Chapter 2 LANDSCAPE ASSESSMENT

We describe in this chapter the features of the FMA area that are relevant to integrated planning of multiple use of the forest. It is important to understand the ecological, social, and economic values of the forest in order to be able to plan a sustainable yield of fibre. More than ensuring a sustainable yield of fibre, however, is the necessity to clearly identify the indirect effects of timber harvesting on all components of physical and biological (including human activities and values) attributes of the forest.

This chapter is a "snapshot" of the components of the FMA area in 1999, which is taken as time 0 for assessing the effects of the activities of ANC Timber Ltd. on the landbase. The usual way to assess the impact of forestry operations is to compare current or historical conditions to conditions created under the proposed management regime. This can be done both theoretically (through modeling expected outcomes using established scientific principles) and empirically (comparing pre-harvest to post-harvest conditions). Unfortunately direct comparisons are often difficult or impossible due the long timelines involved in re-establishing forests. Either way, baseline data covering all aspects of the forest environment (e.g., soils, climate, water, and recreational opportunities), must be available for analysis.

2.1 Introduction

The landscape assessment section of the DFMP consists of three main subsections: abiotic factors, biotic features, and socio-economic features.

The abiotic features section describes nonliving components of the FMA area. The abiotic factors are necessary to identify in order to carry out responsible decision-making and establishing adaptive forest management targets. This section includes detailed description of climate, soils, and water resources within the FMA area.

The biotic features section describes living components in the FMA area. The biotic features consist of the vegetation and ecosite characteristics, rare and endangered plants, age class structure of the treed portion of the landbase, fragmentation/connectedness of the treed landscape, wildlife species occurrences, wildlife habitat types as measured by types of vegetated cover, aquatic species occurrences, and insect and disease occurrences.

The socio-economic feature section is developed from direct input of local communities and indirectly from the Regional Forest Advisory Committee. It describes the role of non-market goods and services in the FMA area.

2.2 Abiotic Features

Baseline abiotic data is necessary for two primary reasons. First, it helps form the basis for developing management regimes. It does this by defining critical ecological parameters that are necessary to responsible decision-making. For example, soils data regarding compactness is crucial in determining block layout, road construction and season of harvest. The second purpose baseline data serves is in establishing management targets. Baseline data is necessary in determining what targets need to be met in order to maintain sustainable management of the forest. The following subsections describe the FMA area's climate, soils, water resources, and natural disturbance patterns.

2.2.1 Climate

The climate of the ANC FMA area has a strong continental influence. It is characterized by short, cool summers and long, cold winters, with occasional chinooks. Mean annual precipitation varies widely through the FMA area, from as low as 50 mm to as high as 750 mm, but over most of the region it is between 500 and 600 mm. Accurate temperature data is not available as most of the climate data was collected from fire stations where temperatures are generally higher than what is representative for the overall area. The high level of variation in elevations and the complex contours in the region further complicate climate data. Elevation, slope and exposure all have significant influences on microclimate conditions.

2.2.2 Soils

Forest vegetation and surface litter protect the mineral soil surface by reducing the amount of surface runoff. Otherwise, runoff can pick up soil materials and cause erosion. Soil erosion can cause damage in two ways. First, through the removal of productive soil and, second, through discharging the soil matter into streams, rivers or lakes.

Soil is fundamental to the productivity and health of forest ecosystems. Soils provide a medium for plant growth, as well as most of the nutrients a plant requires. In addition, soils store and release water for both plant use and for streams and rivers. Inherent soil characteristics play a major role in determining the effect forestry operations have on site productivity. Therefore, a good understanding of soil properties is essential when developing forest management plans at all levels.

The soils in ANC Timber's FMA area have been described in two documents:

- The Reconnaissance Soil Survey of the Iosegun Lake Area, Alberta (Knapik and Lindsay 1983). This survey describes most of the soils in the FMA area.

- Soil Survey and Land Evaluation of the Hinton-Edson Area (Dumanski et al. 1972). Some of the southern region of the FMA area is described in this survey.

This section describes the physiography, bedrock geology, surficial materials and common soil units found in the ANC FMA area. This is followed by a description of several of the more important soil physical properties for each soil unit.

2.2.2.1 Physiography

Rivers deposited course gravels and sands during the mid to late Tertiary period, and eroded broad valleys in the soft sediments laid down in early Tertiary and Cretaceous times. Further uplift in the region deepened valleys and created a plateau-benchland landscape. Pleistocene glaciation further modified the landscape, but only slightly. Valleys were widened and smoothed, and thin till layers were deposited in upland areas. Morainal and glacial lake sediment deposits in the plains areas resulted in subdued slopes. These processes led to the formation of four major geomorphological elements in the area: valleys, plains, benchlands and dissected plateaus.

The region described in the Hinton-Edson survey is divided into four physiographic subdivisions. All the soils in the FMA area are described by the Alberta Plateau-Benchlands subdivision. This region is underlain by very gently dipping Cretaceous and Tertiary material covered by a thin layer of Pleistocene sediment (highly variable but usually less than 10 feet in depth). The landscape is characterized by smooth uplands separated by wide, dissected valleys.

2.2.2.2 Bedrock Geology

Sandstones, silty mudstones and coalbeds underlay much of the FMA area. This material is covered by varying depths of glacial drift. The bedrock strata is classified as either the Paskapoo Formation or Wapiti Group. The Paskapoo Formation covers the uplands across the southern half of the sheet and northeast to the Swan Hills. The northern part of the Paskapoo Formation is characterized by sandstones, siltstones and mudstones, while the southern part is comprised primarily of sandstones. Bedrock in the area is highly susceptible to water erosion when exposed. The Wapiti Group is composed of sandstones, siltstones and mudstones with localized coal seams. The contact between the Paskapoo Formation and the underlying Wapiti Group occurs at around 915 m.

The Alberta Plateau-Benchlands subdivision is underlain by material belonging to the Paskapoo Formation. These are composed primarily of sandstones, siltstones and some coalbeds. Upland plateaus are often capped by thin beds of cobbly, metaquartzite gravel.

2.2.2.3 Surficial Materials

Over most of the region soils were derived from glacial parent materials, and soil properties tend to reflect this glacial origin. Morainal materials are the most common surficial deposit in uplands and plateaus. Thickness varies from less than one metre to several metres. Till derived from Wapiti Group bedrock is commonly clay loam in texture and is dark gray. Paskapoo Formation till is usually sandy clay loam in texture and dark brown in color. Glaciofluvial sediments, deposited by streams, are scattered throughout the landscape. There are also organic, fluvial and colluvial deposits scattered around the region.

The surficial materials in those regions covered by the Hinton-Edson Survey are primarily of glacial and postglacial origin. Till, lacustrine sediments, glaciofluvial sediments, preglacial gravels and recent deposits are the chief surficial deposits in the region. A common characteristic of the tills in this area is the presence of well-rounded metaquartzite cobbles. The dominant depositional landform associated with till is low-relief ground moraine. Lacustrine deposits are also common. The topography of these regions varies from gently undulating to moderately rolling. Finally, glaciofluvial deposits occur along major streambeds in the region.

2.2.2.4 Common Soil Units

This subsection describes the most common soil units found within the ANC FMA area and some of their associated soil properties in Table 2.1 and Table 2.2.

Table 2.1 Dominance, parent materials, soil series, and texture for common soil units in the FMA area

Hinton-Edson Report						
Dominance	**Soil Unit (code)**	**PM1**	**PM2**	**SS1**	**SS2**	**Texture**
1	Mayberne (MBN3)	M		BR.GL	O.GL	
2	Blackmud (BKM1)	GF		O.GL	E.EB	S-SL
2	Erith (ETH1)	M	GL	H.LG	O.G	
2	Erith (ETH3)	M	GL	H.LG	O.G	
2	Lodge (LDG4)	E	M/GL	BR.GL	O.GL	
3	Alluvium (AL)	F		O.R.	CU.R	
3	Fickle (FKE1)	O		M	H	O
3	Heart (HRT1)	E		E.EB		S
3	Jarvis JRV3)	GF		BR.GL	O.GL	g-s
3	River Bank (RB)	C				
3	Summit SMT1)	X	F*	BR.GL		s-g
Iosegun Report						
Dominance	**Soil Unit (code)**	**PM1**	**PM2**	**SS1**	**SS2**	**Texture**
1	Edson (EDS4)	M		O.GL	BR.GL	CL
1	Edson (EDS5)	M		O.GL	O.G	CL
1	Mayberne (MBN7)	M		BR.GL	G	scl-cl
1	Mayberne (MBN5)	M		O.GL	BR.GL	scl-cl
2	Blackmud (BKM8)	GF		E.EB	BR.GL	s-ls
2	Blackmud (BKM9)	GF		E.EB	O.G	s-ls
2	Copton (COP1)	X	C	E.EB	E.DYB	sl-l
2	Deep Valley (DPV)	C	X	E.EB	BR.GL	sl-cl
2	Eaglesham (EGL)	O		M	F	O
2	Heart (HRT1)	E		E.DYB	O.HFP	s-ls
2	Jarvis (JRV4)	GF		E.DYB	PZ.GL	s-g
2	Jarvis (JRV5)	GF		E.DYB	G	s-g
2	Kenzie (KNZ)	O		M	F	O
2	Lodge (LDG7)	GF	M	O.GL		
2	Lodge (LDG9)	GF	M	BR.GL	G	s-c
2	Smoky (SKY3)	M		G	O.GL	cl-scl
2	Simonette (STT2)	F*	X	O.HG	O.G	g-sl
2	Toad (TOD2)	GF		BR.GL		sl-sil
2	Wanham (WHM1)	GF		O.LG		sl-sil
2	Wanhamn (WHM2)	GF		O.LG	O.GL	sl-sil
3	Donnelly (DON2)	GL	M	O.LG		c-hc
3	Goose (GOS4)	GL		O.G	O.HG	c-hc
3	Gunderson (GUN1)	GF		R. HG		s-sl
3	Iosegun (IOS2)	F		CU.R	R.G	si-g
3	Judy (JUY2)	F*	X	BR.GL	G	g-sl
3	Snipe (SIP1)	GL		O.LG	O.G	c-hc
3	Iosegun (IOS1)	F		CU.R	O.R	si-g
3	Torrens (TOR2)	X	C	O.GL	BR.Gl	cl-sic
3	Tri-Creek (TRC3)	GL		O.GL	BR.GL	si-c
3	Rough Broken (RB)	C				

Dominance: 1=most common, 2=common, 3=present but less common

Table 2.2 Soil descriptions for common soil units in the FMA area

Hinton-Edson Report	
Soil Unit (code)	**Description**
Alluvium (AL)	found on floodplains of major rivers, exceedingly variable in texture, color and morphology
Blackmud (BKM1)	coarse textured soils developed on water laid sandy materials
Erith (ETH1)	affected by poor internal drainage, generally peaty but less than 24 inches, found in depress ional areas and lower slope positions
Erith (ETH3)	affected by poor internal drainage, generally peaty but less than 24 inches, found in depressional areas and lower slope positions
Fickle (FKE1)	organic soils; peat accumulation exceeds 24 inches; found in depressional areas and lower slope positions
Heart (HRT1)	coarse textured sand, moderately calcareous
Jarvis JRV3)	coarse textured gravels and sands, weakly to moderately calcareous, exceedingly cobbly
Lodge (LDG4)	Thin deposit of alluvial/eolian sand resting unstably on till or lacustrine materials
Mayberne (MBN3)	medium textured till of Continental origin, weakly calcareous and exceedingly cobbly
River Bank (RB)	strongly eroded continuous landforms formed by recent river erosion
Summit SMT1)	Coarse textured gravels and sands, weakly to moderately calcareous, exceedingly cobbly; found only on elevated plateaus or tablelands
Iosegun Report	
Soil Unit (code)	**Description**
Blackmud (BKM8)	dominated by brunisolic and luvisolic soils developed on GF sands; occur on GF deltas and outwash plains
Blackmud (BKM9)	dominated by brunisolic and luvisolic soils developed on GF sands; occur on GF deltas and outwash plains
Copton (COP1)	brunsolic and luvisolic soils developed on weathered, soft sandstone and on colluvium derived from sandstone (Paskapoo fm)
Donnelly (DON2)	dominantly gleyed solonetzic gray luvisols developed on glaciolacustrine clays with scattered pebbles;
Deep Valley (DPV)	eroded plateau escarpments in the Little Smoky, Berland and Maybern plateaus, restricted to very steeply sloping escarpments with colluvial veneers and blankets
Edson (EDS4)	landscapes dominated by O.GL develop on clay loam textured till; generally rolling to hummocky
Edson (EDS5)	landscapes dominated by O.GL develop on clay loam textured till; generally rolling to hummocky
Eaglesham (EGL)	very poorly drained fen peatlands; occupy lowest position in local landscape; peat covered with water table usually at surface; nutrient rich
Goose (GOS4)	glaciolacustrine plains and glaciolacustrine blankets and veneers overlying morainal landforms, stratified and slightly saline
Gunderson (GUN1)	sand, loamy sand and sandy loam textured fluvial deposits of Pleistocene and Holocene age; rapidly permeable but have high water table due to groundwater seepage and ponded surface runoff
Heart (HRT1)	glaciofluvial deltaic sediments blown into sand dune landscape (tree covered and no longer active)
Iosegun (IOS1)	terraces and floodplains of modern (Holocene) streams; level to dissected and fluvial processes of erosion and deposition actively modifying landscapes
Iosegun (IOS2)	terraces and floodplains of modern (Holocene) streams; level to dissected and fluvial processes of erosion and deposition actively modifying landscapes
Jarvis (JRV4)	glaciofluvial terraces of the Athabasca River and on large kame and esker complex in upper Little Smoky River Valley
Jarvis (JRV5)	glaciofluvial terraces of the Athabasca River and on large kame and esker complex in upper Little Smoky River Valley
Iosegun Report	
Soil Unit (code)	**Description**
Kenzie (KNZ)	bowl, blanket and occasionally raised bogs; occur on M and GL landscapes where surface run-off is ponded, fluvial landscapes with underfit streams and eolian landscapes between dunes
Lodge (LDG7)	sand veneer overlies a strongly contrasting material; in most cases the veneer is F or E overlying GL clay or M clay loam
Lodge (LDG9)	sand veneer overlies a strongly contrasting material; in most cases the veneer is F or E overlying GL clay or M clay loam

Table 2.2 Continued

Soil Unit (code)	Description
Mayberne (MBN5)	A variety of morainal landforms in the benched and highly dissected uplands; generally M blankets overlying Paskapoo formation or Saskatchewan sands and gravels
Mayberne (MBN7)	A variety of morainal landforms in the benched and highly dissected uplands; generally M blankets overlying Paskapoo formation or Saskatchewan sands and gravels
Snipe (SIP1)	Glaciolacustrine plains and glaciolacustrine blankets and veneers overlying undulating moraine, stratified, moderately calcareous and slightly saline
Smoky (SKY3)	A variety of morainal landforms in the benched and highly dissected uplands; generally M blankets overlying Paskapoo formation or Saskatchewan sands and gravels; lowland or depressional landscape positions
Simonette (STT2)	Elevated fluvial plateaus which are flanked by erosional escarpments; remnants of Tertiary landscape and consist of Saskatchewan sands and gravels
Toad (TOD2)	Glaciofluvial deltas and terraces associated with glacial-aged lakes; materials are stratified, deltaic sediments that dent to be fine sandy loam or silt loam textured
Torrens (TOR2)	Steeply sloping elongate ridges, meandering erosional escarpments and fairly level bedrock plains; soft weathered mudstones and shales of Wapiti group and colluvium derived from these formations
Tri-Creek (TRC3)	Clayey GL veneers and blankets overlying clay loam till or weathered mudstone; small basins separated from the main GL basin on Iosegun Plain
Wanham (WHM1)	Glaciofluvial deltas and terraces associated with late glacial-aged lakes; stratified deltaic sediments that tend to have mostly silty textures
Wanhamn (WHM2)	Glaciofluvial deltas and terraces associated with late glacial-aged lakes; stratified deltaic sediments that tend to have mostly silty textures
Rough Broken (RB)	steeply sloping banks of active streams

2.2.2.5 Characteristics of Soils Susceptible to Erosion

Understanding soil characteristics at a fine scale of resolution is valuable for two key reasons. First, the impact of disturbance on soils is a direct result of its susceptibility to disturbances in each of the distinct components that make up the soil medium. Second, since soil is the main medium for plant growth, soil characteristics have a direct bearing on the quantity and type of vegetation growing on a particular site. Information related to soil physical properties, organic matter and nutrients is presented in order to develop an understanding of those characteristics that contribute to the sensitivity of soils to disturbance.

Soil Physical Properties

A number of soil physical properties affect forest plant communities, in relation to their nutrient and water-retention capabilities, and their ability to develop roots effectively (Table 2.3).

Table 2.3 Selected soil physical properties and their relationships to forestry

Property	Definition	Relationship to Forestry
Soil Mineral Particle Size	The effective diameter of a particle, upon which particles are differentiated into size classes (i.e. sands, silts, clays)	Contributes to soil texture Affects soil water and nutrient retention Affects soil pore space shape and quantity
Soil Texture	Percentage by weight of sand, silt and clay in the mineral fraction of soil	Affects soil water and nutrient retention Affects forestry operations (i.e. season of operability, road construction, erosion potential, compaction hazard, etc.)
Porosity	The total volume of space, usually expressed as a percentage of the total soil volume	Affects soil water and nutrient retention Affects rooting ease and depth
Permeability	Ease with which gases, liquids, or plant roots penetrate or pass through the soil	Affects soil water and nutrient retention Affects rooting ease and depth
Infiltration	The downward entry of water into the soil	Affects soil water and nutrient retention Affects forestry operations (i.e. season of operability, road construction, erosion potential, compaction hazard, etc.)
Structure	The combination or arrangement of individual soil particles into definable aggregates of peds, which are characterized and classified on the basis of size, shape and degree of distinctness	Affects soil water and nutrient retention Affects rooting ease and depth Affects forestry operations (i.e. season of operability, road construction, erosion potential, compaction hazard, etc.)
Bulk Density	A function of the particle density and the proportionate volumes of solid particles and pore space in the soil.	Affects soil water and nutrient retention Affects rooting ease and depth Affects forestry operations (i.e. season of operability, road construction, erosion potential, compaction hazard, etc.)
Cohesion	Attraction of a substance for itself; the mutual attraction among molecules or particles comprising a substance that allows it to cling together as a continuous mass	Affects forestry operations (i.e. season of operability, road construction, erosion potential, compaction hazard, etc.)
Adhesion	The attraction or clinging together of unlike substances	Affects forestry operations (i.e. season of operability, road construction, erosion potential, compaction hazard, etc.)

(Definitions adapted from Hausenbuiller 1985)

Particle Size

Particle size is one of the most fundamental physical soil properties. Different particle size classes contribute significantly to several soil properties. The classification scheme we use (AEP 1994) recognizes two broad groups of particles: *coarse fragments* and *soil separates*. Coarse fragments include subclasses such as gravels, cobbles and stones, which are differentiated from each other on the basis of size. Soil separates are also differentiated based on size, into the subclasses of sands, silts and clays (Table 2.4).

Table 2.4 Soil particle size classes

Soil Characteristics	Diameter (cm)
Gravels	<7.5
Cobbles	7.5-25
Stones	>25
Soil Separates	**Diameter (mm)**
Clays	<0.002
Silts	0.002-0.05
Sands	0.10-2.0

Source: Alberta Environmental Protection 1994

Sands are further separated into various subclasses, from very fine to very coarse sands. This is due to the wide range in properties through its full range in size (i.e., 0.1-2.0 mm). For example, the potential for wind erosion is greater for very fine sands (0.1 mm) than for very coarse sands (2.0 mm).

Several properties can vary with particle size, including mass, volume, surface area and shape. Of these properties, surface area is of greatest importance because the total surface area of particles influences the ability of soils to retain water and nutrients for plant use (Hausenbuiller 1985). In general, the smaller the particle sizes, the greater the total surface area for the entire collection of soil particles. Particle shape also influences the size and shape of pore spaces in the soil matrix, and the size and shape of pore spaces is important because they are major factors affecting the permeability of soils (Hausenbuiller 1985).

Soil Texture

Texture is a relatively permanent feature of the soil (i.e., it can change but only over a period of thousands of years) compared to structure or organic matter content. For soil separates, the relative contributions of the three main constituents (sand, silt and clay) and their inherent physical properties significantly determine soil texture, which directly affects the soil's water retention, nutrient holding capacities, and plant root penetration (Alberta Environment 1996).

The water-retention capacity of soil is largely determined by the mineral soil texture, in addition to organic matter content. For example, coarse soils with little organic matter tend to have low water retention capacities, due to the relatively low amounts of surface area for water adhesion and large pore spaces (Alberta Environment 1996). Soils with finer textures have a greater amount of surface area, which increases the overall water-holding capacity. However, fine-textured soils are often saturated due to their very high water storage capacity and thus are often poorly drained. Consequently, anaerobic conditions may occur and plant growth may be impaired due to a limitation in nutrient and water uptake (Grier et al. 1989). Medium-textured soils generally have the best balance of water-holding characteristics and adequate drainage to promote good plant growth.

Texture also significantly influences the nutrient holding capacity of the soil. Valuable soil nutrients—including nitrogen, phosphorus, potassium and calcium—are weakly held to soil particles by a negative charge on the soil particle (AEP 1996). Thus, the greater the content of finer soil particles (and/or organic matter), which have a larger total surface area, the greater the capacity of the soil to hold positively charged nutrients.

Porosity/Permeability/Infiltration

The capability of soils to transmit water down the soil profile is generally referred to as the infiltration capacity or rate. This characteristic is predominantly related to soil texture, and coarse textured soils have much higher infiltration rates than do more finely textured soils. Soils that have high infiltration rates (highly permeable) tend to have lower nutrient holding capacity, as water soluble nutrients pass through the soil profile rapidly and are not available for plant uptake.

Soils with lower infiltration rates (less permeable) tend to be more prone to erosion from runoff. Because water moves more slowly through the soil profile, water remains on the soil surface for a greater period of time, thus increasing the potential for surface erosion (Hausenbuiller 1985). This potential for erosion needs to be reduced when planning forestry operations such as road construction (particularly near stream courses), harvesting and site preparation.

Cohesion/Adhesion/Structure

The cohesive and adhesive properties of soils are largely determined by particle shape. Particle shape affects these properties by determining the degree of contact between surfaces, with the maximum contact occurring between flat surfaces situated parallel to one another (Hausenbuiller 1985). The soil's cohesive and adhesive properties are commonly measured indirectly through the hardness of aggregates when the soil is dry, or by the plasticity of the soil when it is wet. Plasticity generally refers to the ability of soils to be molded and is measured by the force required to deform soils in a wet, pliable condition (Hausenbuiller 1985). Clay tends to be both sticky and plastic when wet and it forms hard clods when dry. Silt is generally more cohesive and adhesive than sand, but still displays only limited stickiness and plasticity. When dry, clods of silt are easily crushed to a fine powder. Because of the large size of sand particles, sand is neither plastic nor sticky when wet. This results in sand not forming stable aggregates in soils. This contributes to sandy soil's tendency towards large pore spaces and high permeability to air and water (Hausenbuiller 1985).

The aggregation of soils principally results from the cohesive nature of finer particles and natural processes that cause them to form into specific structural components, known as *peds*, which have definable shapes and sizes (Hausenbuiller 1985). There are two fundamental requirements for the formation of structure in soil. First, there must be present cohesive properties that allow soils to hold together in an aggregate form. Second, there must be a mechanism that separates the soil into aggregate forms. Some of these mechanisms include root growth, ice formation, shrinking/swelling and the action of soil fauna (micro-organisms, worms, beetles, etc.). Soil structure is important for tree growth in that it allows for airflow to roots and contributes to the retention of water for plant uptake.

The structural stability of soils refers to the ability of soil to withstand physical breakdown (Hausenbuiller 1985). One major concern to forestry and forest productivity is maintaining the surface layers of soil in a permeable state; otherwise aeration, water penetration and seedling root development can be hindered. Machinery operating in areas with structurally sensitive soils can result in the loss of structure, compaction, and abrasion. The formation of ruts on saturated, structurally sensitive soils can occur, resulting in a reduction in macropore space (inherent with structure) and a reduction of the infiltration capacity, making the soil more susceptible to erosion or surficial crusting (McNabb 1992; Hausenbuiller 1985).

Bulk Density

Bulk density is a measure of both particle density and pore space; it is generally a function of soil texture. Coarse-textured soils typically have higher bulk densities than fine-textured soils. This is due to coarse-textured soils consisting of large particles with uneven surfaces, resulting in fewer, but larger pore spaces. The net result is a comparatively low total pore space volume (Hausenbuiller 1985). In contrast, fine-textured soils have very small pore spaces, but they occur in such great numbers, that the total pore space volume exceeds that of coarse textured soils (Hausenbuiller 1985). Compacted subsoil layers, however, may demonstrate higher bulk densities due to a decrease in the relative pore space.

Bulk density is commonly used to evaluate the degree of disturbance (e.g., compaction) on a site. Soil compaction generally leads to an increase in bulk density, or a decrease in void space or porosity (McNabb 1992). Increases in bulk density can inhibit root growth (soil is less penetrable), decrease aeration, lower the infiltration capacity of soil (leading to runoff rather than recharging of the soil), and decrease the growth of root organisms. All of these conditions can directly affect plant survival and growth (McNabb 1992).

Soil Organic Matter and Nutrients

The organic soil horizon, or humus, is a vital component of forest soil productivity (Page-Dumroese et al. 1990). Although soil texture is the primary factor in soil moisture retention, organic matter content of the soil can be of considerable importance. Organic matter can modify the relationship between texture and other soil properties, and this can vary over time or can change following modification (e.g., harvesting and road construction). The surface organic litter or duff is an important source of water for plants due to its high water holding capacity (AEP 1996). Moreover, the duff layer in effect acts as a mulch, helping to maintain soil moisture and buffer changes though seasonal fluctuations (Page-Dumroese et al. 1990).

The organic litter layer is also an important source of macronutrients for tree growth. While the composition and origin of the material is wide-ranging (e.g., deciduous leaf, coniferous needle, mosses, and grasses), the litter layer generally tends to have a higher macronutrient concentration than the underlying mineral soil (AEP 1996). A substantial portion of the nutrient resources (including nitrogen, phosphorus, potassium, calcium and magnesium) is found within the organic litter layers (Page-Dumroese et al. 1990). The different humus forms (Table 2.5) that occur in forest communities can be a sign of the rate of nutrient cycling and the potential productivity of a site. The main humus forms associated with forest communities are mor, moder and mull, although mulls are relatively uncommon.

Table 2.5 Humus forms and their general characteristics

Humus Form	Definition[1]	Characteristics[2]
Mor	Humus form that displays diagnostic fibric or humic horizons, with a distinct boundary evident between the organic and mineral layers; little or no mixing or mineral and organic horizons	➢ least biologically active ➢ decomposed by fungi ➢ acidic litter ➢ slow release of nutrients ➢ most common on coniferous and cold sites
Moder	Humus form that displays the diagnostic organic horizons with varying degrees of intermixing between the organic and mineral horizons producing a gradual transition between the horizons	➢ decomposition by fauna as well as fungi ➢ more available nutrients (than a mor) ➢ more rapid decomposition (than a mor) ➢ common under deciduous and mixedwood forests
Mull	Humus form where the diagnostic fibric and humic horizons are commonly lacking; there is considerable mixing of organic material into the surface mineral horizon usually creating a relatively thick Ah horizon	➢ rapid decomposition and humification ➢ faunal mixing of organic and mineral layers ➢ good soil aeration ➢ balanced moisture supply ➢ nutrient rich soil or seepage ➢ higher pH and base saturation ➢ most common under deciduous forests in the Dry Mixedwood and Aspen Parkland subregions

[1] Definitions for Beckingham et al. (1996)
[2] Adapted from Alberta Environmental Protection (1996)

Timber harvesting can impact the soil organic matter, both in the short and long term. In most instances, organic matter is incorporated into the surface mineral soil layers during harvest, increasing the organic matter content for the first few years after harvest. However, this generally declines as the new stand develops. Typically, the organic matter content of the forest floor decreases follow cutting, but can be mitigated through the supplementation of logging slash (Jurgensen et al. 1990).

2.2.2.6 Sensitive Soils in the FMA Area

Based on the understanding of the physical properties that make soils susceptible to disturbance and erosion, areas that have sensitive soils have been identified within the FMA area (Figure 2.1). Based on an understanding of the physiography and surficial materials within the FMA area, sensitivity classes were focused on those soils most susceptible to erosion. These classes were derived using soil characteristics such as morphology, parent material and texture. Due to the differences in soil characteristics, each soil type has different tolerance levels associated with its susceptibility to erosion. Soil sensitivity can be classified by considering the soil classification type (soil unit) and the slope class of the soil. However, the Iosegun Soil Survey does not encompass the entire FMA area. When additional data becomes available, it will be incorporated into the current assessment of conditions. The total area of 373, 828 ha is the total area of the forested and non-forested landbase, with deletions subtracted (see Chapter 3). The area associated with each risk level is summarized below.

Table 2.6 Risk of soil erosion in the FMA area

Soil Erosion Risk Level	Area (ha)	% of FMA area
Slight Erosion Hazard	190,264	50.9
Slight to Moderate Erosion Hazard	31,385	8.4
Moderate Erosion Hazard	38,017	10.2
Moderate to Extreme Erosion Hazard	23,533	6.3
Extreme Erosion Hazard	31,415	8.4
Outside Iosegun Soil Survey	16,706	4.5
No Soil Survey Data Available	37,668	10.1
Miscellaneous Land Type	3,233	0.9
Water	1,607	0.4
Total Area	**373,828**	100.1 (due to rounding)

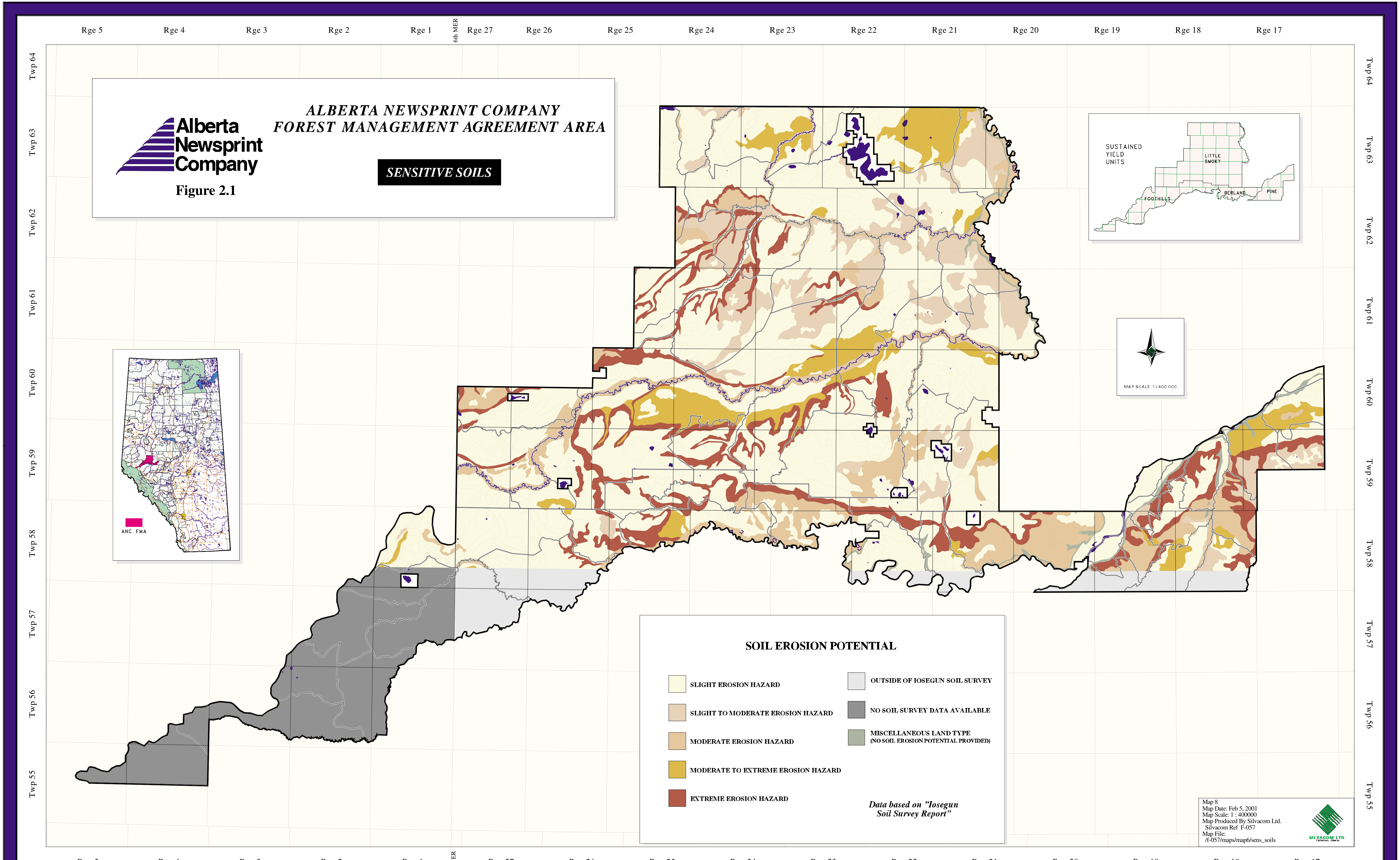
2.2.3 Water Resources

Surface water locations within the FMA area are summarized in Figure 2.2. Surface areas have been calculated for large permanent streams, rivers, lakes, flooded lands, aquatic vegetation and several wetland categories. Small permanent, intermittent and ephemeral streams are summarized by length.

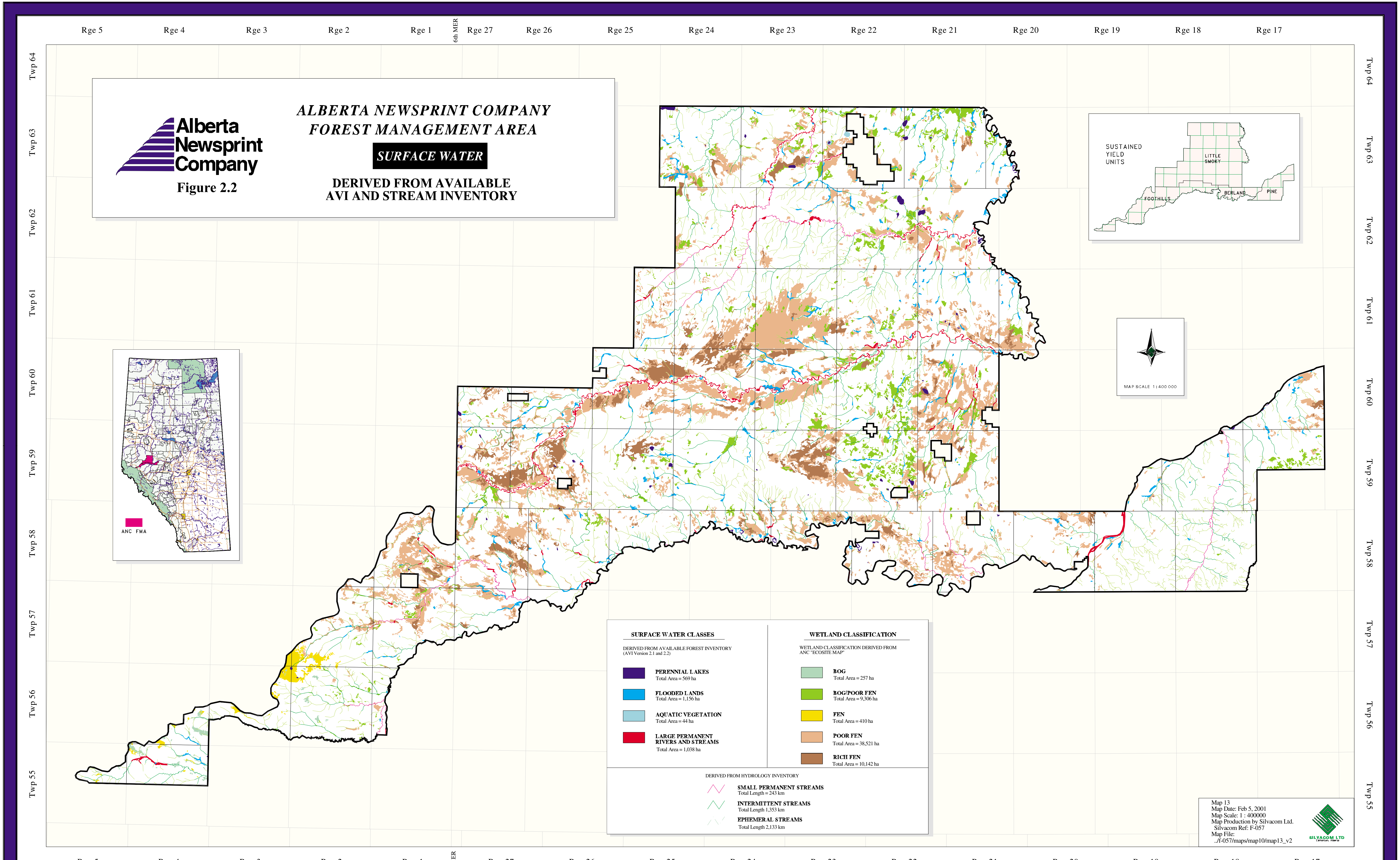
This map establishes the location and extent of surface water within the FMA area. Figure 2.3 depicts the major watersheds in the FMA area. Figure 2.4 depicts the main wetland areas in the FMA area.

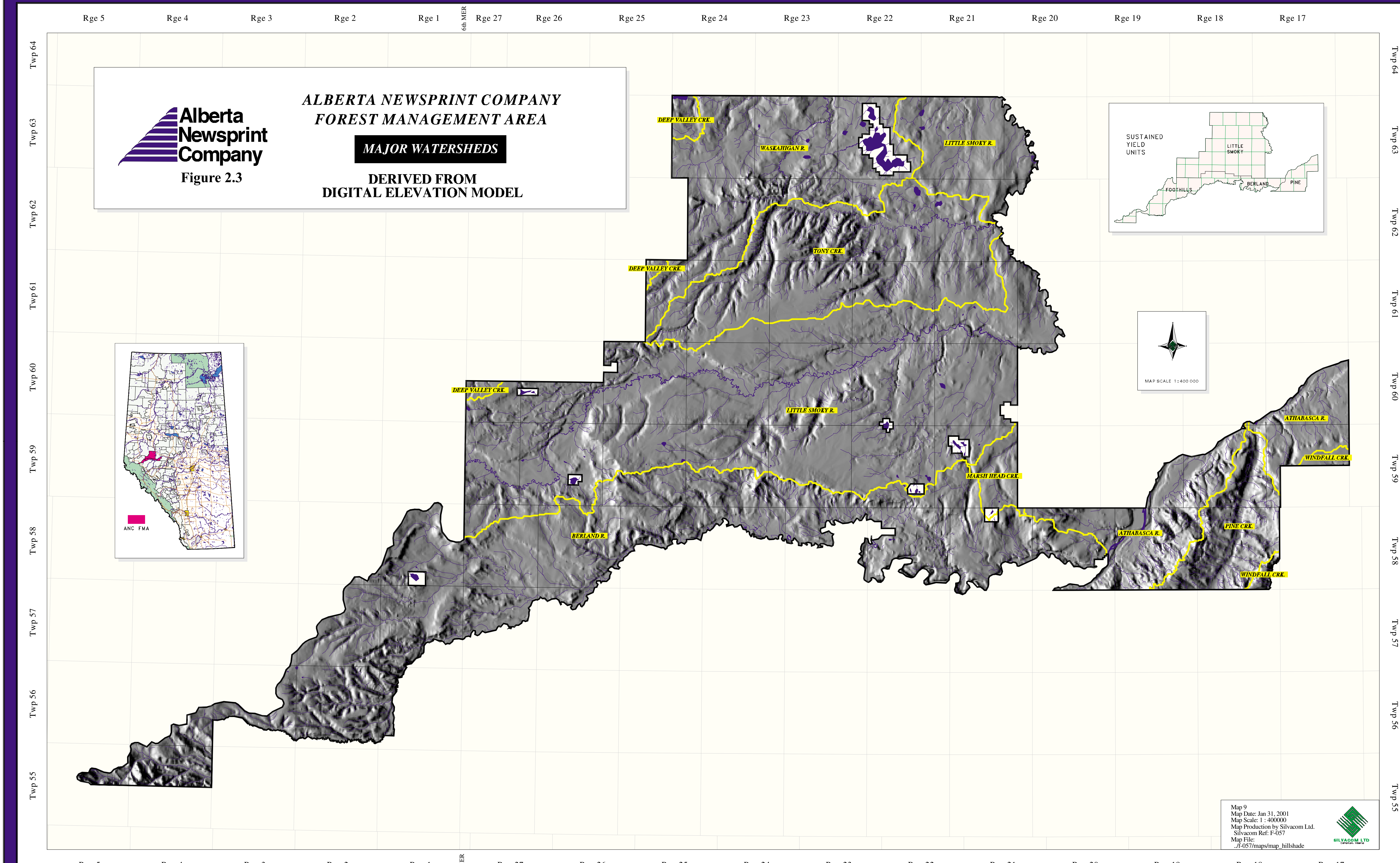
Flood Risk

An assessment of the flood risk at various stream crossings (for all utility, seismic, and permanent and temporary road crossings) was completed for the ANC FMA area and is presented in Figure 2.5. These areas were mapped as a function of watershed area, as determined by ANC's Digital Elevation Model (DEM), upstream of the crossing structure. The watershed basin size (ha) is noted above each crossing point, thus providing a relative indication of how much water may be flowing through that particular crossing. The larger the basin size the greater the probability of increased water volume, which influences the risk of flooding events. Thus, areas that have a higher influx of water through a stream crossing are at a much greater risk of seeing a negative event occur. The means and ranges of long-term flow rates for each monitoring station near the FMA area, as well as the average peak flows for various flood events ranging from 1:2 to 1:100 year floods, are provided in Table 2.7. The average peak flows for the various flood events were calculated using the flood frequency analysis (Chow et al. 1988).



Alberta Newsprint Company
Figure 2.1
ALBERTA NEWSPRINT COMPANY
FOREST MANAGEMENT AGREEMENT AREA
SENSITIVE SOILS
Rge 5
Rge 4
Rge 3
Rge 2
Rge 1
6th MER
Rge 27
Rge 26
Rge 25
Rge 24
Rge 23
Rge 22
Rge 21
Rge 20
Rge 19
Rge 18
Rge 17
Twp 64
Twp 63
Twp 62
Twp 61
Twp 60
Twp 59
Twp 58
Twp 57
Twp 56
Twp 55
SUSTAINED YIELD UNITS
LITTLE SMOKY
FOOTHILLS
BERLAND
PINE
ANC FMA
MAP SCALE 1:400 000
SOIL EROSION POTENTIAL
SLIGHT EROSION HAZARD
SLIGHT TO MODERATE EROSION HAZARD
MODERATE EROSION HAZARD
MODERATE TO EXTREME EROSION HAZARD
EXTREME EROSION HAZARD
OUTSIDE OF IOSEGUN SOIL SURVEY
NO SOIL SURVEY DATA AVAILABLE
MISCELLANEOUS LAND TYPE
(NO SOIL EROSION POTENTIAL PROVIDED)
Data based on "Iosegun Soil Survey Report"
Map 8
Map Date: Feb 5, 2001
Map Scale: 1 : 400000
Map Produced By Silvacom Ltd.
Silvacom Ref F-057
Map File:
/f-057/maps/map6/sens_soils
SILVACOM LTD
Edmonton, Alberta


Alberta Newsprint Company
Figure 2.2
ALBERTA NEWSPRINT COMPANY
FOREST MANAGEMENT AREA
SURFACE WATER
DERIVED FROM AVAILABLE
AVI AND STREAM INVENTORY
Rge 5
Rge 4
Rge 3
Rge 2
Rge 1
6th MER
Rge 27
Rge 26
Rge 25
Rge 24
Rge 23
Rge 22
Rge 21
Rge 20
Rge 19
Rge 18
Rge 17
Twp 64
Twp 63
Twp 62
Twp 61
Twp 60
Twp 59
Twp 58
Twp 57
Twp 56
Twp 55
SUSTAINED
YIELD
UNITS
LITTLE
SMOKY
FOOTHILLS
BERLAND
PINE
ANC FMA
MAP SCALE 1:400 000
SURFACE WATER CLASSES
DERIVED FROM AVAILABLE FOREST INVENTORY
(AVI Version 2.1 and 2.2)
PERENNIAL LAKES
Total Area = 569 ha
FLOODED LANDS
Total Area = 1,156 ha
AQUATIC VEGETATION
Total Area = 44 ha
LARGE PERMANENT
RIVERS AND STREAMS
Total Area = 1,038 ha
WETLAND CLASSIFICATION
WETLAND CLASSIFICATION DERIVED FROM
ANC "ECOSITE MAP"
BOG
Total Area = 257 ha
BOG/POOR FEN
Total Area = 9,306 ha
FEN
Total Area = 410 ha
POOR FEN
Total Area = 38,521 ha
RICH FEN
Total Area = 10,142 ha
DERIVED FROM HYDROLOGY INVENTORY
SMALL PERMANENT STREAMS
Total Length = 243 km
INTERMITTENT STREAMS
Total Length 1,353 km
EPHEMERAL STREAMS
Total Length 2,133 km
Map 13
Map Date: Feb 5, 2001
Map Scale: 1 : 400000
Map Production by Silvacom Ltd.
Silvacom Ref: F-057
Map File:
../f-057/maps/map10/map13_v2
SILVACOM LTD
Edmonton, Alberta



Alberta Newsprint Company
Figure 2.3
ALBERTA NEWSPRINT COMPANY
FOREST MANAGEMENT AREA
MAJOR WATERSHEDS
DERIVED FROM
DIGITAL ELEVATION MODEL
Rge 5
Rge 4
Rge 3
Rge 2
Rge 1
6th MER
Rge 27
Rge 26
Rge 25
Rge 24
Rge 23
Rge 22
Rge 21
Rge 20
Rge 19
Rge 18
Rge 17
Twp 64
Twp 63
Twp 62
Twp 61
Twp 60
Twp 59
Twp 58
Twp 57
Twp 56
Twp 55
DEEP VALLEY CRK.
WASKAHIGAN R.
LITTLE SMOKY R.
TONY CRK.
BERLAND R.
MARSH HEAD CRK.
ATHABASCA R.
WINDFALL CRK.
PINE CRK.
ANC FMA
SUSTAINED
YIELD
UNITS
LITTLE
SMOKY
FOOTHILLS
BERLAND
PINE
MAP SCALE 1:400 000
Map 9
Map Date: Jan 31, 2001
Map Scale: 1 : 400000
Map Production by Silvacom Ltd.
Silvacom Ref: F-057
Map File:
../f-057/maps/map_hillshade
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