1. Introduction

This chapter of Millar Western Forest Product Ltd.'s (Millar Western) 2007-2016 Detailed Forest Management Plan (DFMP) describes the Defined Forest Area (DFA) in terms of administrative boundaries, physical conditions, forest landscape pattern and structure, forest landscape disturbance and succession, and landscape fire assessment. This chapter also provides an overview of the various land use activities on the DFA.

To ensure that all obligations arising from this DFMP are easily accessed, understood and realized, Millar Western has elected to consolidate all commitments, including those being carried forward from the 1997-2006 DFMP, in one location: *Appendix XXIII – Commitments.* Only commitments contained within this appendix are to be construed as obligations of the company.

2. Administrative Boundaries

This section identifies and describes regions, operational and strategic management units, and other areas that are influenced by Millar Western's forest management practices.

2.1 FMA, FMUs and the DFA

A Forest Management Agreement (FMA) is an area-based agreement between the Government of Alberta and a company that gives the company the rights to establish, grow, harvest and remove timber from a particular area of land. Millar Western's FMA area is located in west-central Alberta, approximately 175 km northwest of Edmonton (Figure 1). It is situated within two Forest Management Units (FMUs), W11 and W13. An FMU is a defined area of forest located in Alberta's Green (forested) Area that is designated by the Alberta government for management purposes. W11 and W13 cover 69 townships between Township 57 – 66, Range 2 – 18, west of the 5th Meridian (Figure 2). Table 1 shows the location of the FMUs and the FMU subunits within the townships of the Alberta Legal Survey grid.

The Millar Western 2007-2016 Detailed Forest Management Plan (DFMP) applies not only to the FMA area but, also, to a number of grazing dispositions that together form a land base known as the Defined Forest Area (DFA) (Figure 2).

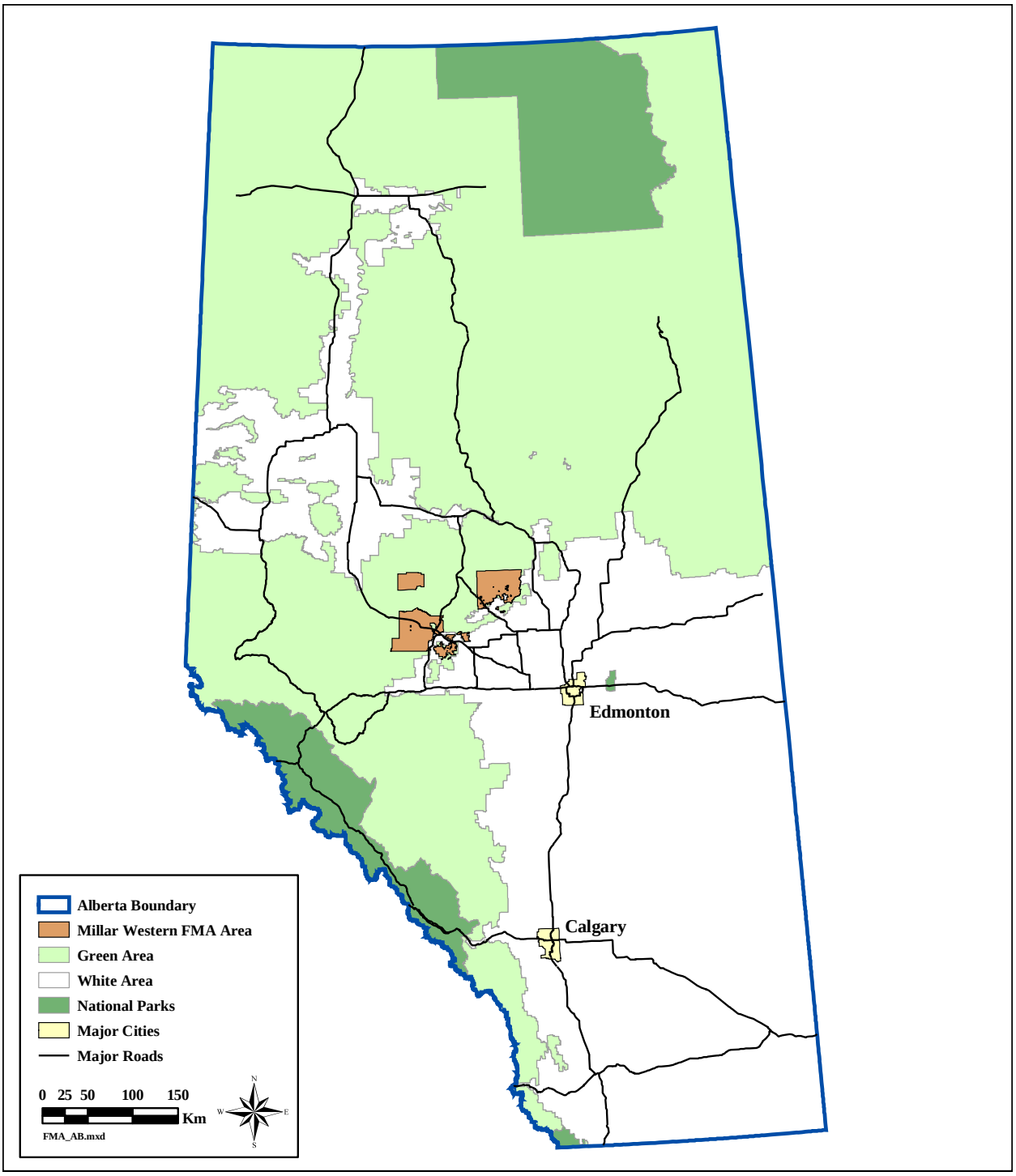

Figure 1. Location of Millar Western's FMA area within the province of Alberta.

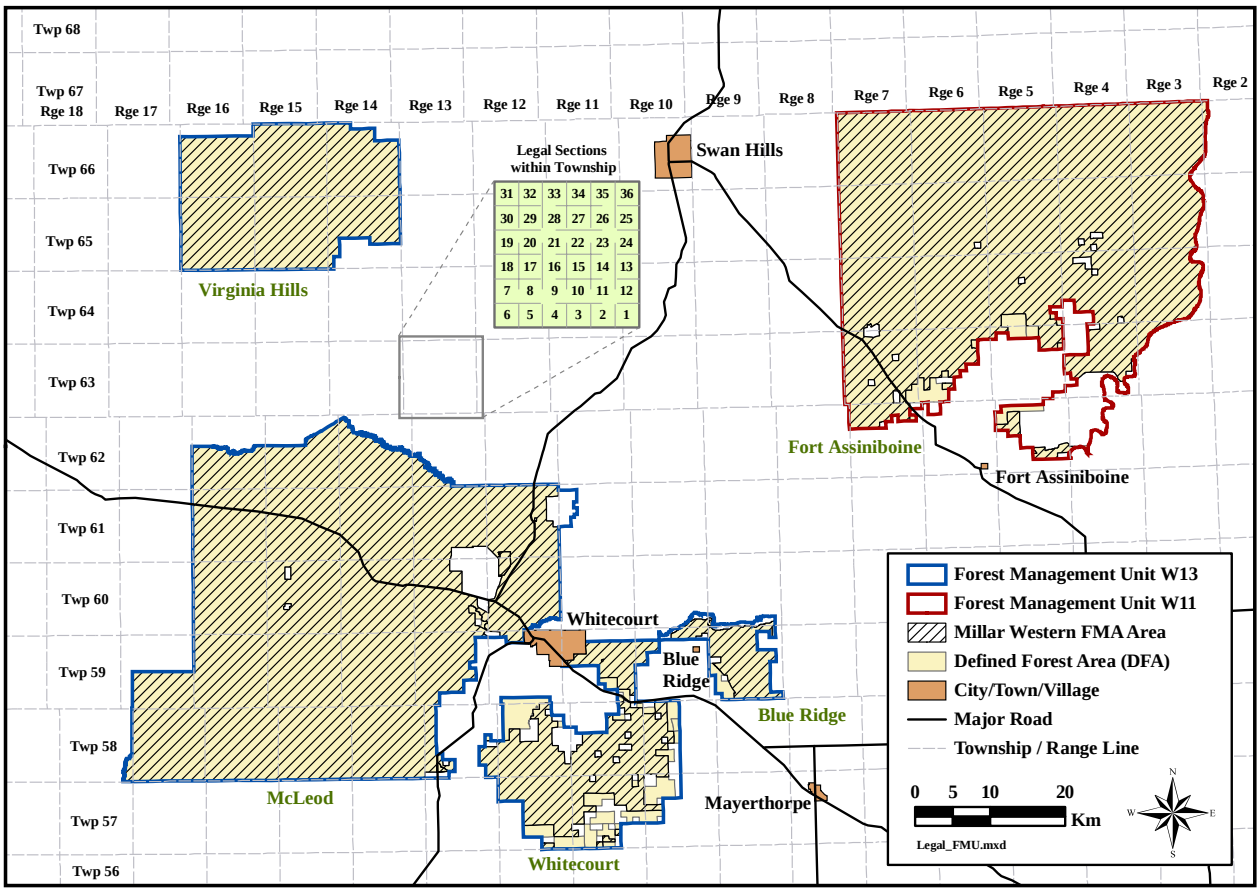

Figure 2. Location of the FMUs, within the Alberta Legal Survey Grid, and the relationship between the FMUs, FMA area and DFA.

Table 1. DFA Township coverage within the W11 and W13 FMUs.

FMU	Subunit	Townships	Ranges[1]	# Townships
W11	Fort Assiniboine	62 - 66	2 - 7	23
	Total			23
W13	Virginia Hills	65 - 66	14 - 16	6
	McLeod	58 - 62	12 - 18	26
	Whitecourt	57 - 59	10 - 13	10
	Blue Ridge	59 - 60	9 - 10	4
	Total			46
Grand Total				69

[1]West of the 5th Meridian.

FMU W11 has a gross area of 176,635 ha; it contains one subunit, 'Fort Assiniboine' (Figure 3 and Table 2). As well as 162,057 ha of FMA area, FMU 11 comprises grazing dispositions (3,740 ha), parks and other recreational areas (8,706 ha), private land (1,056 ha) and other non-FMA area (1,075 ha).

With a gross area of 301,874 ha, FMU W13 contains four subunits: 'Virginia Hills', 'McLeod', 'Whitecourt' and 'Blue Ridge' (Figure 3). The FMU is composed of FMA area (277,174 ha), a common FMA and grazing disposition area (98 ha), independent grazing dispositions (10,162 ha), a First Nations' reservation (3,602 ha), industrial areas (297 ha), parks and other recreational areas (2,215 ha), private land (1,115 ha), and other non-FMA land (7,210 ha).

The DFA within W11 includes the FMA area and the grazing dispositions, for a total area of 165,798 ha. The DFA within W13 includes the FMA area, the common FMA and grazing disposition and the independent grazing dispositions, for a total area of 287,435 ha. The total size of the DFA is 453,232 ha.

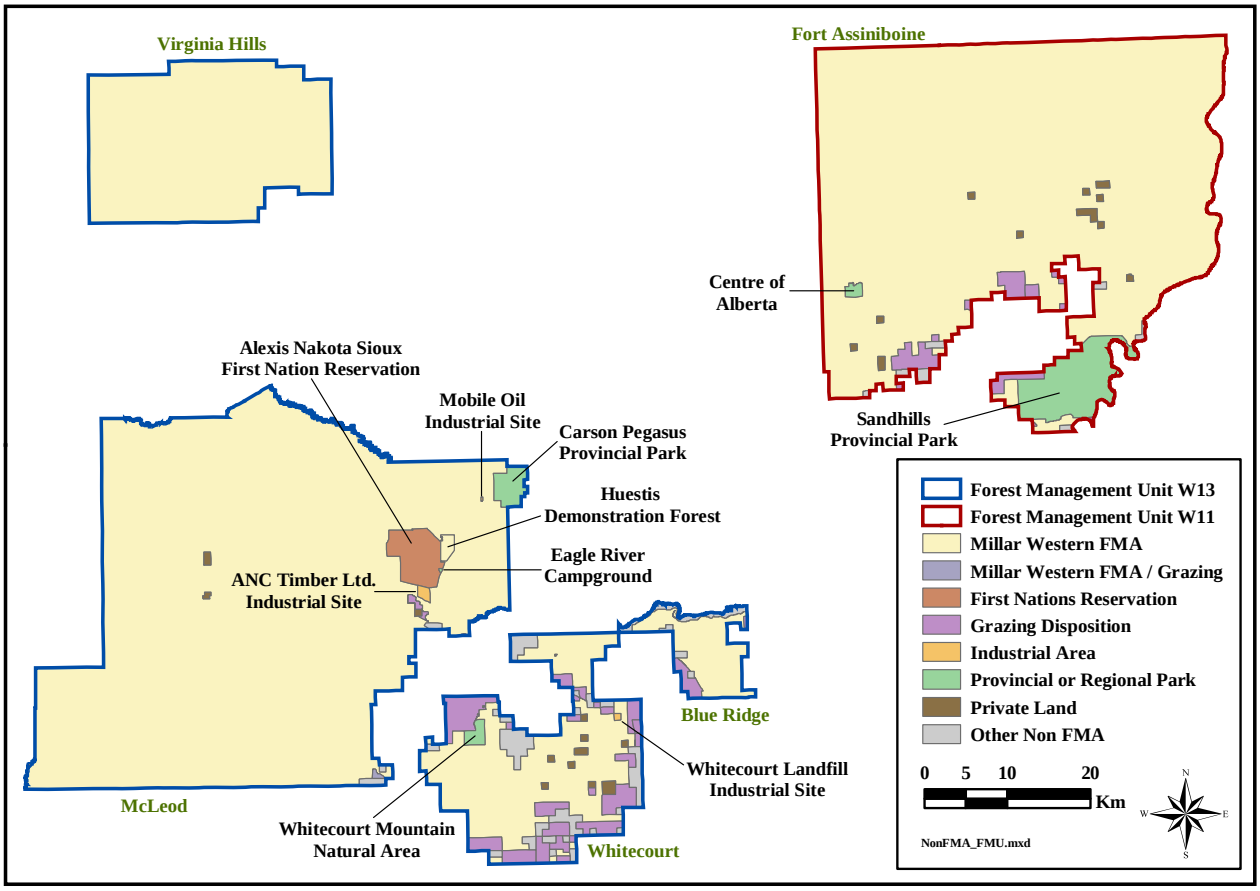

Figure 3. Land classifications within the W11 and W13 FMUs.

Table 2. Land classification area summary of the W11 and W13 FMUs.

Land Classification	FMU W11		FMU W13					W11 & W13 Total (ha)
	Ft. Assiniboine (ha)	W11 Total (ha)	Virginia Hills (ha)	McLeod (ha)	Whitecourt (ha)	Blue Ridge (ha)	W13 Total (ha)	
Within Defined Forest Area								
FMA	162,057	162,057	51,094	188,627	29,949	7,504	277,174	439,232
FMA & Grazing Disp.	-	-	-	98	-	-	98	98
Grazing Disp.	3,740	3,740	-	242	9,091	829	10,162	13,903
Total	165,798	165,798	51,094	188,967	39,040	8,333	287,435	453,232
Outside of Defined Forest Area								
First Nations Reserve	-	-	-	3,602	-	-	3,602	3,602
Park/Reserve	8,706	8,706	-	1,642	573	-	2,215	10,921
Industrial	-	-	-	231	66	-	297	297
Private	1,056	1,056	-	261	854	-	1,115	2,171
Other Non-FMA	1,075	1,075	-	576	5,333	1,301	7,210	8,285
Total	10,837	10,837	-	6,312	6,826	1,301	14,439	25,276
Grand Total	176,635	176,635	51,094	195,279	45,866	9,634	301,874	478,508

2.2 Compartments

Millar Western has further divided the FMU areas to accommodate strategic and operational forest planning and management. The operational and BAP compartmentalization schemes are the two most significant of these categories.

2.2.1 Operational Compartments

For the purposes of planning and operations, Millar Western has divided the FMUs into named operational compartments (Table 3 and Figure 4). Within W11, there are 15 operational compartments; within W13, there are a total of 29 compartments in the four subunits of the FMU. With the exception of a small compartment on an island within the Athabasca River, the compartments range in size from 3,559 ha to 31,450 ha, averaging 10,934 ha (standard deviation of 4,654).

Table 3. Operational compartment listing and gross area by FMU and subunit.

FMU W11		FMU W13			
Comp. Name	**Area[1] (ha)**	**Comp. Name**	**Area[1] (ha)**	**Comp. Name**	**Area[1] (ha)**
Fort Assiniboine		Virginia Hills		McLeod	
Akuinu	17,598	Goose	8,391	Athabasca	14,045
Clearwater	10,497	Headless Valley	11,787	Athabasca Hills	3,559
Coutts	10,675	Meekwap	9,253	Baseline Lake	14,676
Doris	8,124	North Goose	8,891	Bessie Creek	12,604
Erickson Lake	11,932	West Goose	12,773	Carson Creek	5,908
Foley Creek	7,534	Whitecourt		Carson Lake	11,463
Foley Lake	10,051	Hardluck Creek	13,760	Chickadee Creek	12,455
Klondike	13,785	Paddle River	13,320	Goodwin Lake	10,439
Long End Lake	31,450	Robison	4,302	Groat Creek	6,837
Mud Creek	11,614	Sand Hills	5,879	Island	482
North Freeman	10,048	Whitecourt Mountain	8,606	Kaybob	5,192
Roche Lake	8,126	Blue Ridge		Ocelot	12,555
South Freeman	4,452	Leech Lake	8,636	Pass Creek	8,269
Timeu Creek	12,035			Sakwatamau	13,338
Windfall Lake	7,106			Tom Hill	16,523
				Two Creeks	13,690
				West Windfall	15,479
				Windfall	12,504

[1] Total areas contained within compartments do not account for all area in the FMUs, but more area than the DFA.

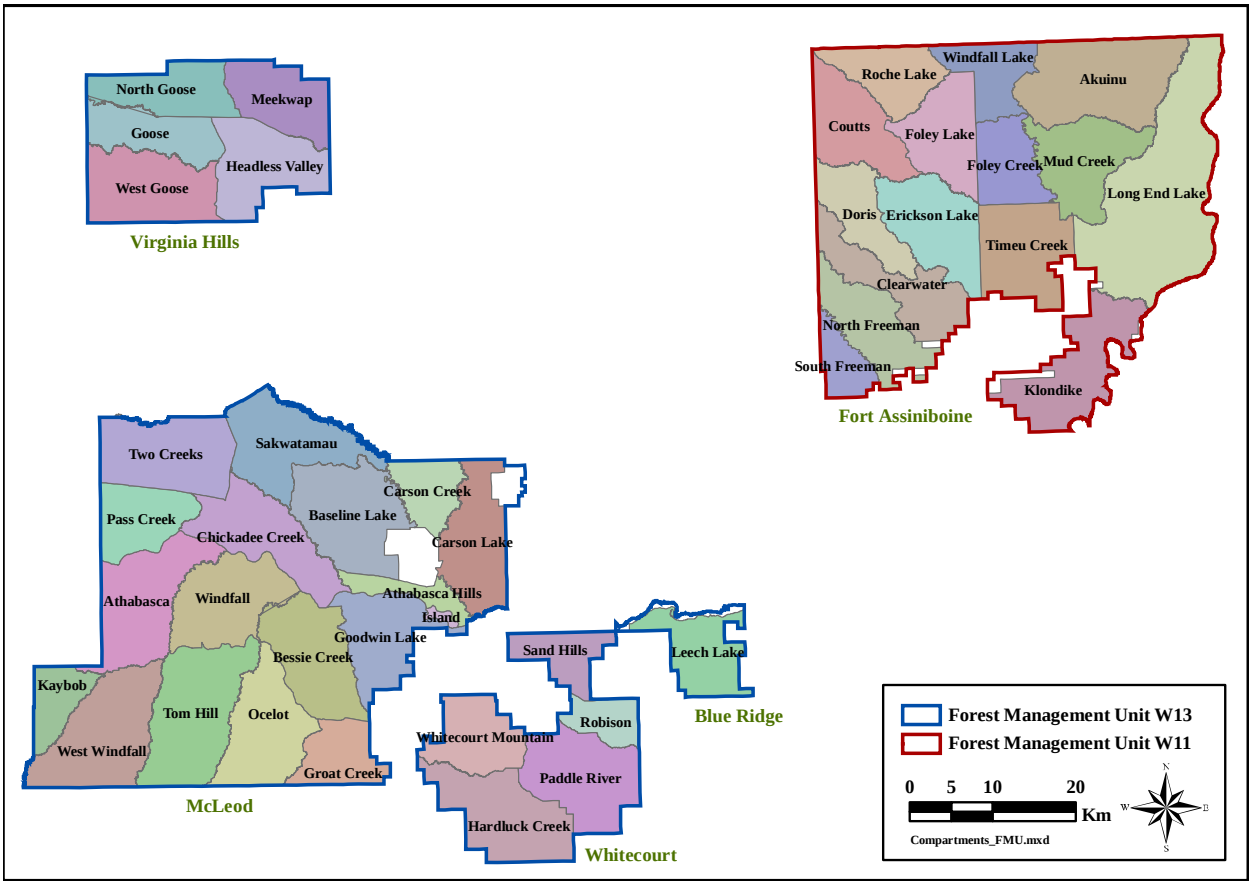

Figure 4. Millar Western's operational compartments.

2.2.2 BAP Compartments

In addition to the operational compartments, the BAP (Biodiversity Assessment Project) group delineated compartments for controlling and reporting biodiversity targets (Figure 5). These compartments, known as the BAP compartments, were designed to ensure a spatial distribution of biodiversity attributes within each compartment of the DFA.

Within W11, there are two BAP compartments: 'W11-East' (102,265 ha) and 'W11-West' (74,369 ha). Within W13, there are six BAP compartments: 'W13-Virginia Hills' (51,094 ha), 'W13-McLeod-North' (88,615 ha), 'W13-McLeod-South' (106,663), 'W13-Whitecourt' (45,867 ha) and 'W13-Blue Ridge' (9,634 ha). The average size of the BAP compartments is 68,358 ha (standard deviation of 34,918 ha).

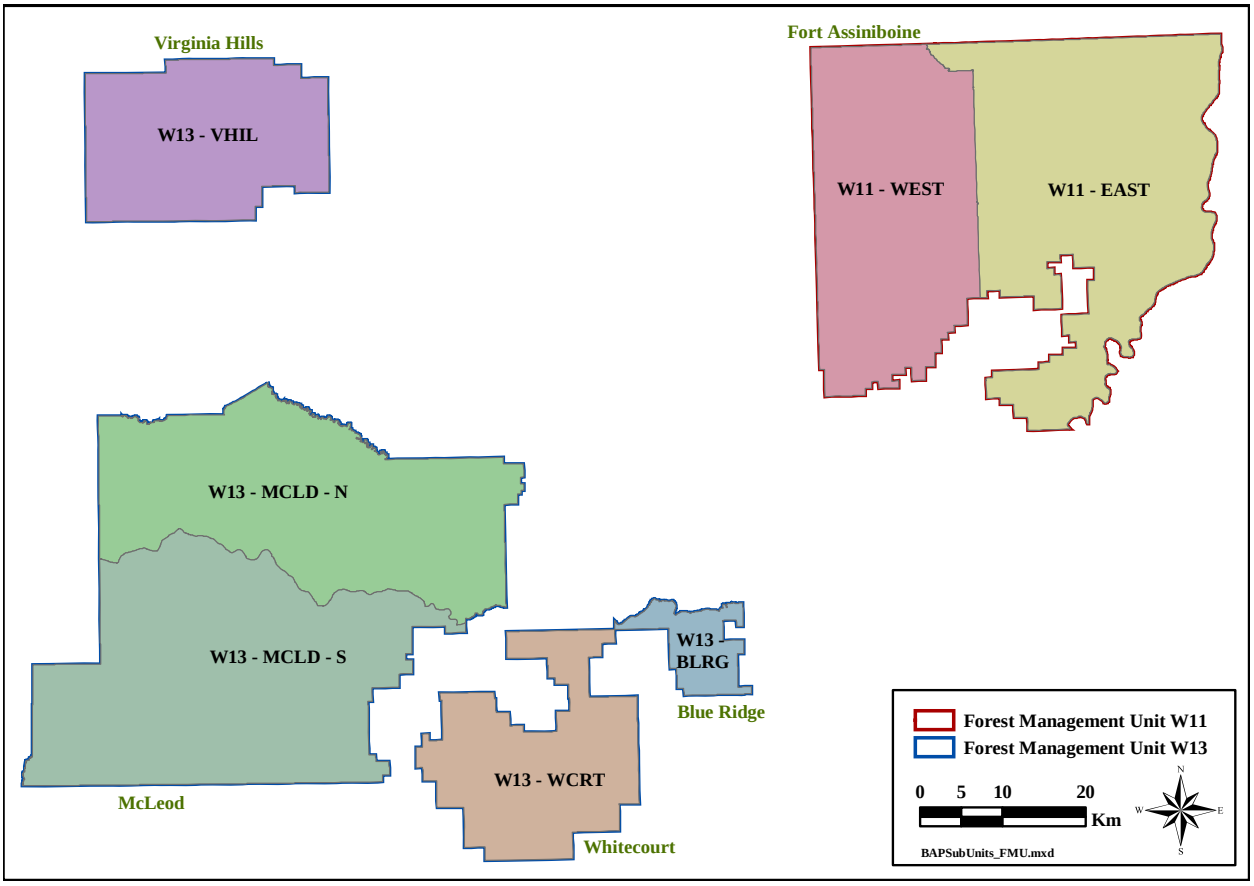

Figure 5. Millar Western's Biodiversity Assessment Project (BAP) compartments.

2.3 Natural Subregions

Millar Western's DFA lies within the Boreal and Foothills Natural Regions (Figure 6 and Table 4) of Alberta's ecological classification system. The DFA lies within the Central Mixedwood Natural Subregion of the Boreal Natural Region (121,972 ha or 27%) and the Lower Foothills (310,165 ha or 68%) and Upper Foothills (21,094 ha or 5%) Natural Subregions of the Foothills Natural Region.

The DFA portion of W11 lies within the Central Mixedwood Natural Subregion of the Boreal Natural Region (93,368 ha or 56%) and the Lower Foothills of the Foothills Natural Subregion (72,429 ha or 44%) (Table 4).

The DFA portion of W13 lies within the Central Mixedwood Natural Subregion of the Boreal Natural Region (28,604 ha or 10%) and the Lower Foothills (237,736 ha or 83%) and Upper Foothills (21,094 ha or 7%) Natural Subregions of the Foothills Natural Region (Table 4).

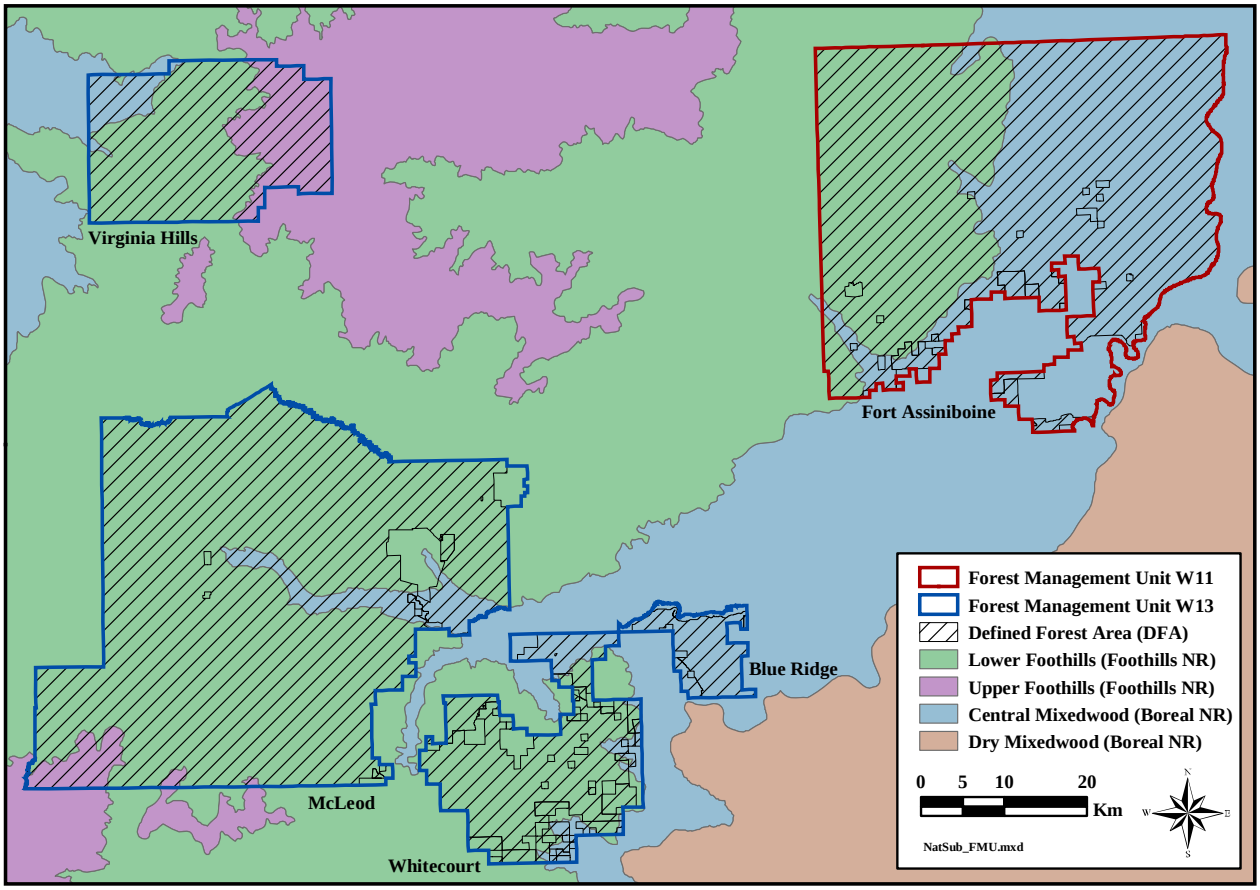

Figure 6. Natural subregions within and surrounding the W11 and W13 FMUs.

Table 4. Natural subregion area summary within the DFA area of W11 and W13.

		Boreal		Foothills					
		Central Mixedwood		Lower Foothills		Upper Foothills		Grand Total	
FMU	Subunit	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)
W11	Fort Assiniboine	93,368	21%	72,429	16%	-		165,797	37%
	Total	93,368	21%	72,429	16%	-		165,797	37%
W13	Virginia Hills	4,924	1%	30,861	7%	15,309	3%	51,094	11%
	McLeod	9,330	2%	173,754	38%	5,785	1%	188,869	42%
	Whitecourt	6,017	1%	33,121	7%	-		39,138	9%
	Blue Ridge	8,333	2%	-		-		8,333	2%
	Total	28,604	6%	237,736	52%	21,094	5%	287,435	63%
Grand Total		121,972	27%	310,165	68%	21,094	5%	453,232	100%

2.4 Municipal Districts and Counties

Millar Western's DFA is situated primarily within the Woodlands County and Greenview Municipal Districts (MD), with a small portion located within Yellowhead County (Figure 7). The DFA borders the Barrhead, Lac Ste. Anne and Westlock Counties, as well as the Big Lakes and Lesser Slave River MDs.

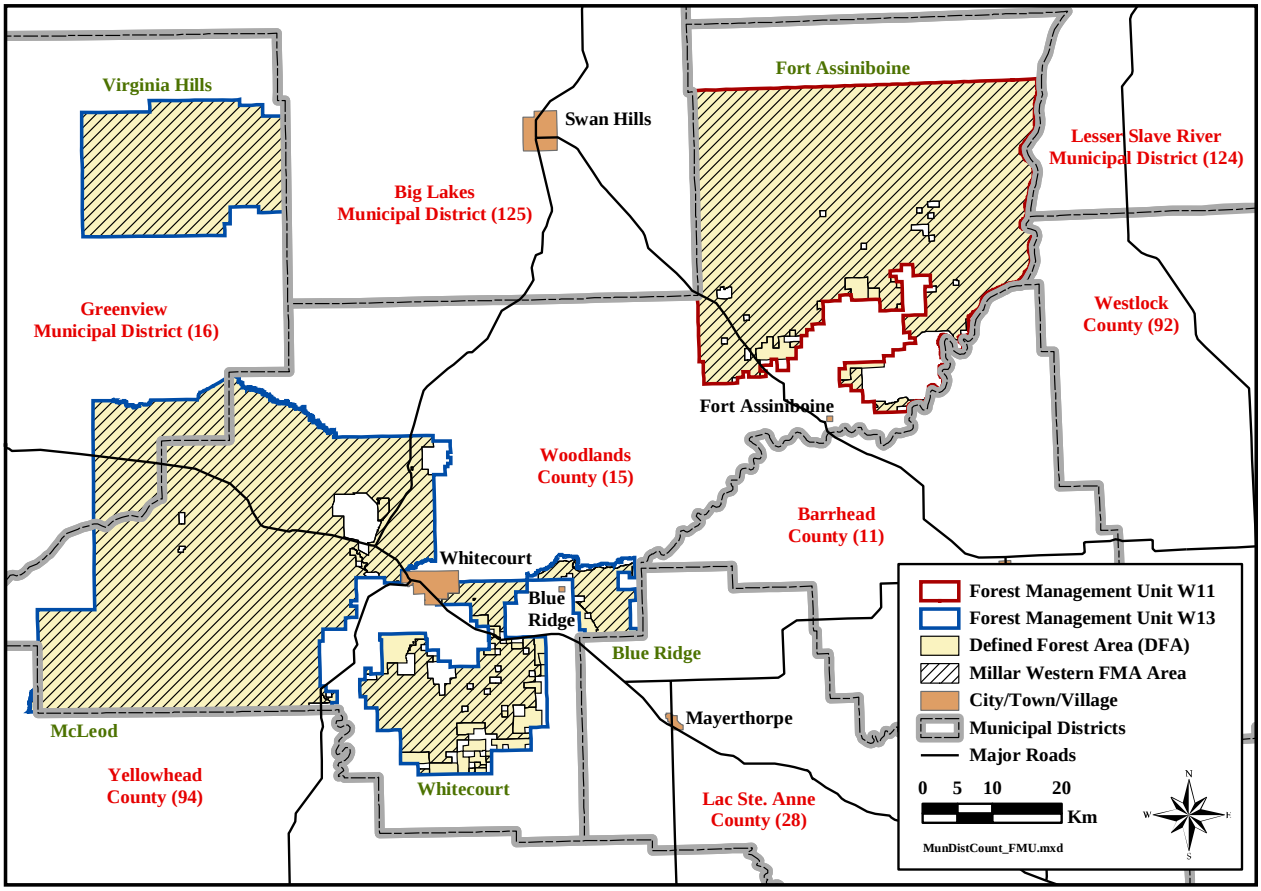

Figure 7. Municipal Districts and Counties within and surrounding the W11 and W 13 FMUs.

2.5 Wildfire Management Areas

Millar Western's DFA is located entirely within the Woodlands Wildfire Management Area (WMA) (Figure 8). The northern boundary of the DFA borders the Lesser Slave Lake WMA, and the southern boundary borders the Foothills WMA.

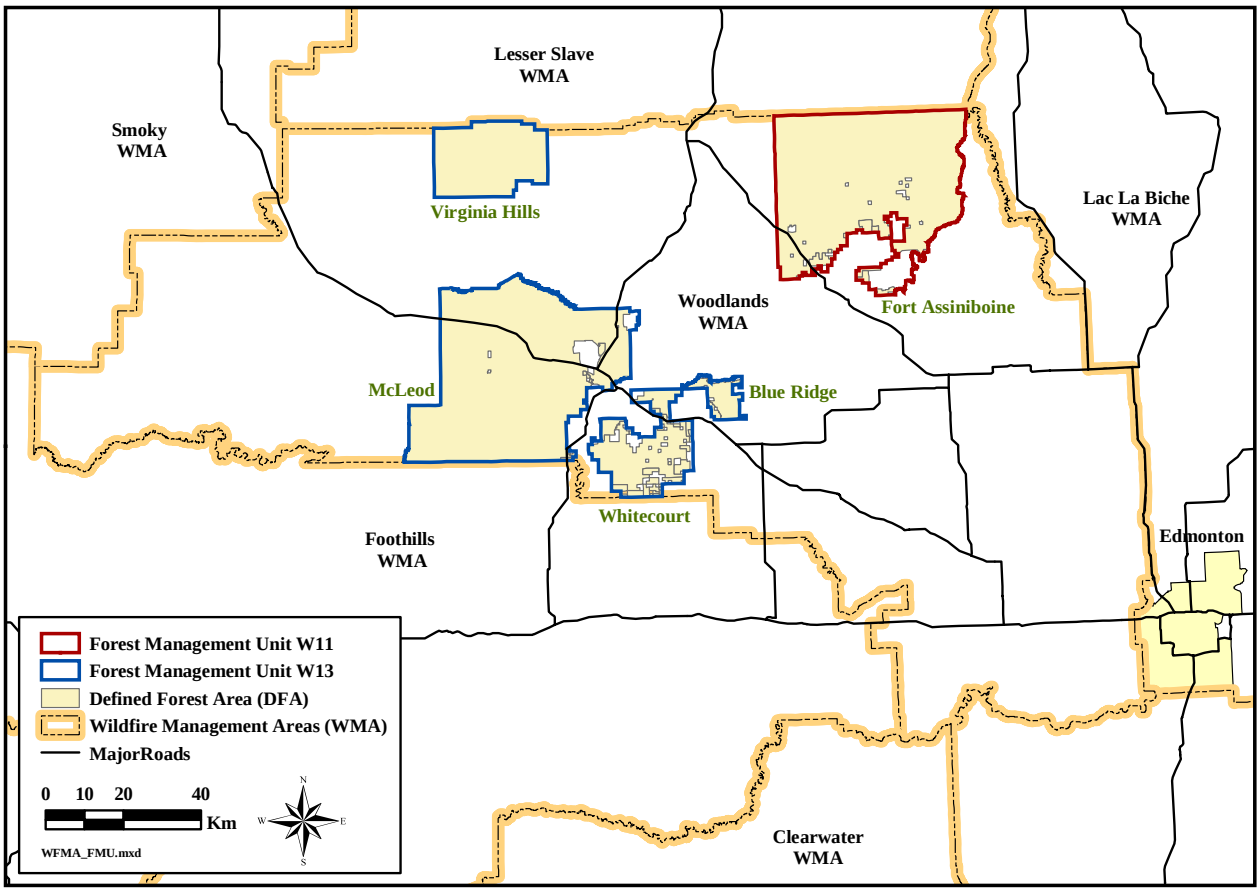

Figure 8. Wildfire Management Units (WMA) within and surrounding the W11 and W13 FMUs.

3. Physical Conditions

3.1 Topography

As indicated in the previous section of this chapter, the DFA consists of five subunits. The western-most portions of the DFA are situated in the Foothills Natural Region, which consists primarily of rolling terrain. Moving eastward toward the Boreal Forest Natural Region, the elevation and rolling terrain diminish and become generally level. The Athabasca River valley transects the McLeod subunit and runs adjacent to the Fort Assiniboine subunit.

The following sections describe the DFA in terms of its elevation, slope and aspect, which are derived from digital elevation models (DEM).

3.1.1 Elevation

The elevation within the DFA ranges from 568 m along the Athabasca River in the Fort Assiniboine subunit, to 1,383 m in the Virginia Hills of the Virginia Hills subunit (Figure 9). At 726 m, the Fort Assiniboine subunit has the lowest average elevation, while the Virginia Hills subunit, at 1,001 m, has the highest. Although the elevation range within the DFA spans over 800 m, 73% of the area falls between 700 and 1,000 m, while the areas above and below this range represent approximately 13% each (Table 5 and Figure 10).

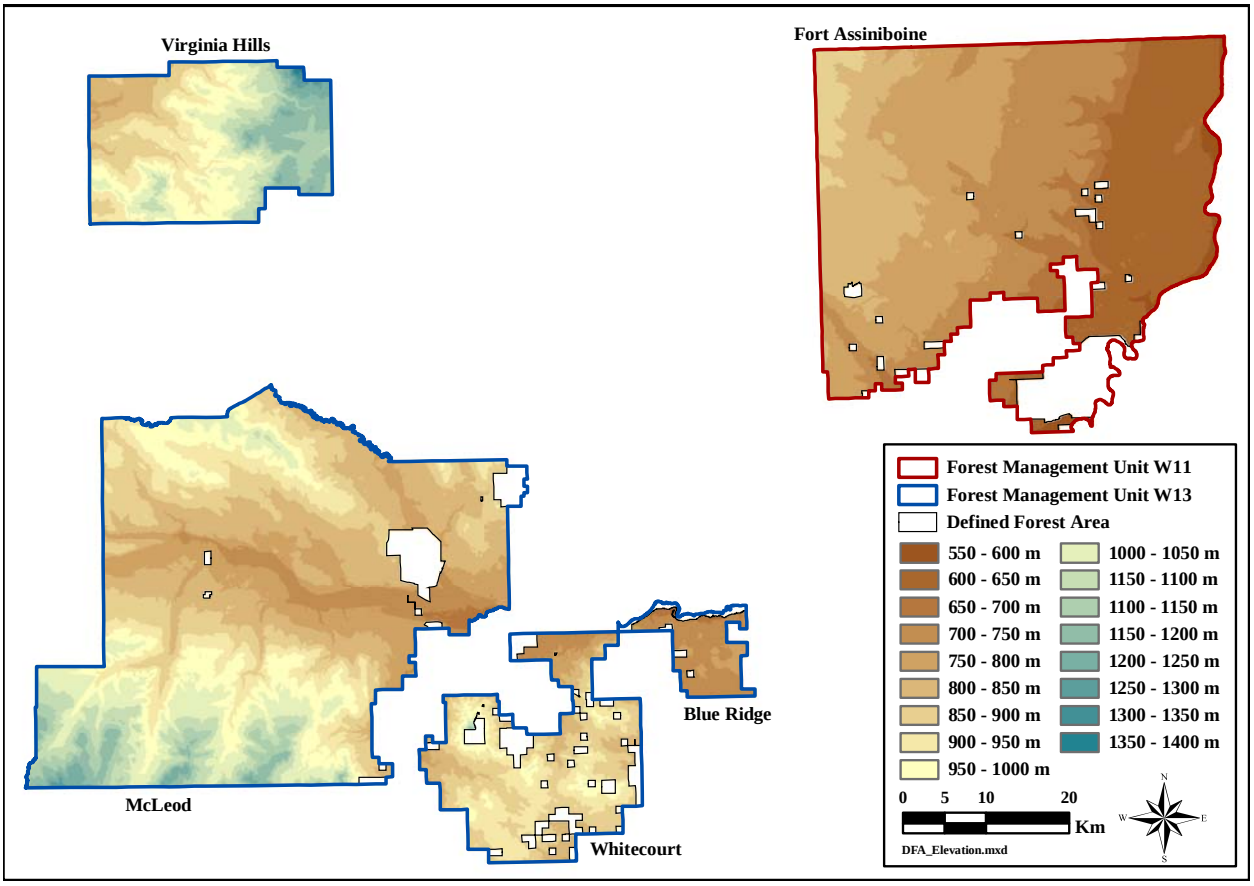

Figure 9. Elevation classification within the DFA.

Table 5. Elevation summary for the DFA.

FMU	Subunit	DFA Area (ha)	DFA Area (%)	Minimum (m)	Maximum (m)	Average (m)	Std. Dev. (m)
W11	Fort Assiniboine	165,797	37%	568	901	726	75
W13	Virginia Hills	51,094	11%	780	1,383	1,001	112
	McLeod	188,869	42%	678	1,265	904	113
	Whitecourt	39,138	9%	686	1,160	878	60
	Blue Ridge	8,333	2%	642	782	737	23

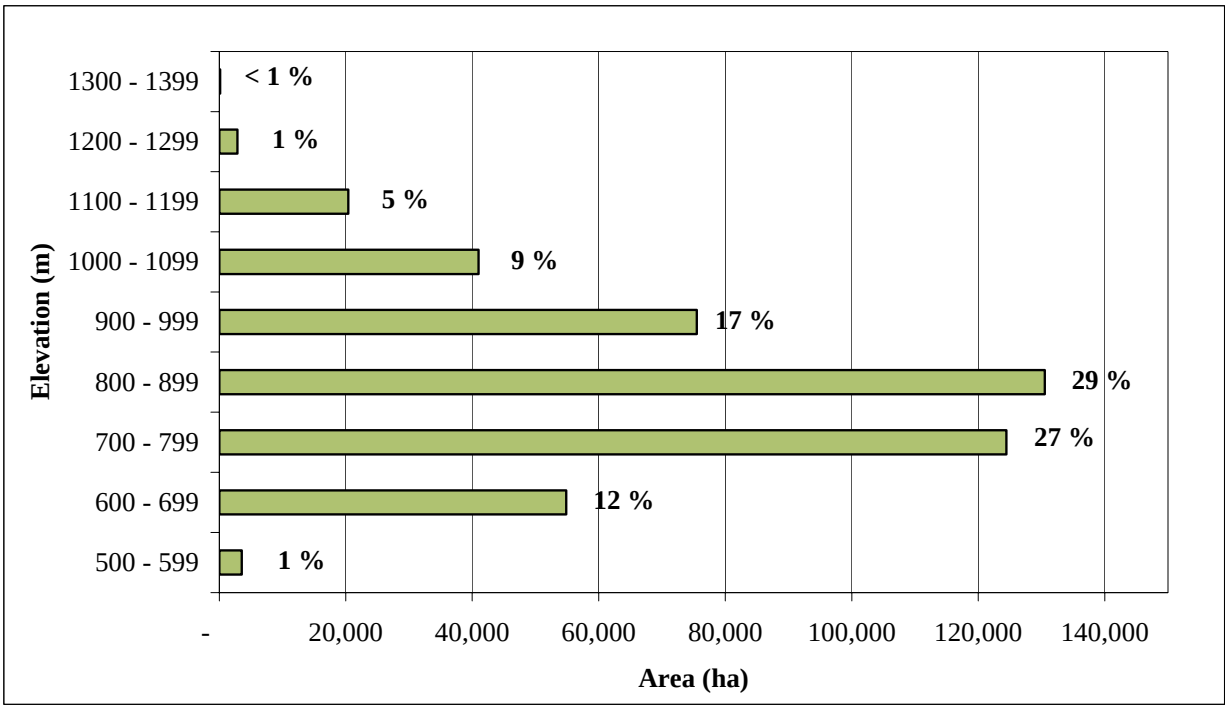

Figure 10. Elevation class area representation within the DFA.

3.1.2 Slope

The Virginia Hills, McLeod and Whitecourt subunits contain more undulating terrain and greater average slopes than the Fort Assiniboine and Blue Ridge subunits. While all operating areas contain significant slopes (> 50%), the portion of the DFA with significant slopes is relatively small (Figure 11 and Table 6).

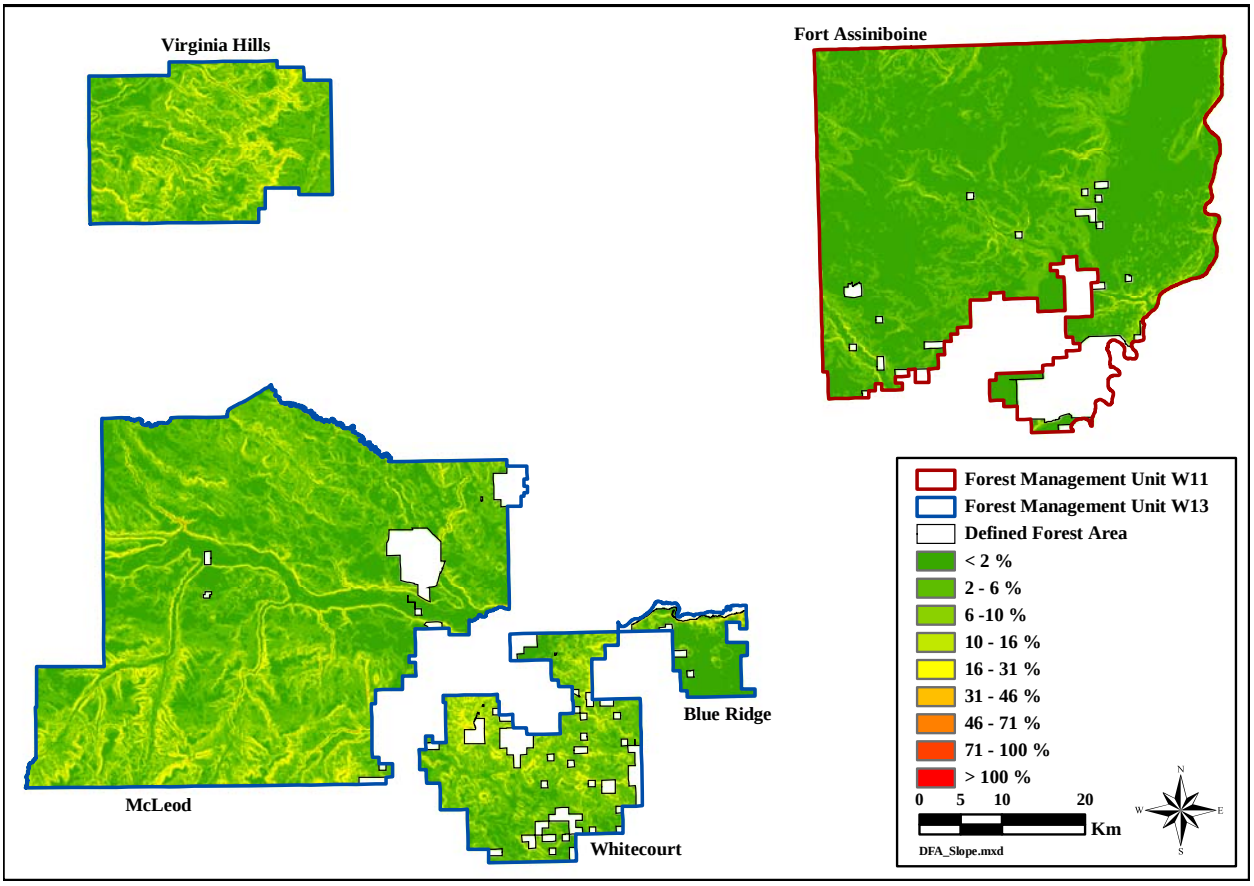

Figure 11. Slope classification within the DFA.

Table 6. Slope area summary for the DFA.

FMU	Subunit	DFA Area (ha)	DFA Area (%)	Minimum (%)	Maximum (%)	Average (%)	Std. Dev. (%)
W11	Fort Assiniboine	165,797	37%	0	51	2	2
W13	Virginia Hills	51,094	11%	0	66	7	6
	McLeod	188,869	42%	0	71	5	5
	Whitecourt	39,138	9%	0	51	6	5
	Blue Ridge	8,333	2%	0	88	3	6

3.1.3 Aspect

The DFA contains a mix of cardinal point aspect classes, along with areas classified as having no aspect (aspect <= 1.5%). As illustrated in Figure 12, the Fort Assiniboine and Blue Ridge operating areas have the most area classified as flat. (Note that this assessment includes water bodies).

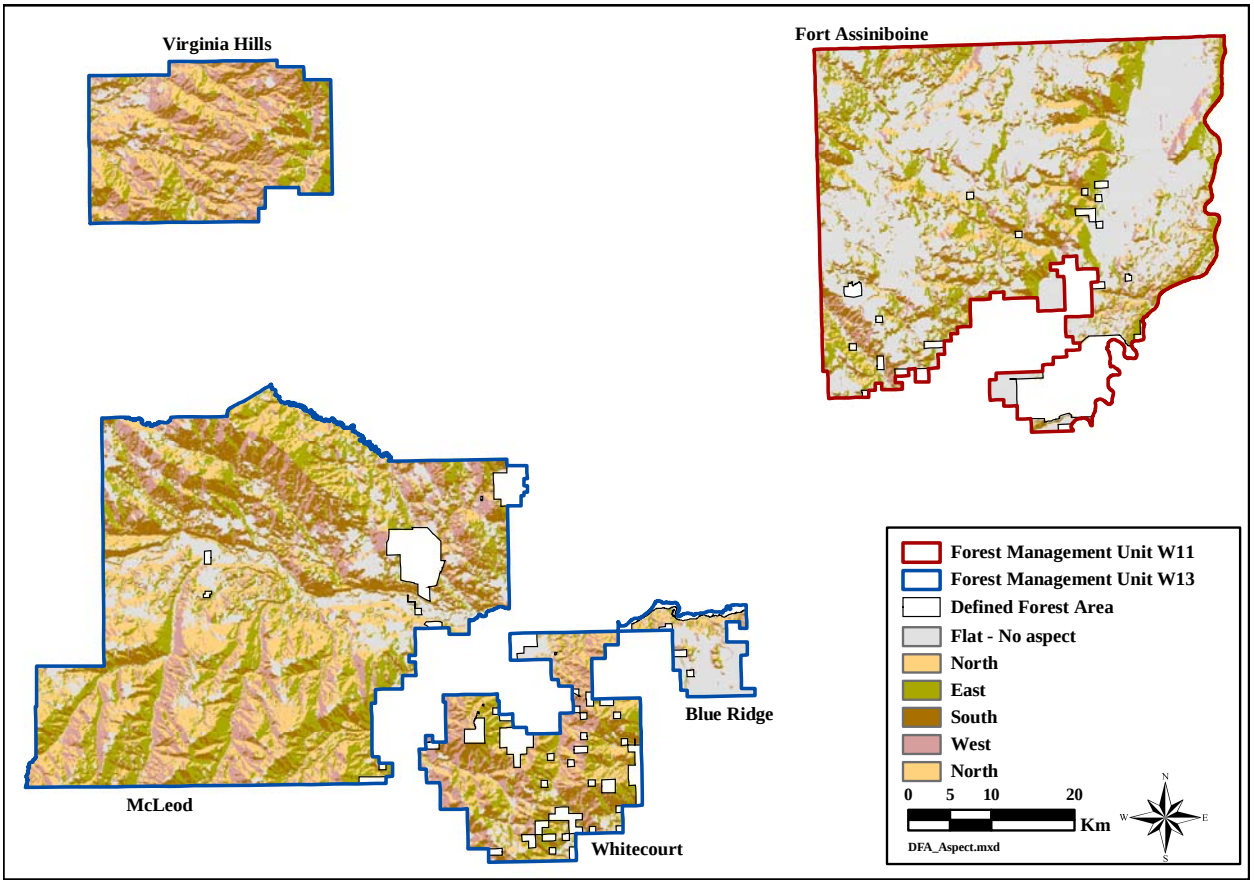

Figure 12. Aspect classification within the DFA.

3.2 Soils and Landforms

This section describes the soils, wetlands and landforms present within the DFA.

3.2.1 Soils

This soils summary includes classification and description information for the DFA's soil orders, textures and wetlands.

Soil Order

Because the soil order information contained within this section was compiled using several survey reports, unexpected changes in soil orders were encountered at the fringes where surveys meet. Soil order information is not included for an area totalling 98,691 ha, either because no compatible soil surveys exist or the area is contained within water bodies.

For the balance of the DFA, or 354,541 ha, the dominant soil orders are Luvisols (226,899 ha or 64%), Brunisols (47,516 ha or 13%) and Organics (34,259 ha or 10%). (Figure 13 and Table 7).

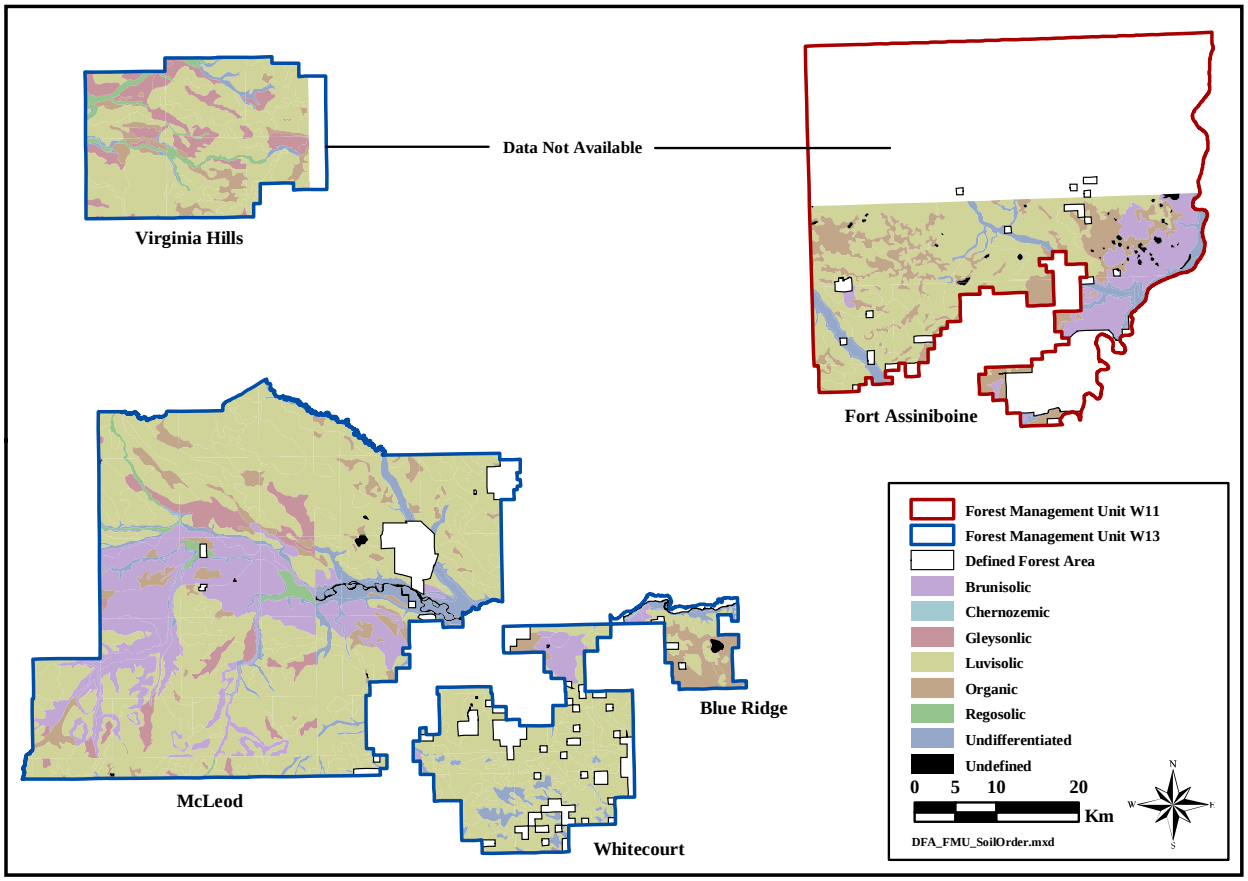

Figure 13. Soil order distribution within the DFA.

Table 7. Soil area summary for the DFA

FMU	Subunit	Brunisolic (ha)	Chernozemic (ha)	Gleysolic (ha)	Luvisolic (ha)	Organic (ha)	Regosolic (ha)	Undifferentiated (ha)	Undefined (ha)	Grand Total (ha)
W11	Fort Assiniboine	10,014	10	3	39,218	15,650	-	6,401	94,502	165,798
	Total	10,014	10	3	39,218	15,650	-	6,401	94,502	165,798
W13	Blue Ridge	397	86	4	2,795	3,945	-	874	232	8,333
	McLeod	34,515	-	8,524	119,923	10,075	2,566	12,342	1,023	188,967
	Virginia Hills	-	-	8,056	32,154	3,943	2,552	1,455	2,934	51,094
	Whitecourt	2,590	60	63	32,809	646	-	2,871	-	39,040
	Total	37,502	146	16,648	187,681	18,609	5,119	17,541	4,189	287,435
Grand Total		47,516	156	16,650	226,899	34,259	5,119	23,942	98,691	453,232

Table 8 provides a general overview of the textures, drainage, and management implications associated with the various soil orders found within the DFA.

Table 8. General characterization of the soil orders found within the DFA.

Proportion of Classified DFA (%)	Common Soil Texture(s)	Description	Management Implicaitons/General Comments
Brunisolic			
13 %	Clay Loam, Loamy Sand, Sandy Loam	Weakly developed; well to imperfectly drained.	Generally, very high soil structure; good operability; found in eolian/glaciofluvial areas.
Chernozemic			
< 1 %	Clay loam, Loam	Well to imperfectly drained.	Good productivity but uncommon in DFA.
Gleysolic			
5 %	Clay Loam, Silty Clay	Mottled from prolonged saturation: poorly drained.	Highly susceptible to compaction; operation limited to dry summer and winter; frequently found in depressions and thus may be susceptible to frost heave.
Luvisolic			
64 %	Sandy Clay Loam, Clay Loam, Sandy Loam	Silicate clay accumulation; well to imperfectly drained.	Highly variable in physical characteristics, and therefore, variable operational considerations.
Organic			
10 %	Organic	Prolonged saturation; poorly and very poorly drained.	Predominantly inoperable and significant regeneration difficulties.
Regosolic			
1 %	Sandy Loam	Weakly developed; rapid to imperfectly drained.	Generally not susceptible to compaction; often associated with colluvial materials and therefore potentially susceptible to erosion (and sedimentation).
Undifferentiated			
7 %	N/A	N/A	N/A

Texture

The broad soil texture classification contained within this section was developed by the Forest Watershed and Riparian Disturbance (FORWARD) group, for watershed modeling purposes. Under this classification regime, the soil textural classes are broken down into fine, medium, coarse, valley, and farmland. Table 9 provides a general description of these classes.

Table 9. General characterizations of the soil textures found within the DFA.

Proportion of DFA (%)	Soil Texture Class Description
Fine	
79%	Fine textured soils are most common throughout the DFA. In the soil classification process, fine was assigned not only to those areas where the attributes indicated such, but also to those areas where the attributes didn't support one of the other texture classifications. All organic and wetlands are contained within this category.
Medium	
2%	Medium textured soils are not common throughout the DFA, but where they occur, they are often associated with dune and esker formations.
Coarse	
13%	Coarse textured soils found throughout the DFA, generally associated with current or historic watercourses.
Valley (Coarse)	
6%	Generally very coarse textured, often containing gravel. Generally found on steep banks and are associated with current or historic river courses.
Farmlands	
< 1 %	Farmlands represent areas of finer-textured soils that occur within or adjacent to river courses.

All soil texture classes are found in both FMUs within the DFA (Figure 14). As shown in Table 10, fine-textured soils represent the vast majority of the area (365,771 ha or 79%), followed by coarse (57,816 ha or 13%), valley (28,861 ha or 6%), medium (9,700 ha or 2%) and, lastly, farmland (85 ha or < 1%).

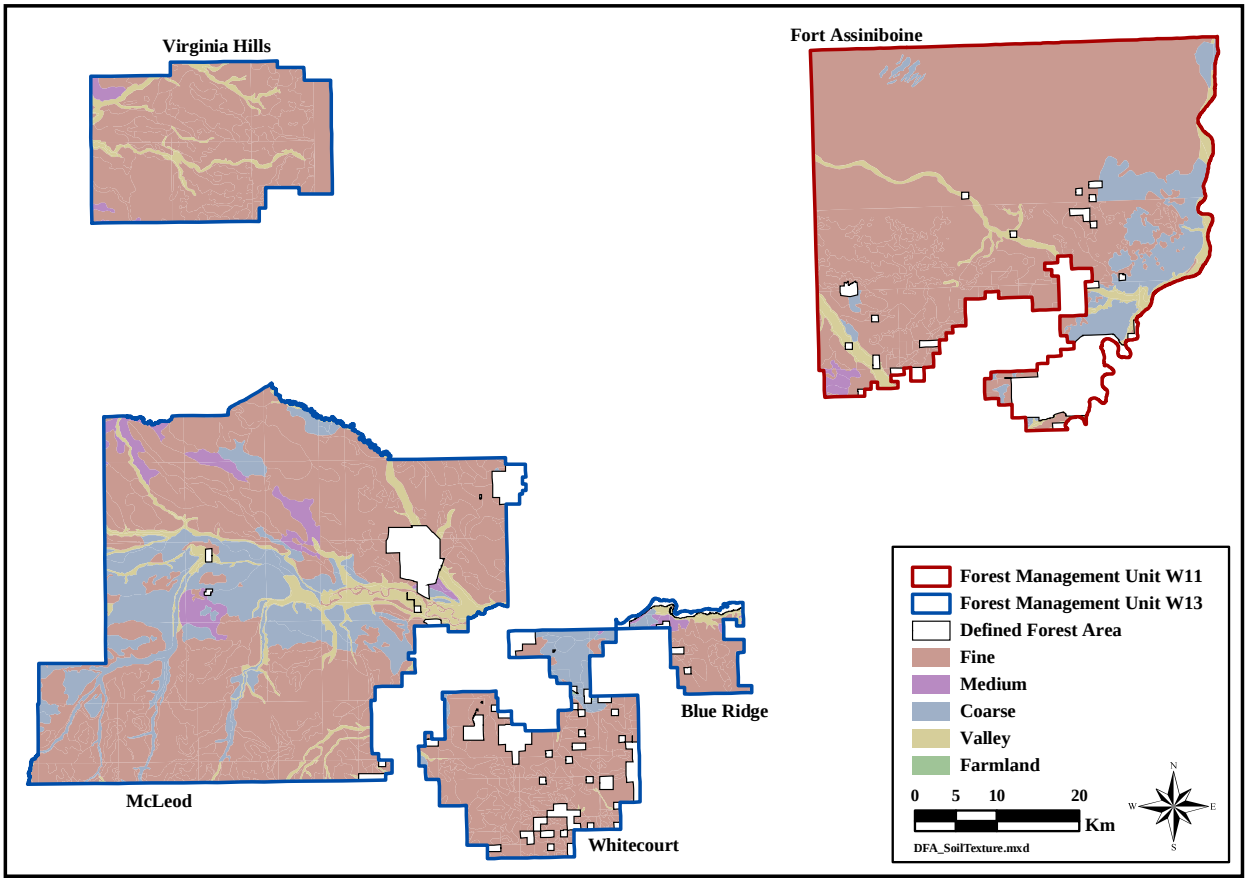

Figure 14. Soil texture distribution within the DFA.

Table 10. Soil texture area summary for the DFA.

FMU	Subunit	Soil Texture Class Area (ha)					Total (ha)
		Fine	Medium	Coarse	Valley	Farmland	
W11	Fort Assiniboine	139,938	1,092	16,297	8,407	64	165,798
	Total	139,938	1,092	16,297	8,407	64	165,798
W13	Virginia Hills	46,128	959	-	4,007	-	51,094
	McLeod	130,453	6,903	36,273	15,338	-	188,967
	Whitecourt	33,875	60	4,850	236	20	39,040
	Blue Ridge	6,378	685	397	874	0	8,333
	Total	216,833	8,608	41,519	20,455	20	287,435
Grand Total		356,771	9,700	57,816	28,861	85	453,232

Wetlands

The wetlands classification used in this section was developed by the FORWARD group for watershed modeling purposes. FORWARD classifies wetlands as treed or non-treed, based on Alberta Vegetation Inventory (AVI) stand attributes. The treed wetlands are subdivided according the dominant tree species, again according to the AVI stand attributes. Figure 15 illustrates the distribution of cover for the wetland areas within the DFA.

Within the DFA, a total of 123,972 ha (27%) is classified as wetlands (Table 11). Of this area, 102,602 ha (83%) is treed and 21,370 ha (17%) is non-treed.

Within the DFA portion of W11, a total of 64,461 ha (39%) is classified as wetlands (Table 11). Of this area, 47,973 ha (74%) is treed and 16,651 ha (26%) is non-treed. The treed wetlands are composed of primarily larch (23,418 ha or 49%) and black spruce (23,171 ha or 48%); lodgepole/jack pine, aspen and balsam poplar account for the remainder (1,384 ha or 3%).

Within the DFA portion of W13, a total of 59,348 ha (21%) is classified as wetlands (Table 11). Of this area, 54,630 ha (92%) is treed and 4,718 ha (8%) is non-treed. The treed wetlands are composed primarily of black spruce (41,290 ha or 76%), larch (7,464 ha or 14%) and lodgepole/jack pine (5,569 ha or 10%); aspen, white birch, balsam poplar and balsam fir account for the remainder (305 ha or < 1%).

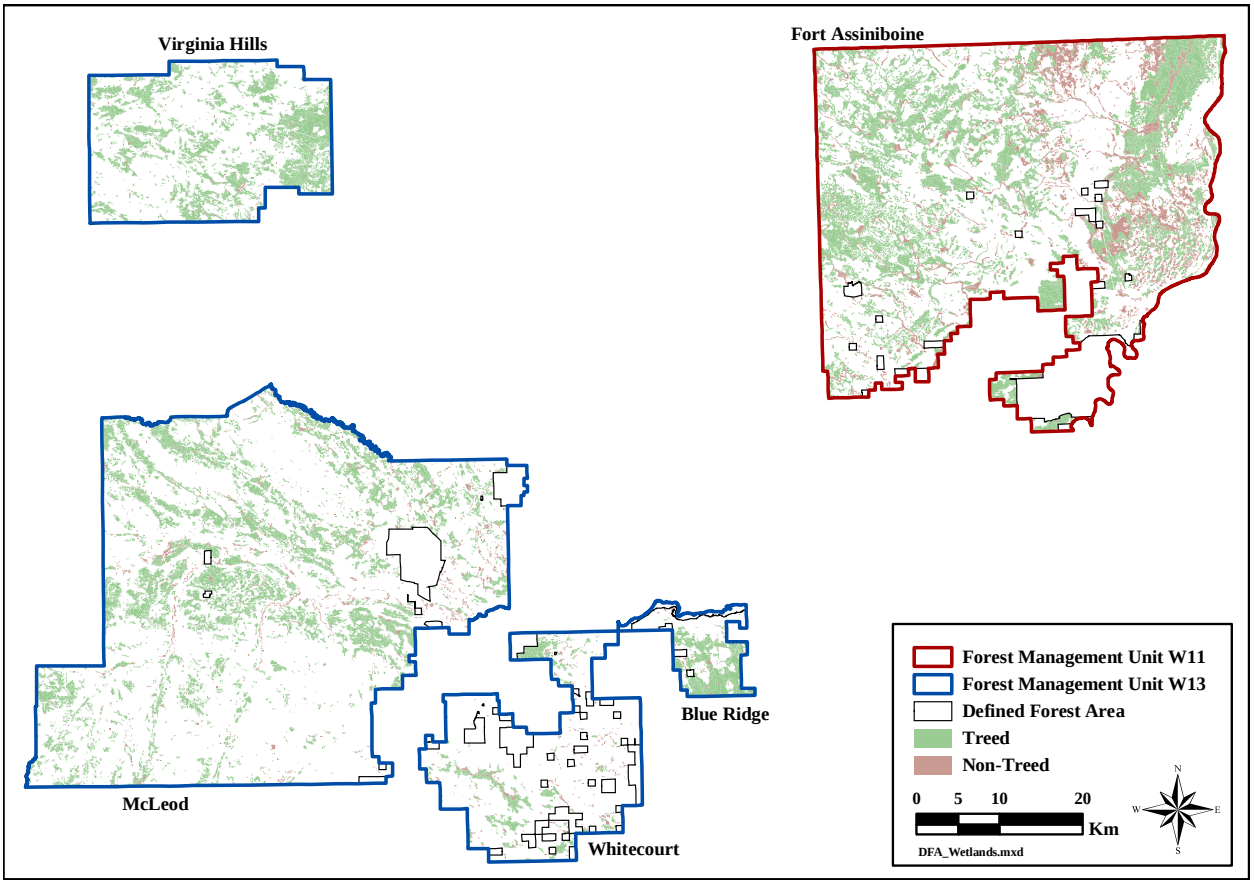

Figure 15. Wetland distribution within the DFA.

Table 11. Wetland area summary for the DFA.

FMU	Subunit	Treed (ha)							Non Treed (ha)	Grand Total (ha)
		Aw	Bw	Fb	Lt	Pb	Pl/Pj	Sb		
W11	Fort Assiniboine	109	-	-	23,418	11	1,263	23,171	16,651	64,624
	Total	109	-	-	23,418	11	1,263	23,171	16,651	64,624
W13	Virginia Hills	34	-	8	555	-	2,316	11,244	333	14,491
	McLeod	149	27	-	5,081	16	3,103	25,467	3,384	37,229
	Whitecourt	5	29	-	657	31	53	2,321	816	3,912
	Blue Ridge	3	-	-	1,171	3	97	2,258	185	3,716
	Total	191	56	8	7,464	50	5,569	41,290	4,718	59,348
Grand Total		300	56	8	30,882	61	6,832	64,461	21,370	123,972

Aw - aspen, Bw - birch, Fb - balsam fir, Lt - larch, Pb - poplar, Pl - lodgepole pine, Pj - jack pine, Sb - black spruce

3.2.2 Landforms

The two primary geologic formations found within the DFA are the Wapiti and the Paskapoo, both of which are sedimentary formations that date back to between the Early Tertiary and Late Cretaceous periods. The Wapiti Formation is a sequence of irregularly bedded shale and feldspathic and bentonitic sandstone that is several metres thick. The Wapiti also includes dark gray mudstone and siltstone, with scattered coal deposits. The Paskapoo Formation is composed of sandstone and soft shale and is relatively low in soluble salt content (Twardy and Lindsay 1971).

The Wapiti is the dominant formation within the DFA portion of W11, occupying all but a small section in the northwest region, which contains the Paskapoo Formation. The Paskapoo is the dominant formation within the DFA portion of W13, occupying all but the northwest corner of the Virginia Hills subunit, the northern portion of the Whitecourt subunit, the smaller Blue Ridge subunit and the area along the Athabasca River in the McLeod subunit, which are occupied by the Wapaiti.

The area within and around the DFA was subjected to glacial activity during the Pleistocene epoch (1,640,000 to 10,000 years ago). As the glacial ice eroded and smoothed the landscape, it deposited drift (Knapik and Lindsay 1983). The predominant geomorphological processes attributable to preglacial fluvial processes within the area are evident today in the form of valleys, plains, benchlands and dissected plateaus.

3.3 Hydrography

This section summarizes the significant water bodies on the DFA, the Strahler stream classification and the first- and third-order watershed classification within the area known as the Greater FORWARD Area (GFA).

3.3.1 Significant Rivers, Creeks and Lakes

Figure 16 illustrates the locations of significant rivers, creeks, and lakes associated with the DFA. The Athabasca River is the most prominent water body in the area, originating from the

Columbia Glacier, which is part of the Columbia Icefield in Jasper National Park, and emptying some 1,500 km later into Lake Athabasca. It flows through the McLeod subunit and adjacent to the Blue Ridge and Fort Assiniboine subunits. The vast majority of the rivers and creeks surrounding the DFA drain into the Athabasca River.

Other significant rivers within the vicinity of the DFA include the Akuinu, Coutts, Freeman, Goose, Little Paddle, McLeod, Morse, Paddle and Sakwatamau. Some of the more prominent creeks in the area include the Beaver, Bessie, Carson, Chickadee, Christmas, Clearwater, Corbett, Doris, Goose, Groat, Moose, Mud, Oldman, Pass, Stony, Timeu, Two, Weasone and Windfall. Noteworthy lakes include Baseline, Foley, Freeman, Goose, Leech, McLeod, Roche and Windfall.

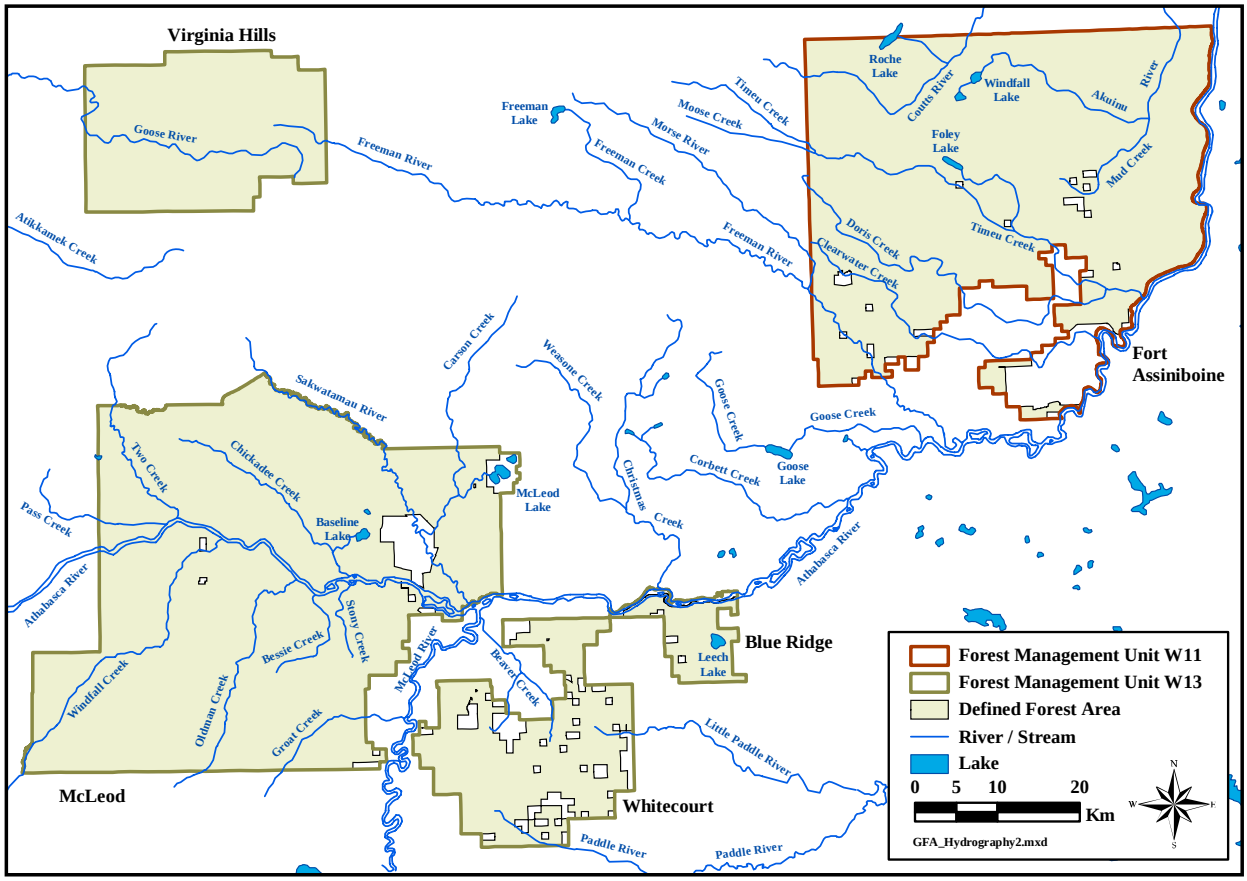

Figure 16. Significant rivers, creeks and lakes within and around the DFA.

3.3.2 Stream Classification

In 2006, Millar Western classified the streams in the Greater FORWARD Area (GFA) according to the Strahler stream classification system. According to this classification scheme, a waterway must be perennial (i.e. water present during all seasons of the year) to be termed a stream. A first-order stream is defined as one with no tributaries. When two first-order streams come together, they form a second-order stream. When two second-order streams come together, they

form a third-order stream, and so on (Figure 17). Lower order streams that join a higher order stream do not affect the order of the higher stream.

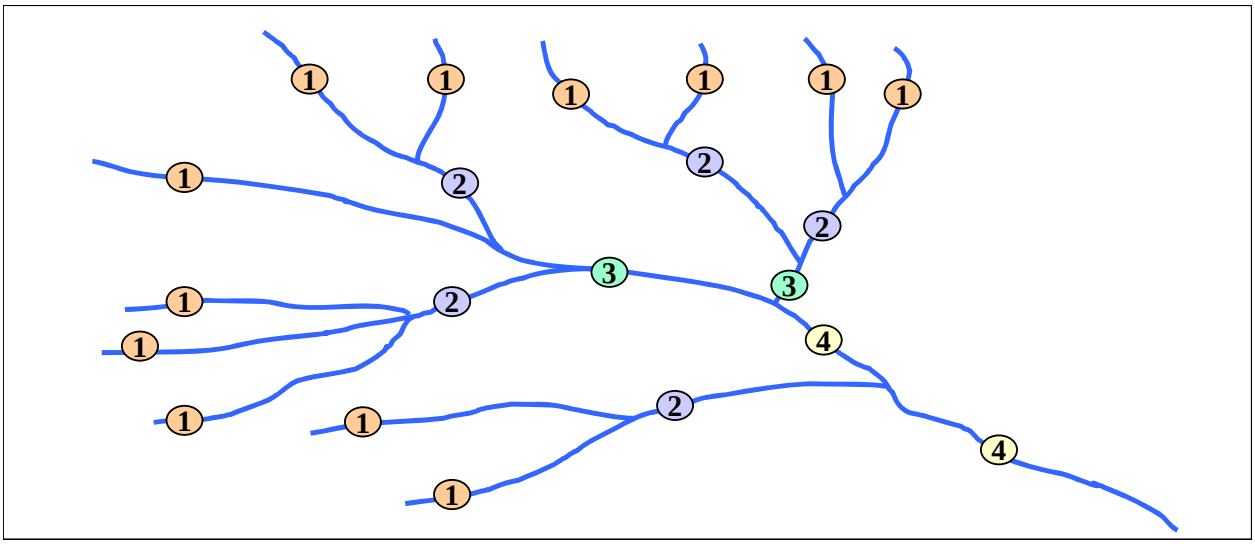

Figure 17. Graphical representation of the Strahler Stream Order System.

Figure 18 illustrates the Strahler Stream Classification for the streams within the GFA.

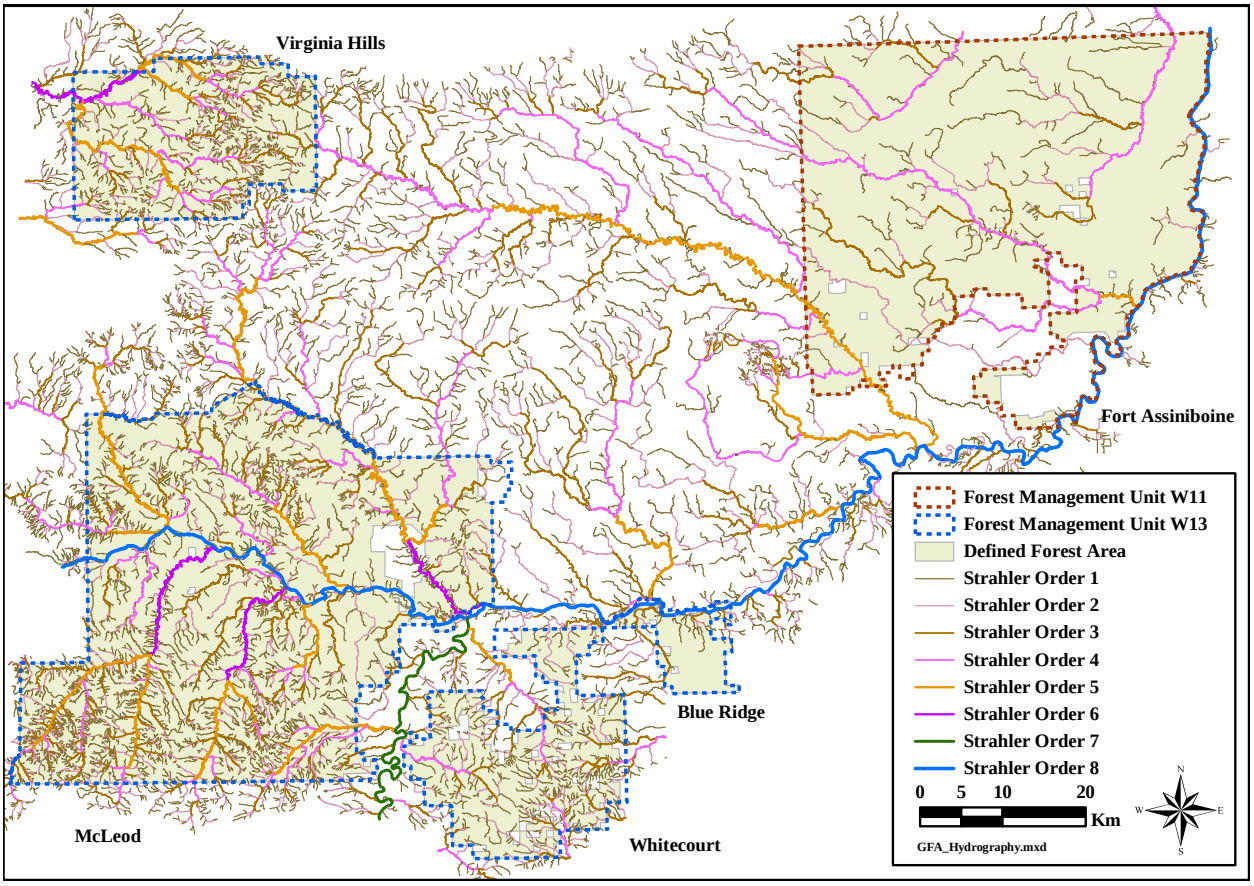

Figure 18. Strahler Stream Order classification within the GFA.

The total length of Strahler classified streams within the DFA is 5,902 km, while those in the GFA total 12,202 km in length (Table 12).

The Athabasca River is the only Strahler 8th order stream in the DFA. Approximately 60 km of the Athabasca River flows through the DFA and 245 km through the GFA (Table 12). The McLeod River is the only 7th order stream in the vicinity, and, although it does not run directly through the DFA, approximately 50 km of the river runs through the GFA. The Goose River, Oldman Creek, Windfall Creek and Sakwatamau River are classified as 6th order streams. Portions of these streams totalling approximately 92 km run through the DFA, and 114 km through the GFA.

Table 12. Strahler Stream Order summary of the GFA and DFA.

Watershed Order	Length (km)	
	DFA	GFA
1	2,916	5,850
2	1,236	2,675
3	727	1,518
4	532	1,069
5	339	681
6	92	114
7	0	50
8	60	245
Total	5,902	12,202

3.3.3 Watershed Classification

The watersheds within the GFA are classified according to the Strahler order of the stream that runs through the confluence (i.e. where the water flows out) of the watershed. The first- and third-order watersheds for the GFA are shown in Figure 19. Within the GFA, there are a total of 1,930 first-order watersheds, averaging 581 ha in size, and 90 third-order watersheds, averaging 12,244 ha in size. Within the DFA, there are a total of 1,014 first-order and 65 third-order watersheds that are contained partially or entirely within the DFA (Table 13).

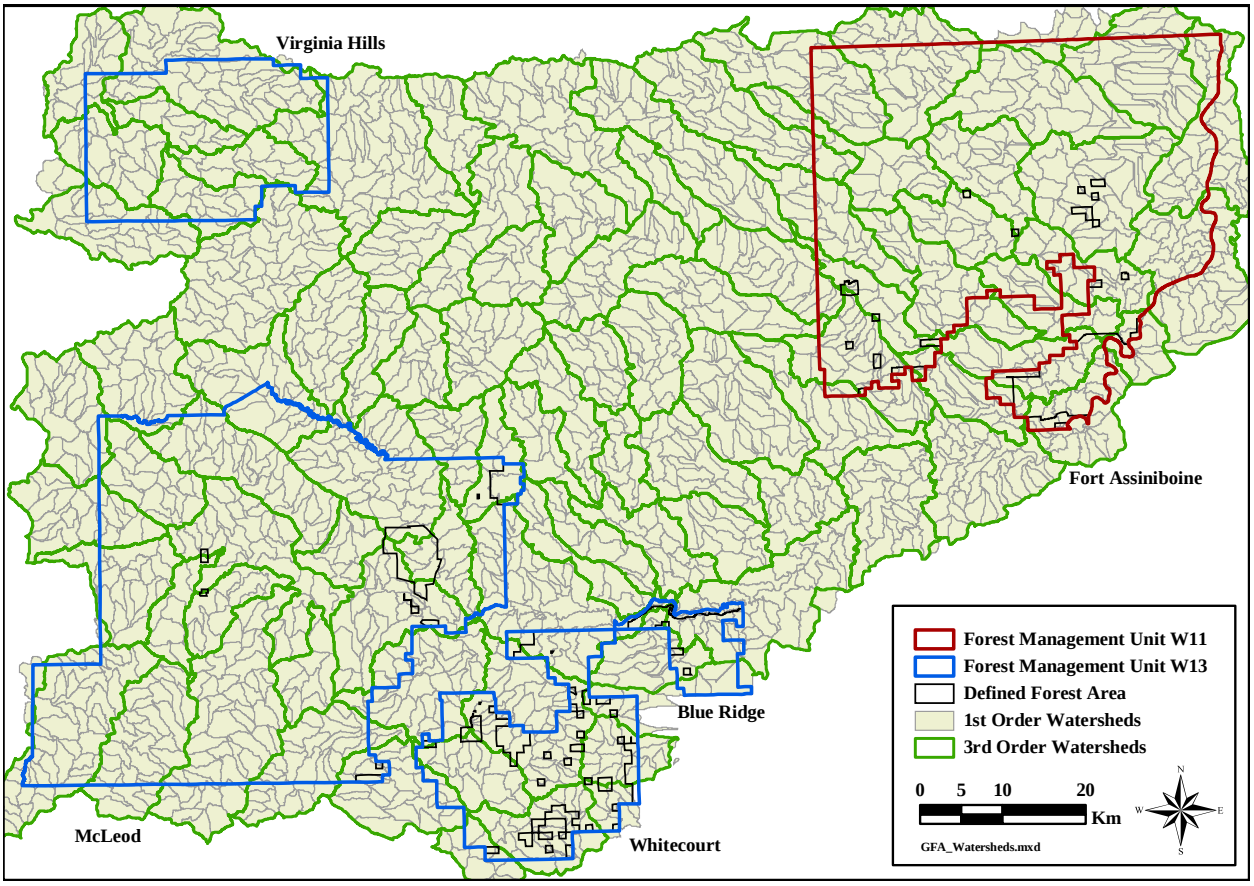

Figure 19. First- and third-order watershed classification within the GFA.

Table 13. First- and third-order watershed summary within the GFA and DFA.

Watershed Order	DFA		GFA	
	Count	Avg. Area (ha)[1]	Count	Avg. Area (ha)
1	1,014	-	1,930	581
3	65	-	90	12,244

[1] Since watersheds are not entirely contained within DFA boundary, an average area calculation is not appropriate.

3.4 Climate

Climate is dictated by several factors, including latitude, topography, elevation, distance from large water bodies and atmospheric circulation (Olson, 1985). The characterization of the DFA's climate is based on the Natural Regions Committee's 2006 publication, *Natural Regions and Subregions of Alberta* (Natural Resources Committee 2006). Millar Western recognizes that these natural subregions, which include the Upper and Lower Foothills of the Foothills Natural Region and the Central Mixedwood of the Boreal Forest Natural Region, are large, covering an area that extends well beyond the DFA. Consequently, the climatic conditions attributed to a subregion may not be representative of the DFA in all cases.

By examining temperature, precipitation, growing degree-days and frost-free periods, this section concludes that Millar Western's DFA experiences a continental climate characterized by short, cool summers and long, cold winters, with relatively low annual precipitation.

3.4.1 Temperature

Table 14 summarizes the temperature-related means and associated standard deviations for the natural subregions within the DFA.

Table 14. Climate statistics for the natural subregions within the DFA.

	Boreal		Foothills				Area Weighted Average	
	Central Mixedwood		Lower Foothills		Upper Foothills			
Mean Climate Attribute	Avg. Value	Std. Dev.	Avg. Value	Std. Dev.	Avg. Value	Std. Dev.	Avg. Value	Std. Dev.
Proportion of DFA (%)	26.9%	N/A	68.4%	N/A	4.7%	N/A	100%	N/A
Temperature								
Annual Temp. (^{o}C)	0.2	1.1	1.8	0.5	1.3	0.4	1.3	0.7
Temp. of Warmest Month (Jul) (^{o}C)	15.9	0.5	14.7	0.4	13.4	0.6	15.0	0.4
Temp. of Coldest Month (Jan) (^{o}C)	-18.7	2.8	-12.8	1.5	-11.6	0.6	-14.3	1.8
Daily Max. Temp. (June - Aug) (^{o}C)	22.0	0.7	20.9	0.6	19.5	0.7	21.1	0.6
Daily Min. Temp. (Dec - Feb) (^{o}C)	-24.2	2.7	-18.9	1.3	-17.8	0.7	-20.3	1.6
Precipitation								
Annual Precip. (mm)	478	56	588	33	632	40	561	40
Growing Season Precip. (Apr - Aug) (mm)	336	47	430	33	450	29	406	37
Summer Moisture Index (Apr - Aug)	3.8	0.6	2.7	0.3	2.1	0.2	3.0	0.4
Degree-Days								
Growing Degree-Days > 5 ^{o}C	1,240	49	1,145	62	949	81	1,161	59
Degree-Days < 0 ^{o}C	2,106	354	1,466	169	1,401	84	1,635	215
Frost								
Frost-Free Period (Days)	97	7	94	12	79	17	94.1	11
Last Spring Frost	1-Jun	3	5-Jun	6	15-Jun	9	4-Jun	5
First Fall Frost	4-Sep	3	4-Sep	5	30-Aug	6	4-Sep	5

Annual Temperature

The mean annual temperatures tend to decrease with increases in elevation and latitude.

Temperature of Warmest Month

In all three natural subregions found within Millar Western's DFA, the warmest month (i.e. month with the highest average monthly temperature) is July. In general, the temperature of the warmest month decreases with an increase in elevation.

Figure 20 shows the average monthly mean, and the minimum and maximum temperatures for each of the natural subregions found within the DFA. The coloured bars represent the daily mean temperature, while the bottom and the top of the line bars represent the minimum and maximum average daily temperatures for the month.

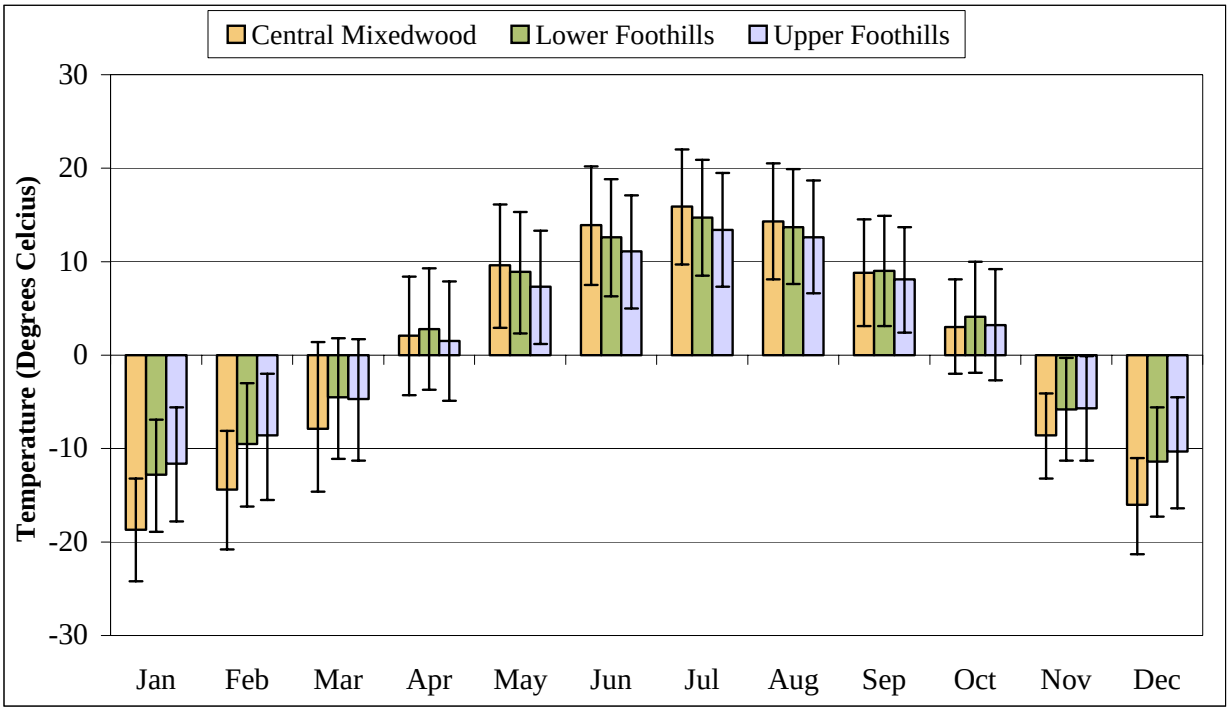

Figure 20. Average monthly temperatures for natural subregions.

Temperature of Coldest Month

In each of the three natural subregions found within the DFA, the coldest month (i.e. month with the lowest average monthly temperature) is January. In general, the temperature of the coldest month decreases with an increase in latitude.

Daily Maximum Temperature

The mean daily maximum temperature is the average maximum daily temperature for the months June through August.

Daily Minimum Temperature

The mean daily minimum temperature is the average minimum daily temperature for the months December through February.

3.4.2 Precipitation

Table 14 summarizes the precipitation-related means and associated standard deviations for the natural subregions within the DFA.

Annual Precipitation

All three natural subregions experience the most precipitation in July and the least in February. Figure 21 shows the mean monthly precipitation for each natural subregion. Within this figure, the coloured bars represent the mean precipitation for the month, while the line bars represent one standard deviation.

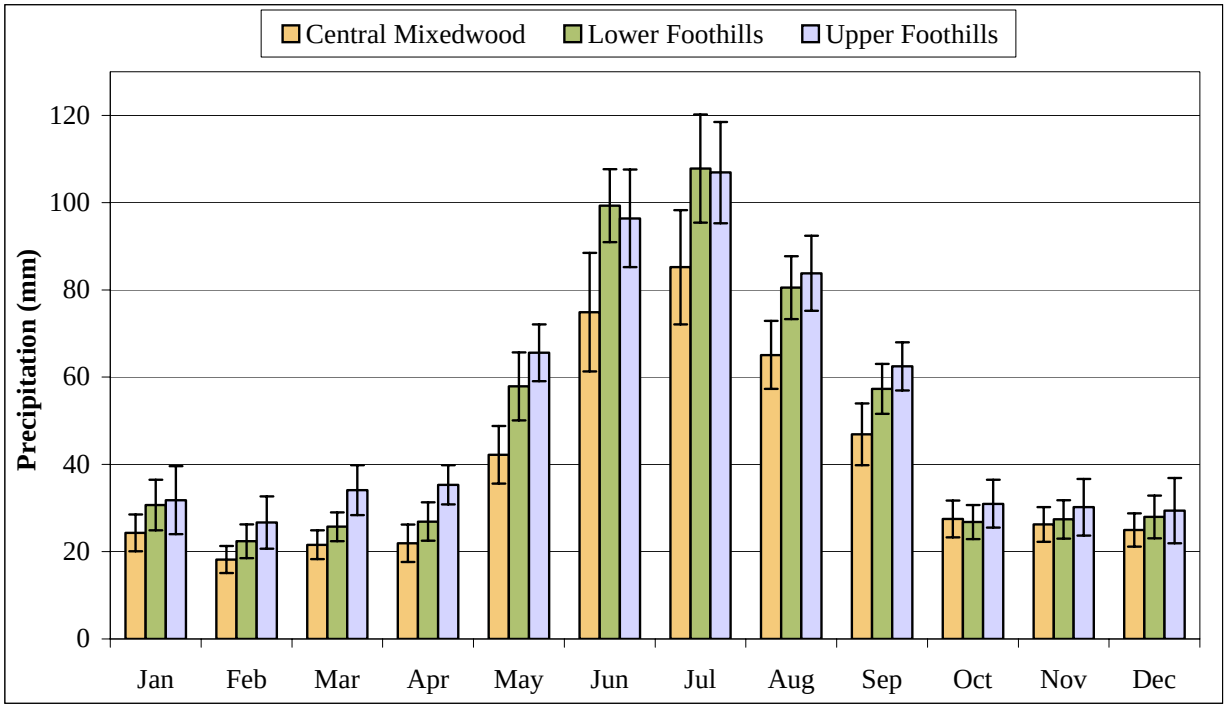

Figure 21. Average monthly precipitation for each natural subregion.

Growing Season Precipitation

Growing season precipitation is the sum of the mean monthly precipitation for the months April through August.

Summer Moisture Index

The summer moisture index is the measure of precipitation effectiveness during the growing season. It is calculated by dividing the number of growing degree-days greater than 5 ^{o}C (see the following section) by the growing season precipitation. A high ratio indicates a greater likelihood that evaporation will exceed precipitation at some point in the growing season. Values greater than 4 indicate dry to very dry conditions, with the likelihood of significant moisture deficits for extended periods during the growing season. Values between 3 and 4 indicate neither dry nor wet climatic conditions, with the likelihood of moderate moisture deficits for short periods during the growing season. Values less than 3 indicate moist-to-wet climatic conditions, with no moisture deficits during the growing season.

3.4.3 Degree-days

Table 14 summarizes means related to degree-days and associated standard deviations for the natural subregions within the DFA.

Growing Degree-Days > 5 ^{o}C

Growing degree-days > 5 ^{o}C is the annual sum of the daily number of ^{o}C above 5 ^{o}C for the daily mean temperature. Growing degree-days (GDD) are used to match plant heat requirements to the amount of heat available and to permit comparisons of areas in terms of plant growth potential. The reference temperature for calculating GDDs is the minimum threshold temperature at which plant growth starts (in most cases > 5 ^{o}C).

Degree-Days < 0 ^{o}C

Degree-days < 0 ^{o}C is the annual sum of the daily number of ^{o}C below 0 ^{o}C for the daily mean temperature.

3.4.4 Frost Presence

Table 14 summarizes the means related to frost presence and associated standard deviations for the natural subregions found within the DFA.

Frost-Free Period

The mean frost-free period represents the annual average number of consecutive days that the temperature is above 0 ^{o}C.

Last Spring Frost Day

The last spring frost day represents the average calendar day when the temperature ceases to be at or below 0 ^{o}C.

First Fall Frost

The first fall frost day represents the average calendar day when the temperature falls below 0 ^{o}C.