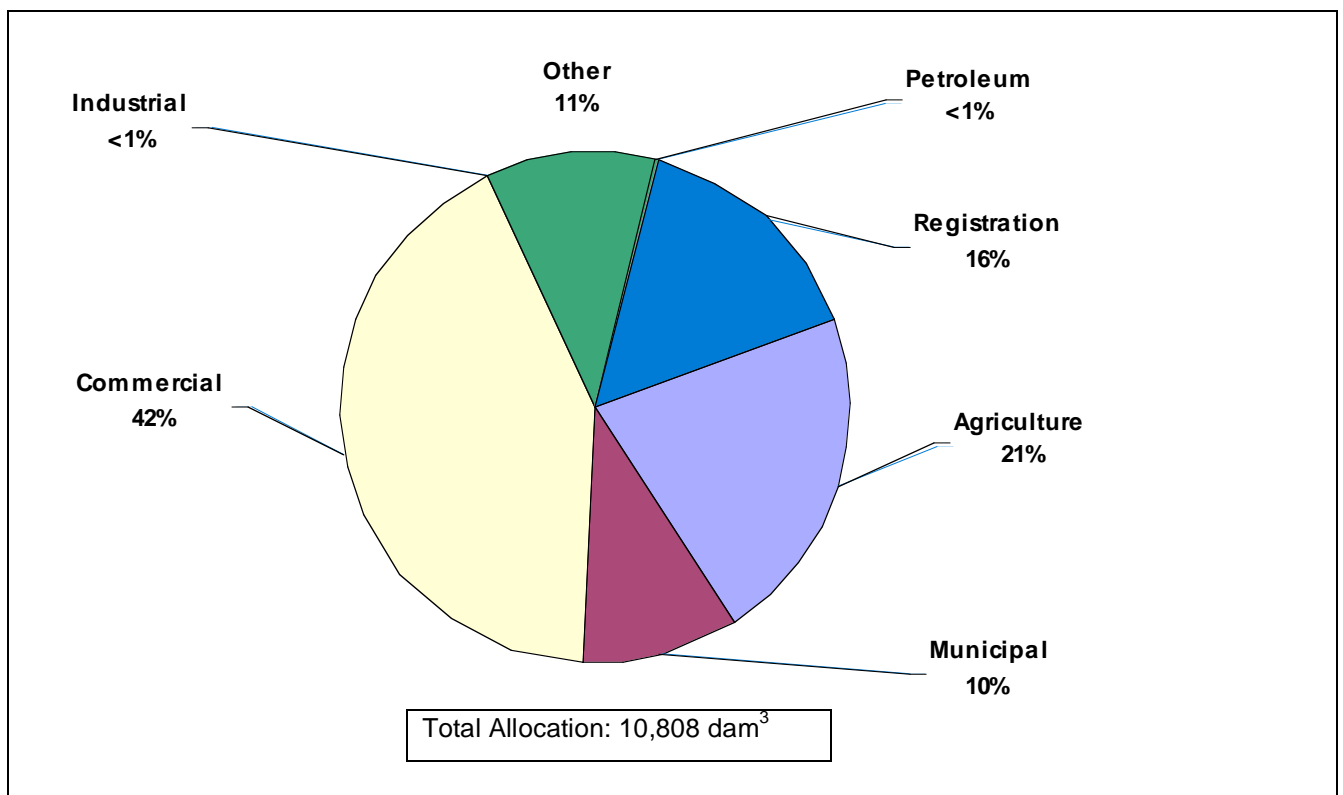


11.0 WHITE EARTH

The White Earth Sub-basin is about 6,500 km² in area and occupies nearly 12 percent of the North Saskatchewan Basin. In 2005, the sub-basin had a population of about 17,900 people, which represents less than 2 percent of the Basin population, with a population density of about 2.7 people per square kilometre. The White Earth Sub-basin consists all or parts of eight urban municipalities, seven rural municipalities, one specialized municipality and one Aboriginal Settlement.

An overview of current surface and groundwater allocations is provided in Figure 11-1. It shows that the commercial sector accounts for 42 percent of total allocations or 4,553 dam³ while the agriculture sector (including registrations) accounts for 37 percent of total allocations or 3,999 dam³. The remaining allocations are for the municipal, other, industrial and petroleum sectors. Total allocations in the sub-basin in 2005 were 10,808 dam³, including 8,011 dam³ (74 percent) for surface water.

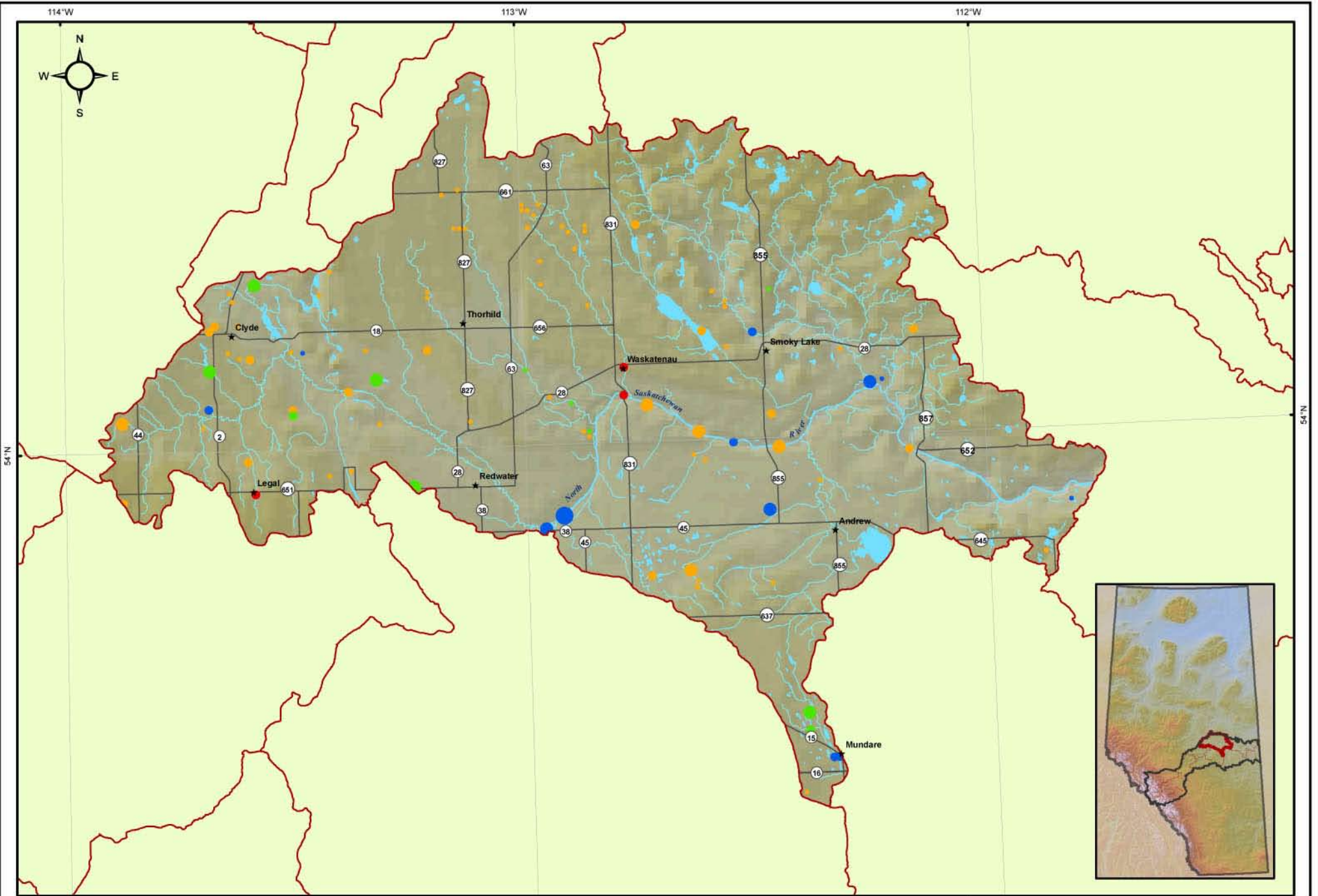
Figure 11-1 Distribution of Active Water Allocations in the White Earth Sub-basin



Figures 11-2 and 11-3 show the location, allocation and sector of all active water licences in the White Earth Sub-basin. The locations of registrations issued in this sub-basin are provided in Figure 11-4.



Figure 11-2 White Earth Sub-basin Surface Water Licences



Legend

★ Settlement	Industry Category - Maximum Allowable Diversion (dam ³ /yr)					
— Major Road	● 0.01 - 10.00	● 0.01 - 10.00	● 0.01 - 10.00	● 0.01 - 10.00	● 0.01 - 10.00	● 0.01 - 10.00
Watercourse	● 10.01 - 100.00	● 10.01 - 100.00	● 10.01 - 100.00	● 10.01 - 100.00	● 10.01 - 100.00	● 10.01 - 100.00
Waterbody	● 100.01 - 1000.00	● 100.01 - 1000.00	● 100.01 - 1000.00	● 100.01 - 1000.00	● 100.01 - 1000.00	● 100.01 - 1000.00
Sub Basin	● 1000.01 - 10000.00	● 1000.01 - 10000.00	● 1000.01 - 10000.00	● 1000.01 - 10000.00	● 1000.01 - 10000.00	● 1000.01 - 10000.00
	● > 10000.01	● > 10000.01	● > 10000.01	● > 10000.01	● > 10000.01	● > 10000.01

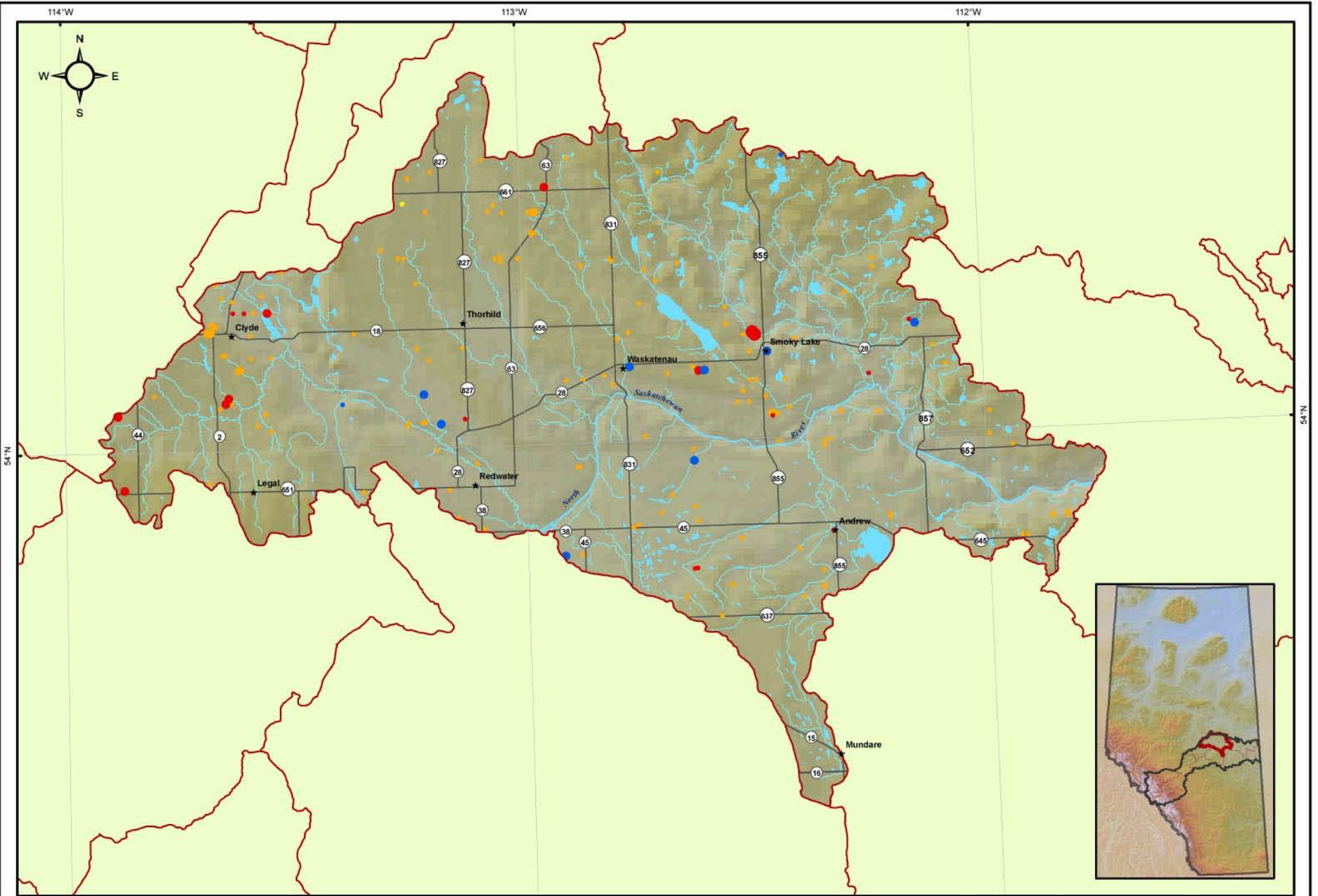
North Saskatchewan Watershed Alliance

WHITE EARTH SUBBASIN SURFACE WATER LICENSES

DATE: MAY 2007
 AMEC PROJECT: EE27047
 GIS FILE: SW_SB_WHITE EARTH.MXD
 PDF FILE: SW_SB_WHITE EARTH.PDF
 PREPARED BY: amec

PROJECTION: 10TM | DATUM: NAD83
 SCALE: 1:700,000
 FIGURE 11-2

Figure 11-3 White Earth Sub-basin Groundwater Licences



Legend		Industry Category - Maximum Allowable Diversion (dam ³ /yr)						
★	Settlement	● 0.01 - 10.00	● 0.01 - 10.00	● 0.01 - 10.00	● 0.01 - 10.00	● 0.01 - 10.00	● 0.01 - 10.00	● 0.01 - 10.00
—	Major Road	● 10.01 - 100.00	● 10.01 - 100.00	● 10.01 - 100.00	● 10.01 - 100.00	● 10.01 - 100.00	● 10.01 - 100.00	● 10.01 - 100.00
—	Watercourse	● 100.01 - 1000.00	● 100.01 - 1000.00	● 100.01 - 1000.00	● 100.01 - 1000.00	● 100.01 - 1000.00	● 100.01 - 1000.00	● 100.01 - 1000.00
—	Waterbody	● 1000.01 - 10000.00	● 1000.01 - 10000.00	● 1000.01 - 10000.00	● 1000.01 - 10000.00	● 1000.01 - 10000.00	● 1000.01 - 10000.00	● 1000.01 - 10000.00
—	Sub Basin	● > 10000.01	● > 10000.01	● > 10000.01	● > 10000.01	● > 10000.01	● > 10000.01	● > 10000.01

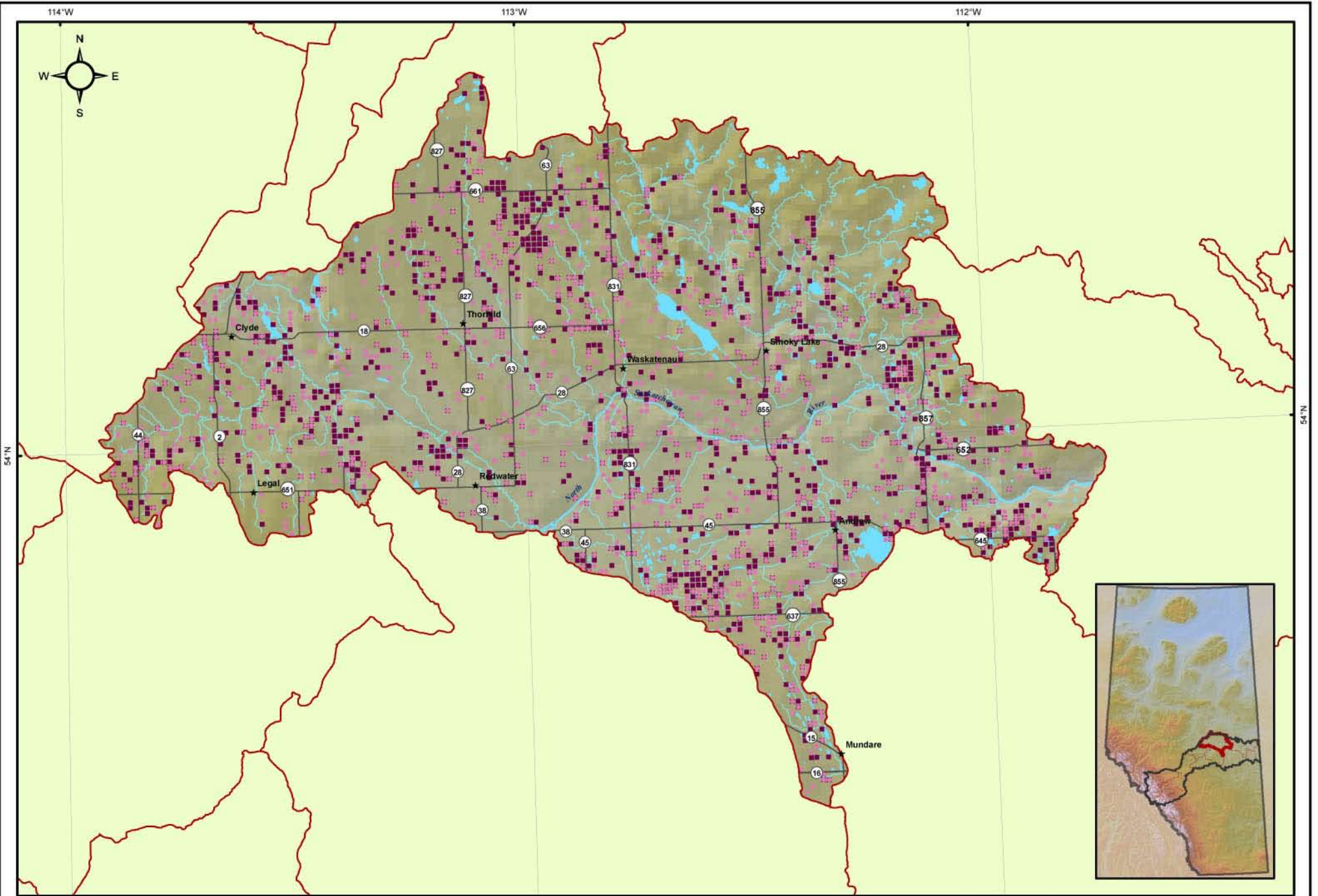
North Saskatchewan Watershed Alliance

WHITE EARTH SUBBASIN GROUNDWATER LICENSES

DATE: MAY 2007
 AMEC PROJECT: EE27047
 GIS FILE: GW_SB_WHITE EARTH.MXD
 PDF FILE: GW_SB_WHITE EARTH.PDF
 PREPARED BY: amec

1:700,000
 PROJECTION: 10TM/DATUM: NAD83
 FIGURE 11-3

Figure 11-4 White Earth Sub-basin Registrations

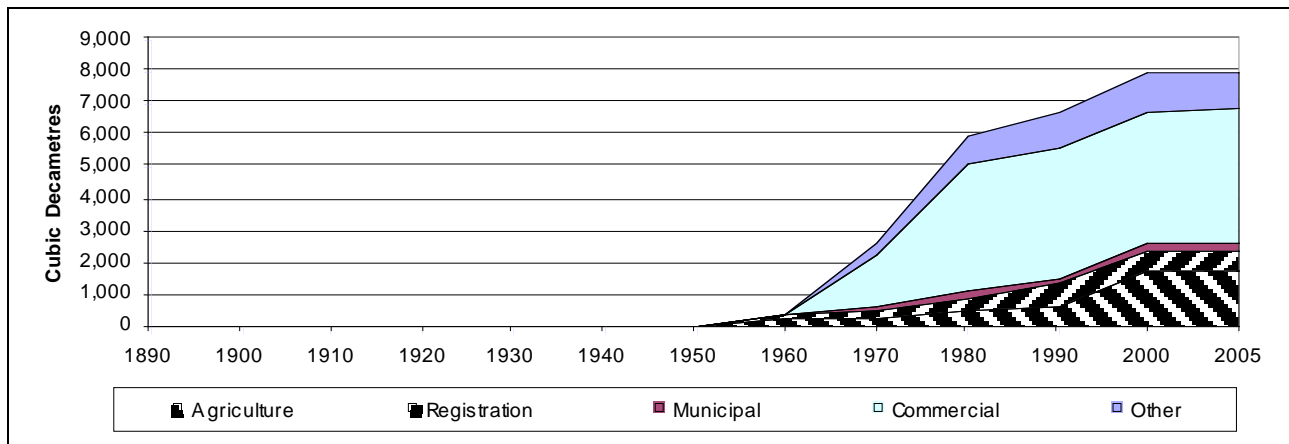


- Legend**
- ★ Settlement
 - Major Road
 - Watercourse
 - Waterbody
 - Sub Basin
- Industry Category - Maximum Allowable Diversion (dam³/yr)**
- Groundwater Registrations
 - 0.01 - 6.25
 - Surface Water Registrations
 - 0.01 - 6.25

WHITE EARTH SUBBASIN REGISTRATIONS	
DATE: MAY 2007 AMEC PROJECT: EE27047 GIS FILE: RG_SB_WHITE EARTH.MXD PDF FILE: RG_SB_WHITE EARTH.PDF PREPARED BY:	1:700,000 PROJECTION: 10TM/DATUM: NAD83 FIGURE II-4

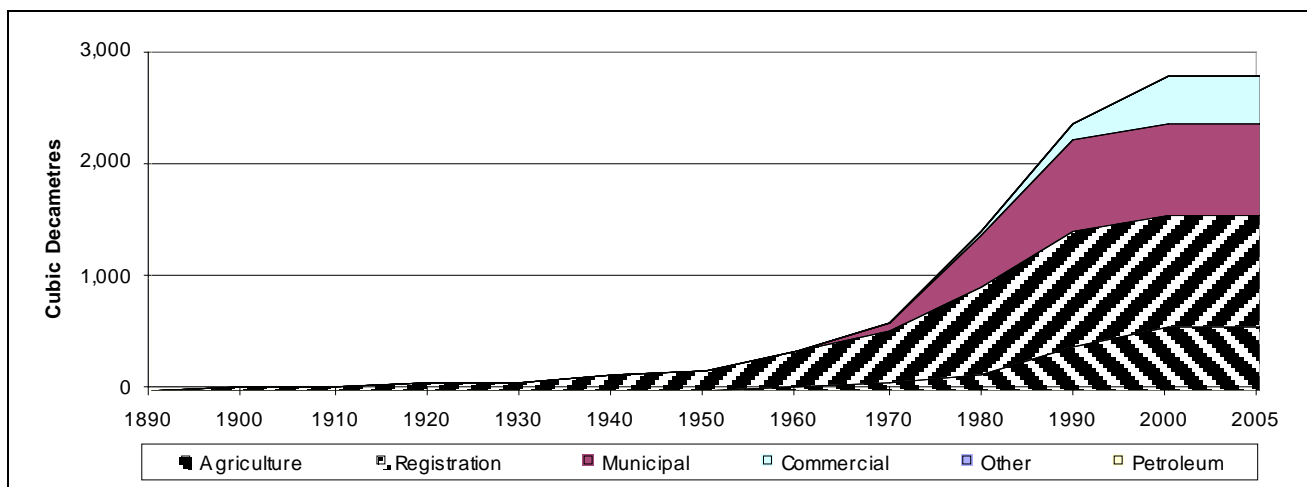
An historical perspective on water allocated among the sectors is provided in Figure 11-5 (surface water) and Figure 11-6 (groundwater). The largest allocations for surface water in the White Earth Sub-basin are for the commercial and the other sectors. Allocations for the commercial and other sectors were first issued in the 1960s increased substantially, in the 1970s, but have remained relatively stable since 2000. Surface water allocations for the remaining sectors display similar patterns with the exception of registrations, some of which have priority dates in the 1890s.

Figure 11-5 Historical Trends in Surface Water Allocation in the White Earth Sub-basin



The largest allocations for groundwater are for registrations and the municipal sector. Registration allocations were first issued in the 1890s. Since that time allocations have grown substantially, especially in the 1980s. Since 2005, the allocations have remained unchanged. Allocations for the municipal, commercial, petroleum and sectors display similar patterns. Allocations for the agriculture sector were first issued in the 1910s, and have also increased over time in a pattern similar to that of registrations.

Figure 11-6 Historical Trends in Groundwater Allocation in the White Earth Sub-basin



11.1 Municipal and Residential Sector

11.1.1 Population

The population of White Earth Sub-basin is predominantly rural, as shown in Table 11-1. Sixty-four percent of the population lives in rural municipalities. Urban municipalities comprise 36 percent of the population. Urban municipalities grew slowly from 2001 to 2006 at 3 percent. Rural municipalities declined dramatically over the inter-censal period, by 9 percent. Although small parts of the specialized municipality of Strathcona County and Saddle Lake First Nation overlap with the White Earth Sub-basin, no people live within these parts of the two jurisdictions.

Table 11-1 Population Distribution and Growth in the White Earth Sub-basin

	2006		2001	2001 to 2006 Population Change
	Population	Percent	Population	Percent
Urban Municipality	6,374	35.7%	6,173	3.3%
Specialized Municipality	0	0.0%	0	N/A
Rural Municipality	11,498	64.3%	12,643	-9.1%
First Nations and Métis Settlements	0	0.0%	0	N/A
Total	17,872	100.0%	18,816	-5.0%

Table 11-2 lists all municipalities situated in the White Earth Sub-basin, their estimated 2006 sub-basin populations, and a summary of their water licence information. The largest urban centre is the Town of Redwater (2,192 residents), followed by the Town of Legal (1,192) and the Town of Smoky Lake (1,010). Smoky Lake County has the largest population of the rural municipalities (3,044), followed by the County of Thorhild No. 7 (3,021) and Lamont County (2,787).

11.1.2 Allocations

As of 2005, 32 municipal water licences had been issued for 10 licensees in White Earth Sub-basin. These licences allow maximum withdrawals of 1,072 dam³ per year. As shown in Figure 11-1, municipal water uses account for 10 percent of licensed water allocations in the basin. Surface water licences account for 23 percent or 250 dam³ of total municipal water allocations in the sub-basin. All of the surface water allocation is for urban use. Groundwater licences represent 77 percent or 822 dam³ of total municipal water allocations. Urban users can withdraw up to 816 dam³. Other users can withdraw up to 5 dam³ of groundwater and rural users are allocated withdrawals totaling 1 dam³.

Licensees that are not municipalities but have municipal water use licences within the White Earth Sub-basin are shown in Table 11-3. It should be noted that the EMS database includes a licence for the Village of Warspite, but the Village of Warspite dissolved in 2000 and amalgamated with Smoky Lake County.

Table 11-2 Municipal Populations and Water allocations within White Earth Sub-basin

Municipal Name		2006 Population	Source	2005 Allocation (dam ³)
Urban	TOWN OF REDWATER	2,192		
	TOWN OF LEGAL	1,192	SURFACE	98.7
	TOWN OF SMOKY LAKE	1,010	GROUNDWATER	555.2
	VILLAGE OF THORHILD	505		
	VILLAGE OF CLYDE	470	GROUNDWATER	91.3
	VILLAGE OF ANDREW	465	GROUNDWATER	1.0
	VILLAGE OF WASKATENAU	278	SURFACE	151.5
	TOWN OF MUNDARE	262		
Specialized	STRATHCONA COUNTY	0		
Rural	SMOKY LAKE COUNTY	3,044		
	COUNTY OF THORHILD No. 7	3,021	GROUNDWATER	37.0
	LAMONT COUNTY	2,787	GROUNDWATER	6.8
	STURGEON COUNTY	1,754		
	WESTLOCK COUNTY	840	GROUNDWATER	102.4
	COUNTY OF TWO HILLS No. 21	51		
	COUNTY OF ATHABASCA No. 12	0		
Aboriginal	SADDLE LAKE FIRST NATION	0		

Table 11-3 Additional Municipal Water Use Licensees in the White Earth Sub-basin

Licensee	Water Source	Allocation (dam ³)
VILLAGE OF WARSPITE	GROUNDWATER	23.4
ALBERTA INFRASTRUCTURE AND TRANSPORTATION	GROUNDWATER	4.9

11.1.3 Licensed Water Use

Table 11-4 summarizes licensed water use for the municipal sector in the White Earth Sub-basin. Under the terms of these licences, a maximum of 310 dam³ is assigned for use (i.e. 29 percent of allocations are expected to be consumed and/or lost) with the remainder (71 percent or 762 dam³) expected to be returned. Seventy-five percent of allocated urban groundwater and 59 percent of allocated urban surface water is designated as return flow, whereas all other uses are not expected to return any water after use.

11.1.4 Actual Water Use

Two municipal licensees (The towns of Legal and Smoky Lake) which represents 12 percent of the White Earth Sub-basin population, reported their 2004 water and wastewater flows to MWWWS. The Town of Smoky Lake reported diversions and returns of 320 dam³ for a net water use of zero. The Town of Legal reported diversions of less than 96 dam³ and returns of over 106 dam³ for a net water use of -11 dam³. These estimates of not consumption likely result because estimates of treated waste waters include storm water run-off and sewage from rural residents who do not need water licences. An alternate method for calculating municipal water use is to combine the average with the population of the North Saskatchewan Basin per capita water use. White Earth Sub-basin assuming that the per capita municipal diversions, water use



and returns for the White Earth Sub-basin are the same as those for the North Saskatchewan Basin as a whole, while accounting for groundwater and stormwater contributions to wastewater return flows and population growth from the MWWS 2004 data year, the estimated actual water use for the White Earth Sub-basin is 217 dam³ during 2005. This is equivalent to (70 percent of licensed use) and suggests withdrawals of 2,020 dam³ and returns of 1,803 dam³. These total estimates are apportioned according to the licensed ratios, as shown in Table 11-4, to derive groundwater and surface water estimates for urban, rural and other municipal uses.

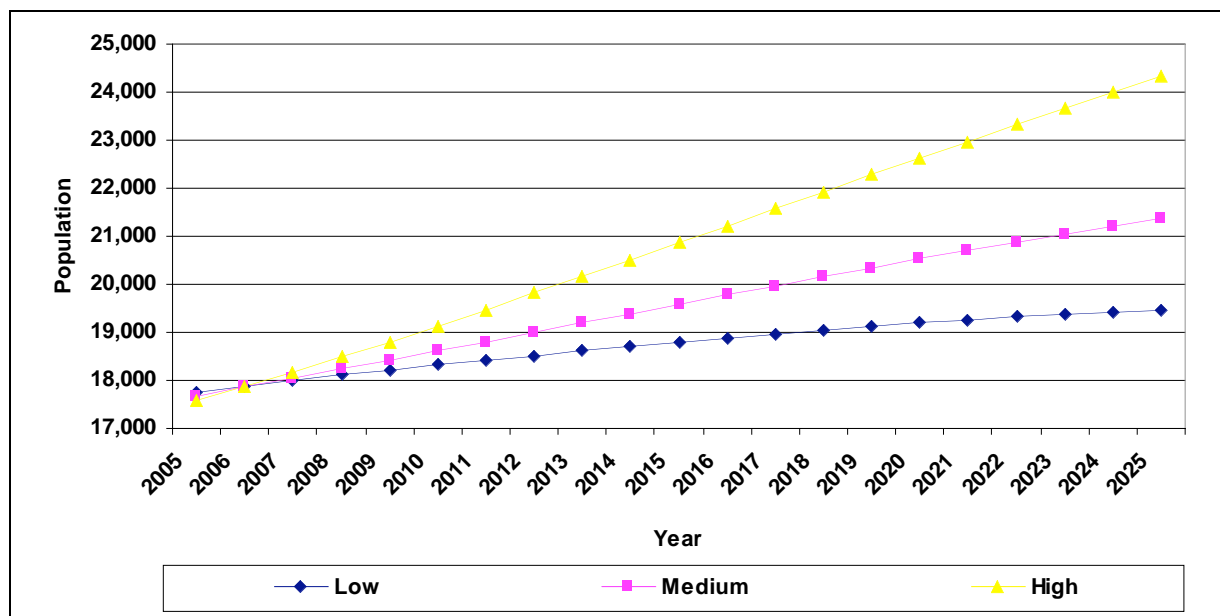
Table 11-4 Licensed Municipal Allocations and Use and Estimated Actual Use, White Earth Sub-basin

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	6	250.2	102.1	148.0	472	72	350
	Groundwater	24	815.8	202.1	613.7	1,538	142	1,452
	Subtotal	30	1,065.9	304.2	761.7	2,009	213	1,803
Rural**	Surface	0	0	0	0			
	Groundwater	1	1.2	1.2	0.0	2	1	0
	Subtotal	1	1.2	1.2	0.0	2	1	0
Other***	Surface		0	0	0			
	Groundwater	1	4.9	4.9	0.0	9	4	0
	Subtotal	1	4.9	4.9	0.0	9	4	0
Total	Surface	6	250.2	102.1	148.0	472	72	350
	Groundwater	26	821.9	208.3	613.7	1,549	146	1,453
	Total	32	1,072.1	310.4	761.7	2,021	217	1,803
* Urban includes villages, summer villages, towns, cities, hamlets; ** Rural includes condominiums / townhouses / mobile homes / complexes, hotels / motels, cooperatives, farmsteads, single-multi homes, colonies and subdivisions *** Other includes camps, institutions, senior/correctional centres, nursing/children's homes, hospitals								

11.1.5 Future Water Use Forecasts

Figure 11-7 shows low, medium and high population projection scenarios for White Earth Sub-basin based on Alberta Finance Census Division projections. The population forecasts in Figure 11-7 have been used to predict future municipal surface and groundwater use. The resulting forecasts of water use are provided in Table 11-5, and are based on the estimated per capita water use in 2005.

Figure 11-7 White Earth Sub-basin Population Growth Forecasts



Under the Low Population Growth scenario, municipal water use in 2025 is expected to be 10 percent greater than at present and actual water use will be 77 percent of the present licensed use amount. Under the High Population Growth scenario, water use will increase by 38 percent over current levels and water use is expected to be 97 percent of the amount currently allowed in the licences.

Table 11-5 Projected Municipal Water Use in the White Earth Sub-basin
(dam³)

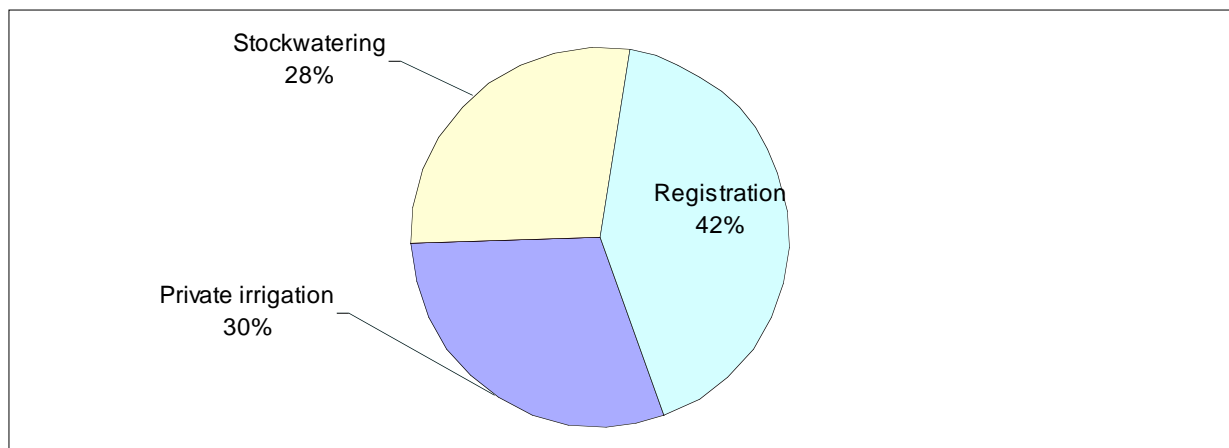
Scenario	Source	2005	2010	2015	2020	2025
Low Population Growth	Surface	71	73	75	77	78
	Groundwater	146	151	155	158	160
	Total	217	224	230	235	238
Medium Population Growth	Surface	71	75	79	82	86
	Groundwater	146	154	162	170	177
	Total	217	229	240	252	262
High Population Growth	Surface	71	77	84	91	98
	Groundwater	146	159	173	188	202
	Total	217	236	258	279	300

11.2 Agriculture Sector

As of December 2005 a total of 3,998 dam³ had been allocated to the agricultural sector in the White Earth Sub-basin. This includes 2,945 registrations representing 1,678 dam³ and 245 licences representing 2,321 dam³ of water. Water allocated to agriculture accounts for 37 percent of all allocation in the White Earth Sub-basin.

Figure 11-8 shows how this water is distributed among the different agricultural activities in the sub-basin. The largest allocation is for registrations (42 percent). Private irrigation accounts for 30 percent and stockwatering accounts for 28 percent of total allocations.

Figure 11-8 Water Allocation for Agricultural Activities in the White Earth Sub-basin, 2005



A total of 1,603 registrations and 81 licences allow withdrawal of up to 2,436 dam³ of surface water; this accounts for 61 percent of water allocations for the agricultural sector. Groundwater accounts for the other 39 percent of allocations, with 1,563 dam³ being allocated through 174 licences and 1,342 registrations.

11.2.1 Overview of Agriculture

Based on information from the 2001 Census of Agriculture, there were about 1,913 farms in the White Earth Sub-basin (15.6 percent of North Saskatchewan total) with an average size of 676 acres. At the North Saskatchewan Basin level there are about 12,300 farms with an average size of 625 acres. Farms in the White Earth Sub-basin cover an area of nearly 1.3 million acres; this is equivalent to about 5,238 km² or about 81 percent of the sub-basin. As shown in Table 11-6, 57 percent of the land in the sub-basin is used to raise crops. About 32 percent of agricultural land is pasture. The rest of the lands are in summer fallow or other uses.

Table 11-6 Agricultural Land Use in the White Earth Sub-basin, 2001

Land Use	Acres	Percent
Crop Land	741,233	57.3%
Summerfallow	38,587	3.0%
Tame/Seeded Pasture	157,926	12.2%
Natural Pasture	254,090	19.6%
Other	102,479	7.9%
Total	1,294,314	100.0%

The types of farming activity vary within the sub-basin. Table 11-7 shows the classification of farms based on the commodity groups that accounted for 51 percent or more of total gross farm receipts.

Table 11-7 Classifications of Farms in the White Earth Subbasin and North Saskatchewan, 2001

Farm Type (Farms with Gross Receipts >\$2,500)	Percent of Farms in the Sub-basin	Percent Share of North Saskatchewan	North Saskatchewan Farm Type (Percent)
Dairy Farms	0.6%	5.1%	1.9%
Cattle (beef) Farms	43.3%	14.8%	45.8%
Hog Farms	1.7%	18.1%	1.4%
Poultry & Egg Farms	1.0%	14.9%	1.1%
Wheat Farms	5.4%	19.8%	4.2%
Grain & Oilseed Farms	25.0%	20.0%	19.6%
Field Crop Farms	10.1%	18.4%	8.6%
Fruit Farms	0.1%	5.6%	0.2%
Misc. Specialty Farms	8.2%	10.0%	12.9%
Sum of Livestock Comb. Farms	2.7%	16.6%	2.6%
Sum of Vegetable Farms	0.0%	5.0%	0.1%
Sum of Other Comb Farms	1.9%	20.0%	1.5%
Total	100%	15.7%	100%

The table shows that the White Earth sub-basin accounts for 15.6 percent of total farms in the North Saskatchewan. About 43 percent of the farms in the sub-basin raise beef cattle and about 25 percent are grain and oilseed farms. Field crop farms make up about 10 percent of the farms. Like the North Saskatchewan, cattle (beef) farms are the most common type of farm in the sub-basin. The general mix of other types of farms is similar for both White Earth and North Saskatchewan.

11.2.2 Stockwatering

As noted in Table 11-8 about 45 percent of farms in the White Earth Sub-basin were classified as livestock operations, primarily cattle. Estimated livestock populations for major species are provided in Table 11-9. The table shows that there are about 157,000 cattle and calves which, together, accounted for about 65 percent of the livestock population. Other livestock in the sub-basin included poultry, pigs, sheep and lamb, horses and ponies, bison, deer and elk.

Table 11-8 Estimated Livestock Populations in the White Earth Sub-basin, 2001

Livestock Species	White Earth	North Saskatchewan	% North Saskatchewan
Hens and Chicken	363,463	3,090,930	0.5%
Turkey	586	41,519	0.1%
Cattle	112,631	990,169	2.4%
Calves	44,250	365,725	2.8%
Pigs	25,665	232,169	0.6%
Sheep and Lamb	5,798	55,204	1.7%
Horse and Ponies	2,776	35,172	3.4%
Bison	1,444	18,906	5.7%
Deer	300	2,864	12.2%
Elk	123	6,426	3.8%

11.2.2.1 Water Allocation

Overall, 3,186 licences and registrations have been issued for livestock watering with total allocation amounting to 2,801 dam³. In addition to these allocations, farmers are able to obtain up to 1,250 m³ of water for household purposes. The numbers of such households in the sub-basin is not known. Furthermore, the numbers of “exempted agricultural” users are also not known in the sub-basin. Table 11-9 summarizes current water licences and registrations issued for livestock according to the water source. It shows that surface water accounts for about 44 percent of allowable diversions for livestock and that registrations account for 60 percent of the allocations.

11.2.2.2 Licensed Water Use

Table 11-9 shows that the licences and registrations assume that all water diverted for use will be consumed or lost, and that there will be no return flow.

11.2.2.3 Actual Water Use

There is no information in Alberta Environment's WURS that indicates the extent to which water allocations are actually used in the White Earth Sub-basin. However, a reasonable estimate of water use can be derived using the actual animal population in the basin as shown in Table 11-8. Based on livestock populations for the White Earth Sub-basin in 2001, the total water required for livestock was estimated to be 1,422 dam³, or about 51 percent of the licensed allocation.¹ The calculations for this estimate are provided in Table 11-10 which shows livestock populations in the basin and the daily water requirements for various livestock species as provided by Alberta Environment in its “Guide to Calculate Quantities for Water for Raising Animals”.² In terms of water requirements by species, cattle accounts for about 88 percent of the total, about 5 percent is required by pigs, and all other species accounted for the remaining 7 percent.

¹ This approach to estimating water use for stockwatering was employed in the 1986 Battle River Basin water use study undertaken by Stanley Associates in 1985.

² http://www3.gov.ab.ca/env/water/Legislation/Approvals_Licences/CalculationChart.doc.



Table 11-9 Summary of Water Licences and Registrations Issued for Livestock Watering in the White Earth Sub-basin,

Activity	Source	Number of Licences/ Registrations	Licensed Allocation and Use (dam ³)			Reported Actual Water Use	
			Allocation	Water Use	Return	Licences Reporting	Reported Use (dam ³)
Registration	Surface	1,603	667.2	667.2	0.0	0	N/A
	Groundwater	1,342	1,010.4	1,010.4	0.0	0	N/A
	Subtotal	2,945	1,677.6	1,677.6	0.0	0	N/A
Stockwatering	Surface	68	576.7	576.7	0.0	0	N/A
	Groundwater	173	546.2	546.2	0.0	0	N/A
	Subtotal	241	1,122.9	1,122.9	0.0	0	N/A
Total	Surface	1,671	1,243.9	1,243.9	0.0	0	N/A
	Groundwater	1,515	1,556.6	1,556.6	0.0	0	N/A
	Total	3,186	2,800.5	2,800.5	0.0	0	N/A

The estimated actual consumption (1,422 dam³) based on livestock populations shown in Table 11-10 does not include an allowance for the evaporative and seepage losses associated with storing water for livestock use. Typically, licensed consumption accounts for only 35 percent of surface water allocated for livestock use while losses account for 65 percent (Watrecon 2005).

Table 11-10 Estimated Livestock Water Requirements for 2001

Livestock Species	Animal Population	Daily Consumption (gallons)	Annual Use (dam ³)
Hens and Chickens	363,463	0.045	27.1
Turkey	586	0.15	0.1
Bulls	2,203	9.0	32.9
Milk Cows	823	30.0	40.9
Beef Cows	51,147	9.0	763.4
Heifers	14,304	6.0	142.3
Steers	4,568	6.0	45.5
Calves	44,250	3.0	220.1
Boars	184	6.5	2.0
Sows and Gilts - Breeding	2,723	6.5	29.4
Nursing and Weaner Pigs	8,226	0.5	6.8
Grower and Finishing Pigs	14,532	1.5	36.1
Sheep and Lambs	5,798	2.0	19.2
Horse and Ponies	2,776	10.0	46.0
Bison	1,444	2.0	4.8
Deer	300	10.0	5.0
Elk	123	3.5	0.7
Total			1,422.4

Since 56 percent of livestock water consumption comes from groundwater (no losses) and the balance comes from surface water with 65 percent losses, a total allocation of 1,762 dam³ would be required to support the animal populations in Table 11-10. This water requirement is about 63 percent of the water allocation through licences and registrations.

11.2.2.4 Forecasts of Future Stockwatering Water Use

Future water use is dependent on future livestock population in the sub-basin. Information from the NRCB indicates that, as of December 31, 2005, there had been no applications from farmers throughout the sub-basin for new or expanded cattle and dairy operations. A study undertaken by Alberta Agriculture in the late 1990s also provides some insights regarding the potential for expansion of cattle. Figures 2-3 and 2-4 in Section 2.3 show areas where there is capability of supporting a 5,000-head back grounding operation and a 20,000-head operation. The figures show that there are some townships that meet all of the criteria for backgrounding and finishing operations only. For townships that meet some of the criteria limiting factors include groundwater for both types of operations. Based on Alberta Agriculture's assessment, it would appear that there are more opportunities for backgrounding than finishing operations in the White Earth Sub-basin. Table 11-11 shows water use projections to 2025. By 2025, relative to 2005, water use is expected to 11 percent, 30 percent and 60 percent higher under Low, Medium and High Growth Scenarios respectively.

Table 11-11 Projected Water Use for Livestock in the White Earth Sub-basin,
 (dam³)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	972	996	1,023	1,051	1,079
	Groundwater	790	809	831	854	877
	Total	1,762	1,805	1,854	1,905	1,957
Medium Growth	Surface	972	1,034	1,102	1,175	1,252
	Groundwater	790	840	896	955	1,018
	Total	1,762	1,874	1,998	2,130	2,270
High Growth	Surface	972	1,090	1,225	1,375	1,542
	Groundwater	790	886	995	1,117	1,253
	Total	1,762	1,975	2,220	2,492	2,795

11.2.3 Irrigation

The other major use of water for agricultural purposes is irrigation or crop watering. Irrigation in this sub-basin is done by private irrigators who have their own water licences and divert water using their own pumps and water distribution equipment.

When aggregate information from the 2001 Census of Agriculture for individual counties and municipal districts is modified to reflect river basin boundaries, the resulting estimates suggest that about 1,434 acres of land in the White Earth Sub-basin were irrigated in 2001. Another approach for estimating irrigated acres involves dividing water allocations by irrigation water requirement of about 450 mm (18 inches) per acre. Based on this method it is estimated that water allocations are sufficient to support irrigation on about 985 acres. There is no information on the mix of crops grown by private irrigators. However, AAFRD has indicated that most private irrigation in Alberta is used to raise supplemental forages to feed livestock.

11.2.3.1 Water Allocation

There are 14 licences that allocate approximately 1,198 dam³ for irrigation purposes. Over 99 percent of this allocation is from surface water.

11.2.3.2 Licensed Use

Table 11-12 shows that it is expected that nearly all of the allocations will be consumed or lost. Only 7 dam³ (0.6 percent of allocation) is expected to be returned after use. . Licensed use is 1,191 dam³.

Table 11-12 Irrigation Allocations and Use and Reported Actual Water Use, White Earth Sub-basin

Activity	Source	Number of Licences/ Registrations	Licensed Allocation and Use (dam ³)			Reported Actual Water Use (dam ³)	
			Allocation	Water Use	Return	Licensees Reporting	Reported Use
Private irrigation	Surface	13	1,191.8	1,184.4	7.4	0	N/A
	Groundwater	1	6.2	6.2	0.0	0	N/A
	Subtotal	14	1,198.0	1,190.6	7.4	0	N/A
Total	Surface	13	1,191.8	1,184.4	7.4	0	N/A
	Groundwater	1	6.2	6.2	0.0	0	N/A
	Total	14	1,198.0	1,190.6	7.4	0	N/A

11.2.3.3 Actual Water Use

Neither Alberta Agriculture nor Alberta Environment has any information on actual water use by private irrigators. For the purposes of this study it is assumed that actual use is equal to licensed water use. However, actual water use in any given year will depend on how much of the crop water demand can be satisfied by natural precipitation. It is noteworthy that actual stockwatering use in the sub-basin (1,762 dam³) is about 32 percent higher than water used for crop watering.

11.2.3.4 Forecasts of Future Irrigation Water Use

With expansion of livestock, additional demand for livestock forage is expected. However, due to climatic conditions and poor returns on forage production additional forage production is not expected. It is assumed that available forage will be able to support modest increases in livestock populations. Irrigation water use is projected remain at 1,191 dam³ over the forecast period.

11.2.4 Summary

In summary, current agricultural water use in the White Earth Sub-basin is estimated to be about 2,952 dam³, of which 40 percent is for stockwatering and 60 percent is for irrigation. In the future, agricultural water demand in the basin is expected to increase as a result of expansion of livestock populations. Irrigation water use is expected to remain constant. Table 11-13 shows a summary of future agricultural water use.

Table 11-13 Projected Water Use for Agriculture in the White Earth Sub-basin
 (dam³)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	2,156	2,180	2,207	2,235	2,263
	Groundwater	796	815	837	860	883
	Total	2,952	2,995	3,044	3,095	3,147
Medium Growth	Surface	2,156	2,218	2,286	2,359	2,436
	Groundwater	796	846	902	961	1,024
	Total	2,952	3,064	3,188	3,320	3,460
High Growth	Surface	2,156	2,274	2,409	2,559	2,726
	Groundwater	796	892	1,001	1,123	1,259
	Total	2,952	3,165	3,410	3,682	3,985

Agricultural water use in 2025 would be about 3,147 dam³ (an increase of 7 percent from 2005) under Low Growth. Under High Growth, water use is projected to be 3,985 dam³ by 2025; this represents an increase of 35 percent from 2005. For Medium Growth, agricultural water use in 2025 is expected to increase by 17 percent over current levels.

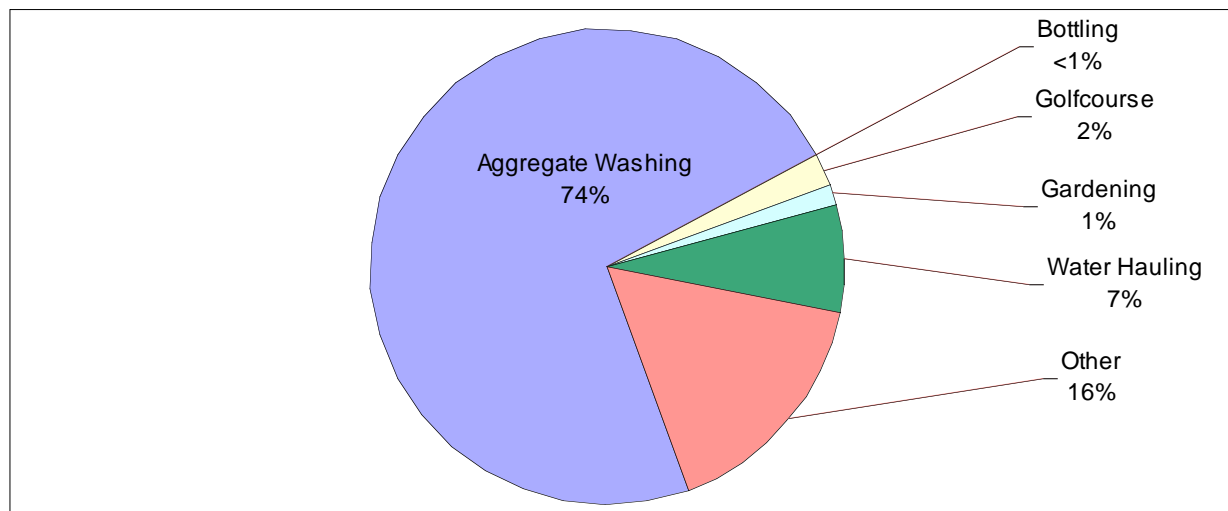
11.3 Commercial Sector

There are 24 licences that allow diversion of 4,553 dam³ of water in the White Earth sub-basin. This allocation accounts for 42 percent of total allocations in the sub-basin.

11.3.1 Water Allocations

Figure 11-9 shows how this allocation is distributed among the various commercial sector activities, including aggregate washing (74 percent), other (16 percent) and, water hauling (7 percent). Golf course, gardening, and bottling together account for the remaining 3 percent of allocations. Surface water accounts for 91 percent of allocations and the largest allocation is for aggregate washing. Groundwater accounts for the remaining 9 percent of the allocations and the largest allocation is for water hauling.

Figure 11-9 Water Allocation for Commercial Activities in the White Earth Sub-basin



11.3.2 Licensed Water Use

Table 11-14 provides a summary of licensed allocations, use and return for various activities within the commercial sector in the White Earth sub-basin. The table shows that for most commercial used, licensee will consume all of the water they withdraw. However; it is expected that for aggregate washing the majority of withdrawals (72 percent) will be returned after use. Overall, licences issued for commercial purposes assume that 2,391 dam³ (53 percent of allocation) will be returned to surface water sources.

11.3.3 Actual Water Use

At the present time Alberta Environment's Water Use Reporting System contains no information on actual water use in 2005 by any of the licensees in the commercial sector in the White Earth sub-basin. Given the lack of information on actual water use, it is assumed that all licensees are withdrawing and using the full amount of water to which they are entitled. This assumption may overstate the actual commercial sector water use as well as the overall water use.

11.3.4 Future Water Use Forecasts

Since most of the allocation (90 percent) is for two activities – aggregate washing, and other, forecasts of future demand will be based on those activities.



Table 11-14 Licensed Commercial Allocations, Reported and Actual Water Use, White Earth Sub-basin

Activity	Source	Number of Licences	Licensed Allocation and Use (dam ³)			Reported Actual Water Use (dam ³)		
			Allocation	Water Use	Return	Licenses Reporting	Reported Use	Percent of Allocation
Aggregate Washing	Surface	5	3,231.8	841.3	2,390.5	0	N/A	N/A
	Groundwater	2	81.4	81.4	0.0	0	N/A	N/A
	Subtotal	7	3,313.2	922.7	2,390.5	0	N/A	N/A
Bottling	Surface	0	0.0	0.0	0.0			
	Groundwater	1	1.2	1.2	0.0	0	N/A	N/A
	Subtotal	1	1.2	1.2	0.0	0	N/A	N/A
Gardening	Surface	4	60.4	60.4	0.0	0	N/A	N/A
	Groundwater	0	0.0	0.0	0.0			
	Subtotal	4	60.4	60.4	0.0	0	N/A	N/A
Golf Course	Surface	3	100.1	100.1	0.0	0	N/A	N/A
	Groundwater	0	0.0	0.0	0.0			
	Subtotal	3	100.1	100.1	0.0	0	N/A	N/A
Other	Surface	3	750.0	750.0	0.0	0	N/A	N/A
	Groundwater	0	0.0	0.0	0.0			
	Subtotal	3	750.0	750.0	0.0	0	N/A	N/A
Water Hauling	Surface	0	0.0	0.0	0.0			
	Groundwater	6	328.5	328.5	0.0	0	N/A	N/A
	Subtotal	6	328.5	328.5	0.0	0	N/A	N/A
Total	Surface	15	4,142.2	1,751.7	2,390.5	0	N/A	N/A
	Groundwater	9	411.1	411.1	0.0	0	N/A	N/A
	Total	24	4,553.4	2,162.9	2,390.5	0	N/A	N/A

11.3.4.1 Aggregate Washing

Demand for aggregate material (and water use) is related to the level of economic activity, particularly construction so the water use projections are related to change in economic activity (GDP growth rate). Although Alberta is experiencing higher than average rate of GDP growth relative to historic levels, the water use forecasts use long term annual growth rates of 1.2 percent (Low Growth), 2.2 percent (Medium Growth) and 3.2 percent (High Growth). Projections using these assumptions are shown in Table 11-15.

Table 11-15 Projected Water Use for Aggregate Washing, White Earth Sub-basin
 (dam³)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	841	893	948	1,006	1,068
	Groundwater	82	87	92	98	104
	Total	923	980	1,040	1,104	1,172
Medium Growth	Surface	841	938	1,045	1,166	1,300
	Groundwater	82	91	102	113	126
	Total	923	1,029	1,147	1,279	1,426
High Growth	Surface	841	984	1,152	1,349	1,579
	Groundwater	82	96	112	132	154
	Total	923	1,080	1,265	1,480	1,733

In 2025, water use is expected to be 1,172 dam³ under Low Growth, this is a 27 percent increase from 2005. Under High Growth water use is expected to 1,733 dam³ which is an 88 percent increase. Water use is expected to be 54 percent higher by 2025 under Medium Growth.

11.3.4.2 Other

Water use for the other activity is assumed to remain unchanged from the current level of 750 dam³, all from surface water sources, over the forecast period.

11.3.5 Summary

A summary of the projected water demand for the commercial sector in the White Earth Sub-basin is provided in Table 11-16. Note that this forecast combines the estimates for aggregate washing and other (which together account for 90 percent of allocation in the sub-basin), with the assumption that all of the remaining commercial licensees are using their full entitlements.

Under the Low Growth Scenario, water use in 2025 is projected to rise to 2,412 dam³ which is a 12 percent increase from current levels. Under the High Growth Scenario, water use is projected to rise to 2,973 dam³ which is a 37 percent increase. Water use is projected to increase by 23 percent from the current level by 2025 under the Medium Growth.

Table 11-16 Projected Water Use for the Commercial Sector, White Earth Sub-basin
 (dam³)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	1,752	1,804	1,859	1,917	1,979
	Groundwater	411	416	421	427	433
	Total	2,163	2,220	2,280	2,344	2,412
Medium Growth	Surface	1,752	1,849	1,956	2,077	2,211
	Groundwater	411	420	431	443	456
	Total	2,163	2,269	2,387	2,519	2,666
High Growth	Surface	1,752	1,895	2,063	2,260	2,490
	Groundwater	411	425	441	461	483
	Total	2,163	2,320	2,505	2,720	2,973

11.4 Petroleum Sector

11.4.1 Gas and Petrochemical

11.4.1.1 Water Allocation

In the White Earth Sub-basin, there is only one active groundwater licence that allows up to 1 dam³ of water to be withdrawn by the petroleum sector for gas and petrochemical plants (Table 11-17). Petroleum allocations accounts for less than one percent of total allocations in the sub-basin. This sector's single licence was issued in the 1970s and assumes that the licence holder will consume all the water they are allowed to withdrawal. There is no allowance for return flow so all of the allocations can be used.

11.4.1.2 Actual Water Use

There is no information on actual water use. For the purposes of this analysis, it is assumed that licensees are using their full entitlement.

11.4.1.3 Future Water Use

There are currently plans to construct two new upgraders in the basin in the near future. As shown in Table 11-18 these include Synenco Energy's Northern Lights Upgrader Project and the Northwest Upgrader Project. While additional upgraders may eventually be required in the basin, potential development beyond 2015 and their water requirements are unknown.

The amount of water required by these facilities will ultimately depend on their production capacity and technology. According to the public disclosure documents filed with Alberta Environment, the two upgraders are expected to require 16,870 dam³ of freshwater from the North Saskatchewan River and 1,527 dam³ for surface water runoff.



Table 11-17 Licensed Allocations, Estimated Actual Water Use for the Petroleum Sector, White Earth Sub-basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam ³)			Estimated Water Use (dam ³)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Gas/ Petrochemical Plant	Surface	0	0.0	0.0	0.0	0	0%	0%
	Groundwater	1	1.2	1.2	0.0	1	100%	100%
	Subtotal	1	1.2	1.2	0.0	1*	100%	100%
Total	Surface	0	0.0	0.0	0.0	0	0%	0%
	Groundwater	1	1.2	1.2	0.0	1	100%	100%
	Total	1	1.2	1.2	0.0	1	100%	100%

*Estimated water use is assumed to be 100 percent of licensed consumption.

Table 11-18 List of Proposed Upgraders in the White Earth Sub-basin³

Company	Name of Project	Status	Timeline for Operations	Amount of Product	Water Required (dam ³ /year)	Average Water Requirement (litres/barrel)
Synenco Energy Inc.	Northern Lights Upgrader Project	EIA/ Application submitted	Phase 1 – 2010	Phase 1 - 50,000 BPD	10,300 dam ³	282
			Phase 2 - 2012	Phase 2 – 50,000 BPD		
North West Upgrading Inc.	North West upgrader Project	EIA submitted	Phase 1 - 2010	Phase 1-77,000 BPD	6,570 dam ³	117
			Phases 2&3 - 2015	Phase 2&3 -154,000 BPD		
					16,870 dam³	182

³ Alberta Environment. June, 2007. Register of Environmental Assessment Information: Summary of Environmental Assessment Activity. Website available at http://www3.gov.ab.ca/env/protenf/assessment/pub/EA_Activity_Summary.pdf

It should be noted that these represent gross water requirements and, as some of the water is being used for cooling, there will be some return flow. Using information contained in the application by Petro-Canada for its proposed upgrader in the Beaverhill Sub-basin (see Section 10.4), it is estimated that between 72 and 80 percent of water diversions will be consumed and the balance will be returned after use. With this assumption, estimated water use when all new industrial operations are operating at capacity will be about 13,800 dam³.

Although it is expected that the two upgraders will be built in the White Earth Basin, the forecasts reflect different assumptions about when they will become fully operational. The Medium Growth Scenario (as proposed by the companies) assumes that Phases 1 and 2 of Synenco's upgrader will be fully operation in 2010 and 2012, respectively, and that Phase 1 of the North West upgrader will be fully operational by 2010 followed by Phase 2 and 3 by 2015. The Low Growth Scenario assumes that construction on each phase of both upgraders will be delayed by two years. The High Growth Scenario assumes that the first phase of both upgrades is operational by 2010 and that the timetable for completing the second phases of each upgrader is moved forward by two years. As shown in Table 11-19, water use under the various scenarios is different over the period to 2015, but is the same thereafter because each of the upgraders will be operating at capacity.

Table 11-19 Forecast of Petroleum Water Use in the White Earth Sub-basin
 (dam³)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	0	0	10,189	12,653	12,653
	Groundwater	1	1	1	1	1
	Total	1	1	10,190	12,654	12,654
Medium Growth	Surface	0	3,863	12,653	12,653	12,653
	Groundwater	1	1	1	1	1
	Total	1	3,864	12,654	12,654	12,654
High Growth	Surface	0	6,326	12,653	12,653	12,653
	Groundwater	1	1	1	1	1
	Total	1	6,327	12,654	12,654	12,654

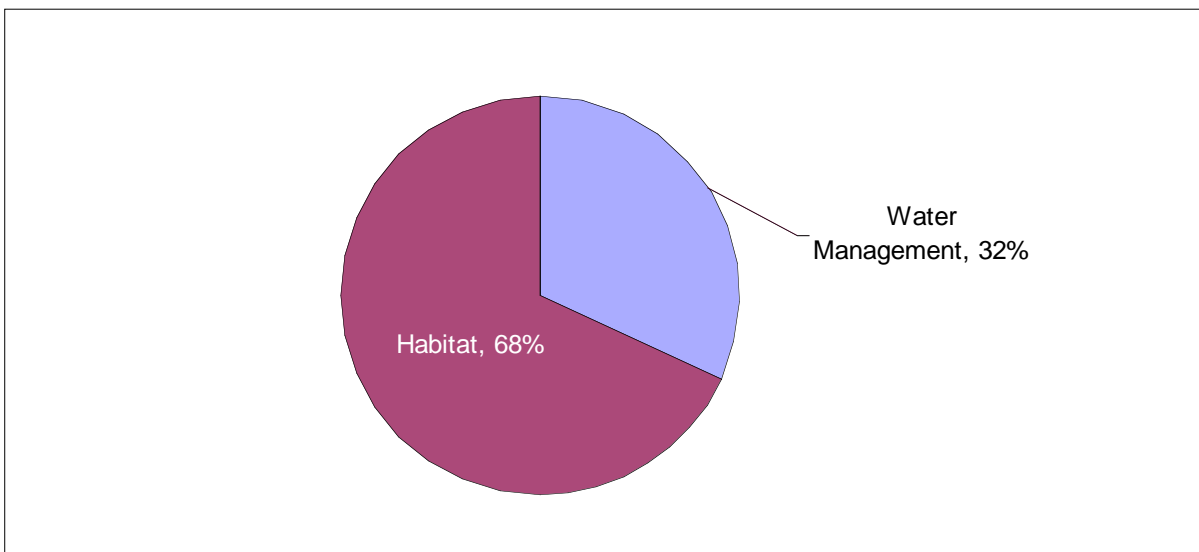
11.5 Industrial Sector

There are no industrial water licences in the White Earth Sub-basin. No industrial water uses that would require their own water licences is expected for the period to 2025.

11.6 Other Sector

In the White Earth Sub-basin 15 active licences allocate 1,183 dam³ of water to the other sector. These licensees assume that 29 percent of withdrawals will be returned after use. The other sector activities account for about 11 percent of licensed water use in the White Earth Sub-basin. Almost all of the water allocated is for surface water (1,183 dam³). Other sector uses include water management for flood control and lake stabilization, and fish, wildlife and habitat enhancement (Figure 11-10). Water licences have been issued to Alberta Environment (one), the County of Thorhild (three), Ducks Unlimited (eight), and private individuals (three).

Figure 11-10 Other Sector Water Allocation by Use in the White Earth Sub-basin



11.6.1 Water Management

In the White Earth Sub-basin, five surface water licences have been issued for water management activities and they allow withdrawals of up to 374 dam³ of water. Water management allocations commenced in the 1970s for surface water and increased sizably in the 1980s. Surface water licences expect licence holders will consume up to 31 dam³ and will return 341 dam³ (Table 11-20).

There is no information on the actual water diversions and consumption for water management licences and, for purposes of this analysis, it is assumed that the licence holders are using their full entitlement.

In the future, there is expected to be light growth in water requirements for water management projects in the White Earth Sub-basin (see the Section 2.0). The forecasts in Table 11-21 assume that, under the High Growth Scenario, future water use will increase by one licence every five years and each project will have the same water requirements as the average current Ducks Unlimited project. The Low Growth Scenario assumes that there is no change in water management projects. The Medium Growth Scenario assumes that new projects will be constructed at half the rate of the High Growth Scenario.



Table 11-20 Licensed Allocations and Estimated Actual Water Use for the Other Sector, White Earth Sub-basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam ³)			Estimated Water Use (dam ³)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Water Management	Surface	5	373.8	32.8	341.0	32	100%	8%
	Groundwater	0	0.0	0.0	0.0	0		
	Subtotal	5	373.8	32.8	341.0	32	100%	8%
Habitat	Surface	9	809.3	809.3	0.0	809	100%	100%
	Groundwater	1	0.2	0.0	0.2	0		
	Subtotal	10	809.5	809.3	0.2	809	100%	99%
Total	Surface	14	1,183.1	842.1	341.0	842	100%	71%
	Groundwater	1	0.2	0.0	0.2	0		
	Total	15	1,183.3	842.1	341.2	842	100%	71%

Table 11-21 Forecast of Water Management Water Use in the White Earth Sub-basin
 (dam³)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	33	33	33	33	33
	Groundwater	0	0	0	0	0
	Total	33	33	33	33	33
Medium Growth	Surface	33	88	143	198	253
	Groundwater	0	0	0	0	0
	Total	33	88	143	198	253
High Growth	Surface	33	143	253	363	473
	Groundwater	0	0	0	0	0
	Total	33	143	253	363	473

11.6.2 Habitat Enhancement

In the White Earth Sub-basin, nine surface water licences and one groundwater licence have been issued for wildlife and habitat enhancement projects. These licences allow withdrawals of up to 810 dam³ of water. Habitat enhancement allocations commenced in the 1970s for surface water and in the 1990s for groundwater. Surface water licensees are assumed to consume all of the water they withdraw. The single groundwater licence expects the licence holder to return their total withdrawals.

There is no information on the actual water diversions and consumption for habitat enhancement licences. For purposes of this analysis, it is assumed that the licence holder is using their full entitlement.

In the future, there is expected to be light growth in water requirements for habitat enhancement projects in the White Earth Sub-basin and the water use forecasts, employ the same assumption as far water management projects (Section 11.6.1). The resulting forecasts of water use are provided in Table 11-22.

Table 11-22 Forecast of Habitat Enhancement Water Use in the White Earth Sub-basin
 (dam³)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	809	809	809	809	809
	Groundwater	0	0	0	0	0
	Total	809	809	809	809	809
Medium Growth	Surface	809	843	877	911	945
	Groundwater	0	0	0	0	0
	Total	809	843	877	911	945
High Growth	Surface	809	919	1,029	1,139	1,249
	Groundwater	0	0	0	0	0
	Total	809	919	1,029	1,139	1,249

11.6.3 Summary

The other sector in the White Earth Sub-basin is dominated by water allocated for habitat enhancement. These projects account for 68 percent of the water allocation and 96 percent of the licensed water use. However, given that licences issued for water management purposes have also been issued to be the same parties who have licences for habitat enhancement, it is likely that these are no real differences between these two types of water use.

In the future, there is expected to be light growth in the other sector projects in the White Earth Sub-basin. The forecasts in Table 11-23 combine the forecasts for water management purposes (Table 11-21) and for habitat enhancement projects (Table 11-22).

Table 11-23 Forecast of Other Sector Water Use in the White Earth Sub-basin
 (dam³)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	842	842	842	842	842
	Groundwater	0	0	0	0	0
	Total	842	842	842	842	842
Medium Growth	Surface	842	931	1,020	1,109	1,198
	Groundwater	0	0	0	0	0
	Total	842	931	1,020	1,109	1,198
High Growth	Surface	842	1,062	1,282	1,502	1,722
	Groundwater	0	0	0	0	0
	Total	842	1,062	1,282	1,502	1,722

Table 11-23 shows increases in water demand as low as 42 percent for the Medium Growth Scenario or as high as 105 percent for the High Growth Scenario.

11.7 Summary

Table 11-24 provides a summary of licensed allocations and estimated water use for each of the water use sectors in the White Earth Sub-basin. In total, existing licences and registrations allow a maximum of 10,808 dam³ of water to be withdrawn. Of this total 68 percent (7,308 dam³) is expected to be used. Figure 11-11 shows the allocations, licensed use and actual use for the different sectors. Actual use (6,175 dam³) is about 85 percent of licensed use. The largest water user is the commercial sector. Figure 11-12 shows the forecasts to 2025 for all of the sectors under Medium Growth. By 2025 water use is expected to increase by about 212 percent under Low Growth (Table 11-25), about 228 percent under Medium Growth (Table 11-26), and about 250 percent under High Growth (Table 11-27).

Figure 11-11 Water Allocations and Actual Use, by Sector, White Earth Sub-basin

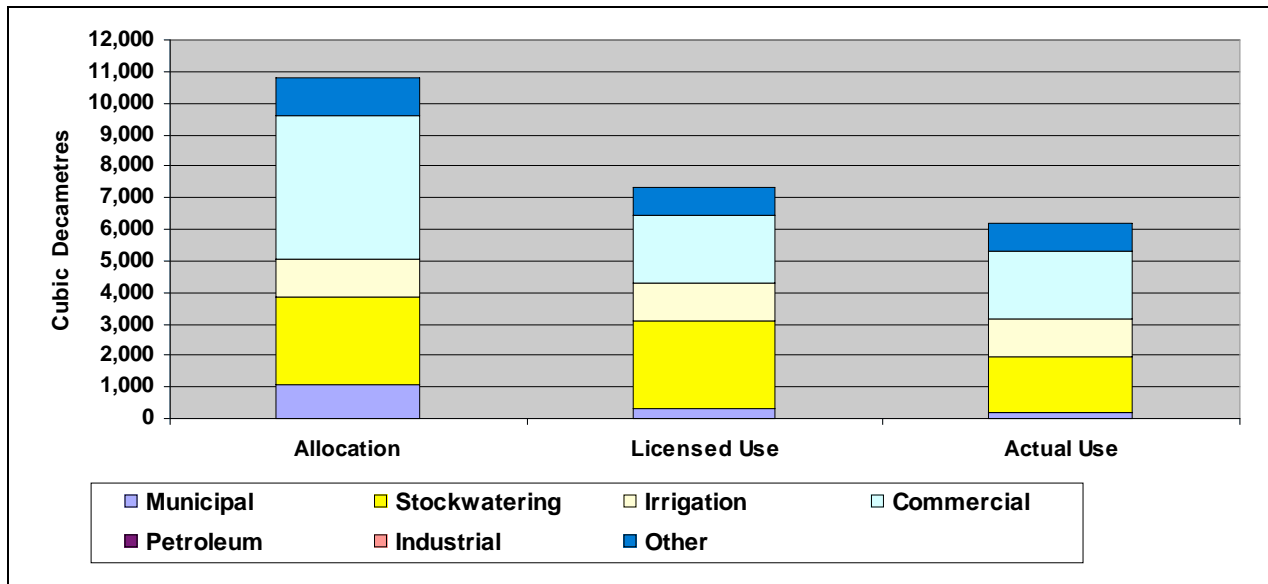


Figure 11-12 Forecast Water Use in White Earth Sub-basin: Medium Scenario

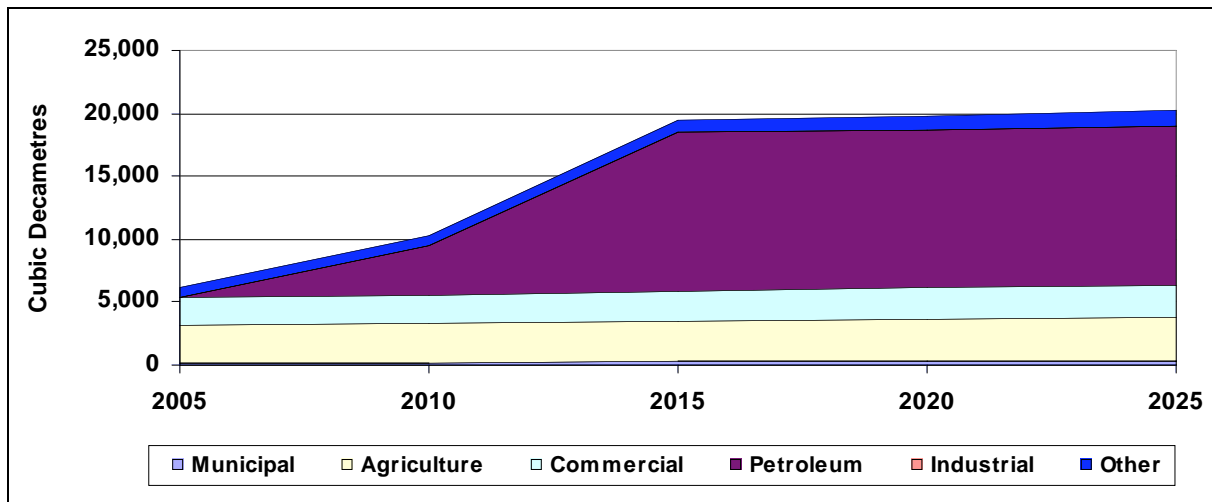




Table 11-24 Summary of Allocations and Estimated Water Use, White Earth Sub-basin

Sector		Licensed Allocation and Use (dam ³)				Estimated Water Use (dam ³)		
		Allocation	Water Use	Return	Percent of Total Use	Use	Percent of Licensed Use	Percent of Total Use
Municipal		1,072	310	762	4%	217	70%	4%
Agricultural	Stockwatering	2,801	2,801	0	38%	1,762	63%	29%
	Irrigation	1,198	1,191	7	16%	1,191	0%	19%
Commercial		4,553	2,163	2,390	30%	2,163	100%	35%
Petroleum		1	1	0	0%	1	0%	0%
Industrial		0	0	0	0%	0	0%	0%
Other		1,183	842	341	12%	842	100%	14%
Total		10,808	7,308	3,500	100%	6,175	85%	100%

Table 11-25 Forecast Water Use, By Sector, White Earth Sub-basin: Low Scenario
 (dam³)

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	71	73	75	77	78
	Agricultural	2,156	2,180	2,207	2,235	2,263
	Commercial	1,752	1,804	1,859	1,917	1,979
	Petroleum	0	0	10,189	12,653	12,653
	Industrial	0	0	0	0	0
	Other	842	842	842	842	842
	Total		4,821	4,899	15,172	17,724
Groundwater	Municipal	146	151	155	158	160
	Agricultural	796	815	837	860	883
	Commercial	411	416	421	427	433
	Petroleum	1	1	1	1	1
	Industrial	0	0	0	0	0
	Other	0	0	0	0	0
	Total		1,354	1,383	1,414	1,446
Total	Municipal	217	224	230	235	238
	Agricultural	2,952	2,995	3,044	3,095	3,146
	Commercial	2,163	2,220	2,280	2,344	2,412
	Petroleum	1	1	10,190	12,654	12,654
	Industrial	0	0	0	0	0
	Other	842	842	842	842	842
	Total		6,175	6,282	16,586	19,170

Table 11-26 Forecast Water Use, By Sector, White Earth Sub-basin: Medium Scenario
 (dam³)

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	71	75	79	82	86
	Agricultural	2,156	2,218	2,286	2,359	2,436
	Commercial	1,752	1,849	1,956	2,077	2,211
	Petroleum	0	3,863	12,653	12,653	12,653
	Industrial	0	0	0	0	0
	Other	842	931	1,020	1,109	1,198
	Total		4,821	8,936	17,994	18,280
Groundwater	Municipal	146	154	162	170	177
	Agricultural	796	846	902	961	1,024
	Commercial	411	420	431	443	456
	Petroleum	1	1	1	1	1
	Industrial	0	0	0	0	0
	Other	0	0	0	0	0
	Total		1,354	1,421	1,496	1,575
Total	Municipal	217	229	241	252	263
	Agricultural	2,952	3,064	3,188	3,320	3,460
	Commercial	2,163	2,269	2,387	2,520	2,667
	Petroleum	1	3,864	12,654	12,654	12,654
	Industrial	0	0	0	0	0
	Other	842	931	1,020	1,109	1,198
	Total		6,175	10,357	19,490	19,855

Table 11-27 Forecast Water Use, By Sector, White Earth Sub-basin: High Scenario
 (dam³)

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	71	77	84	91	98
	Agricultural	2,156	2,274	2,409	2,559	2,726
	Commercial	1,752	1,895	2,063	2,260	2,490
	Petroleum	0	6,326	12,653	12,653	12,653
	Industrial	0	0	0	0	0
	Other	842	1,062	1,282	1,502	1,722
	Total		4,821	11,634	18,491	19,065
Groundwater	Municipal	146	159	173	188	202
	Agricultural	796	892	1,001	1,123	1,259
	Commercial	411	425	441	461	483
	Petroleum	1	1	1	1	1
	Industrial	0	0	0	0	0
	Other	0	0	0	0	0
	Total		1,354	1,477	1,616	1,773
Total	Municipal	217	236	257	279	300
	Agricultural	2,952	3,166	3,410	3,682	3,985
	Commercial	2,163	2,320	2,504	2,721	2,973
	Petroleum	1	6,327	12,654	12,654	12,654
	Industrial	0	0	0	0	0
	Other	842	1,062	1,282	1,502	1,722
	Total		6,175	13,111	20,107	20,838