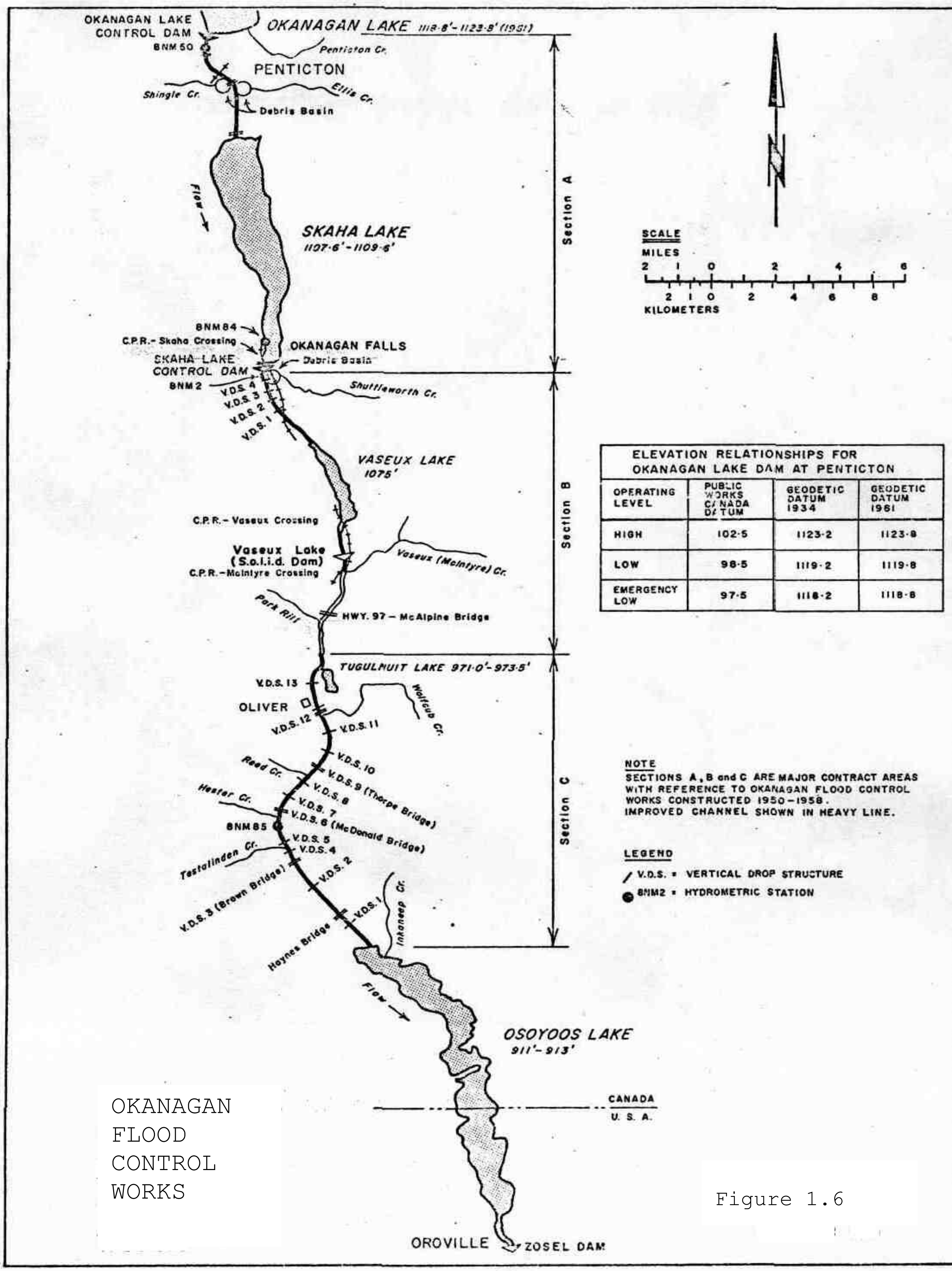

ELEVATION RELATIONSHIPS FOR OKANAGAN LAKE DAM AT PENTICTON

OPERATING LEVEL	PUBLIC WORKS CANADA DATUM	GEODETIC DATUM 1934	GEODETIC DATUM 1961
HIGH	102·5	1123·2	1123·8
LOW	98·5	1119·2	1119·8
EMERGENCY LOW	97·5	1118·2	1118·8

OKANAGAN FLOOD CONTROL WORKS

Figure 1.6

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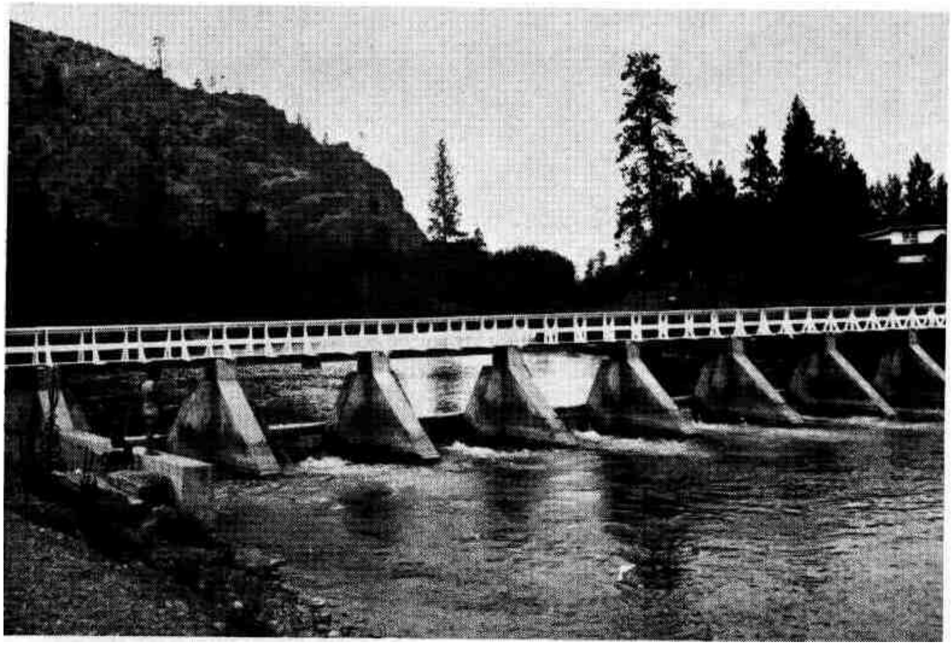


Photo 1 DROP STRUCTURE #17
Flow 300 c.f.s. (August, 1973)

Photo 2 OKANAGAN FLOOD CONTROL CANAL AND
SHUTTLEWORTH DEBRIS BASIN - D.S. #16 (in foreground)
Flow 300 c.f.s. - Looking North (Sept. 12, 1973)

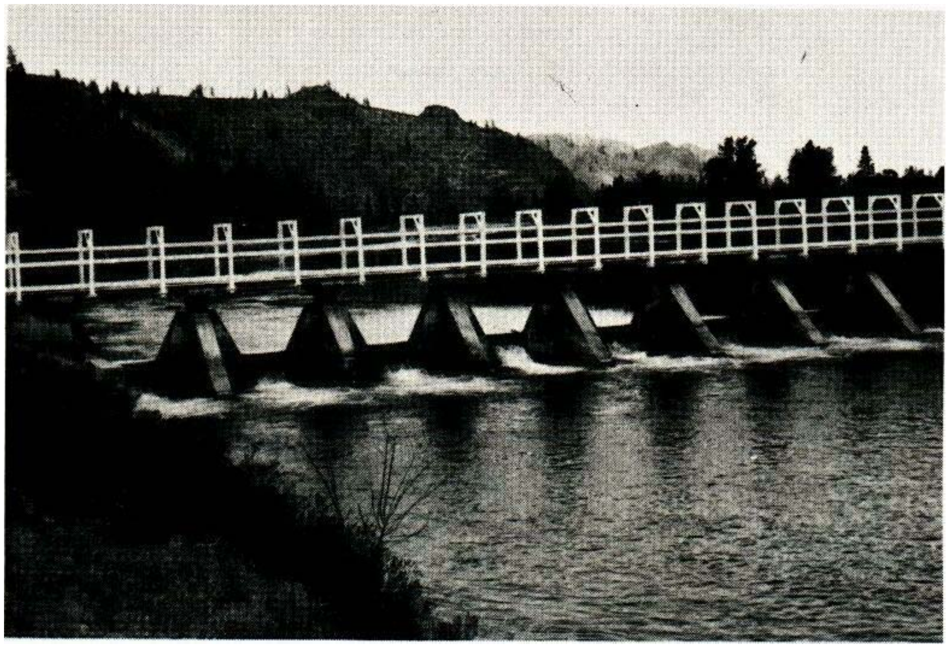


Photo 3 DROP STRUCTURE #15 (Cattle Crossing Type)
Flow 300 c.f.s. (August, 1973)

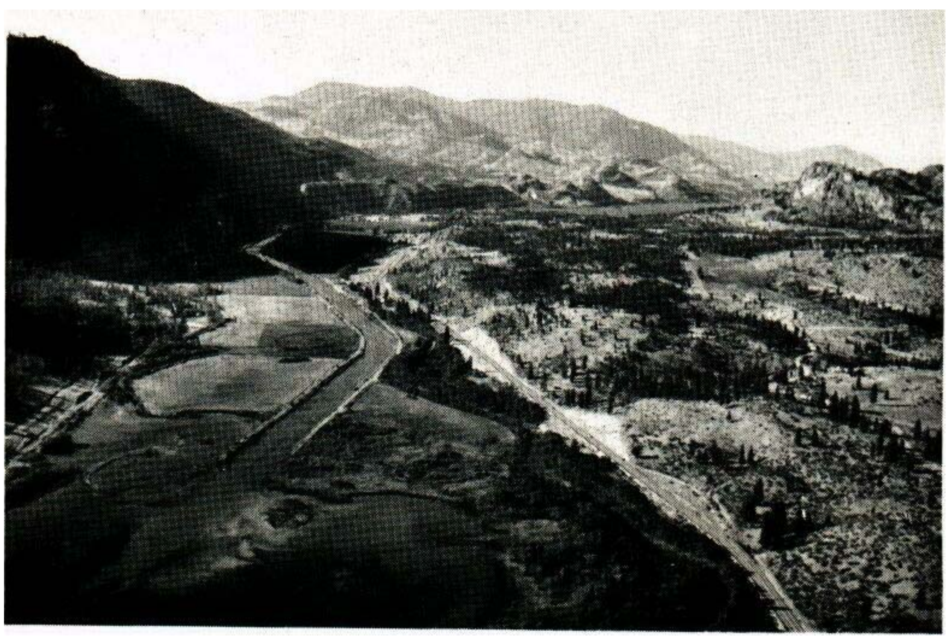


Photo 4 OKANAGAN FLOOD CONTROL CANAL
at entrance to Vaseux Lake
Looking North (Sept. 12, 1973)

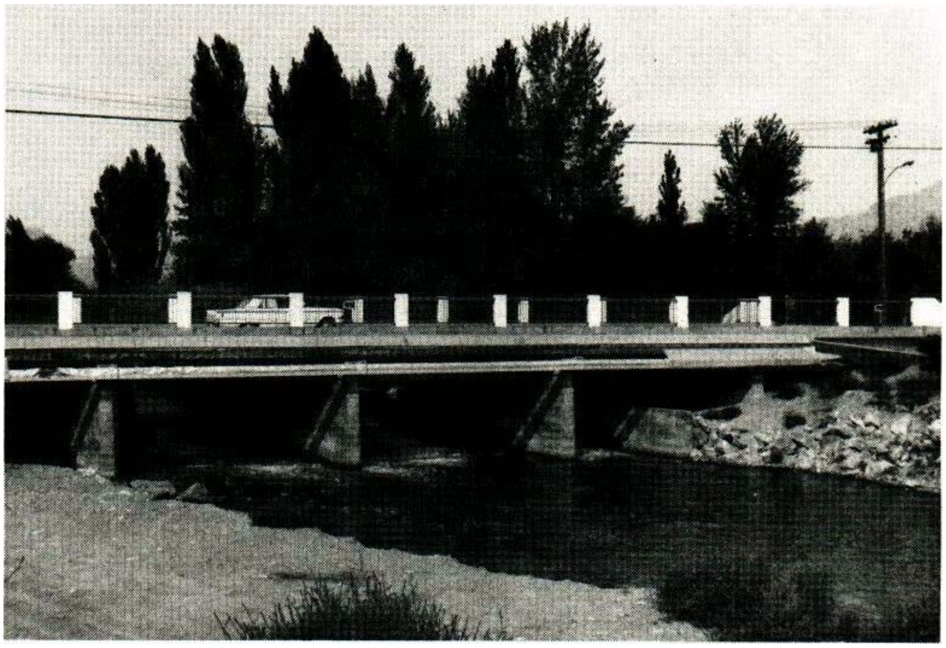


Photo 5   DROP STRUCTURE #12 (Road Type) AT OLIVER
(August, 1973)

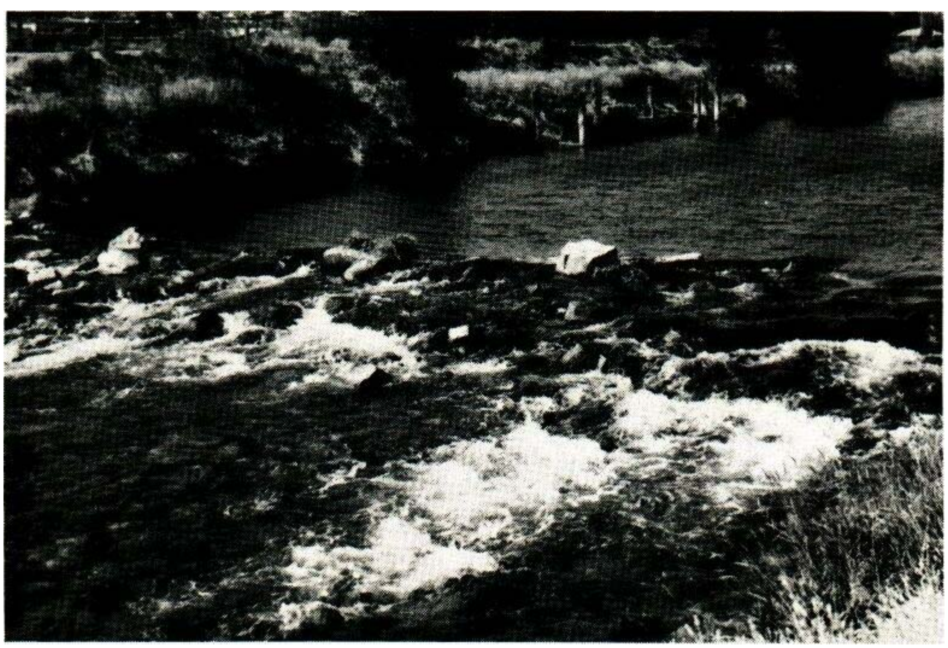


Photo 6 TEMPORARY BARRAGE WEIR Between D.S. 11 and 12
To maintain river water levels at intakes

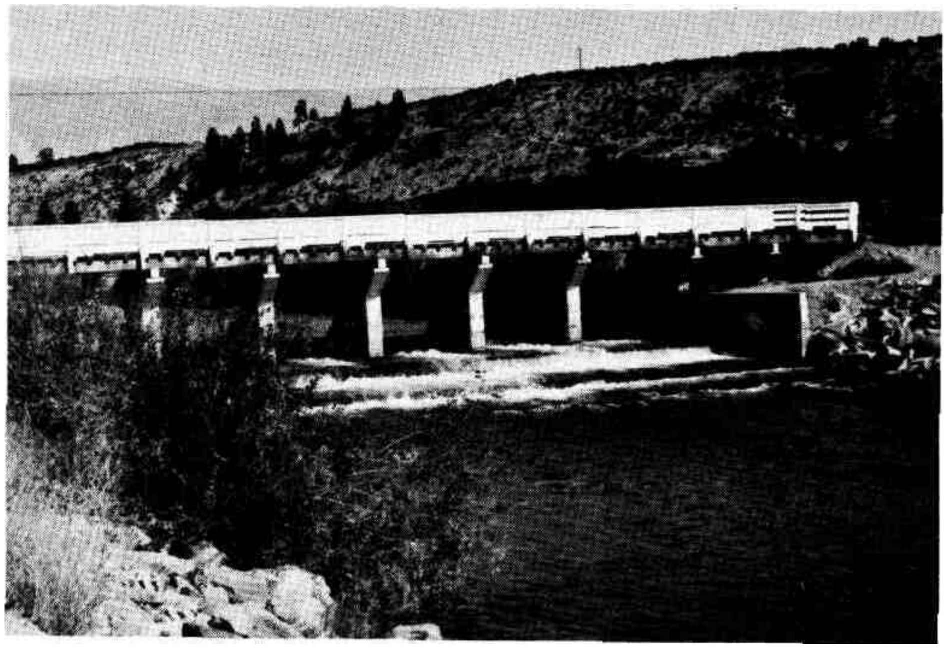


Photo 7 DROP STRUCTURE #9 (Road Type)
Flow 300 c.f.s. (August, 1973)

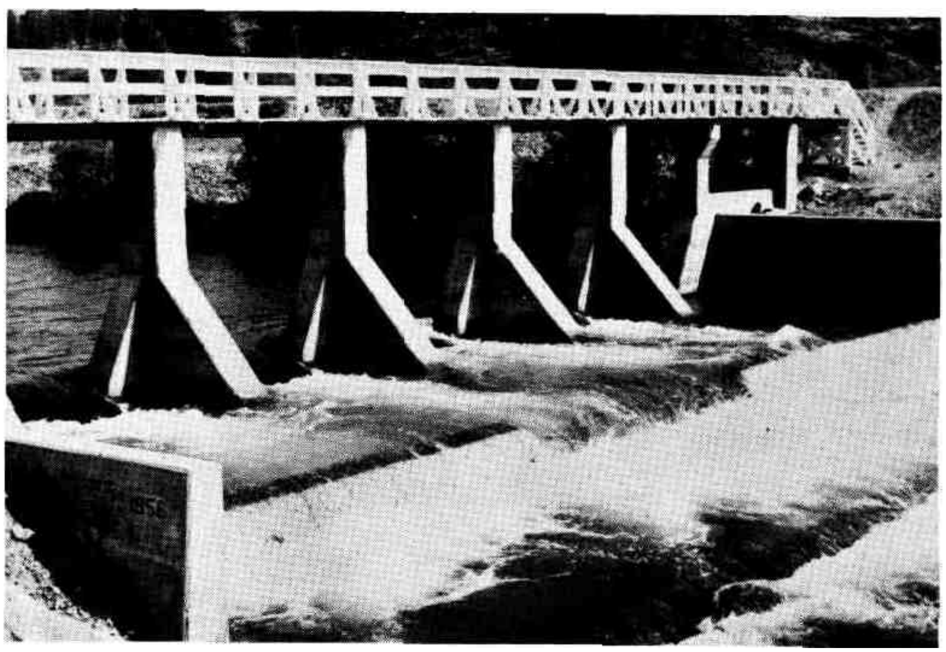


Photo 8 DROP STRUCTURE #8
Flow 300 c.f.s. (August, 1973)

Photo 9 OKANAGAN FLOOD CONTROL CANAL showing Oxbows D.S. #3 (in foreground) - Flow 300 c.f.s. Looking North (Sept. 12, 1973)

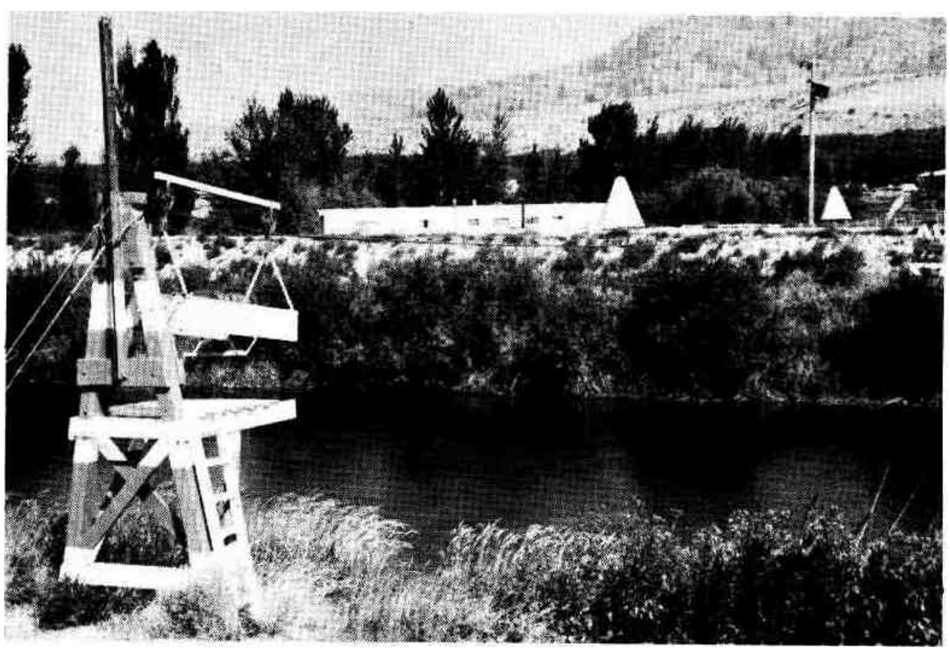


Photo 10 GAUGING STATION 8NM85 Near Oliver (between D.S. 3 and 4 - August, 1973)

are part of the Okanagan Flood Control Project, which was constructed jointly by the Federal and Provincial Governments during 1950 to 1958 under the terms of the Okanagan Flood Control Act. While one of the main objectives of the project was to relieve flooding such as occurred din 1942 and 1948 it also provides storage regulation for irrigation, fisheries, water based recreation and aesthetics within the Okanagan Mainstem System.

The project also includes a concrete dam at Okanagan Falls which regulates the level of Skaha Lake. The discharge from this dam flows southward through an improved Okanagan River channel for 3.3 miles to discharge into Vaseux Lake. The fall of approximately 30 feet in this portion of the river is controlled by four drop structures.

Below the Vaseux Lake Dam, the Okanagan River remains In Its natural state for four miles, and a portion of this reach, about a mile downstream from the dam, together with Wenatchee Lake in the State of Washington, form the two remaining major spawning areas for the sockeye (blueback) salmon in the Columbia River System. Some 30 years ago (prior to the construction of Grand Coulee Dam upstream of the confluence of the Okanagan River with the Columbia River in the United States) the much larger Upper Columbia Watershed was also available as a spawning area for the salmon. There is normally no salmon migration above Vaseux Lake Dam.

In its lower reaches, the Okanagan River channel has been improved from just north of Oliver downstream some 10 miles to Osoyoos Lake. In this section of the river, there are 13 drop structures, each designed for a fall of three feet. These concrete structures have multiple weir openings specially designed for fish passage.The normal low water elevation of Osoyoos Lake is maintained by the Zosel Dam at Oroville, Washington.

At Oroville and immediately downstream, the Okanagan and incoming Similkameen Rivers follow meandering courses for about one and a half miles before becoming a single channel.

The Similkameen River Basin is situated about 125 miles east of the Pacific Coast astride the International Boundary as shown in Figure 1.5. The Similkameen Basin consists of approximately 2,800 square miles in Canada, the balance of the total catchment of 3,580 square miles being in the United States.

The Similkameen River headwaters are in the Cascade Mountains in the vicinity of the International Boundary. It Is joined by the Pasayten River from the south, flows northerly for 35 miles to Princeton, where it is joined by its largest tributary, the Tulameen River. From Princeton, its course is generally south-westerly for 88 miles to its confluence with the Okanagan near Oroville, after crossing the boundary near Nighthawk. The largest tributaries downstream from Princeton are Allison, Hayes, Hedley and Keremeos Creeks from the north and the Ashnola River from the south. The relative significant of these tributaries, as far as runoff is concerned, is realized when it is noted that the watershed above Princeton, consisting of only 40 per cent of the whole basin, yields approximately 70% of its runoff.

While the Study is limited to the Canadian portion of the main Okanagan River Basin the fact that Osoyoos Lake is divided by the International Border has required the extension of hydrological analysis downstream to the lake outlet at Oroville, Washington. Further, the backwater effect from the Similkameen River at its confluence with the Okanagan River near Oroville, which can reduce and even reverse the direction of flow at the outlet of Osoyoos Lake during extreme floods, has required an examination of peak flows on this major tributary.

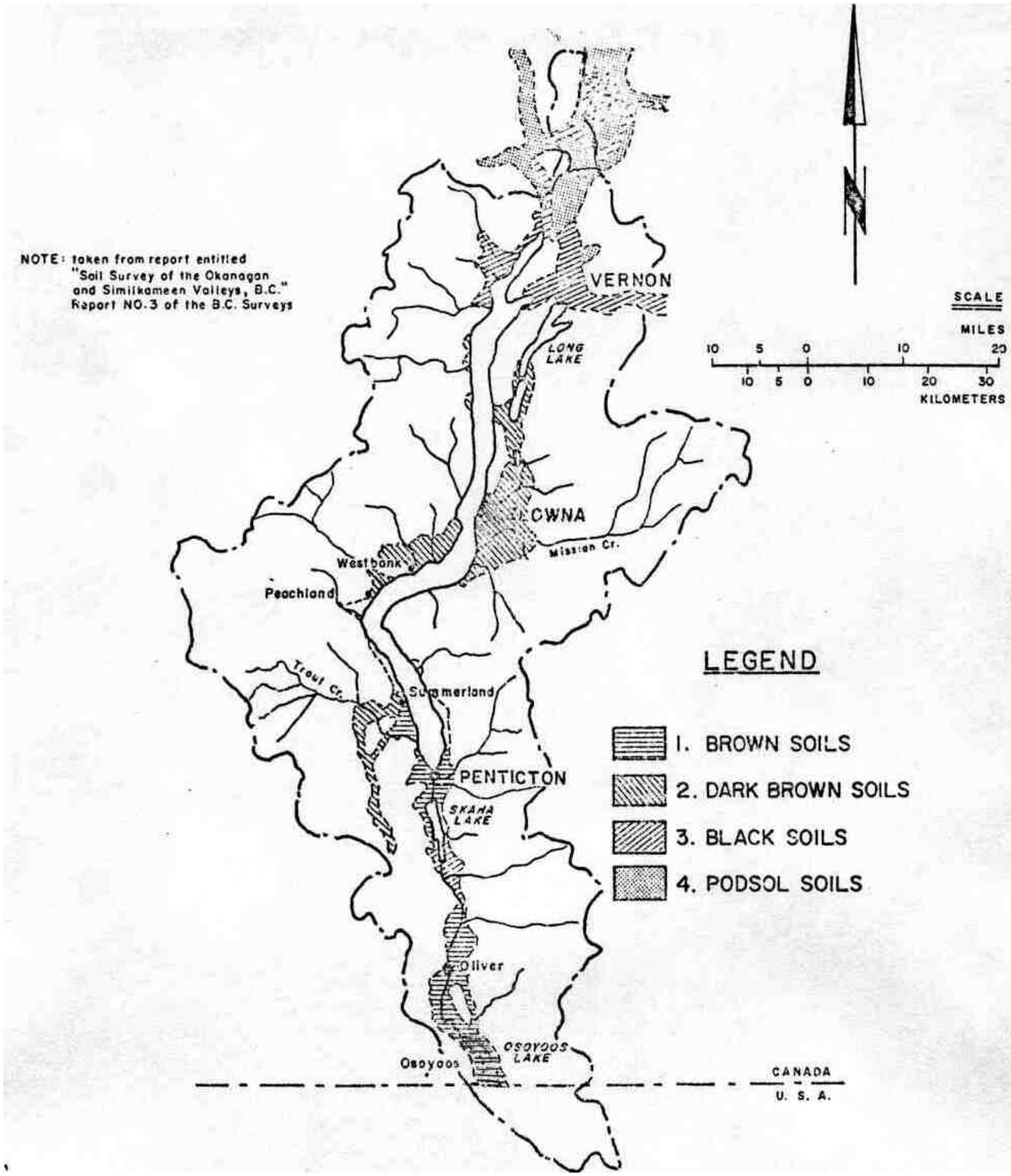
Only minor storage development has taken place on tributaries of the Similkameen River in Canada.

The only important development in the United States portion of the basin Is the hydro-electric plant of the Okanagan County Public Utility District In the mainstem some five miles above Oroville at the Enloe Dam. This run of the river plant has an installed capacity of 3200 kilowatts and operates under a maximum head of 78 feet. While the Similkameen River is considered to be a tributary of the Okanagan it carries about four times the annual flow of the latter as measured at Oroville.

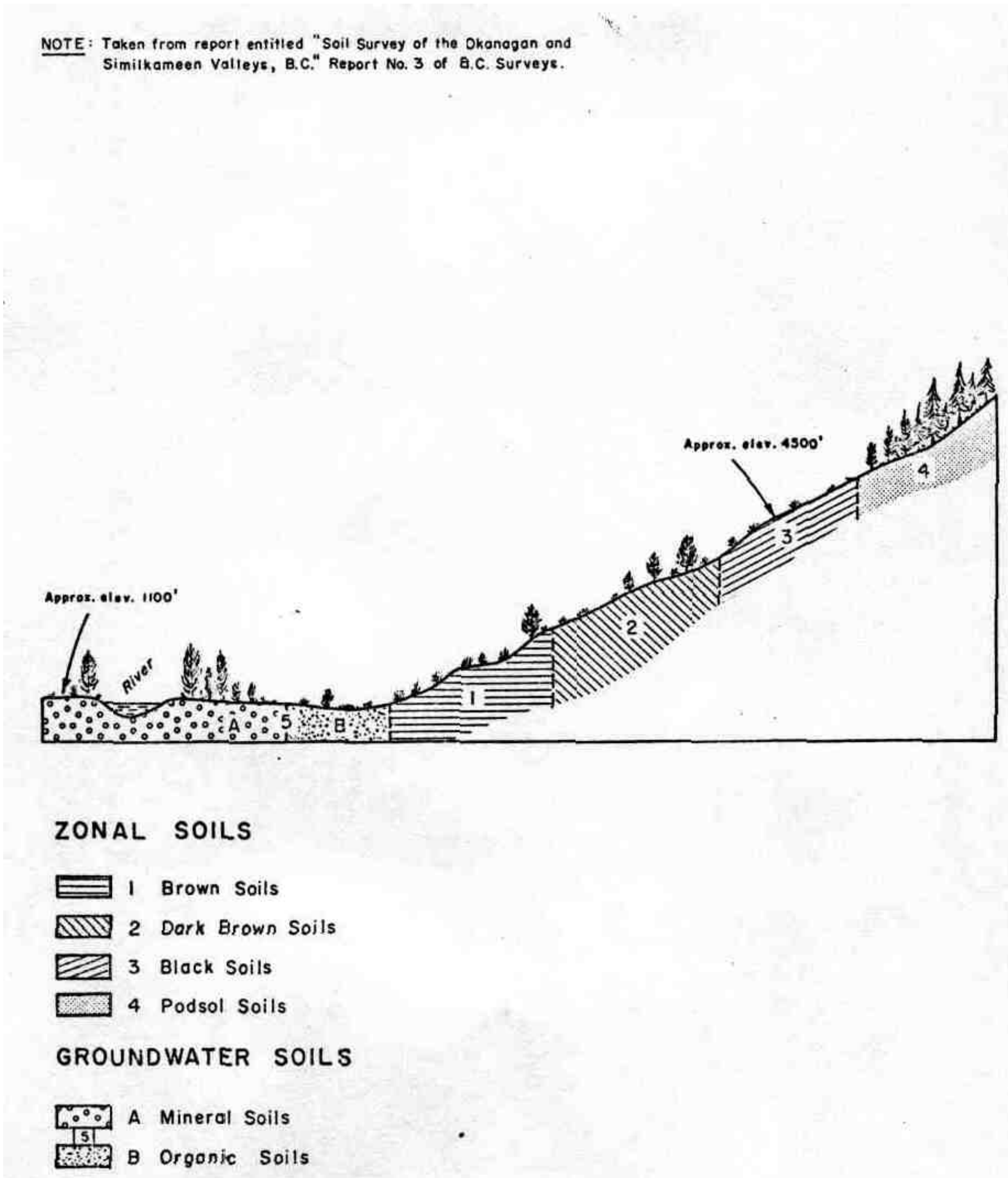
1.5.3 Soils

As outlined in an earlier section most soils in the Okanagan Basin originated from glacial deposits. The influence of organic matter, topography, climate and time on this glacial till has in may places formed cultivable soils. It is estimated that there are 177,000 acres of arable land in the Okanagan Basin as shown in Table 1.1.

Five major soil groups exist within the Okanagan Basin - namely, Brown, Dark Brown, Black, Brown Podzolic-Grey Wooded and Groundwater Soils (Figure 1.7a and b).



PLAN SHOWING
ZONAL SOIL GROUPS, OKANAGAN BASIN Figure 1.7(a)



SOIL PROFILE
OKANAGAN VALLEY

Figure 1.7(b)

Brown soils are confined to the Okanagan Valley south of Summerland and are typically found in the driest, hottest sites where annual precipitation is about nine to eleven inches.

The Dark Brown soils have more organic matter in the surface horizons that Brown soils, and texture varies from finely granular in sandy soils to fine crumb structure in clay loam and clay. They are more fertile and with irrigation produce large varieties of fruit and vegetables. These soils are found between Summerland and Oyama.

The Dark Brown soils give way to the Black Soils at higher elevations where grass and areas of timber are found. These soils are fertile, rich in organic matter and with a soil structure varying from fine granular in the sandy loams and loams, to granular and crumbly in the clay loam and clay. For maximum production these soils should be irrigated. They are currently used for grazing, dry farmed for cereals or irrigated for forage crops and vegetables.

TABLE 1.1

LAND USE IN THE OKANAGAN BASIN 1970
(in round figures)

LAND USE	ACRES	SUBTOTAL ACRES	PERCENT
Forests - sustained Yield Units - Tree Farm Licences	 1,067,000 286,000	1,353,000	68%
Agriculture - Irrigated - Dryland Farming - Arable Potential (below 1800 feet in elevation)	 60,000 26,000 71,000	157,000*	8%
Urban - Removed from Agriculture		57,000	3%
Lake Surface Areas Other		104,000 329,000	5% 16%
TOTAL		2,000,000	100%

* Land capable of being cultivated to elevation 5000 feet is 272000 acres

The Brown-Podzolic-Grey Wooded soils are located at higher elevations and support a tree cover. These soils are quite fertile and those with medium to heavy texture could be used for dry farming.

Groundwater soils may be determined as those having a fluctuating water table and bog or much soils which have a water table at or near the surface. Typically found on level or gently sloping land these soils are medium tex-tured and generally support a moderate to dense tree cover. The better drained lands are in orchard, and the balance is used for forage crops, gardens and berries.

1.5.4 Vegetation

There are three main vegetation zones in the Okanagan composed of the Osoyoos-Arid, Dry Forest and Sub-Alpine. The Osoyoos-Arid is, in general associated with low elevations, (normally less than 2,000 feet) and low precipitation, which is typical of the southern Okanagan. Higher annual precipitation, (10 - 20 inches) broadly separates the Dry Forest from the Osoyoos-Arid zone. Sub-Alpine vegetation is mostly observed at elevations from 4,000 to 6,000 feet. It is typically associated with the plateau surface and mountain slops on both sides of the valley. Cooler temperatures and 20 to 30 Inches of precipitation are characteristic (Figure 2.3, Chapter 2).

The Osoyoos-Arid zone does not support trees except for yellow pine or deciduous groves along river courses. Short grasses, mainly bunch grass, are the common cover with associated desert shrubs such as rabbit-brush, sage brush and cactus.

In the Dry Forest zone good quality grazing grasses characterize the vegetation cover, except where over grazing has introduced less palatable grasses and herbs. Yellow pine is the climax forest species and grows over muck of the Dry Forest zone as individual specimens or within stands. Douglas fir and western larch are widely distributed on the moister fringes of the Dry Forest. Deciduous species, such as mountain birch, aspen and alder are found in moist sites in valley bottoms, or near lake shores. Spring blooming plants are abundant when winter snows have melted.

Generally, above 4,000 - 4,500 feet elevation the upper limit of the Dry Forest is reached and the Sub-Alpine zone begins. It is typically forested with open grassland found in scattered patches on drier south-facing slopes. Englemann spruce and alpine fir are the most common variety of trees between 4,000 and 6,000 feet. Burnt or logged over areas are frequently characterized by extensive stands of sub-dominant lodgepole pine. The forest under-growth consists mostly of grasses and shrubs.

Although not extensive in the basin, an Alpine vegetation zone occurs in some areas above 6,000 feet where sub-alpine species such as heather, dwarf juniper, willow, etc., grow.

From a study of Table 1.1 which covers land use in the Okanagan, it is evident that some 80% of the area is being utilized by the forestry Industry as Sustained Yield Units or Tree Farm Licences.