2.0 METHODOLOGY

The methodology for the study consists of three components: understanding the allocations, determining current water use and preparing water use forecasts.

2.1 Water Allocations

In Alberta, water is allocated under the *Water Act* in terms of licences and registrations. A complete list of surface and groundwater licences and registrations, as recorded in the Environmental Management System (EMS), was provided by Alberta Environment in October 2006. The EMS database includes a list of all active, cancelled, and expired water licences (approximately 32,000). The EMS database also includes approximately 90,000 registrations. A list of water licences (2,919) and registrations (19,385) specific to the North Saskatchewan Basin was extracted from this master database.

The analysis of current water demand only considered active water licences up to 2005 (approximately 2,462), although cancelled and expired were used to determine historical trends. In addition, licences that did not contain allocations were excluded from the analysis. This report uses 2005 as the base year for the analysis. Registrations do not have an expiry date and all were issued prior to 2005.

Three water use factors are considered in issuing water allocations. Allocations reflect the amount of water that the licensee is expected to consume, plus losses due to seepage or evaporation, and a possible allowance for returning water back to rivers and lakes after use. In this assessment, the term “licensed water use” reflects those components of the allocation that are expected to be consumed or lost. In determining what percentage of allocations is currently being used, actual water use is compared to licensed water use. While understanding the return flow allowance is important because return flows represent water that can be available for use by other licensees, the allowances only form part of the overall allocation and are not enforceable.

The assessment differentiates between water allocations, which represent the amount of water that can be taken from surface or groundwater sources, and licensed water use, which includes the portion of the licence the amounts specified in licensed for consumption and losses and represents water that is not available for reuse. The difference between water withdrawals and water use consists of return flows, which are available for reuse. The assessment of water use also differentiates between licensed water use, which represents the maximum amounts that licensees are entitled to use, and actual water use, which is based on current levels of water use.

The main objective in reviewing water allocations was to organize the licence data into specific water use sectors that could then be used for preparing water use forecasts for each sector in each sub-basin. The licence information for each sector was then aggregated to produce estimates of the maximum water volumes that could be diverted, maximum consumption, losses

and return flows identified in the terms of these licences. The water use sectors developed for this assessment were previously determined in consultation with Alberta Environment and reflect a refinement of the “Activity” and “”Specific Activity” classifications currently used in the EMS database. These refinements are necessary because some of the categories in EMS are so broad that it is not currently possible to differentiate among water used for various purposes. In addition, variations in licensing practices among Alberta Environment offices has meant that some uses currently identified as “Commercial” may have previously been classified as “Industrial”, so it was necessary to reclassify licences to improve overall consistency and to align with the economic sectors used for water use forecasting.

Overall, six general water use sectors are used in this assessment. These six sectors, and the individual water uses contained in each sector are described in Table 2-1. Although some components, such as oilsands mining, are not applicable to the North Saskatchewan River Basin, the table is meant to illustrate the revisions and reclassification made to the EMS data.

The classification of water licences into the six sectors involved looking at the original classification in EMS, examining the name of the licensee, and sometimes even checking against the original licence document, using the priority number as the reference.

A number of problems and challenges arose during the process of classifying licences into appropriate sectors and/or sub-basins:

- Although priority numbers are supposed to be unique, there were a number of situations where licences had the same number. In these cases, information from both licences were included the analysis, but the details have been forwarded to Alberta Environment for further investigation.
- The database contains some licences that are shown as having expired. Where it appears that these licences are in the process of being renewed, they have been considered to be active because Alberta Environment allows a one-year grace period after the posted expiry date.
- Licences that are not currently being used because the licensee or the project for which the licence was issued may actually no longer exist.
- The river basin classifications does not always correspond to the location information (latitude and longitude) provided in the EMS. However, since it was undetermined whether it was the location or the basin classification information that was incorrect, no corrections were made for this discrepancy so river basin classifications in EMS were used in data analysis. This discrepancy is minor, affecting about one percent of the total allocation at the provincial scale. At the basin level this discrepancy is higher but is not likely to appreciably change the overall results and conclusions contained in the report.

Table 2-1 Current and Revised Water Use Sectors and Components

Sector	Current Environmental Management System (EMS)			Revised Water Use Classifications
	Activity	Specific	Specific Activity Name	
Municipal and Residential Water Use	WDMUN	URBAN	Urban, villages, summer villages, towns, cities, hamlets	Municipal
		SUBVDIVID	Subdivisions	
		CONDOD	Condominium/townhouses/mobile homes/complexes, hotels, motels	
		COOPD	Cooperatives, farmsteads, single-multi homes, colonies	
		CAMPS	Camps	Municipal Institutional/Other
		INSTITUT	Institution, senior/correctional centres, nursing/children's homes, hospitals	
		SCHOOLS	Schools, training centres	
		MOTHER	Other (fire protection)	
Agricultural Water Use	WDAGR	FEEDLT	Feedlots	Agriculture – Feedlot
		STCKWT	Stockwatering	Agriculture – Crops & Stockwatering
	WDIRR		Crops	Agriculture – Irrigation
	WDREG	REGISTRY	Traditional Agriculture User Registration	Agriculture – Traditional use
Commercial Water Use	WDCOM	GRDN	Gardening, market gardens, sod and tree farms	Commercial – Gardening & Sod
		GLFCRS	Golf courses	Commercial – Golf Courses
		PRK	Parks	Commercial – Parks & Recreation
	WDREC	RCRTN	Recreation	
	WDCOM	AGGWSH	Aggregate washing	Commercial – Gravel Mining & Washing
		CNSTRCT	Construction	Commercial – Construction
		BTTLNG	Bottling	Commercial - Bottling
		GWHAULING	Groundwater well – water hauling	Commercial – Water Hauling
		SWHAULING	Surface water – water hauling	
		OTHR	Other (dust controls, abattoirs, bridge washing, hydroseeding)	Commercial – Other
Petroleum Water Use	WDIND	INJECTN	Oilfield injection	Industrial- Oil & Gas – Injection
		GAS/PTRO	Gas/petrochemical plants	Industrial – Oil & Gas Plants
	WDCOM	OIL/GAS	Drilling (developing oil/gas wells	Industrial – Oil & Gas Drilling
	NEW			Industrial – Oil and Gas Thermal
				Industrial – Oil Sand
				Industrial – Disposal - Injection
Industrial Water Use	NEW			Industrial – Pulp & Paper Mills
				Industrial – Chemical Plants
				Industrial – Fertilizer Plants
	WDPOWER	HYDRPWR	Hydro-power	Industrial – Hydropower/ Non-thermal
	WDCOM	COOLING	Cooling	Industrial – Power Plants - Cooling
	NEW			Industrial – Mining - Coal
				Industrial – Mining - Other
Other Water Use	WDDEWAT	DRAINAGE	Drainage (gravel pits, mines)	Other – Water Management
		REMEDIA	Remediation	
		FLOODCNT	Flood control	
	WDWMNGT	STBLZTN	Stabilization (lake level)	
	WDFISH	FISHERY	Fish, fish farms/hatcheries	Other – Fish, Wildlife & Enhancement
	WDWILD	SRWILD	Storage reservoir for wildlife	
	WDHBTENH	WTLANDS	Wetlands	
	WDOTHER	SOTHER	Specified by the Director	Other –Specified Use
	WDWCO	WDC	Water conservation holdback	Other – Water Conservation Objective

- The NSWA boundaries for the Cline and Ram Sub-basins do not match the Water Survey of Canada (WSC) sub-watershed boundaries (05DA for the Cline and 05DC for the Ram). The WSC sub-watershed boundaries were used for this analysis because licences are described in terms of their WSC classification. Given that the headwaters of the North Saskatchewan Basin have few water licences, the difference in the sub-basin classification of the licences resulting from the use of different boundaries is minor.

2.2 Current Water Use

This assessment differentiates between licensed allocations, which represent the maximum amounts that licensees are entitled to withdraw, and actual water use, which reflects actual levels of water use. Actual water use is typically less than licensed water use because licensees may not actually withdraw the maximum amount of their entitlement and their net consumption is the difference between what they withdraw and what they put back (return flow).

The main source of information for determining actual water use was Alberta Environment's electronic Water Use Reporting System (WURS). The WURS database contains information on annual and monthly water withdrawals and use voluntarily submitted by licensees on an annual basis. However, WURS is a very new database and contains only a few years of information for a small percentage of licensed water users. The information that is available in WURS does not represent all of the water use information that is available. Some water licences, especially the larger ones, require licensees to submit annual reports and these have typically submitted in paper form and have been archived in a mix of paper and electronic files. No attempts were made during this study to access individual paper water use records. A review of the archived electronic records showed that about 35 percent of these records could not be traced back to specific licences (i.e. no or incomplete priority numbers), the remaining records were very dated, and most historical water use data was for injection purposes and there are better sources of recent water use information for this sector.

2.2.1 Municipal and Residential Sector

For the municipal sector, the water diversion, return and use information within the provincial Water Use Reporting System (WURS) is very limited. To make reasonable municipal water use estimates, it was necessary to use information from Environment Canada's 2006 Municipal Water and Wastewater Survey (MWWS). The MWWS contains 2004 water diversion and wastewater return flow data for 33 municipalities in the NSRB that represent 91 percent of the 2006 basin population. Ratios of diversions to licensed allocations and diversions to return flows were calculated for these communities and were used to estimate water use for those communities for which no other water diversion and/or use information was available.

MWWS contains no information for rural water use. Rural water use includes licences issued for rural condominiums/townhouses/mobile homes/complexes, hotels/motels, cooperatives, farmsteads, single-multi homes, colonies and subdivisions, or other municipal uses (i.e. camps, institutions, senior/correctional centres, nursing/children's homes, hospitals and fire protection). For purposes of estimating actual withdrawals in 2005, the ratio of diversions to allocations determined for primarily urban municipalities was assumed to be the same as for rural users. Only a few of the licences issued for rural use have return flow allowances and, for these

licences, actual return flows were calculated by multiplying estimated withdrawals by the ratio of licensed return flows to licensed allocations. For those rural users that have no return flow allowances in their licences, it was assumed that all water withdrawn was used.

MWWS also does not have water use data for unlicensed municipal uses, such as rural domestic water withdrawals from private wells or surface water sources, nor does it have information on rural wastewater. There are also known to be unlicensed urban water users in the Capital Region (which is situated in the Strawberry, Sturgeon and Beaverhill sub-basins) who are serviced by regional water commissions that purchase water from EPCOR in Edmonton.

Populations serviced by municipal water and wastewater systems were scaled up to the entire sub-basin or Capital Region population to estimate total water use including both licensed and unlicensed users. The total water use estimate was divided into urban, rural and other groundwater and surface water uses according to the urban, rural and other groundwater and surface water allocation ratios of water licensees. This may not result in accurate categorization of use estimates but, given that unlicensed users can be urban, rural or other users and the relative proportion of each of these types of unlicensed users is not known for each sub-basin, allotting water use estimates according to the licensed allocation ratios of the municipal water use types seemed appropriate.

The resulting estimates of actual diversions and water use must be interpreted with caution. Water use estimates for the North Saskatchewan Basin, where 89 percent of the population resides in urban areas in the Capital Region, are generally considered to be reliable because there is MWWS data available for the larger communities and any errors in the estimation process for the rural communities will have a relatively small effect on the overall water use estimates.

With respect to estimating return flows, there is some uncertainty because unraveling the complexity of water and wastewater sharing agreements among municipalities and regional water and wastewater commissions was beyond the scope of this study. Effort was made, however, to understand water and wastewater flows and transfers among major users in the Capital Region.

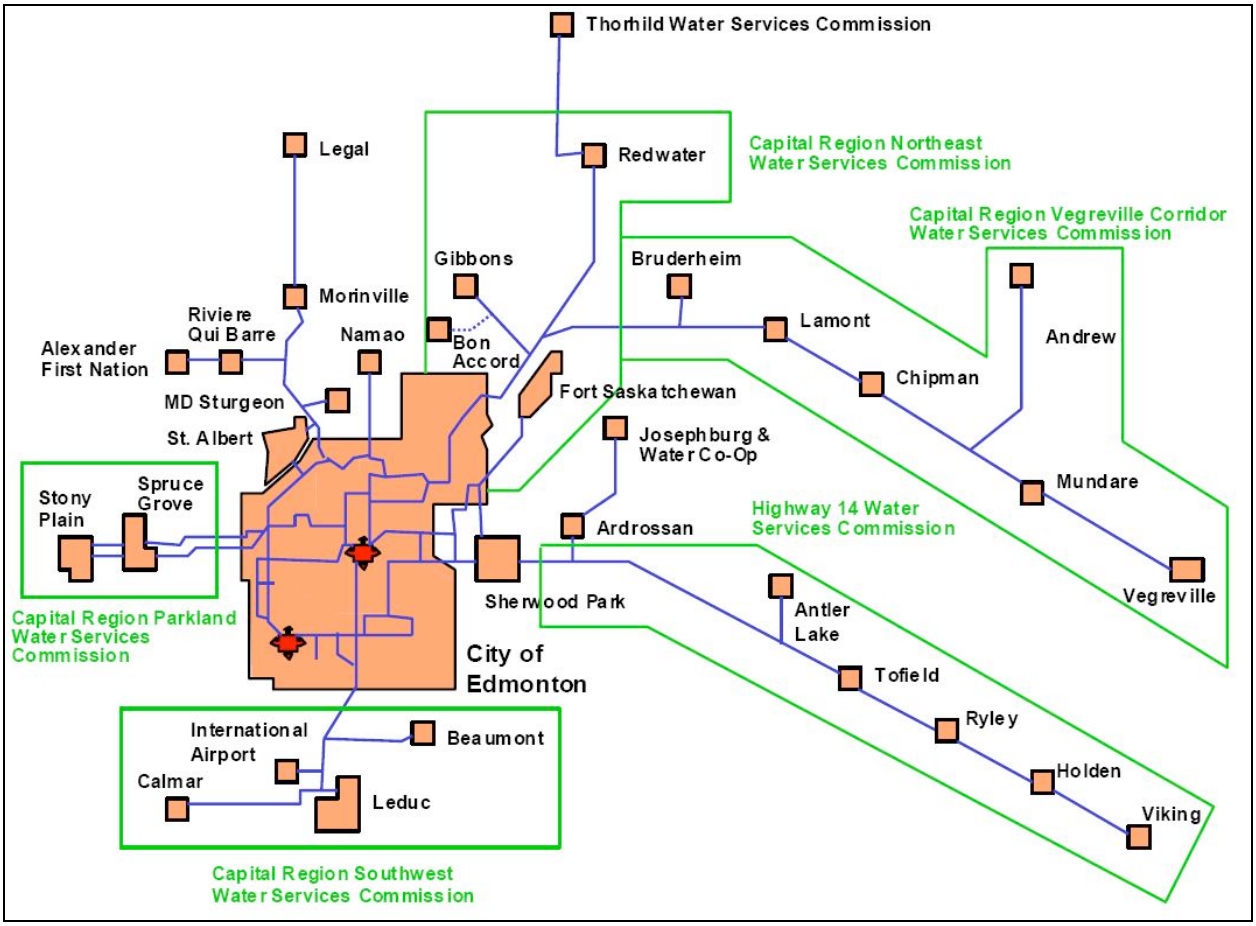
2.2.1.1 Capital Region Water Use

Municipal water use in the North Saskatchewan Basin is complicated by the fact that parts of the Capital Region, which accounts for the majority of the basin's population, are situated in the Strawberry, Sturgeon and Beaverhill sub-basins. Because the Capital Region is not discretely situated in one sub-basin, its water use profile is described here. Additional information is provided in the discussions for each of the sub-basins.

Municipal water and wastewater systems within the Capital Region are complex due to interrelated and interconnected water and wastewater treatment and distribution systems. EPCOR operates the E. L. Smith and Rossdale Water Treatment Plants in Edmonton along the North Saskatchewan River. EPCOR not only distributes treated water to Edmonton water users,

but also to eight regional water commissions that deliver water to 45 communities within the Capital Region. EPCOR-serviced communities and the associated regional water commissions are shown in Figure 2-1. Recipients of this water do not require a water licence because they are purchasing water fro EPCOR rather than withdrawing the water themselves, although some of the municipalities serviced by the regional water commissions also have separate licences for withdrawals within their own municipalities.

Figure 2-1 Capital Region Communities and Water Commissions Served By EPCOR



With respect to return flows, the Goldbar Wastewater Treatment Plant at Edmonton and the Capital Region Wastewater Treatment Plant at Fort Saskatchewan collect and treat wastewater from at least four cities and 12 municipalities, respectively. Additional sewage treatment facilities also exist in the Capital Region. For example, Strathcona County sends wastewater to six lagoons for primary treatment and outflow to wetlands, in addition to sending wastewater to the Capital Region Wastewater Treatment Plant for return to the North Saskatchewan River.

Complicating the picture are domestic water users who draw water from private wells, primarily in the rural areas of Capital Region municipalities. These users draw groundwater but may contribute to surface water when holding tanks are pumped out and added to regional sewage lagoons for treatment and eventual return to surface water sources. Stormwater and groundwater seepage also contribute to wastewater volumes and return flows.

The proportion of municipal populations that are serviced by water and wastewater systems ranges from two percent for Beaver County up to one hundred percent for Devon, Tofield and St. Albert. Those populations that are not serviced by water and/or wastewater distribution systems rely on private water wells or surface water withdrawals, water and/or wastewater haulage, or private septic systems.

To gain understanding of the complex system of municipal water use in the Capital Region, a crude water balance model was built. While a complete water balance model that identifies all water, wastewater, groundwater seepage and stormwater flows and groundwater to surface water and inter-basin transfers (via water haulage or pipes) would be preferable, this was not possible because of the complexity of the system and the lack of information on flows of treated water and wastewater. As a consequence, a simple annotated flow diagram (see Appendix 1, Figure 1) was constructed based on existing 2004 MWWS water and wastewater flow data, treated water flow data from the E. L. Smith and Rossdale water treatment plants received from EPCOR (Tarra Kongsrude, pers. comm. 2007), and wastewater flow data received from the Goldbar (City of Edmonton, 2007) and Capital Region wastewater treatment plants (Capital Region Wastewater Commission, 2006). Additional flow data and system interconnections were provided by NSWA (Gord Thompson, pers. comm. 2007). The flow diagram includes an annualized dry weather estimate of Capital Region water use and identifies the assumptions used.

The figure shows that, based on existing data and assumptions, estimated net water use for the Capital Region was 5,267 dam^3 or approximately 5 percent of the water supplied. This estimate is also shown in Table 2-2. On the water flow side, the estimate includes flows to Edmonton and the regional water commissions and outlying communities shown in Figure 2-1. Treated flow from EPCOR in 2004 was 127,012 dam^3, of which 96,913 dam^3 went to Edmonton and 30,099 dam^3 went to the regional commissions and communities. The water supplied to Goldbar and the Alberta Capital Region Wastewater Commission service areas in 2004 was 120,956 dam^3. On the wastewater side, the estimate accounts for 115,875 dam^3 of annualized dry weather (i.e. winter) treated flow returned to the North Saskatchewan River (NSR) by the Goldbar and Capital Region Wastewater Treatment Plants, 6,056 dam^3 returned elsewhere in the NSR via other treatment mechanisms such as lagoons, and 186 dam^3 lost to the basin through transfer to the Battle Basin community of Viking. The wastewater flow treated by the two wastewater treatment plants including groundwater seepage and stormwater runoff contributions was 122,138 dam^3. Thus, the net municipal water balance would indicate water use of -996 dam^3. Groundwater and stormwater contributions to treated wastewater therefore mask municipal water use. It is important to remember that groundwater and stormwater runoff would flow to the North Saskatchewan River regardless of whether a sewage system and wastewater treatment plant were present or not.

Although the base year for this study is 2005, the need to combine the above data sets justified use of the 2004 data because it is the most recent year for which data was available from all of the different sources. A 2005 estimate would have been virtually identical given that EPCOR, Goldbar and Capital Region flows in 2005 were virtually identical to the 2004 flow values.

Table 2-2 Licensed Municipal Allocations and Use and Estimated Actual Use, Capital Region (Strawberry, Sturgeon and Beaverhill Sub-basins) – Water Balance Model

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Actual Water Use (dam^3)		
			Allocation	Water Use	Return Flow	Diversion	Estimated Use	Return Flow
Urban	Surface	2	135,803	37,033	98,770	127,012	5,267	121,745
	Total	**2**	**135,803**	**37,033**	**98,770**	**127,012**	**5,267**	**121,745**

Figure 2-1 shows that the dry weather treated effluent at ACRWC WWTP is greater than the water supplied to the ACRWC WWTP service area. A possible explanation for this may be that some municipalities have residents with private water wells that are not counted in the water flow system, but are connected to the wastewater collection system.

It was noted that there are discrepancies between MWWS flow data among the municipalities belonging to the regional water commissions and EPCOR's data of the flow it delivers to the regional water commissions. EPCOR's data is considered more authoritative and was used given that it is direct from the source rather than indirect via the MWWS. To what degree are municipalities double-counting flows within the regional distribution system when they report to MWWS? In order to answer this question a study would need to be undertaken that compares all MWWS flow values with those provided directly by the source communities and commissions responsible for those flows. Other gaps that would have to be filled in order to increase the accuracy of the use estimation using the regional water balance method include identification of groundwater seepage, stormwater flows and variability and flow data for individual wastewater treatment lagoons in the region.

2.2.1.2 Water Use in Other Sub-basins

The method employed throughout this study for sub-basins outside the Capital Region relies on MWWS water and wastewater flow data of licensed municipalities to determine a combined water diversion, return and water use for those municipalities. Available data was used to estimate per capita diversion and return, use values for each sub-basin, and this information was scaled up to reflect the total population of each sub-basin. The proportion of the population served by the water and wastewater systems are accounted for, so that the per capita estimates are based on those served rather than the entire population. In this manner, an appropriate per capita value can be scaled up to the sub-basin or regional population to arrive at water use estimates that include both those served by a public system as well as those with private, unlicensed systems.

However, some data gaps and potential errors include the potential for double-counting of flows among municipalities belonging to regional water distribution systems, and inability to accurately identify inter-basin transfers. To identify groundwater to surface water transfers one should have the knowledge of what portion of a system's water flow is groundwater (MWWS provides this information in some cases), and what portion of unlicensed domestic users draw water from surface versus groundwater sources (no information is available on this). Other questions about those not serviced by water distribution systems include whether they are serviced by wastewater systems within or outside their municipality.

This estimation method was also applied to the Capital Region sub-basins as a means of checking the results of the water balance method previously described, as is discussed in the following paragraphs. Eight municipal licensees, the cities of Edmonton and St. Albert, the towns of Tofield, Devon, Bon Accord and Stony Plain, the specialized municipality of Strathcona County and the rural municipality of Beaver County, reported their 2004 water and wastewater flows to MWWS. These municipalities have a combined population of 894,331 within the Capital Region sub-basins out of a total population of 1,023,506 (87 percent of the total). Assuming that their water use characteristics are similar to other rural and urban municipalities within the sub-basin, combining their water use profiles to calculate the average per capita water diversions, returns and use and extrapolating the per capita values to the rest of the Capital Region population allowed estimation of municipal water use for the three sub-basins.

Per capita diversion among the municipal licensees providing flow data was 116 m^3, per capita water use was 2 m^3 and per capita return was 114 m^3. All licensees with the exception of Devon receive the majority of their water from EPCOR in Edmonton, so their water flows dwarf their licensed allocations. Summing the water flows of Edmonton and the municipal licensees served by Edmonton and dividing the result by their summed allocations shows that 84 percent of their existing allocations are being withdrawn. Devon is withdrawing 57 percent of its allocation. The per capita values correspond to Capital Region estimates of 119,061 dam^3 for water diversions (85 percent of licensed diversions), 117,210 dam^3 for water returns (115 percent of licensed returns) and 1,796 dam^3 for municipal water use (five percent of licensed use). Using this method, estimated municipal water use in the Capital Region is 3,471 dam^3 less than that estimated using the water balance method, a similar result. Both results point to the fact that net municipal water use is low compared with other sectors covered in this report.

In reviewing the two estimation methods, it is believed that the water balance model that combines MWWS, EPCOR, Goldbar WWTP and Capital Region WWTP data provides a higher and more realistic water use estimate than the method employing population-adjusted MWWS data only. This is understandable, given that a greater number of data sources provides a better opportunity to crosscheck and validate information than does using data from a single source. Estimating municipal water use in sub-basins and portions of sub-basins outside the capital region required use of the population-adjusted MWWS data because no additional information was available.

2.2.2 Agriculture Sector

Different methods were used to estimate the two major components of agricultural water use: private irrigation and stockwatering.

Although private irrigation licences have been issued to farmers for crop irrigation throughout the North Saskatchewan Basin, very little is known about their actual use of water. According to other sources (Watrecon, 2005), it is believed that most private irrigators use water to grow forage for livestock and that, in the absence of better information, it is reasonable to assume that private irrigators are using all of their entitlement. Thus, estimates of actual water use

reflect the maximum amount of water that can be used under the terms of the licences issued for private irrigation. This likely overstates actual water use in 2005 but, given the relatively small allocations to irrigation, this does not significantly affect the overall assessment of water use.

Farmers can acquire water for livestock through licences and registrations, but can also obtain small amounts of water for livestock as part of domestic use or as an exempted water user which allows them to use up to 6,250 m^3 of water per year without having to acquire a licence or registration (see Section 1.3). In sub-basins where there is a discrepancy between water allocation and actual water use and/or requirements, the difference may be explained through domestic or exempted water use. However, lack of data precluded verifying that assumption. This analysis of stockwatering focused only water allocations for livestock through licences and registrations. There is no information on actual use for stockwatering and past water demand studies have simply assumed that the full amount of water allocations were being withdrawn and used. A recent study (Watrecon, 2005) attempted to corroborate this assumption by calculating livestock use by combining known livestock populations based on the 2001 Census of Agriculture, with information on average daily livestock consumption as provided by AENV to assist farmers in determining their water requirements. The resulting calculations showed that, after adjusting for evaporative losses, the resulting estimates of actual consumption very closely matched allocations for the Battle River basin. This report employs the same approach to estimate actual water use for stockwatering.

2.2.3 Commercial Sector

There is no information on actual water used for commercial sector activities. Therefore, estimates of actual water use are based on the assumption that licensees are using their full entitlement.

2.2.4 Petroleum Sector

Data on actual water use by the petroleum sector for 2005 is based on data provided by government agencies and/or the major licence holders. Water used for oilfield injection data is reported to the Alberta Energy and Utilities Board (EUB) and Geowa Technologies Ltd. reviewed the EUB database and provided a summary of actual water use based on activity, basin and water source. Gas and petrochemical plant information is drawn from the WURS database provided by Alberta Environment. No data was available for other petroleum activities. A couple of companies directly provided their 2005 water use data.

Actual water use in 2005 was reported where available. However, actual water use information was not available for many licences. For those activities for which there was very little data or no data at all, it was assumed that licence holders were using 100 percent of their licensed consumption.

2.2.5 Industrial Sector

Estimates of actual water use by the industrial sector for 2005 are based on data available in the WURS database and data provided by the major licence holders. Cooling data is a

combination of the water use information available in WURS and data provided by TransAlta, EPCOR and University of Alberta. Water use for forestry, chemical plants, fertilizer plants, and mining (other than coal) data was based on information in the WURS database and with the assumption that licensees were using all of their entitlement. No data was available for manufacturing, coal mining, or hydroelectricity. These three activities are allocated only a small amount of water and are therefore assumed to use the full capacity of their licensed water use.

Actual water use data for 2005 was reported where available. However, for those industrial activities where use information was reported for a large proportion of the licences representing a large share of the water allocations, the total water use for all licences was calculated by applying water use characteristics for the sample to the entire population of licences. For those activities that have very little data or no data at all, licence holders were assumed to use 100 percent of their licensed consumption.

2.2.6 Other Sector

Little to no data on actual water use were available for water use by the "other" sector. Estimates were based on the assumption that licensees were using all of their entitlements. While this may exaggerate water use by this sector, especially for water management which includes flood control, the resulting inaccuracies are likely not significant for the entire basin because the total allocations to the other sector are relatively small. However, at the sub-basin level, the assumption that "other" licensees were using their full entitlement may significantly overstate water use.

2.3 Future Water Use Forecasts

The *Water for Life* strategy calls for a 30 percent improvement in water use efficiency and productivity between 2005 and 2015. At the time of writing the Alberta Water Council is determining how this goal is to be attained for individual water use sectors and river basins. In the absence of clear direction on what programs and policies will be established to encourage water conservation, the water use forecasts provided in this report reflect a "business as usual" scenario that ties water use to economic and population growth and assumes that companies will improve their operating efficiencies as they have done in the recent past. This "business as usual" scenario provides a useful baseline for determining the strategies that will be most effective in promoting water conservation in the NSRB.

2.3.1 Municipal and Residential Sector

Future water use in the municipal and residential sector was estimated using the population growth rates. The rates used in this analysis reflect the most recent Census Division (CD) population projections provided by Alberta Finance (2004). Although other population projections have been made for various jurisdictions within Alberta, the Alberta Finance projections were chosen because they cover the province and are officially recognized by the provincial government. Population projections for individual sub-basins were calculated by weighting the growth rates for individual CD's based on the percentage of the sub-basin population contributed by each CD intersecting the sub-basin. To ensure that the populations were appropriately distributed among sub-basins intersecting each CD, CD data were spatially

adjusted to reflect road network densities in each sub-basin-CD intersection area, on the assumption that population density is directly related to road network density. Canada Census 2006 census division populations were used as the population baseline to make the projections to 2025 and the 2005 population was backcast based on the 2005 to 2006 growth rates. The municipal water use forecasts assume that per capita water use for each sub-basin in 2005 remains constant throughout the forecast period.

The municipal water use forecast also considered trends in per capita water consumption. Historic information on per capita municipal water diversions from 1990 to 2004 was taken from a recent study by Seneka (2006) and a best-fit linear trend of per capita water diversions was calculated to determine recent trends in per capita use. The resulting analysis found that there was too much variation in the per capita use information to statistically determine any clear trends. Consequently, the municipal water use forecasts assume that per capita water use for each basin in 2005 remains constant throughout the forecast period.

Estimated sub-basin per capita water use was multiplied by the high, medium and low sub-basin population projections to estimate future annual sub-basin municipal water use to 2025. Population projections and forecasts of municipal water use for sub-basins outside the Capital Region are presented in the individual sub-basin chapters. Due to the integrated nature of the population and water and wastewater distribution systems, and therefore water use, in the Capital Region, which is situated in the Beaverhill, Strawberry and Sturgeon sub-basins, the population and water use forecasts for the Capital Region are presented below rather than in the individual sub-basin chapters.

2.3.2 Capital Region Future Water Use Forecasts

Figure 2-2 shows low, medium and high population projection scenarios for the Capital Region based on Alberta Finance Census Division projections. The population forecasts in Figure 2-2 have been used to predict future municipal surface and groundwater use. The resulting forecasts of water use are provided in Table 2-4, and are based on the estimated per capita water use in 2005.

Figure 2-2 Capital Region Population Growth Forecasts

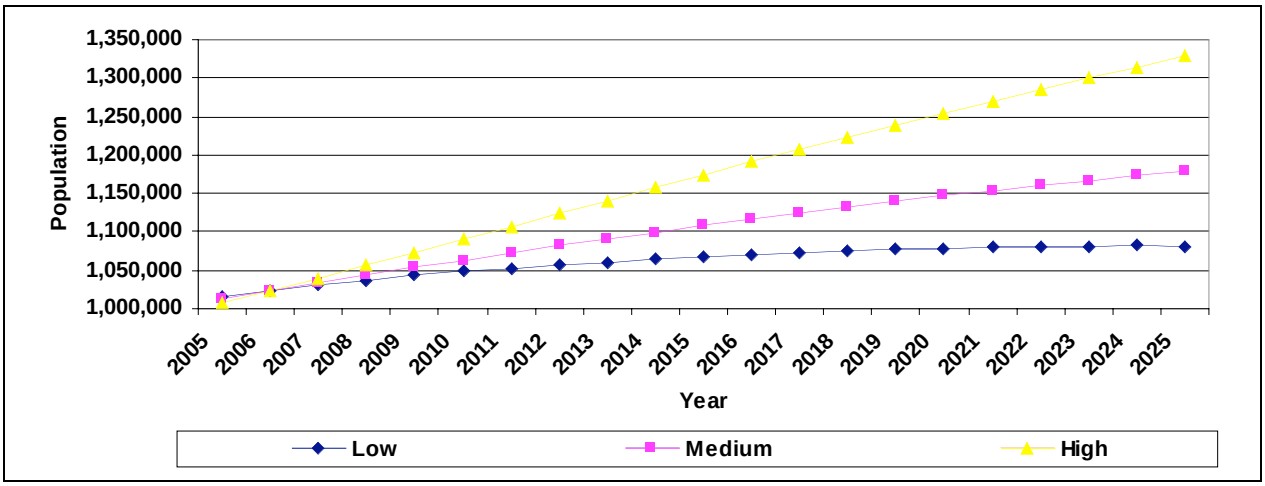


Table 2-3 Projected Municipal Water Use in the Capital Region

(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Population Growth	Surface	5,267	5,436	5,535	5,594	5,609
	Groundwater	0	0	0	0	0
	Total	**5,267**	**5,436**	**5,535**	**5,594**	**5,609**
Medium Population Growth	Surface	5,267	5,528	5,763	5,965	6,127
	Groundwater	0	0	0	0	0
	Total	**5,267**	**5,528**	**5,763**	**5,965**	**6,127**
High Population Growth	Surface	5,267	5,699	6,140	6,560	6,946
	Groundwater	0	0	0	0	0
	Total	**5,267**	**5,699**	**6,140**	**6,560**	**6,946**

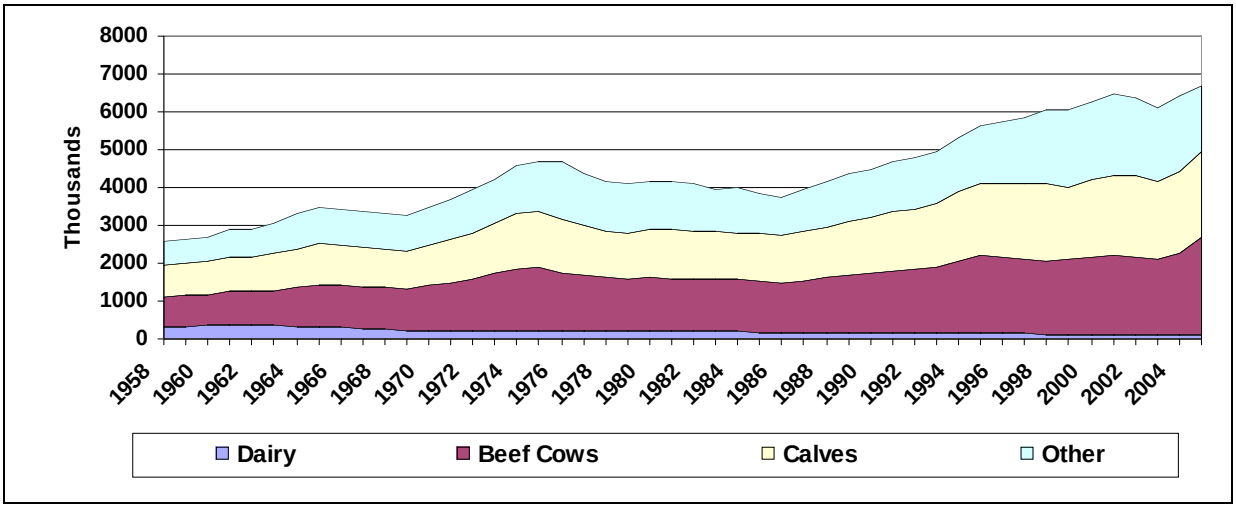
Under the Low Population Growth scenario, municipal water use in 2025 is expected to be six percent higher than at present and actual water use will be 15 percent of the current licensed use amount. Under the High Population Growth scenario, water use will increase by 32 percent over current levels and water use is expected to be 19 percent of the amount presently allowed in the licences.

2.3.3 Agriculture Sector

The key factor affecting future livestock water demand will be changes in the cattle populations in each sub-basin, as cattle account for the vast majority of livestock water demand. Predictions of future cattle populations at this point in time are highly speculative given the recent uncertainty in world and North American cattle markets due to the discovery of several cases of Bovine Spongiform Encephalopathy (BSE) over the last few years and the changing trade rules that have resulted. Although the export market, the mainstay of Alberta's beef industry has begun to rebound, there is still volatility of prices in the cattle markets, the average annual price in 2005 ($ 84.98/CWT) was still below the level found prior to BSE discovery. As a result, cattle sales have dropped and inventories have increased with the result that there are concerns that there could be a significant over supply of slaughter weight cattle in Alberta.

The effects of these lower prices and reduced sales volumes are not reflected in the agricultural statistics presented for each sub-basin, which are based primarily on the 2001 Census of Agriculture. According to AAFRD, the provincial herd has increased in size relative to pre-BSE levels could be partially attributed to BSE as producers held cattle on farms due to the lack of export markets for live cattle.[1] The current description of cattle populations in Alberta is provided in Figure 2-3.

Figure 2-3 Cattle and Calves on Alberta Farms, 1958 to 2005



Although this figure is not specific to the North Saskatchewan Basin, the figure nonetheless provides an indication of likely trends in cattle supply in the Basin. The figure shows that, between 1986 and 2005, the number of cattle on Alberta farms grew steadily from about 3.75 million to 6.50 million animals. This represents about a 75 percent increase, or an annual increase of 3.7 percent. There was a decrease of six percent in cattle numbers in 2003 but populations started to increase due to continued restriction of the export market over the last few years.

A second factor affecting livestock expansion is changes in the regulatory system as a result of the Agricultural Operation Practices Act (AOPA). AOPA, effective January 2002, requires that farmers wanting to develop new livestock operations or expand their annual populations above a certain size threshold must first obtain permission from the Natural Resources Conservation Board (NRCB). For the cattle and dairy operations, the animal population thresholds are outlined in Table 2.5.

[1] http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sdd10294#cattle

Table 2-4 *AOPA* Requirements for Cattle Operations

Type of Livestock	Registration Required	Approval Required
Beef cows/finishers (900+ lbs)	150-349	350+
Beef Feeders (<900 lbs)	200-499	500+
Dairy (milking cows including replacements and dries)	50-199	200+

To obtain this permission, farmers must submit an application that demonstrates how their operations would meet the legislated requirements for manure storage and management. Farmers must also demonstrate that they have or can obtain the rights to sufficient water to support livestock. The NRCB must deny any applications that fail to meet the requirements for manure management, setbacks from neighbours, access to water, or any of the other requirements of the legislation. A review of decision reports issued by the NRCB indicates that, as of December 31, 2005, there appear to have been few applications from farmers for major new or expanded cattle or dairy operations in the basin. Recently, a dairy operation has been proposed for the Strawberry sub-basin, upstream of the Town of Devon.

Given these factors, and when combined with lack of livestock forecasts published on a regional basis, prediction of future livestock water demand is difficult. Toma and Bouma (1997) utilized scenario planning to determine the growth rate required for the Alberta agri-food sector to become a $20 billion manufacturing industry and a $10 billion production sector by 2005. This scenario features a doubling of beef feedlot population, a tripling of the hog population and other livestock sectors following historical growth rates and assumes a strong export market, especially to the US and to Asia. Since the study, there have been significant changes in export conditions due to the discovery of BSE. Further, the study does not outline how growth in livestock activity might be distributed within the province and the North Saskatchewan Basin is not specifically mentioned

In order to assess the potential suitability of livestock operations, Alberta Agriculture, in the late 1990s, undertook a study that examined the potential for expansion of the beef industry in Alberta. With respect to the possible development of feedlots, AAFRD identified five criteria for evaluating the potential for expansion:[2]

1. **Manure odour and population densities** - Manure odours were considered the most limiting factor in selecting sites for new feedlots, in that feedlots can only be located beyondspecific distances from neighbouring residences in order to minimize odour impacts.[3] Thus, feedlot development is more likely in areas with low population densities.
2. **Local silage supplies –** Adequate quantities of silage can only be economically produced in some parts of Alberta. Alberta Agriculture identified areas where sufficient silage could be grown within six miles of the feedlot so that hauling would be economical.
3. **Water supply –** The availability of ground water was the second most important factor in selecting potential feedlot sites. It is estimated that a 5,000-head backgrounding operation would require 50 dam^3 of water per year while a 20,000-head finishing operation would

[2] Some of these criteria are specified in the *AOPA*

[3] In the 1990s these distances were contained in a Code of Practice but setback distances are now specified in the regulations for the *Agricultural Operation Practices Act*.

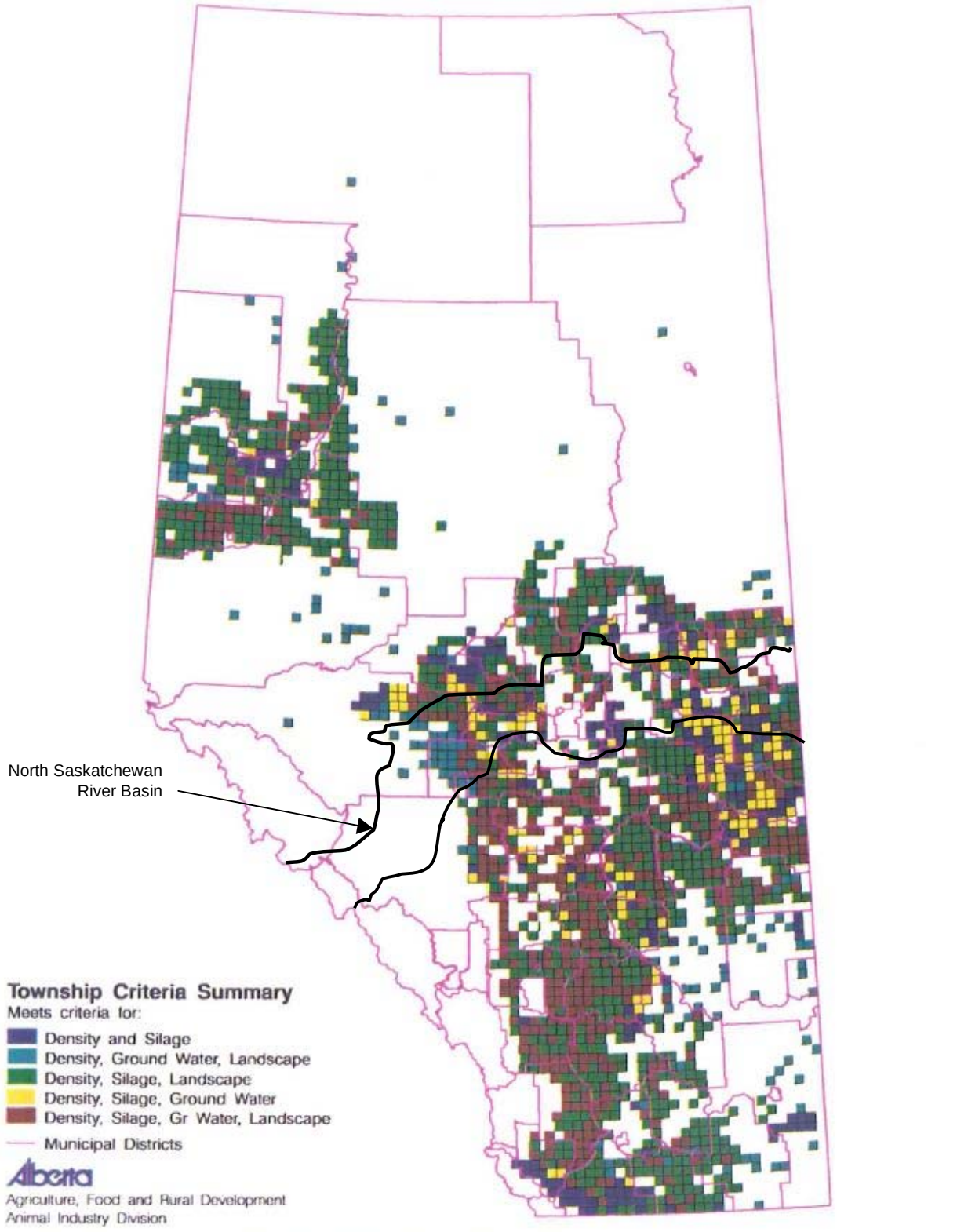
require 300 dam^3. Consequently the study identified areas where sufficient water was available and could reliably be supplied using more than one source (four wells). Surface water sources must be permanently flowing to provide a reliable water supply for feedlots.

4. **Landscape characteristics** – The preferred locations for feedlots are areas with well developed natural drainage to ensure that pens stay dry and drain completely. Suitable areas were identified using slope information from the Soil Landscapes of Canada.
5. **Land for manure spreading** – Extensive lands are required for spreading of manure and are similar to land requirements for barley silage. Land requirements for manure spreading are now identified in the *Agricultural Operation Practices Act* but Alberta Agriculture determined that about 5.5 sections are required for a 20,000-head feedlot.

Using these selection criteria, AAFRD was able to identify townships where development of a 5,000 head backgrounding operation (Figure 2-4) or a 20,000 head finishing feedlot was possible (Figure 2-5). These figures are used to provide some guidance in forecasting future livestock conditions in the North Saskatchewan Basin. Based on these criteria, townships that meet all of the criteria for are located east of the Brazeau, Ram and Clearwater sub-basins for both backgrounding and finishing operations. While this assessment shows that there is potential for future livestock operations, the information from the NRCB indicates that this expansion has not yet occurred, probably due to the fact that the cattle industry is still adjusting to changes in markets associated with the effects of BSE. Information for forecasting cattle population at the sub-basin level was not available so it was assumed that their current share of livestock population and their water use would remain unchanged over the forecast period. For sub-basins which are unsuitable for livestock, further expansion is not expected. The average annual growth forecasts for the suitable sub-basins were 0.6 percent (Low Growth), 1.4 percent (Medium Growth), and 2.9 percent (High Growth). The long term (1958 – 2005) average growth of cattle population has been 2.2 percent so the growth rate assumptions used in the analysis is within historical trends.

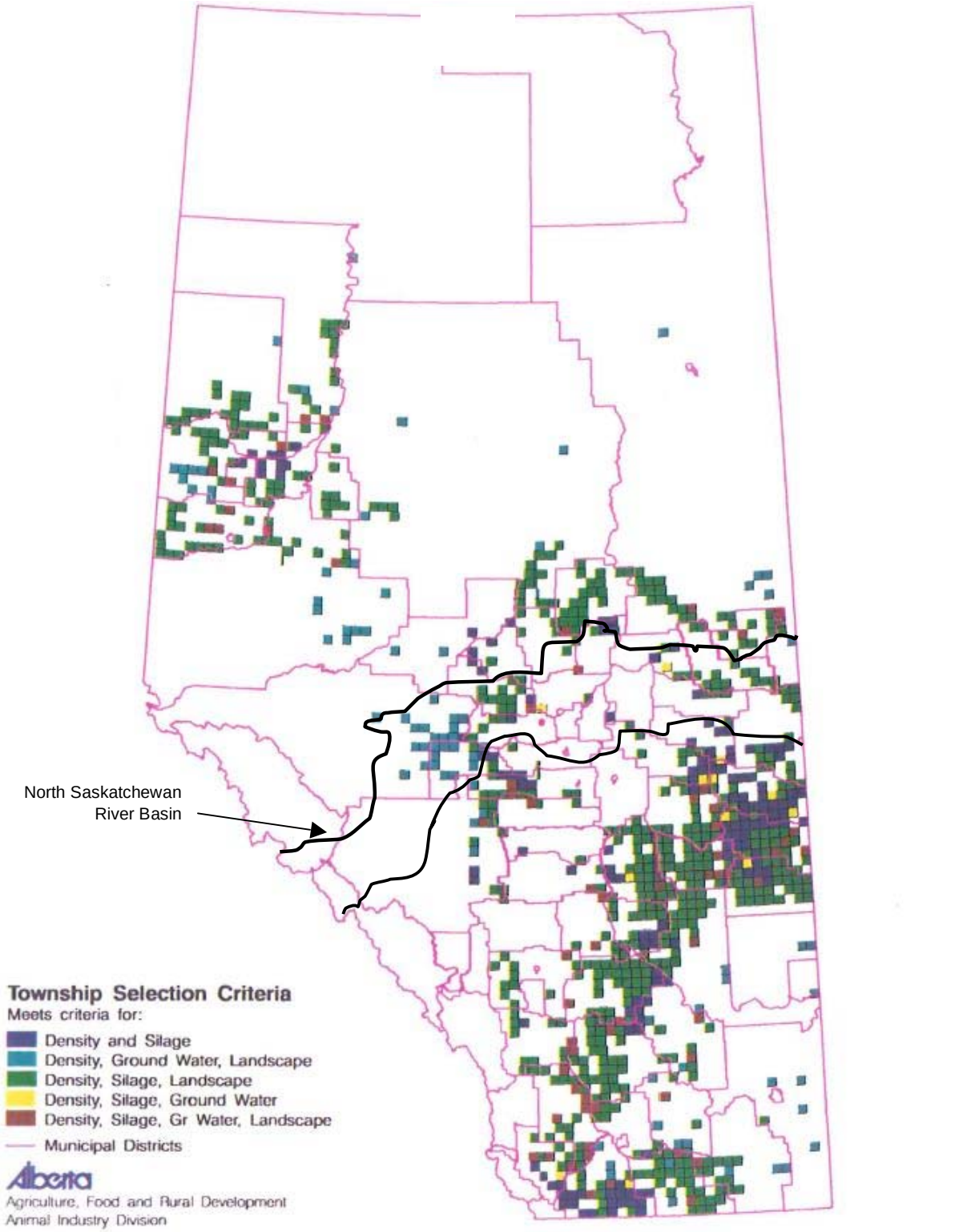
Forecasts of future water use by private irrigator are based on two factors - the assumption that their use of water will be tied directly future changes in livestock populations in each sub-basin because, as noted earlier, most private irrigation is used to raise supplemental forages to feed livestock, and potential for expansion of irrigation acreage. Although the potential for livestock expansion is shown by Alberta Agriculture's assessment, the climatic conditions and limited land base in many parts of the North Saskatchewan Basin precludes expansion of irrigation acreage. Furthermore, irrigation is a capital intensive operation but the net returns from forage production are not great (Watrecon 2005).

Figure 2-4 Township Criteria Summary for 5,000 head Backgrounding Operation



Source: Water Rights, Crow Benefit, Farm Fertilizer, GIC, Agriculture Financial Services Corporation and Soil Landscapes data.

Figure 2-5 Township Criteria Summary for 20,000 head Finishing Operations



Source: Water Rights, Crow Benefit, Farm Fertilizer, GIC, Agriculture Financial Services Corporation and Soil Landscapes data.

2.3.4 Commercial Sector

Major water use activities in the commercial sector include parks and recreation, golf courses, aggregate washing, and construction. Estimates of future water use for these activities were prepared separately in recognition that the factors that drive future water use will be different.

Estimates of future water use for parks and recreation are based on the assumption that demand for these facilities will increase in accordance with population growth. Thus, the annual growth rates in water use for parks and recreation areas reflect the population growth rates in each sub-basin.

With respect to future water use for golf courses, historical trends in Alberta household participation in golfing since 1981 show that demand for golfing has climbed steadily, reaching a peak in 2000. This trend, combined with a growing interest in golfing explains why there has been a proliferation of golf course development. The demand for new golf courses or course expansions is expected to continue as the population continues to grow and an ageing population has more leisure time. With respect to water allocation, licence data indicates that currently there are 40 golf courses that hold 55 licences and the licence data suggest that average water demands for golf courses amount to about 8 dam^3 per hole, although the water demand value ranges from two to 13 dam^3. Future water demand for golf courses has been estimated using the approach outlined in Watrecon (2005) which uses population growth to estimate the increased numbers of new golf course holes required to maintain the current availability of golf facilities for a growing population. Water use estimates for each basin were developed using this approach, the appropriate population forecasts, and the average water requirement per hole for that sub-basin. It was assumed that the proportion of surface and ground water use would not change over the forecast period and that as compared to 2005.

Future water use for aggregate washing, construction and other activities have been estimated based on expected changes in the economic activity in Alberta. Forecasts are based on anticipated GDP growth rate of 1.2, 2.2 and 3.2 percent annually. Future water use for gardening has been estimated using trends in greenhouse cultivation areas between 1996 and 2001 from Census of Agriculture. For the remaining activities, water use is not anticipated to change over the forecast period.

2.3.5 Petroleum Sector

Forecasts of future water use by the petroleum sector were based on consultations with large licence holders and estimates provided by government agencies. Oilfield injection forecasts are based on the outlooks of EUB (2006) and the Canadian Association of Petroleum Producers (2006). Gas and petrochemical plant forecasts focused on potential bitumen upgraders and a gasification plant because these facilities are likely to be the largest drivers of future water demand in the basin. Upgrader forecasts were based on current known proposals (Stringham, 2006; Alberta Environment, 2007) and discussions with EUB and Alberta Environment. In the absence of information about other petroleum activities, it is assumed that water used for these purposes will remain constant for the forecast period.

2.3.6 Industrial Sector

Forecasts of future water use by the industrial sector are based on consultations with large licence holders, and information provided by government agencies. Since water required for cooling purposes accounts for the vast majority of industrial water allocations in North Saskatchewan Basin, forecasts of future industrial water use focused on water use by electrical power plants. The forecast considered information in the EMS database regarding scheduled licence expiries, new water licences for 2006, and list of applications in process. It also incorporated information on power generation forecasts (AMEC Americas Ltd, 2005; AMEC Americas Ltd. 2006), water use estimates from Environment Canada (1996), a list of proposed electricity facilities/upgrades in Alberta (Department of Energy, 2007), and discussions with large water licence holders (including TransAlta, ATCO Electric, University of Alberta, University of Calgary and Milner Power Inc).

Forestry forecasts are based on discussions with Alberta Forest Products Association. In the absence of information about chemical plants, fertilizer plants, manufacturing, mining (other than coal), coal mining, hydroelectricity and other industrial activities, it is assumed that water used for these purposes will remain constant for the forecast period.

2.3.7 Other Sector

Very little information is available regarding future other sector water use. Forecasts of future water use by the other sector were based on consultation with Alberta Environment representatives and Ducks Unlimited. Neither organization has formal forecasts of their future water needs. The number of projects that Ducks Unlimited will implement depends on a number of factors such as its budget, the state of the economy, and environment objectives. It is anticipated that there will be an increased emphasis on restoring drained wetlands to pre-drainage or natural conditions. These types of projects will not require new water licences. In terms of new water licences, Ducks Unlimited foresees an increase of about one or two new water licences per year (Randy Cummer, pers. comm. June 12, 2007). The emphasis will likely be on the Beaverhill, White Earth or Vermilion sub-basins. The forecasts assume that the current ratio of Ducks Unlimited Licences in each of these three basins for the distribution of new projects. Based on discussions with AENV, water use for projects licensed to AENV for other purposes is not expected to change over the forecast period.