

ORIGIN AND DISTRIBUTION OF SURFACE WATER IN ALBERTA

2.1 ORIGIN

Water and climate acting over vast periods of time have influenced the distribution and characteristics of Alberta's water bodies. In the distant past, shallow seas advanced and retreated many times, depositing layer upon layer of sand and silt. These layers became compressed and hardened into the sandstone and shale formations found throughout most of the province (**Figure 2.1**). From the remains of the abundant aquatic life present in the seas, pockets of oil formed in porous rock, sands, and coral reefs. Fossilized remains of plants and animals provide a permanent record of the aquatic ecosystems in the Palaeozoic and Mesozoic eras in Alberta.

With the uplift of land during the Cenozoic Era, the seas retreated. The tropical climate became temperate and a rich mammalian fauna developed. Massive uplift and eastward movements of the earth's crust in what is now British Columbia formed the Rocky Mountains. The resulting folded and broken rock moved far eastward, pushing the sandstone and shale into great ripples, forming the foothills. Rivers that once flowed into Alberta from the west were cut off by the rising mountains. By the end of this first part of the Cenozoic, or the Tertiary Period, the bedrock geology of the province was established and with it, many of the topographic features that affect the flow of surface water and groundwater today.

The Quaternary Period that followed brought a cooling of the climate and four glaciations to North America. Only the last, the Wisconsin Glaciation, is well known. During this glaciation, ice sheets converged from the north and west until all of the province was covered at some point with the exception of parts of the Cypress Hills and Porcupine Hills.

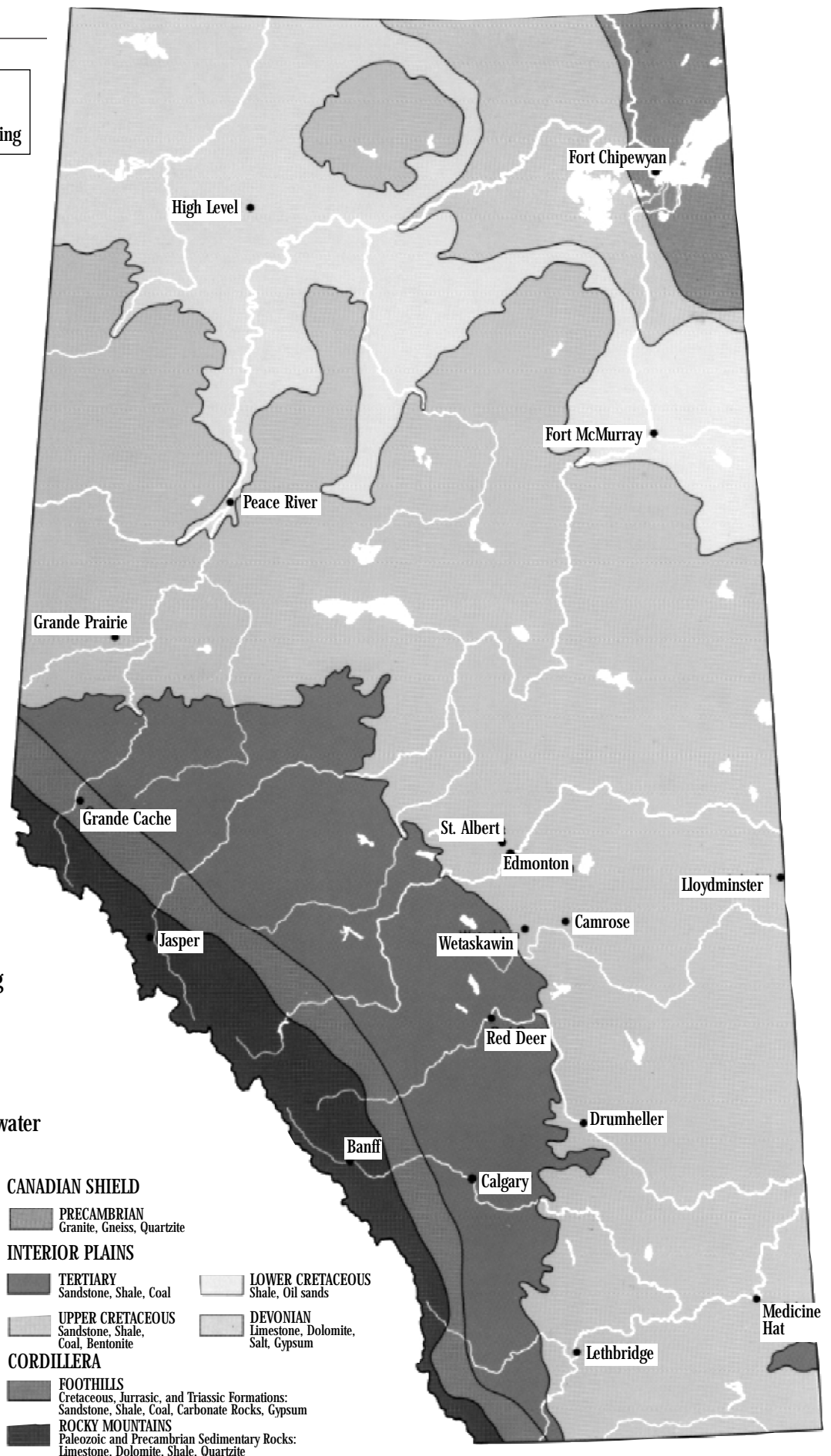
The influence of this glaciation on Alberta's water bodies is described in *The Atlas of Alberta Lakes* by Mitchell and Prepas (1990):

As the ice sheets advanced and retreated over Alberta, they sculptured the land, carving and eroding the mountains, moving rocks and depositing gravel and silts until the landscape was virtually as we see it today. The last retreat of the ice, beginning 12 000 years ago, left behind enduring impressions on Alberta. As the ice sheets melted and retreated, they left behind a blanket of

FIGURE 2.1 BEDROCK GEOLOGY OF ALBERTA
 source: Alberta Bureau of Surveying and Mapping

glacial till up to 100 metres thick over most of Alberta east of the mountains. In southern Alberta, the till forms a ground moraine, leaving a gently undulating surface. Water drains into gentle depressions to form shallow lakes like Eagle and Tyrell lakes. In central Alberta, the terrain is more hummocky and rolling; examples are found around Red Deer, from Elk Island National Park to Cooking Lake and west of Stony Plain. In some areas, large blocks of ice were left by the retreating glacier and till piled up around the ice so when the ice melted, holes or kettles, were left in the landscape. Small lakes fed and drained by groundwater now fill these kettles; examples are Spring, Eden and Hubbles lakes. In some areas, glacial till blocked preglacial channels, impounding water to form lakes like Crowsnest, Rock and Baptiste.

As the glaciers melted, they produced huge volumes of meltwater which cut through the till plain and formed long, steep-sided, flat-floored river valleys. Many of these valleys are now dry, or nearly dry. An example on the southern prairie can be seen where Verdigris, Etsizom, Chin and Forty Mile coulees are part of one series of meltwater channels. A number of these channels are now dammed to form offstream storage



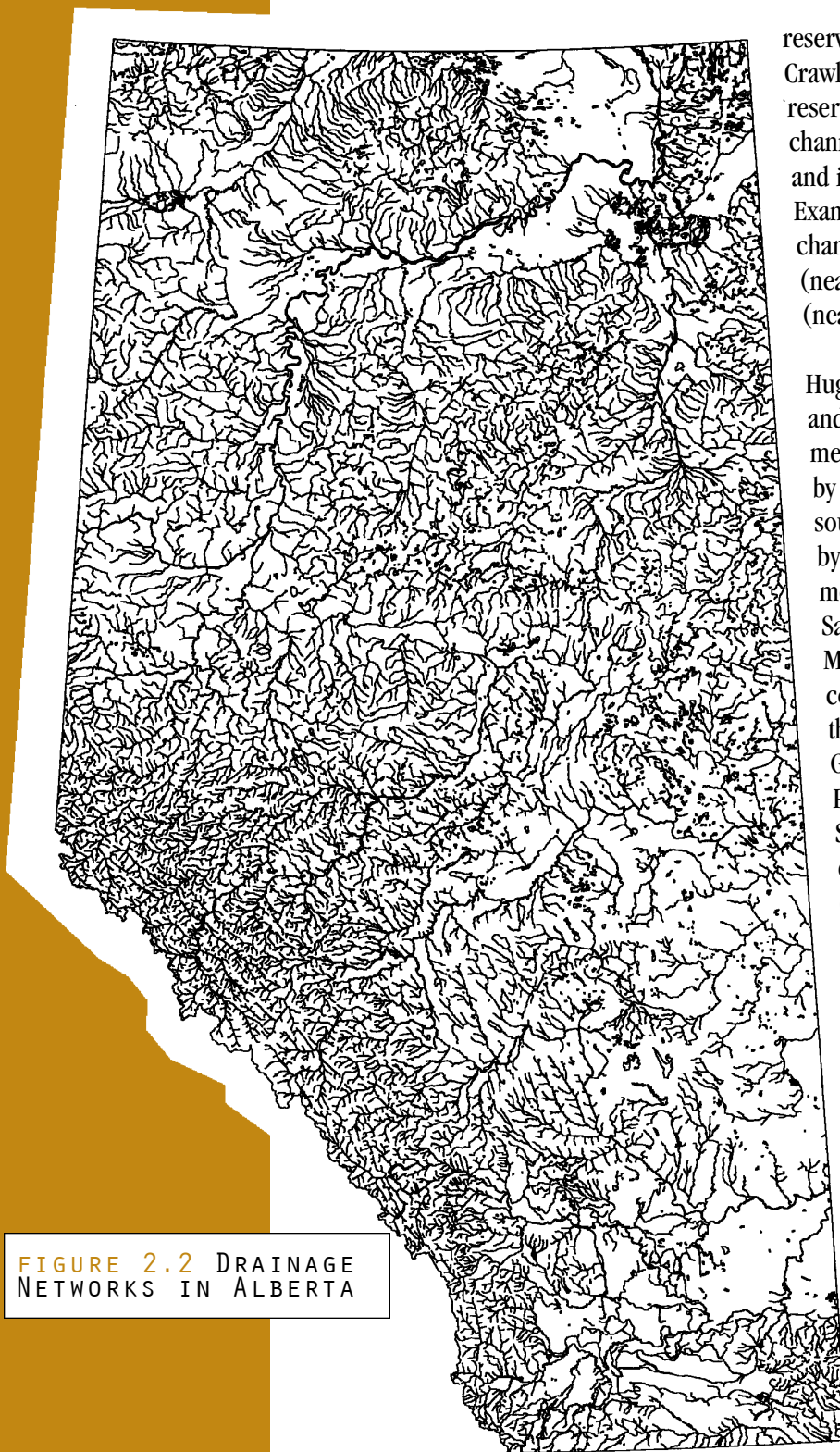


FIGURE 2.2 DRAINAGE NETWORKS IN ALBERTA

reservoirs, for example, Milk River Ridge, Crawling Valley, Chin and Forty Mile Coulee reservoirs. Another conspicuous meltwater channel is now followed by the Battle River and includes Driedmeat and Coal lakes. Examples of lakes in smaller meltwater channels in northern Alberta include Long (near Athabasca), Narrow, Long (near Boyle) and Amisk lakes.

Huge lakes covered large portions of Canada and North America as a result of glacial meltwater. These lakes provided the routes by which fish returned to the midwest from southern areas which had not been covered by ice. One of these, Lake Agassiz, covered most of Manitoba and parts of Saskatchewan, Ontario, North Dakota and Minnesota. This glacial lake provided a connection from the south to Alberta via the North and South Saskatchewan rivers. Glacial Lake Edmonton connected the Peace-Athabasca river system and the Saskatchewan river system. Other dispersal routes included temporary connections between the South Saskatchewan and Milk (and thus Missouri River) drainages. From an unglaciated area on the Columbia River, fish were able to enter Alberta via the Fraser and Peace river systems.

Climate, water, and land still interact today. Climatic factors such as precipitation and temperature determine the amount of water in rivers, lakes and wetlands. Flowing rivers still cut through glacial till and bedrock, eroding the land. In turn, soil and minerals from eroding land affect rivers and lakes, as do changes to the landscape, whether natural or man-made.

2.2 DISTRIBUTION OF AQUATIC ECOSYSTEMS

Precipitation falls to earth in the form of rain, sleet, hail, and snow. Some of this water returns to the atmosphere by evapotranspiration (evaporation plus transpiration from plants), some seeps deep into the ground to become groundwater, and the rest runs over the surface or through the upper layers of soils. This water collects in channels, forming watercourses (brooks, creeks, streams and rivers). These connect to one another in a treelike pattern, becoming ever larger, until they form large rivers. **Figure 2.2** shows the network of watercourses throughout the province.

The total amount of land drained by a large river and its tributaries is termed the drainage basin or river basin. A river basin also includes the lakes and wetlands that drain into the network.

Alberta is generally divided into five major river basins on the basis of its five major river systems. These basins are in turn part of larger continental drainage basins (**Figure 2.3**).

- **The Peace-Athabasca-Slave River Basin** occupies 64 percent of the province and is the largest and most northerly river basin in the province. The large Peace River begins in the British Columbia mountains and flows northeast across Alberta to the Peace-Athabasca Delta. The Athabasca River begins at the Athabasca Glacier in Alberta and

also flows northeast to the delta. The Slave River carries water from the Peace and Athabasca rivers into the Northwest Territories. The Peace-Athabasca-Slave River Basin is a part of the Mackenzie River Basin, which empties into the Arctic Ocean. Most of Alberta's river flow (86 percent) follows this route.

- **The North Saskatchewan River Basin**, in the central part of the province, occupies approximately 12 percent of the province. It is drained by one major river, the North Saskatchewan, which originates in the icefields near the British Columbia-Alberta border. The Battle River, which joins the North Saskatchewan River in Saskatchewan, rises in central Alberta. The entire basin has six percent of the total river flow in the province.

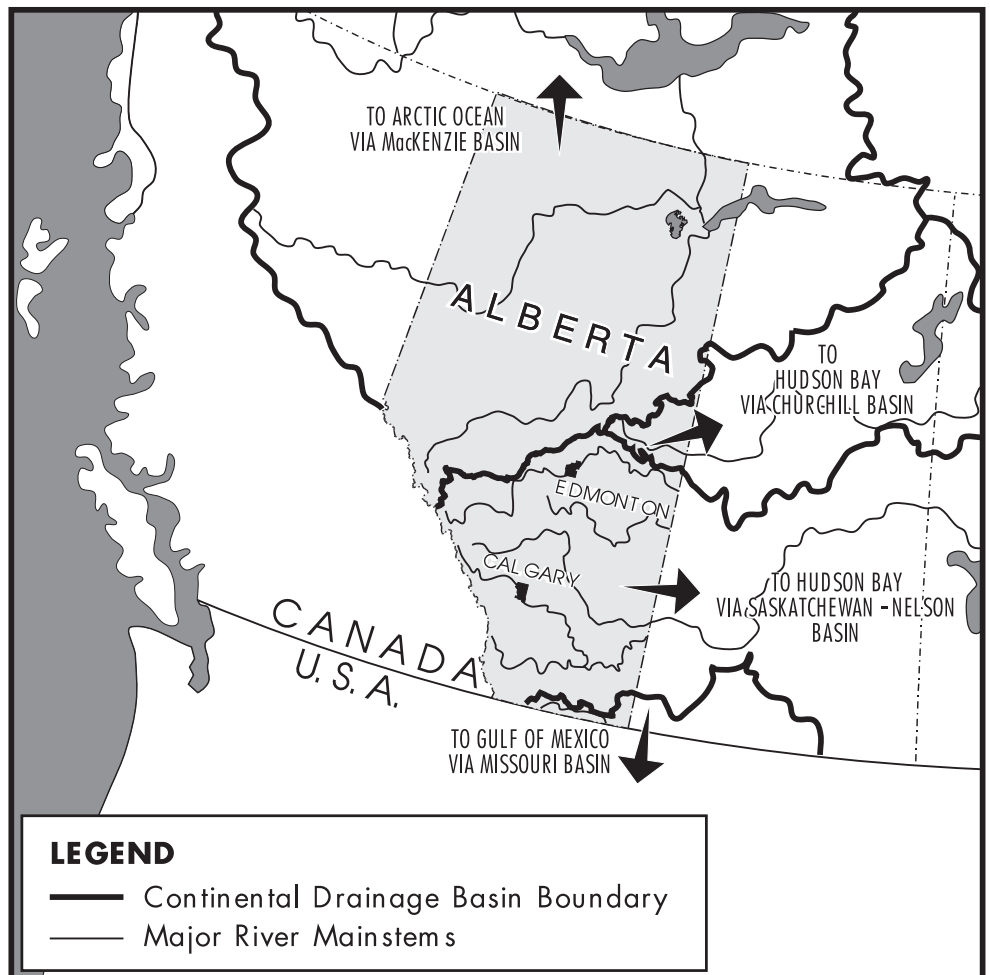


FIGURE 2.3 CONTINENTAL DRAINAGE BASINS IN WESTERN CANADA

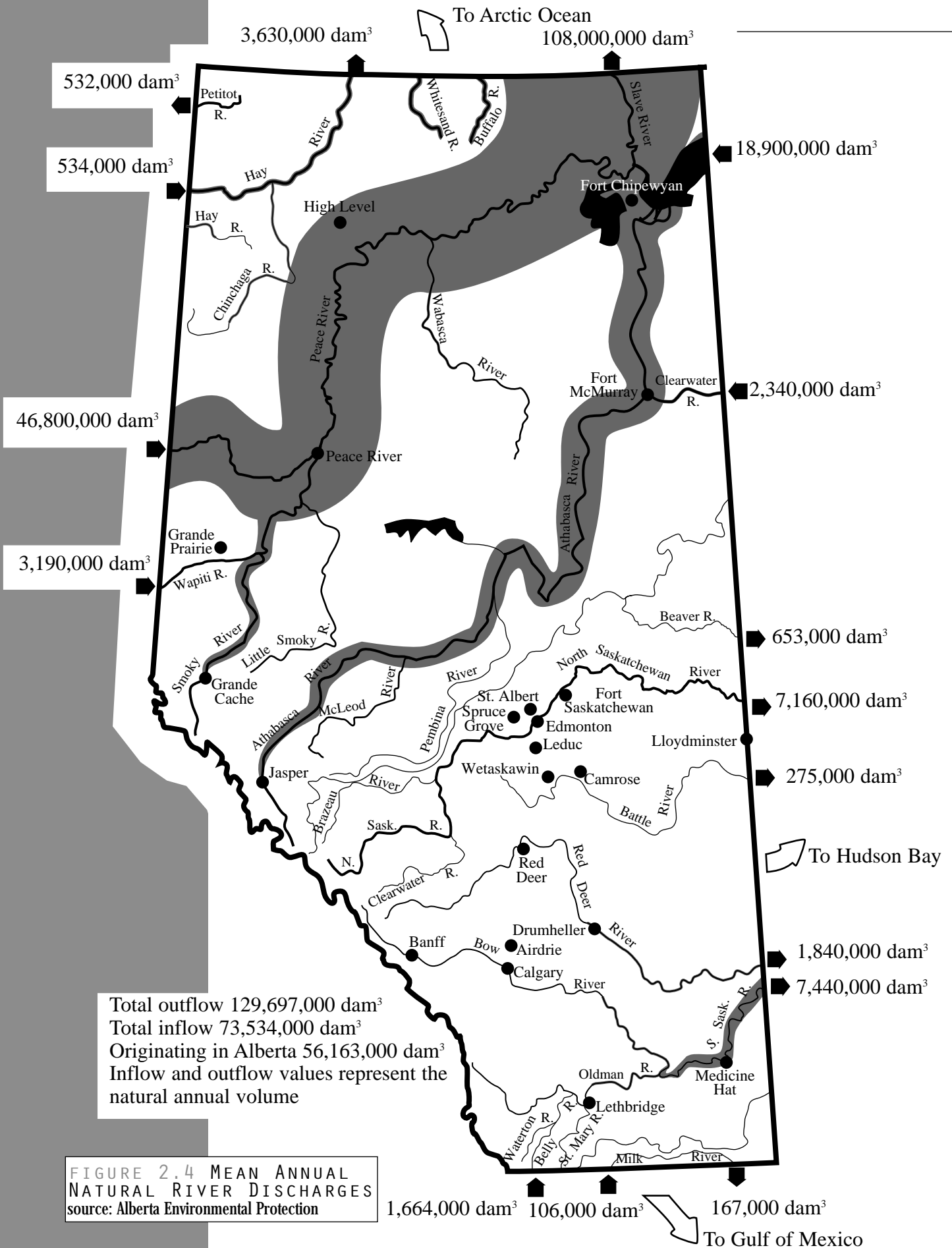


FIGURE 2.4 MEAN ANNUAL NATURAL RIVER DISCHARGES
 source: Alberta Environmental Protection

FIGURE 2.5 ALBERTA LAKES AND RESERVOIRS
 source: Alberta Environmental Protection

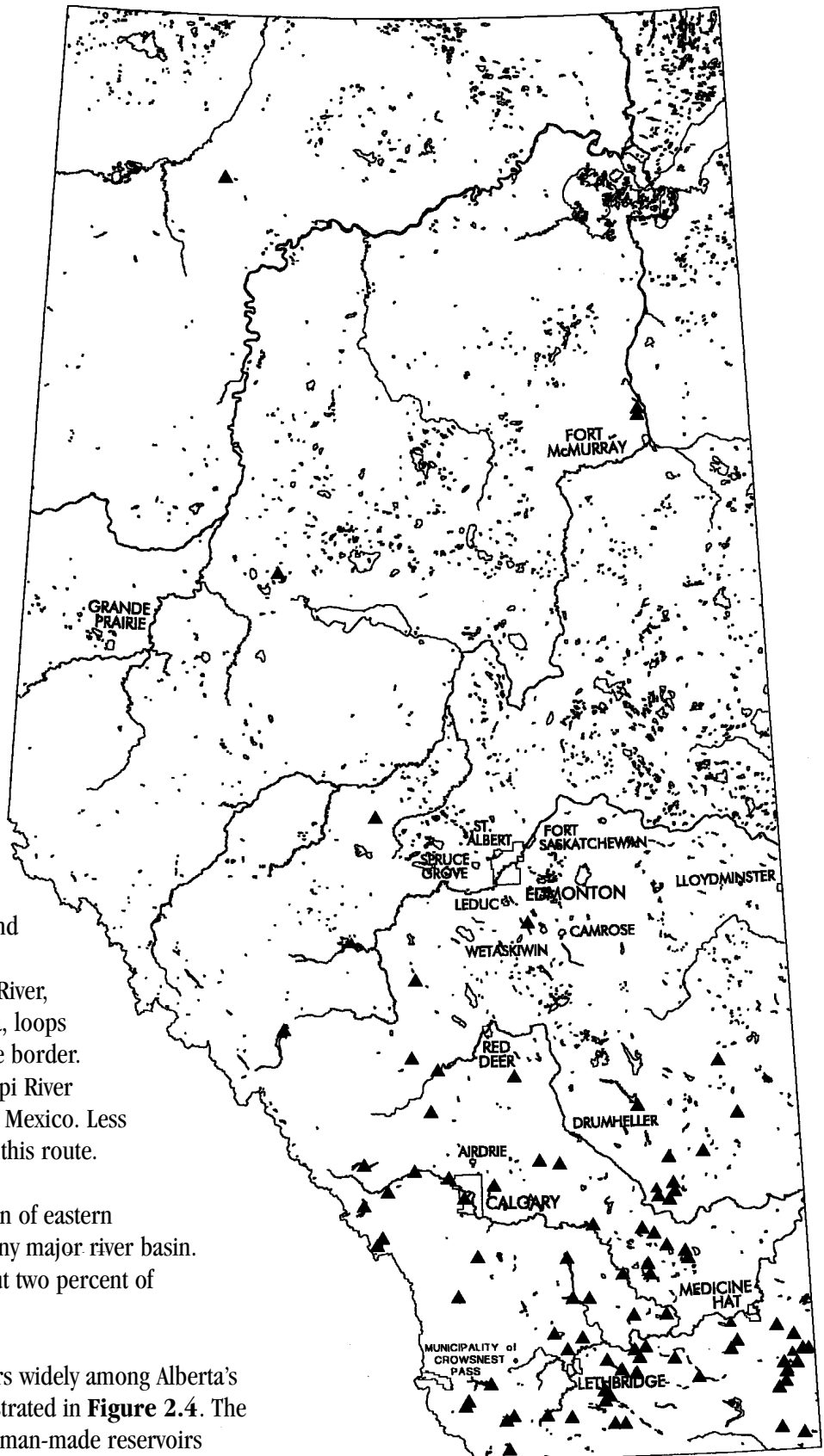
- **The South Saskatchewan River Basin** in the southern part of the province occupies nearly 18 percent of Alberta's land area. It is drained by three major rivers, the Red Deer, Bow and Oldman, all of which originate in the Rocky Mountains. The South Saskatchewan River itself is formed by the confluence of the Oldman and Bow rivers. It flows east across the Saskatchewan border where it is joined by the Red Deer River. Farther downstream, the South Saskatchewan River joins the North Saskatchewan River, as part of the Saskatchewan-Nelson River system flowing to Hudson Bay. The South Saskatchewan River carries seven percent of Alberta's river flow.

- **The Beaver River Basin** is a small basin that occupies approximately three percent of Alberta in the Boreal Forest Natural Region. Its major rivers, the Beaver and Sand, originate in northeastern Alberta and are relatively small in volume; the river flow in the basin amounts to less than one percent of the province's total. The Beaver River flows eastward as part of the Churchill River Basin that empties into Hudson Bay.

- **The Milk River Basin** is the most southerly and smallest basin in Alberta, occupying about one percent of the province. It consists of the Milk River, which rises in the Rocky Mountains of Montana, loops north into Canada, and returns south across the border. The Milk River is part of the Missouri-Mississippi River Basin, which eventually empties into the Gulf of Mexico. Less than one percent of Alberta's river flow follows this route.

A small area in the Provost-Coronation-Oyen region of eastern Alberta is self-contained and does not drain into any major river basin. This basin, the Sounding Creek Basin, covers about two percent of the province.

The abundance and amount of surface water differs widely among Alberta's river basins. Rivers are largest in the north as illustrated in **Figure 2.4**. The largest lakes are also found in the north, whereas man-made reservoirs predominate in the south (**Figure 2.5**). South of Calgary, almost all sizeable bodies



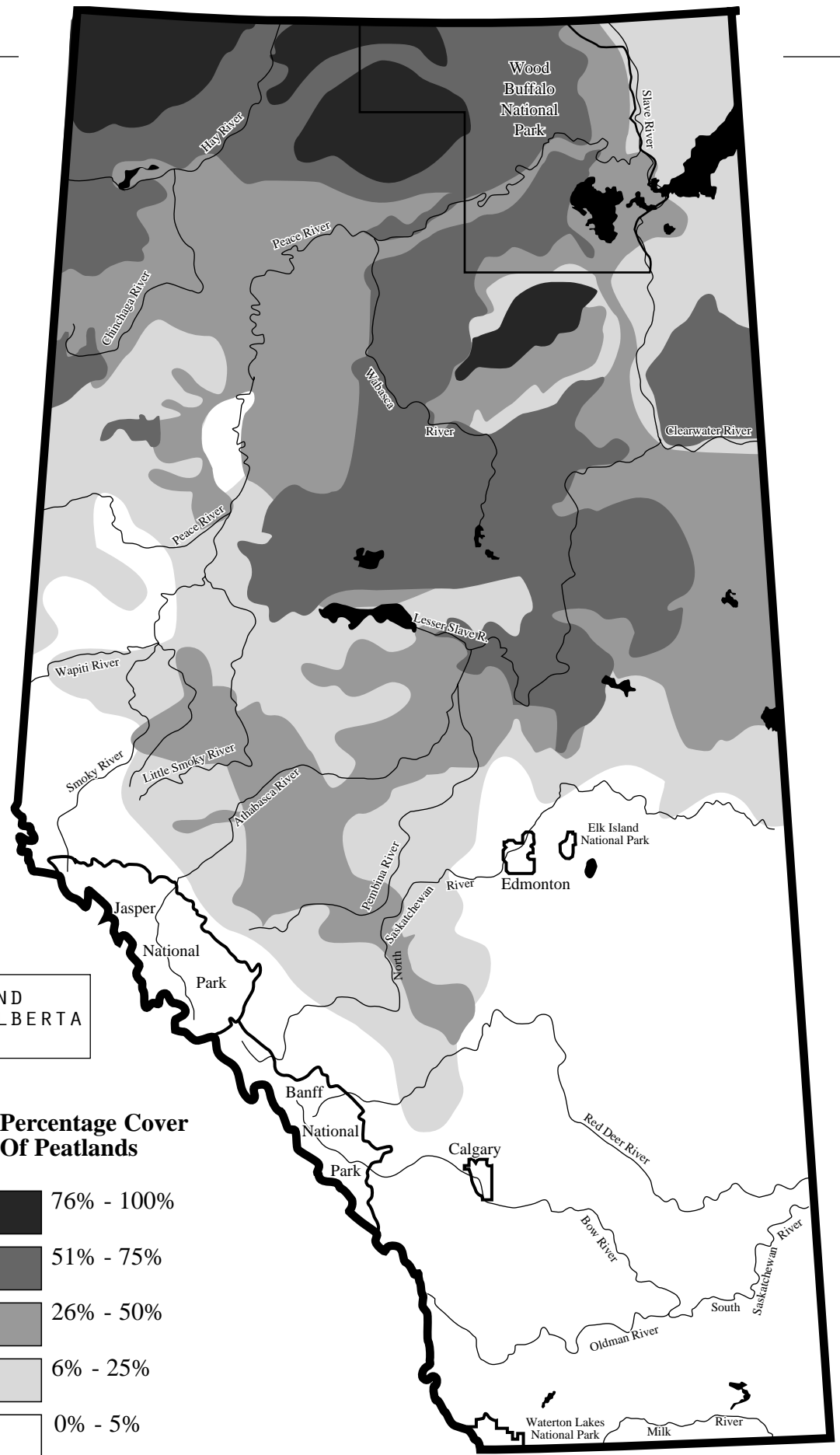
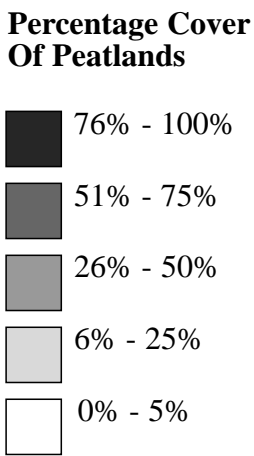


FIGURE 2.6 PEATLAND DISTRIBUTION IN ALBERTA
 source: Turchenek and Pigot, 1988



of water are reservoirs, as few natural lakes exist there. Some of the 89 reservoirs in southern Alberta's irrigation districts have been formed from regulated natural lakes, others from impounded watercourses, and still others from water diverted from streams and rivers (McNaughton 1993). The area covered by wetlands also increases greatly from south to north. In northern Alberta, large peatland complexes cover vast areas (Figure 2.6; see also Section 3.3). In southern Alberta, on the other hand, an estimated 330 000 wetlands cover less than five percent of the total land area. Most of these are small and seasonal, shrinking as the summer progresses. Many of the larger prairie wetlands have been enhanced through cooperative efforts involving Ducks Unlimited Canada and other agencies (Figure 2.7; see also Section 6.4). As one travels north, wetlands become larger and more permanent.

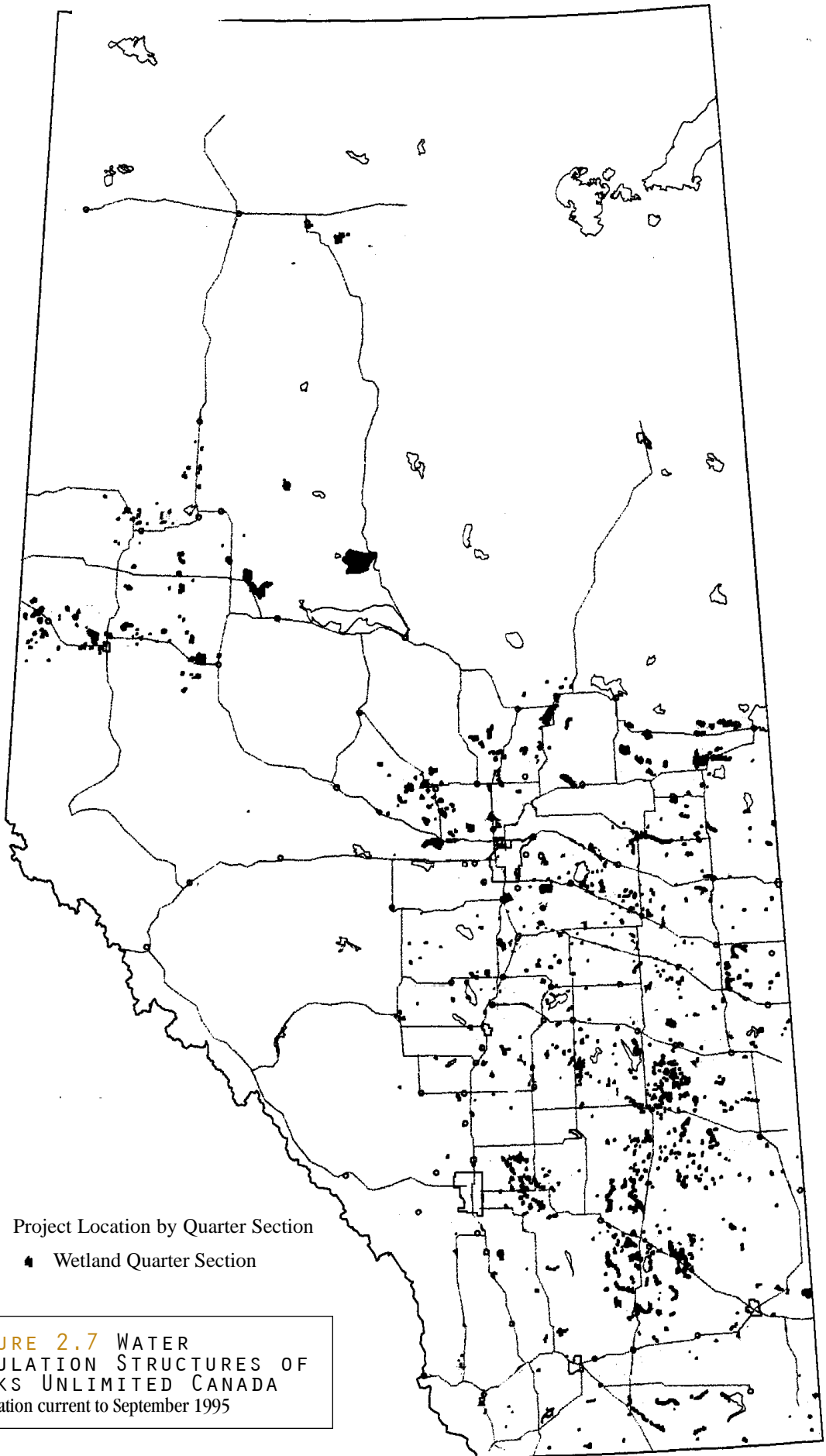


FIGURE 2.7 WATER REGULATION STRUCTURES OF DUCKS UNLIMITED CANADA
 information current to September 1995

Table 2.1 summarizes the distribution of surface water bodies in the province. With the exception of man-made water bodies, this distribution is the result of the glacial history described above and the action of present-day climate on landscapes. These climate-landscape-water patterns are reflected in Alberta's natural regions, as shown in **Figure 2.8**.

TABLE 2.1
DISTRIBUTION OF
AQUATIC
ECOSYSTEMS
AMONG ALBERTA'S
RIVER BASINS

River Basin	Rivers	Lakes	Wetlands
Peace-Athabasca-Slave			
Beaver			
North Saskatchewan			
South Saskatchewan			
Milk			

Total amount of water present



ALBERTA'S NATURAL REGIONS

The Grassland Natural Region has the driest climate in Alberta. The easternmost part of this region receives only about 300 mm of precipitation annually, the rest receiving only marginally more. Because evaporation exceeds precipitation in this region, there are few natural lakes among these flat to gently rolling plains. In wet years, there are many small wetlands scattered throughout the region, but in dry years, many of these disappear. The rivers of the South Saskatchewan and Milk river basins bring life-giving water from the mountains to this region.

The Parkland Natural Region occupies most of the North Saskatchewan River Basin and extends southward into the South Saskatchewan River Basin. An isolated northern patch, the Peace River Parkland subregion, lies between Grande Prairie and Peace River. The climate of the Parkland Natural Region is cooler and wetter than that of the Grassland Natural Region. Precipitation averages approximately 450 mm annually. Thousands of wetlands in small depressions dot the “knob and kettle” terrain created by the last glaciation. Melting snow fills these depressions in the spring, forming “pothole” sloughs. Many shallow lakes are also present along with a few larger ones.

The Boreal Forest Natural Region includes the Beaver River Basin and the Peace-Athabasca-Slave River Basin. The region has more precipitation and cooler temperatures than the Parkland Natural Region, and contains many large and small lakes. Small marsh wetlands are common in the

FIGURE 2.8 NATURAL REGIONS OF ALBERTA
 source: Alberta Environmental Protection

southern portion, while areas of low topography in the north contain some very large wetlands. Large peatland complexes accumulate in the middle and northern parts of the region, which have a colder climate and snow cover lasting an average of 185 days a year. Organic soils on hills and plateaus in the northern portion remain frozen throughout the year.

The snowfields and glaciers of the **Rocky Mountain Natural Region** are the source of many of Alberta's major rivers. In the Alpine and Subalpine subregions, freezing temperatures occur in all months and the frost-free period is usually less than 30 days. Winter precipitation is the highest in the province with often more than 200 cm of snowfall. Lakes occur in glacially carved basins and preglacial valleys. Wetlands occur in depressions and valley bottoms.

Lying between the mountains and plain, the **Foothills Natural Region** is traversed by many of Alberta's major rivers. It is an area of relatively high precipitation (approximately 570 mm annually). Winters here are often warmer than those of the Boreal Forest. Lakes are small and wetlands are common in low-lying areas.

The **Canadian Shield Natural Region** lies within the Peace-Athabasca-Slave River Basin in the northeast corner of the province. The Kazan Upland Subregion is a mosaic of rock barrens, sand plains, lakes, and small streams. The Athabasca Plain Subregion south of Lake Athabasca is an area of sand deposits and dunes. Throughout the entire region, annual precipitation is low and the frost-free period is only 60 days. Peatlands are common in wet depressions.

