PART I

INTRODUCTION

CHAPTER 1

The Okanagan Basin

The Okanagan Basin lies in the south central plateau area of the Province of British Columbia (Figure 1.1). The central drainage system consists of a chain of lakes stretching from Wood Lake near the City of Vernon to the International Border. These lakes are connected by the Okanagan River which flows south to join the Columbia River near Brewster in the State of Washington, U.S.A. The Canadian portion of the basin has a length of 110 miles, a maximum width of 60 miles, and covers an area of 3165 square miles, which represents slightly less than one percent of the total land area of British Columbia.

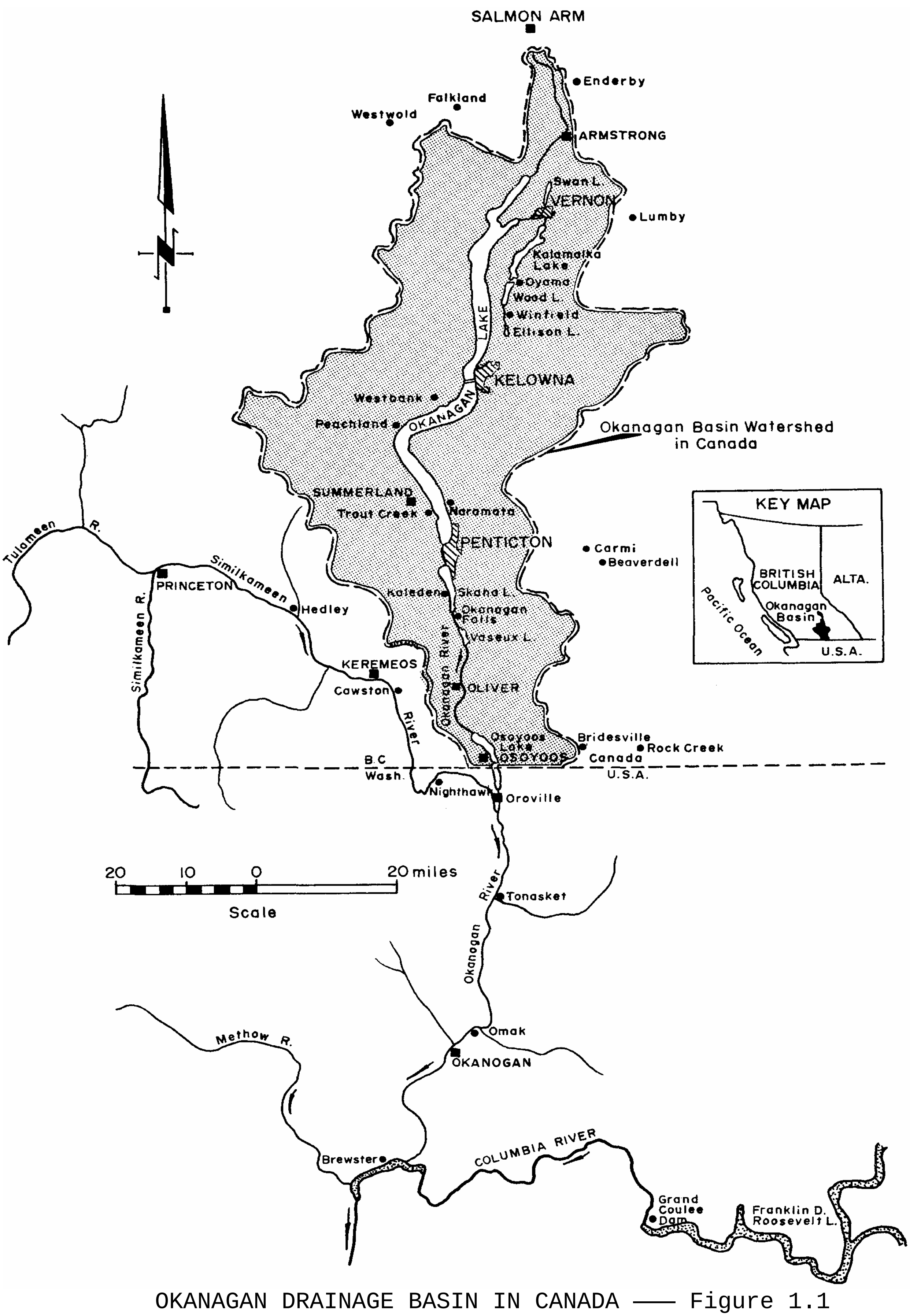
DESCRIPTION OF BASIN

1.1 Physiography

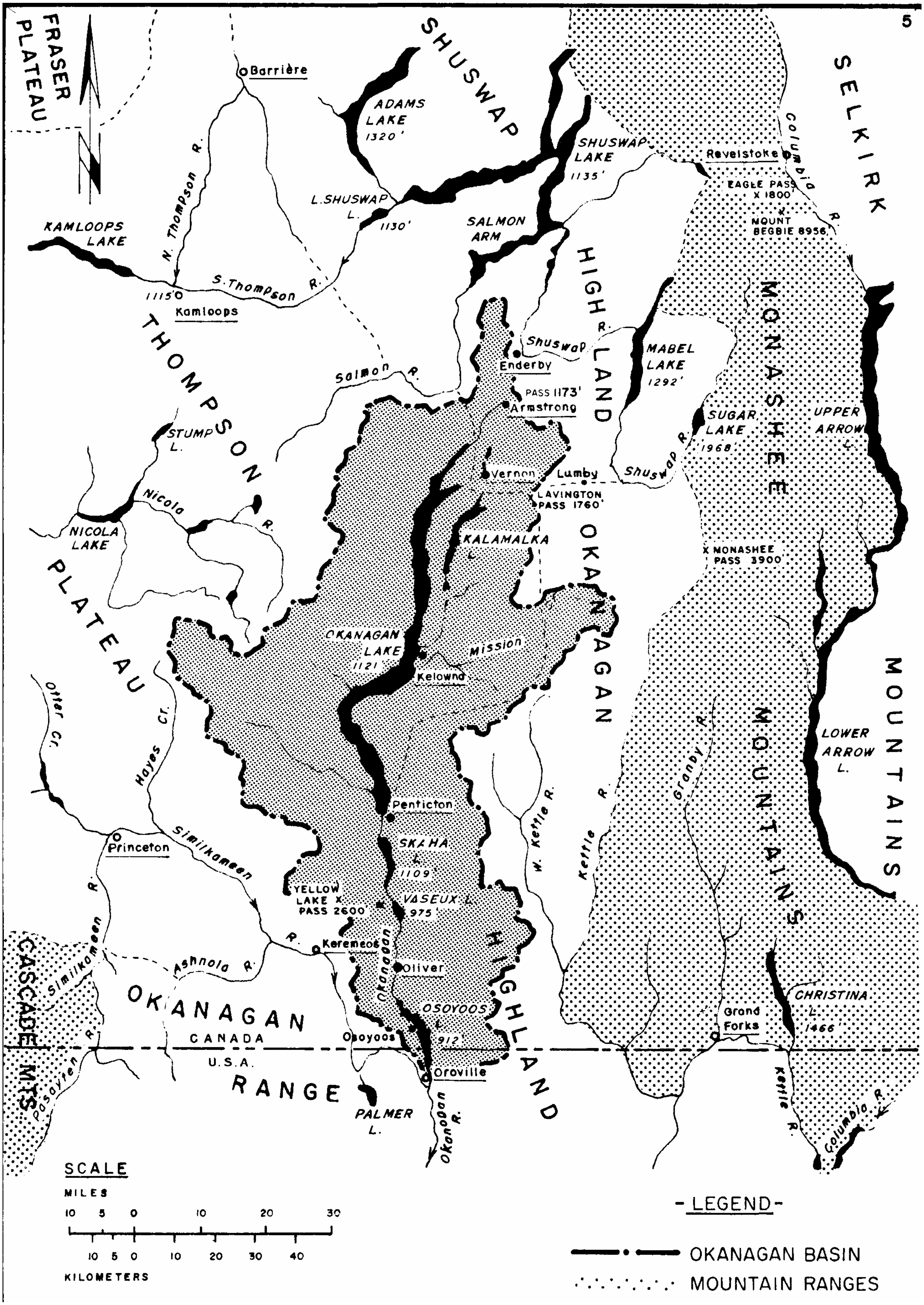
The Okanagan Basin in Canada is bounded on the south by the International Boundary, on the east by the Kettle River Basin, on the west by the Similkameen River Basin and to the north by the Shuswap River Basin. Most of the area within these four watersheds consists of high plateau land with an average elevation of 5000 feet in the south decreasing to 4000 feet in the north (Figure 1.2). 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 east of the trench, 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 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. 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 mantle varies from two to forty feet and has served as the parent material for most of the soils in the area.

When the huge ice sheet began to melt, there was a superabundance of water. Rivers and streams were much larger than at present, and quickly 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



OKANAGAN DRAINAGE BASIN IN CANADA —— Figure 1.1



OKANAGAN BASIN PHYSIOGRAPHIC MAP Figure 1.2

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 lower channels until the drainage pattern became approximately the same as it is today. Along most of the Okanagan Valley between Osoyoos Lake and Armstrong, discontinuous ribbons of material deposited from melt water 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 now 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 glaciers scoured immense depressions in the valley bottoms These "overdeepened" 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.

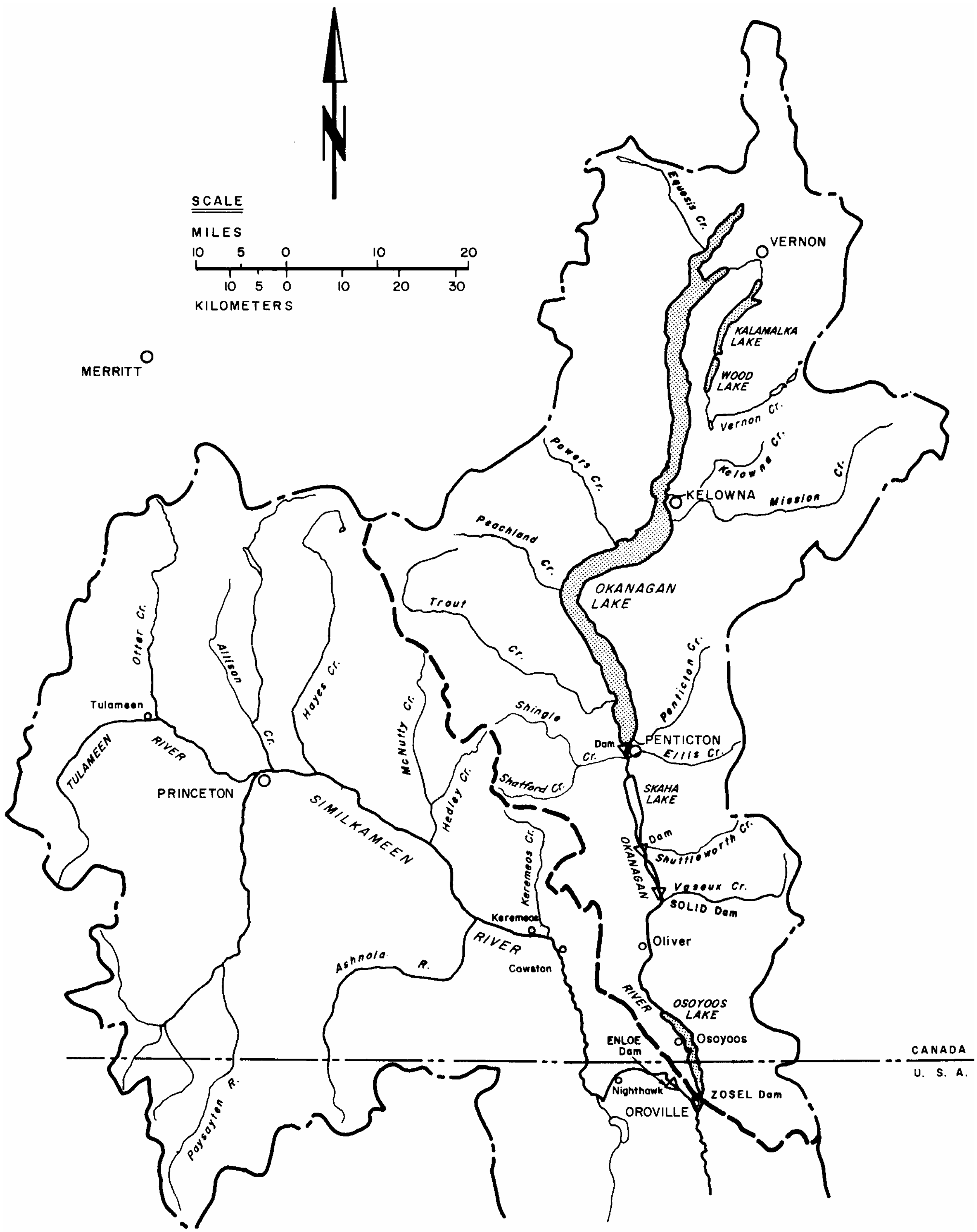
There are several relatively low passes between the Okanagan Basin and adjoining drainage systems including Spallumcheen Valley north of Armstrong (elevation 1,173), the Lavington Pass (elevation 1,760) west of Lumby and the divide between the Southern Okanagan and the Similkameen near Yellow Lake (elevation 2,600). All three are the location for transportation routes and the first two have been studied with respect to possible water diversions into Okanagan Lake.

1.2 Drainage

From the Okanagan Basin divide near Armstrong, drainage is southward through the mainstem lakes including Okanagan, Skaha, Vaseux and Osoyoos Lakes (Figure 1.3).

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 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 in 1942, and 1948 it also provides storage regulation for irrigation, fisheries, water based recreation and aesthetics within the Okanagan mainstem system.



OKANAGAN-SIMILKAMEEN BASIN Figure 1.3

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. Its 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 Okanogan 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 in the Okanagan River above Vaseux Lake Dam.

In its lower reaches, the Okanagan River channel has been improved from just north of Oliver downstream for 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 Okanogan 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 1.3. The Similkameen Basin consists of approximately 2,880 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, and is there joined by its largest tributary, the Tulameen River. From Princeton, its course is generally south-easterly for 88 miles to its confluence with the Okanogan near Oroville, after crossing the boundary near Nighthawk. The largest tributaries downstream from Princeton are Allison, Hayes, Medley and Keremeos Creeks from the north and the Ashnola River from the South. The relative insignificance of these tributaries, as far as run-off is concerned, is realized when it is noted that the watershed area above Princeton, consisting of only 40 percent of the whole basin, yields approximately 70 percent of its run-off.

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

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

The only important development in the United States portion of the basin is the hydro-electric plant of the Okanogan County Public Utility District on the mainstem some five miles above Oroville at the Enloe Dam. This run of the river plant has an installed capacity of 3,200 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 near Oroville.

1.3 Climate

The climate of the Okanagan Basin is somewhat less continental than the rest of the interior. The warm summer with fairly low humidity as well as the relatively mild winters provide an attractive environment for agriculture and recreation. Typical climatic conditions at major urban centers in the Okanagan Valley are shown in Table 1.1.

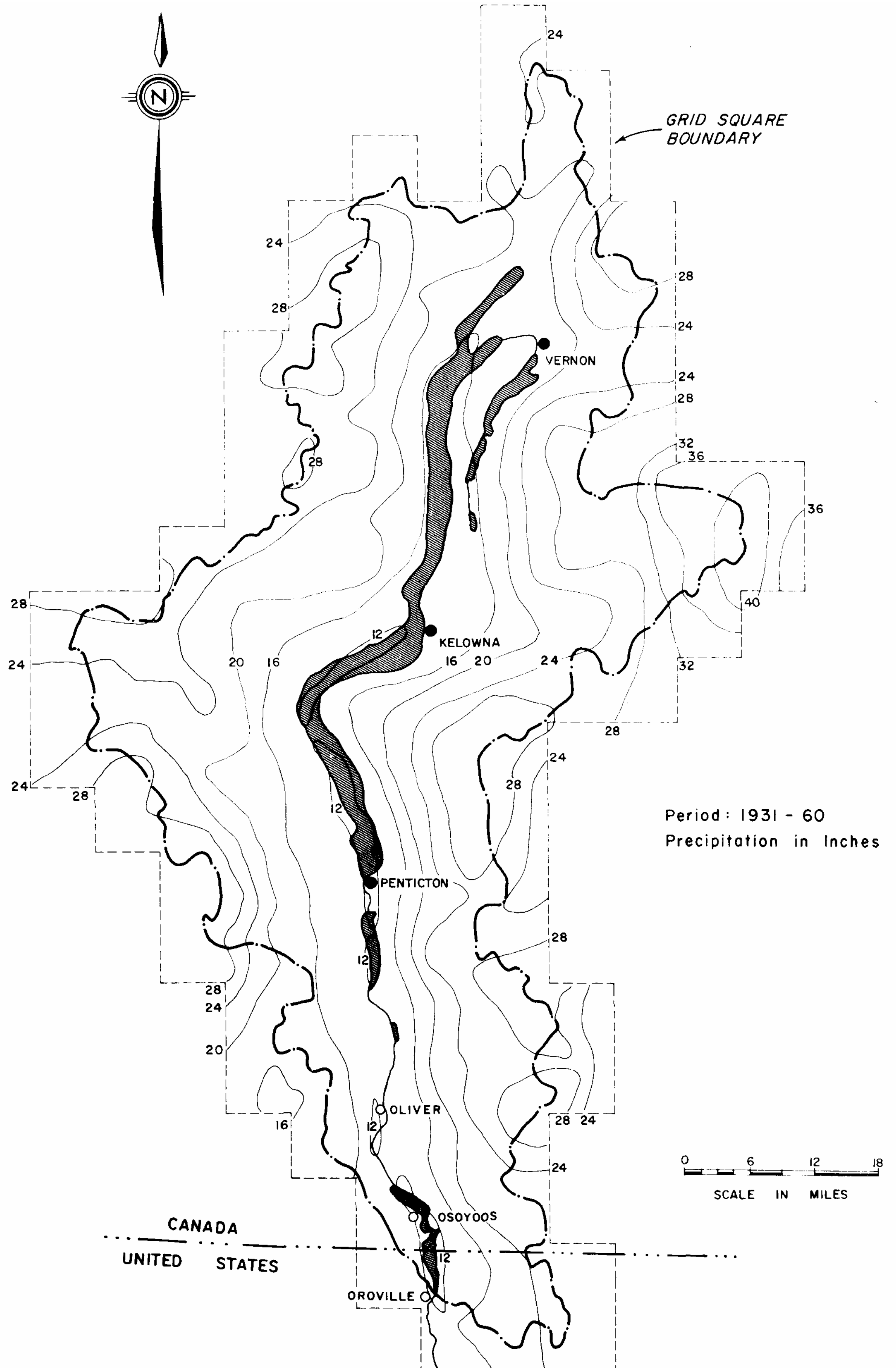
Most of the region is in the dry shadow of the Cascade Mountains which forms a barrier to westerly storms. In the valley bottom precipitation increases from south to north with Oliver having an annual average of only 10.7 inches compared to 17 inches for Armstrong. In the high plateau region near Kelowna, the average annual precipitation as measured at McCulloch, is 27 inches. Conversely, mean air temperature, length of growing season, frost-free period, and the total degree-days during the growing season decreases from south to north.

A more general picture of the average conditions throughout the basin are shown in Figures 1.4 and 1.5 where lines of mean annual precipitation and temperature are shown respectively. The mean annual precipitation (Figure 1.4) increases not only with latitude but also with elevation. Further, there is considerable contrast in the heavier precipitation in the northeast area of some 40 inches, compared to 28 inches for the western portion of the Basin, which

TABLE 1.1

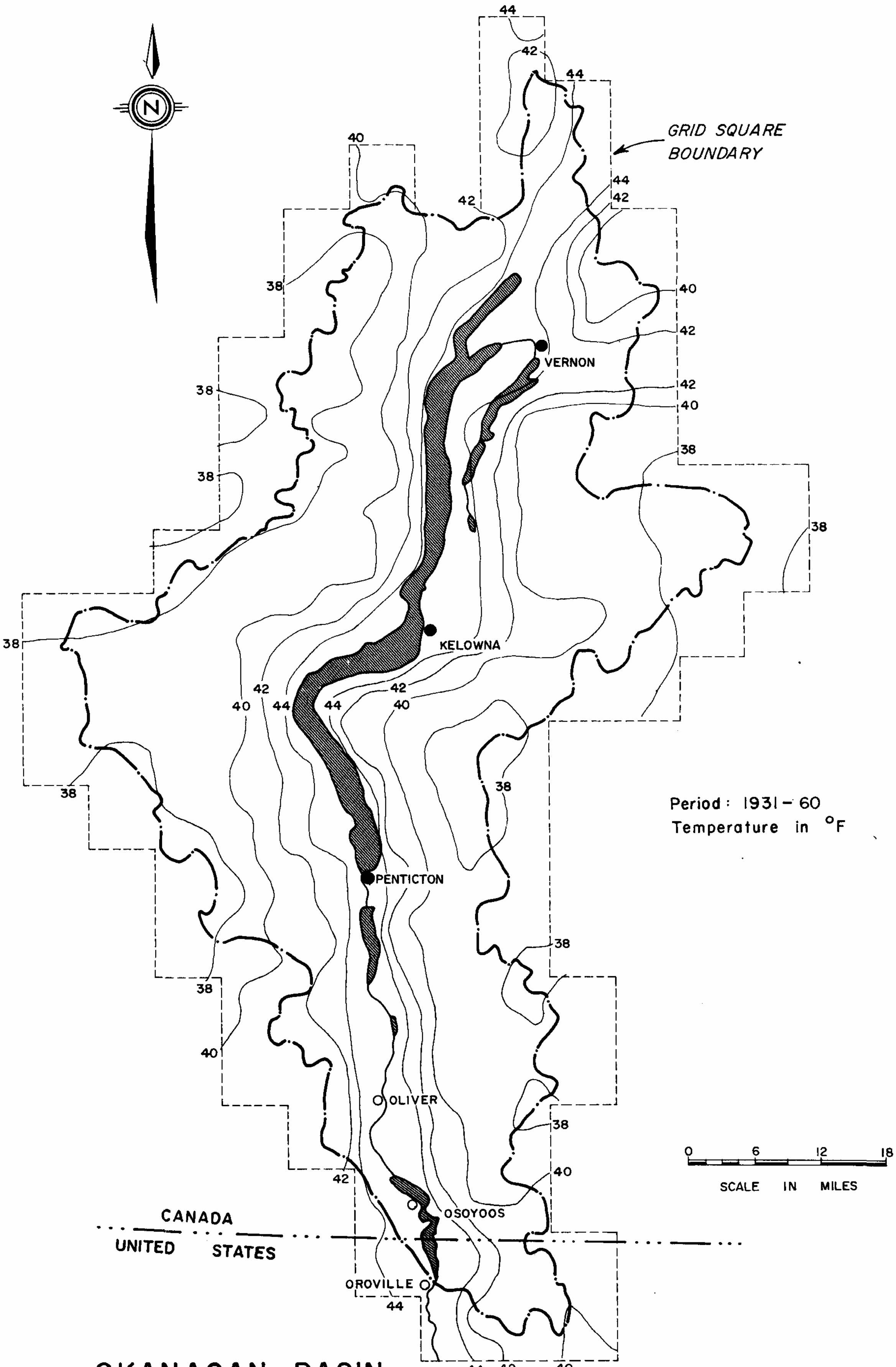
Representative Climatic Data, Okanagan Valley - Taken in part from B.C. Department of Agriculture publication entitled Agricultural Outlook Conferences 1966.

Station	Elevation	Mean Annual Precip-itation	Mean January Precip-itation	Mean July Precip-itation	Mean Annual Temper-ature	Mean January Temper-ature	Mean July Temper-ature	Mean Data Last Spring Frost	Mean Data First Fall Frost	Mean Frost-free Period	Degree Days 42° F.	Mean Growing Season (Mean daily temp. 42° F)
	ft.	in.	in.	in.	°F.	°F.	°F.	-	-	day	-	day
Salmon Arm	1660	21.0	-	-	45	-	-	May 6	Oct. 5	153	3391	199
Armstrong	1200	17.06	1.84	1.13	44	21	66	May 23	Sept. 14	114	3063	194
Vernon (Coldstream)	1582	15.22	1.55	1.06	45	22	67	May 6	Oct. 5	147	3248	200
Okanagan Centre	1140	13.38	1.39	0.95	48	27	68	-	-	134	-	-
Kelowna	1590	12.09	1.06	0.78	47	26	68	May 12	Oct. 3	143	3442	200
McCulloch	4100	26.82	2.87	1.78	37	16	56	-	-	20	-	-
Summerland (Research Sta.)	1491	11.00	1.06	0.86	48	25	70	Apr. 24	Nov. 9	198	3756	212
Penticton (Airport)	1140	11.32	1.08	0.89	48	27	68	May 7	Oct. 3	149	3530	217
Oliver	1008	10.71	1.07	0.76	49	26	71	May 3	Oct. 1	152	4021	226



OKANAGAN BASIN
MEAN ANNUAL PRECIPITATION

Figure 1.4



OKANAGAN BASIN
MEAN ANNUAL TEMPERATURE

Figure 1.5

falls within the "precipitation shadow" for moist Pacific air moving in from the west. The annual mean precipitation for the Okanagan Basin north of Oroville is some 22 inches.

Similarly the mean annual temperature decreases with latitude and elevation as shown in Figure 1.5. Table 1.1 shows a variation in mean annual temperature from 49°F for Oliver (elevation 1008 feet) to 37° F for McCulloch (elevation 4100 feet). The annual mean temperature for the Okanagan Basin north of Oroville is 41° F.

The hot, very dry air of summer, is characteristic of the Okanagan Valley. Even the continental polar air, which invades the valley from the north during the winter is usually warmed during its movement into more southerly latitudes, and as a result, the Okanagan Valley does not undergo long periods of continuous cold such as occur in the more northerly parts of the province.

The movement of Pacific air generally brings comparatively mild weather to the Interior of British Columbia. At times however, cold polar air may produce rapid temperature changes and a Frost Warning Service operated by the Atmospheric Environment Service of Environment Canada, located at Penticton Airport, is active during May and June.

It will be noted that the difference in average temperature in the South Okanagan between the warmest month (July) and the coldest month (January) is about 35° to 45 F. while the northern area, (from Westbank to Grindrod) and the mountainous plateau surface as represented by McCulloch are about five degrees cooler. January mean temperatures are typically from 25° to 28° F. for the South Okanagan and from 21° to 26° F for the rest of the Valley.

Annual evaporation from Okanagan Lake is estimated to vary between 29 and 43 inches while further south at Osoyoos Lake the losses are even higher and in the range of 36 to 50 inches. The average basin evapotranspiration is estimated to be 17 inches.

From an agricultural viewpoint the Okanagan Valley is considered to have one of the most favourable climates in the Province. A long frost-free period (150 to 200 days), and high temperatures 3,000 to 4,000 degree-days) during the growing season, permits the raising of many heat-sensitive crops. South of Vernon, soil moisture deficiencies during the growing season may exceed 12 inches and irrigation is a necessity. North of this point, moisture deficiencies range between nine and 12 inches and dry farming may be practiced successfully on the heavier textured soils, and to some extent on the lighter textured soils.

1.4 Soils

As outlined in an earlier section most soils in the Okanagan basin originated from glacial deposits. As a result of the influence of organic matter, topography, climate and time, this glacial till has in many places formed cultivable soils. It is estimated there are 77,000 acres of arable land in the Okanagan Basin as shown in Table 3.5.(Chapter 3)

Five major soil groups exist within the Okanagan Basin - namely. Brown Dark Brown, Black, Brown-Podzolic-Grey Wooded and Ground Water Soils (Figure 1.6).

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 than Brown soils, and texture varies from finely granular in sandy soil to fine crumb structure in clay loam and clay. They are more fertile and with irrigation produce large varieties of fruits and vegetables. These soils are found between Summerland and Oyama.

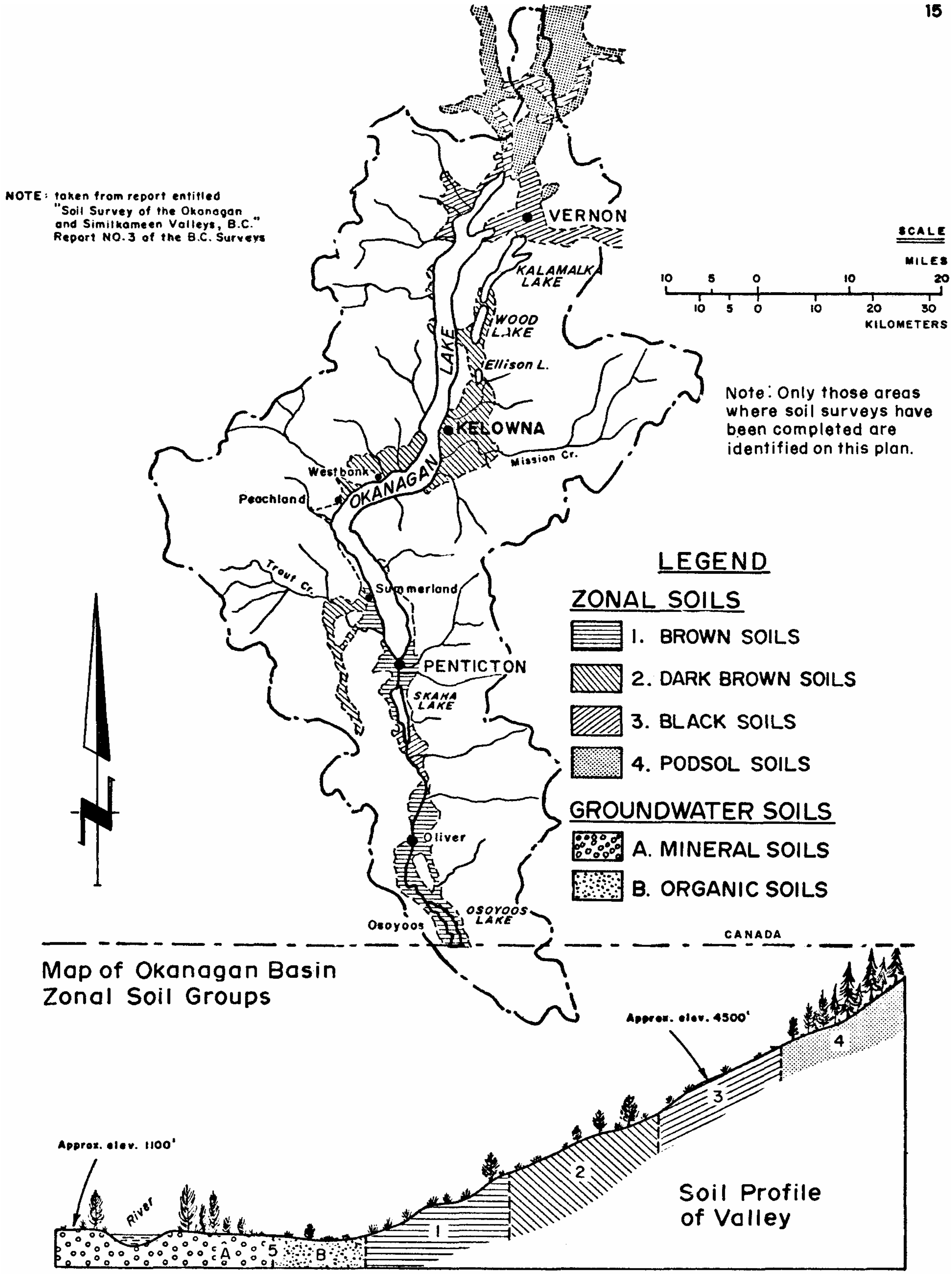
The Dark Brown soils give way to the Black soils at higher elevations where grass and areas of timber are found. These soils are fertile, rich in organic matter and with a soil structure varying from fine granular in sandy loams and loams, to granular and crumbly in clay loam and clay. For maximum production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

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 defined as those having a fluctuating water table, and bog or muck soils which have a water table at or near the surface. Typically found on level or gently sloping land, these soils are medium textured and generally support a moderate to dense tree cover. Groundwater soils with good natural drainage are used for orchard crops. The balance or wetter soils are used for forage crops, gardens and berries.

1 .5 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



PLAN AND PROFILE OF OKANAGAN BASIN SOIL TYPES

Figure 1.6

from 4,000 to 6,000 feet. It is typically associated with the plateau surface and mountain slopes on both sides of the valley. Cooler temperatures and 20 to 30 inches of precipitation are characteristic.

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 much of the Dry Forest zone as individual specimens or in thin 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 often found on moist sites in valley bottoms or near lake shores. Spring blooming plants are abundant when the 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 elevation. Burned or logged-over areas are frequently characterized by extensive stands of sub-dominant lodgepole pine. The forest undergrowth 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.