

THE POTENTIAL FOR REFORESTATION  
IN AGRICULTURAL LEASES WITHIN  
THE DAWSON CREEK AND PRINCE GEORGE  
SPECIAL SALE AREAS

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Ian S. Moss, R.P.F.  
Anne Jankowski, R.P.F.  
Barry W. Hunter, R.P.F.

## **THE POTENTIAL FOR REFORESTATION IN AGRICULTURE LEASES WITHIN THE DAWSON CREEK AND PRINCE GEORGE SPECIAL SALE AREAS**

### **EXECUTIVE SUMMARY**

The purpose of this study was to assess the potential for reforestation in Agriculture Leases located within the Dawson Creek and Prince George Special Sale Areas (SSA's). Agricultural leases are provided through the British Columbia Ministry of Lands to local residents for the purpose of cultivating an agricultural crop. The lessee can gain title to the land if, after a period of time specified in the contract (e.g. 10 years), he fulfils an obligation to cultivate a certain proportion of arable land (25% - 80%).

This study was conducted in June and July, 1991 by firstly identifying all lease lot numbers within the Prince George and Dawson Creek SSA's as listed by the Ministry of Lands. The total area of each lease and the area of arable and non-arable lands were determined at the same time. All lease lands within the Prince George and Dawson Creek SSA's were then classified into the following land use categories using aerial photographs: crop, merchantable timber, non-productive (from a tree growers perspective) and non-merchantable (describing lands not included in the former categories). Areas delineated within each category were determined using a dot grid, with the total areas for each lease being equal to those recorded in Ministry of Lands' files. 44 out of 100 leases were visited in the field in Prince George and 51 out of 203 in Dawson Creek to account for changes in land use since the aerial photographs were made (1984, 1986 and 1988) and to also correct for errors in photograph interpretations. The non-merchantable types were further classified in the field into 4 treatment units, the first of which was estimated to be satisfactorily restocked (SR) with trees according to the B.C. Ministry of Forests' 1991 Silviculture Standards. The remaining treatment types were designated relative to the degree of effort required to produce a stand of trees that would meet these same standards. Based on the samples, estimates of the current land use patterns were made along with statistically derived confidence intervals. The 1991 area with potential for reforestation was defined as the non-merchantable area less the amount found to be satisfactorily restocked.

There were 100 active leases within the Prince George SSA covering 9,358 hectares of land; 77% was arable. Of that total, 3523 hectares (38 %) were described as currently (1991) non-merchantable, of which 2,921 hectares had a potential for reforestation. The remaining portions of land were either cultivated or used for intensive grazing (2,081 ha.; 29%), retained a cover of merchantable timber (3,522 ha.; 49%) or were non-productive (232 ha.; 3%).

Within the Dawson Creek SSA there were 203 leases covering 29,155 hectares of land; 82% was arable. 8,951 (31%) hectares of land were non-merchantable, with 8,864 hectares having potential for reforestation. The remaining areas were cultivated (6,344 ha.; 22%), merchantable timber (11,432 ha.; 39%), or non-productive (2428 ha.; 8.3%).

It was estimated that it would cost \$3.5 million to completely reforest the potential lease land area around Prince George (\$1,192 per hectare), and \$10.9 million for the potential lease area around Dawson Creek and Fort St. John (\$1,227 per hectare).

In the future, a proportion of the area identified as non-merchantable will be transferred to crop land. Given the rate of change in crop land per year observed since the time of aerial photography (Prince George: +0.27% of the lease area per annum. Dawson Creek: -0.68%), versus that for non-merchantable types (Prince George: +1.89%. Dawson Creek: +1.92%), it would appear that the latter land use category will increase, while crop lands will remain stable or increase by very small proportions in the future. This conclusion might change if there are dramatic shifts in the agricultural or timber market economies.

The Ministry of Lands has adopted a new policy (October, 1990) requiring that 70% of the arable land must be cultivated by the lease holder, if at the end of his 10 year contract term, he wishes to retain the area as privately owned. However, this will not affect existing 10 year leases granted since 1980 with the requirement that only 25% of the area be cultivated. Prior to 1980 it was required that 80% of the arable land be cultivated within a 21 year term.

Based on our field observations we were able to estimate how much more arable land must be cultivated in each SSA before the 25% requirement was met. It can be observed within our data that while some lessees had already met this requirement others had not. In the Dawson Creek SSA an additional 2,604 hectares must be cultivated before every lease holder has met "the 25% rule". With this additional area, the total in crop land would be 8,948 hectares -37% of the arable lease land. Assuming that the additional area was to be derived from the not sufficiently restocked (NSR), non-merchantable categories, this would leave a net area of 6,511 hectares available for reforestation. However, only 421 hectares of that amount must come from the non-merchantable category with a potential for the remainder to come from "merchantable timber". This would leave 8,530 hectares with a potential for reforestation. Using the 80% rule, substantially more area (an additional 13,555 ha) would be required in crop production, with 4,926 hectares that must come from the non-merchantable category; this would leave only 4,025 hectares of land with a potential for reforestation. A similar analysis for the Prince George SSA leads to the conclusions below.

## Conclusion

Given:

- I. that the proportion of crop land in both the Prince George and Dawson Creek SSA's was found to be relatively stable, while that for merchantable timber was decreasing and that for nonmerchantable types with potential for reforestation increasing, and
2. that the proportion of arable land required to be put under cultivation by each lessee to ultimately satisfy the terms of their agreement with the Crown must be at least 25%, but may be as much as 80%, and as of October 1990 has been set at 70%, and
3. that the current trends identified in "1" do not indicate that lease holders are making rapid progress toward meeting the higher level of obligations identified in "2",

it is concluded that:

- A) there is a maximum of 8,864 hectares of agricultural lease land with potential for reforestation in the Dawson Creek SSA. To fulfil this potential will cost 10.9 million dollars.
- B) there is a maximum of 2,921 hectares of agricultural lease land with potential for reforestation in the Prince George SSA. To fulfil this potential will cost 3.5 million dollars.

If the date of issue for each lease was part of the data collected, it would have been possible to determine the area of lands with potential for reforestation within more narrow limits (as discussed herein).

The potential for reforestation can only be fulfilled with the complicity of the Ministry of Lands, and the lease holders who are subject to the terms of their agreements, the market economies and their financial limitations. Attitudes toward the best use of land vary amongst lessees and lessors according to how they perceive their existing circumstances and future developments. The Ministry of Lands is committed to ensuring that agriculture lease contracts are satisfactorily implemented and may therefore disagree with the third point raised with regard to the conclusion above. The factors (including policy and legislation) and perceptions affecting the fulfilment of the potential for reforestation in agricultural leases were not considered within the initial terms of reference for this study.

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## APPENDIX

### THE FIELD DATA COLLECTION FORMAT

# **THE POTENTIAL FOR REFORESTATION IN AGRICULTURAL LEASES WITHIN THE DAWSON CREEK AND PRINCE GEORGE SPECIAL SALE AREAS**

## **1.0 INTRODUCTION**

The purpose of this study was to assess the potential for reforestation in Agricultural Leases located in British Columbia within the Dawson Creek and Prince George Special Sale Areas (SSA's). The study was requested by the Ministry of Forests given the importance of forests for protection of the environment (soil, water, air).

Agricultural leases are provided by the Ministry of Lands to those who wish to cultivate Crown land with agricultural potential, i.e. those lands identified within the Canada Land Inventory (CLI) as class 4 or better (Kenk, 1983). "Land in this class has limitations that require special management practices or severely restrict the range of crops or both". Class 4 and better lands are defined as arable by the Ministry of Agriculture. CLI class 5 soils are sometimes accepted as arable within the Dawson Creek SSA and may be used in the Prince George area for improved pasture, forested or native range. "Lands in this class has limitations that restrict its capability to producing perennial forage crops or other specially adapted crops".

In the Dawson Creek SSA, arable land slopes must not exceed 10% and soils must be without coarse fragments. In the Prince George SSA arable Crown land must have slopes less than 15 to 20 percent and soils may contain coarse fragments provided trafficability and the potential for cropping are unaffected.

Leases have traditionally been granted in a "lease to purchase" agreement with the Crown, provided a minimum proportion of the total lease area is arable, and subject to an understanding by the lessee that specified proportions of arable land be cleared and cultivated within a designated period of time. Failure to meet the latter stipulations results in continued Crown ownership of the land and forfeiture of the agreement by the lessee. Prior to 1980 it was required that 80% of the arable land be cultivated within a 21 year term. In 1980 the policy was changed to ensure that only 25% of the arable land be cultivated within a 10 year contract term and in October, 1990 it was changed to 70% within 10 years. Current land use patterns will be altered by lease holders in accordance with their contractual obligations, assuming that it is preferable (economically advantageous) to own the land rather than to abandon the lease.

The potential for reforestation of agricultural lease lands was estimated in terms of identifying current (July, 1991) land uses with consideration given to the historical rates of change. Consideration was also given to the impact of the expected behaviour of lease holders on reforestation potential, given different contractual obligations.

## 2.0 METHODS

### Preparation

The Ministry of Lands in Prince George and Dawson Creek provided data describing lease numbers, lot numbers, total lease area and total area of arable land within each lease. Lease holders were not identified and the date of issuance for each lease was not requested. Following the collection of this data, lease lot numbers were identified on 1:250,000 scale maps and where boundaries were unclear, on 1:20,000 scale maps. The most recent 1:60,000 and 1:70,000 scale aerial photographs available (1984 and '88 in Prince George, '84 and '86 in Dawson Creek) were then used to classify all lease lands into the following primary land use categories:

**Crop or pasture:** an area cleared of vegetation and used specifically for the production of agricultural crops or for livestock grazing.

**Merchantable timber:** an area consisting of commercially acceptable species such as spruce, pine, fir, aspen and cottonwood with a minimum of 100 m<sup>3</sup> ha<sup>-1</sup> of merchantable (pole size) timber.

**Non-productive:** areas such as swamps, gravel pits, areas cleared around houses and outbuildings which will not produce a forest but may, in a few instances produce an agricultural crop (i.e. wetland conversion).

**Non-merchantable timber:** areas of non-commercial cover dominated by willow, alder, dogwood, etc., or those areas that have been logged and/or cleared and left for initiation of an early successional sequence progressing toward the growth of a new forest.

The latter category was presumed to have potential for reforestation. Areas within each category were determined using a dot grid (1 dot per 6 or 7 hectares) with the total area for each lease being made equal to that described by the Ministry of Lands.

### Field observations

Lease lands were stratified by year of photographic coverage and selected, with emphasis on the non-merchantable category, for observation in the field during June and July, 1991. The kind of data collected is described on the field form in Appendix 1, however the primary purpose of the exercise was to update the photographic estimates of areas contained within each primary land use category; ocular estimates of the actual areas within each category were made in the field relative to those delineated on, and estimated from, the photographs.

While in the field, non-merchantable types were further characterized using ocular means as to whether they were sufficiently restocked (SR) or not (NSR), and if the latter, the treatments necessary to produce an SR plantation were also described.

### Analyses: statistics

The magnitude and direction of change in area (hectares) of each primary land use category from the time of photography to the time of observation in the field was calculated for the Dawson Creek SSA as follows:

$$D_{ij} = \text{The sum of } (F_{ijk} - P_{ijk}) \text{ for } k = 1 \dots n \quad \text{Equation (1)}$$

where:

$D_{ij}$  was the total difference in area observed in land use category "j", within aerial photographic year "i" for "k" equals "1 . . . n" leases.

$F_{ijk}$  was the area observed in the field in category "j", lease "k".

$P_{ijk}$  was the area observed in photographs in category "j", lease "k".

The difference in area for each category was then expressed as a percentage (% $D_{ij}$ ) of the total lease area ( $F_i$ ) observed in the field as follows:

$$\%D_{ij} = D_{ij} * F_i^{-1} * 100 \quad \text{Equation (2)}$$

This percentage was used to estimate the actual total area ( $AT_{ij}$ ) in land use category "j", for all lease lands with photographic coverage dating back to year "i" as follows:

$$AT_{ij} = T_i * \%D_{ij} * 100^{-1} + HT_{ij} \quad \text{Equation (3)}$$

where:

$HT_{ij}$  was the "historically observed" total area of land (from the photographs dating back to year "i" estimated to be in category "j" for all lease lands.

The actual (1991) total area ( $AT_j$ ) in land use category "j" in the Dawson Creek SSA without regard to year of photograph was then calculated as follows:

$$AT_j = \text{The sum of all } AT_{ij} \text{ for } i = 1 \dots p \text{ photographic years.} \quad \text{Equation (4)}$$

For the Prince George SSA there were only two field samples representing those leases covered by 1984 photography - an insufficient number to provide any kind of reliable estimate for actual areas within a given primary land use category (13 out of a total of 100 leases were viewed with 1984 photography). As a consequence, the differences between areas described on the right hand side (RHS) of equation (1) for each lease were divided by the number of years since the photographs were taken, i.e. 7 years for the two samples with 1984 photography and 3 years for the remaining samples with photographic coverage from 1988 (hence changes were expressed in terms of hectares per year since the time of aerial photography). Equation (2) was then modified by multiplying the RHS of the equation by 7 or 3 years to reflect the different

total percentage changes in land use category "j" relative to the 1<sup>st</sup> year of photography. Equations 3 and 4 were applied as described above.

Standard errors (SE's) for estimates were calculated based on the paired field and photographic samples according to procedures outlined in Steel and Torrie (1960) and using finite population correction factors. These SE's were used in estimating 95% confidence intervals. SE's for the rate of change figures, used with respect to the Prince George data, were multiplied by the number of years since photography (7 and 3) and weighted in proportion to the area of land within each (photographic year) strata. "t" values were calculated to test the hypothesis,  $H_0$ : that the mean changes in each of the land use categories between the date of photography and the time of observation were not significantly different from zero. "t" values were also estimated with the Dawson Creek data to determine,  $H_0$ : if the mean rate of change in the various land use categories were the same for leases photographed in two different years (1984, 1986). Sample variances were tested using the "F" test to determine the proper procedure for pooling of variances (after Steel and Torrie, 1960) prior to conducting the latter "t" test. The latter "t" test was used to verify the acceptability of using the mean rate of change in land use categories to calculate the 1991 land use patterns given two different years of photography within the Prince George SSA.

### **Analyses: reforestation treatments**

Once the 1991 areas within each primary land use category were estimated, the non-merchantable class was further subdivided into one of the following groups based on field observations:

**Sufficiently restocked (SR):** those areas sufficiently restocked with acceptable coniferous species according to Ministry of Forests standards.

**Treatment regime 1:** areas requiring "raw planting" with or without weed control (These were usually areas of recently abandoned crop land; therefore the vegetation cover was generally low.).

**Treatment regime 2:** areas requiring rehabilitation through winter shearing, piling and planting the following spring (These areas generally consisted of a heavy aspen cover and/or other woody species such as alder, willow, blueberry, etc.).

**Treatment regime 3:** areas requiring mounding and planting (These areas tended to be fairly wet with imperfect to poor soil drainage and also to have a high cover of willow and to a lesser extent, cottonwood and aspen. Deep organic layers contribute to low soil temperatures and reduce the number of acceptable plantable spots. Mounding improves soil temperature, provides a raised microsite with improved drainage and thereby produces better quality planting spots with a greater frequency than would occur naturally.).

The area of non-merchantable lands were allocated to the above mentioned groups for all lease lands in proportion to those observed in the field. The management objective for applying such regimes is to produce sufficiently restocked, free growing plantations in accordance with Ministry of Forests Regional Silviculture Standard Guidelines.

Assuming the following per hectare costs:

|                             |       |
|-----------------------------|-------|
| Winter shear/pile and burn: | \$600 |
| Mound with backhoe:         | 900   |
| Planting:                   | 700   |
| Weeding:                    | 400   |

the average cost per hectare for implementing regimes 1,2 and 3 were estimated to be 1100, 1300 and 1600 dollars respectively. Total costs for reforesting areas of lease land within each SSA were also estimated.

### **Analyses: impacts of cultivation requirements**

A final analysis was done to determine the expected behaviour of lessees given the requirements that either 25% or 80% of the arable land must be cultivated. Using the field observations, each lease was reviewed to determine if the proportion of crop land was greater than or equal to the minimum requirement; if it was not, then the area of non-merchantable land needed under cultivation to meet the minimum requirement was calculated as a "best case" scenario (i.e. estimation of a minimum area with potential for reforestation). A "worst case" scenario was described when the area of merchantable timber was converted to crop land before considering the use of non-merchantable types to meet minimums (i.e. estimation of a maximum area with potential for reforestation). Hence, the impact on the area with potential for reforestation of two scenario's in combination with two alternative cultivation requirements (representing the range of agricultural lease land policies in effect over the last 12 or more years) could be assessed using the field sample data and then extrapolated to represent the entire lease area within each SSA.

With reference to the latter analysis, a direct connection (on the ground) was never established between arable/non-arable designations and the primary land use categories. For example, it was not determined whether SR areas occurred on arable, non-arable or both portions of the landscape within a given lease. However, "crop or pasture" land clearly belonged to the arable portion of the landscape, while "non-productive" areas were assumed to belong to the non-arable portion.

### 3.0 RESULTS

Table 1 provides a general description of the lease lands within the Prince George and Dawson Creek SSA's. In the Prince George SSA, 44 (44%) of the leases were observed in the field or, alternatively, 3,806 hectares (41%). In Dawson Creek the analogous statistics were 51 leases (25%) or 7,503 hectares (26%).

**Table 1. A description of all lease lands and those sampled within each SSA.**

| SSA           | YEAR OF<br>PHOTOGRAPHY | AREA (HECTARES) |        |            | No. OF LEASES |         |
|---------------|------------------------|-----------------|--------|------------|---------------|---------|
|               |                        | TOTAL           | ARABLE | NON-ARABLE | TOTAL         | SAMPLED |
| DAWSON CREEK  |                        |                 |        |            |               |         |
|               | 1984                   | 7,799           | 6,032  | 1,767      | 77            | 20      |
|               | 1986                   | 21,356          | 17,838 | 3,518      | 126           | 31      |
|               | 1984, '86              | 29,155          | 23,870 | 5,285      | 203           | 51      |
| PRINCE GEORGE |                        |                 |        |            |               |         |
|               | 1984                   | 1,421           | 963    | 458        | 13            | 2       |
|               | 1988                   | 7,937           | 6,289  | 1,648      | 87            | 42      |
|               | 1984, '88              | 9,358           | 7,252  | 2,106      | 100           | 44      |
| ALL           | ALL                    | 38,513          | 31,122 | 7,391      | 303           | 95      |

Table 2 describes the changes in land use for each SSA since the time of photography. The area of non-merchantable timber has increased significantly in both SSA's, with a corresponding decrease in merchantable timber. Crop and pasture has remained constant or decreased slightly in the Dawson Creek SSA while little change appears in the Prince George area. No substantial changes are apparent in the non-productive land areas.

**Table 2. Changes in land use in agricultural Crown lease lands within the Dawson Creek and Prince George SSA's.** 95% confidence intervals are presented in parentheses for the 1991 figures. The remaining figures represent a census of all active 1991 lease lands as of the date (year) of aerial photography. \*\*\* is used to indicate, with 95% certainty, that the 1991 figures are different from those estimated in the census.

| SSA           | YEAR      | LAND USE CLASSIFICATION (HECTARES) |                        |                |                            |
|---------------|-----------|------------------------------------|------------------------|----------------|----------------------------|
|               |           | CROP                               | MERCHANTABLE<br>TIMBER | NON-PRODUCTIVE | NON-MERCHANTABLE<br>TIMBER |
| DAWSON CREEK  |           |                                    |                        |                |                            |
|               | 1984      | 1,726                              | 4,079                  | 533            | 1,461                      |
|               | 1991      | 1,440<br>(916)                     | 3,248 ***<br>(502)     | 228<br>(418)   | 2,883 ***<br>(1,139)       |
|               | 1986      | 5,732                              | 9,079                  | 2,063          | 4,482                      |
|               | 1991      | 4,904 ***<br>(725)                 | 8,184 ***<br>(239)     | 2,200<br>(149) | 6,068 ***<br>(769)         |
|               | 1984, '86 | 7,458                              | 13,158                 | 2,596          | 5,943                      |
|               | 1991      | 6,344<br>(1,641)                   | 11,432 ***<br>(741)    | 2,428<br>(567) | 8,951 ***<br>(1,908)       |
| PRINCE GEORGE |           |                                    |                        |                |                            |
|               | 1984      | 33                                 | 1,239                  | 65             | 84                         |
|               | 1988      | 1,955                              | 2,857                  | 323            | 2,802                      |
|               | 1984, '88 | 1,988                              | 4,096                  | 388            | 2,886                      |
|               | 1991      | 2,081<br>(423)                     | 3,522<br>(646)         | 238<br>(220)   | 3,523 ***<br>(633)         |

Table 3 describes the per annum rate of a change in land use between the time of aerial photography and field observations. The percentages are the net change in area for a particular land use category, divided by the total area of lease land and also divided by the number of years between photographic and field observations, multiplied by 100. The merchantable and non-merchantable timber categories have changed significantly, while non-productive and crop land use appears to have remained stable. The Prince George SSA figures were used in estimating the areas shown in Table 2, but such was not the case for Dawson Creek.

**Table 3. The per annum rate of change in land use between the time of aerial photography and field observations within each SSA.** 95% confidence intervals are provided in parentheses. The probabilities that the rates are significantly different from zero are 95% (\*\*\*), 90% (\*\*) and 80% (\*) or not significant.

| SSA           | YEAR | RATE OF CHANGE IN LAND USE (% hectares per year) |                        |                   |                            |
|---------------|------|--------------------------------------------------|------------------------|-------------------|----------------------------|
|               |      | CROP                                             | MERCHANTABLE<br>TIMBER | NON-PRODUCTIVE    | NON-MERCHANTABLE<br>TIMBER |
| DAWSON CREEK  |      |                                                  |                        |                   |                            |
|               |      | -0.68<br>(2.50)                                  | -1.11 ***<br>(1.04)    | -0.14<br>(0.86)   | 1.92 *<br>(2.92)           |
| PRINCE GEORGE |      |                                                  |                        |                   |                            |
|               |      | 0.27<br>(1.25)                                   | -1.70 **<br>(1.92)     | -0.46 *<br>(0.65) | 1.89 ***<br>(1.88)         |

Table 4 describes the rates of change in each land use category by year of photography for the Dawson Creek SSA. For each category, the rates of change with respect to different years of photography were compared to verify the acceptability of calculating a single rate of change figure using both the 1984 and '88 years of photography within the Prince George SSA. The results shown in Table 4 suggest that it would have been preferable to have enough samples to estimate the changes independently for each year of photography.

Table 5 describes the non-merchantable category in terms of stocked, or not sufficiently restocked and requiring one of three treatment regimes to meet Ministry of Forests' Silviculture standards.

**Table 4**      **The per annum rate of change in land use following aerial photography of lease lands within the Dawson Creek SSA in 1984 and 1986.** The probability of there being a significant difference between the rates of change since 1984 and 1986 are either 80 percent (\*) or not significant (ns).

| SSA YEAR     | RATE OF CHANGE IN LAND USE (% hectares per year) |                        |                |                            |
|--------------|--------------------------------------------------|------------------------|----------------|----------------------------|
|              | CROP                                             | MERCHANTABLE<br>TIMBER | NON-PRODUCTIVE | NON-MERCHANTABLE<br>TIMBER |
| DAWSON CREEK |                                                  |                        |                |                            |
| 1984         | 0.52                                             | -1.52                  | -0.56          | 2.60                       |
| 1986         | 0.78                                             | -0.84                  | 0.13           | 1.49                       |
|              | ns                                               | *                      | *              | ns                         |

**Table 5. The subdivision of 1991 non-merchantable types into areas by treatment regime.** Percent of total non-merchantable area is provided in parentheses.

| SSA           | SUFFICIENTLY<br>RESTOCKED | NOT SUFFICIENTLY RESTOCKED<br>TREATMENT REGIME (hectares) |               |            |
|---------------|---------------------------|-----------------------------------------------------------|---------------|------------|
|               |                           | 1                                                         | 2             | 3          |
| DAWSON CREEK  |                           |                                                           |               |            |
|               | 87<br>(1)                 | 3,818<br>(43)                                             | 4,647<br>(52) | 399<br>(4) |
| PRINCE GEORGE |                           |                                                           |               |            |
|               | 602<br>(17)               | 1,582<br>(45)                                             | 1,339<br>(38) | 0<br>(0)   |

Table 6 describes the cost of completely reforesting the non-merchantable and not sufficiently restocked types (Table 5) to meet Ministry of Forests' free growing standards.

Table 7 describes the area that would be available for reforestation after lessees had met the obligation to cultivate 25% or 80% of their arable leased lands. In the Dawson Creek SSA, 2,604 hectares of additional land would need to be put into agricultural use to meet the 25% requirement, but only 2,353 of those hectares could come from non-merchantable types - the remainder must come from the merchantable timber category. When 2,353 hectares are subtracted from the total area of NSR (0% in Table 7), an estimate of the minimum area with potential for reforestation is derived. An alternative scenario is to assume that arable lands will be allocated to agricultural production, firstly by using the merchantable timber category, and secondly by using the remainder from non-merchantable SR, and lastly NSR, types; this strategy leads to an estimate of the maximum area with potential for reforestation, given a minimum agricultural use requirement.

**Table 6. The cost of reforesting non-merchantable types 1 (1100 \$ ha<sup>-1</sup>), 2 (1300 \$ ha<sup>-1</sup>) and 3 (1600 \$ ha<sup>-1</sup>) described in Table 5.**

| SSA           | TOTAL<br>COST | NOT SUFFICIENTLY RESTOCKED<br>TREATMENT REGIME (thousands of \$) |         |       |
|---------------|---------------|------------------------------------------------------------------|---------|-------|
|               |               | 1                                                                | 2       | 3     |
| DAWSON CREEK  | 10,879.3      | 4,199.8                                                          | 6,041.1 | 638.4 |
| PRINCE GEORGE | 3,480.9       | 1,740.2                                                          | 1,740.7 | 0.0   |
| ALL           | 14,360.2      | 5,940.0                                                          | 7,781.8 | 638.4 |

**Table 7. The maximum and minimum area of land (hectares) categorized as non-merchantable that would have potential for reforestation given the requirement that 0, 25, or 80 percent of arable lease land must be under intensive grazing or cultivation.** See the Methods section (2.0, Analyses: impacts of cultivation requirements) for a description of how these figures were derived.

| SSA           | TOTAL AREA | LAND AREA WITH REFORESTATION POTENTIAL GIVEN THREE ARABLE LAND REQUIREMENTS |       |       |       |     |
|---------------|------------|-----------------------------------------------------------------------------|-------|-------|-------|-----|
|               |            | 0%                                                                          | 25%   |       | 80%   |     |
|               |            |                                                                             | Max   | Min   | Max   | Min |
| DAWSON CREEK  | 8,951      | 8,864                                                                       | 8,530 | 6,511 | 4,025 | 0   |
| PRINCE GEORGE | 3,523      | 2,921                                                                       | 2,921 | 2,299 | 1,555 | 113 |

With further reference to Table 7, it is estimated that a total of 8,948 hectares or 37% of the arable land will be put to agricultural use in the Dawson Creek SSA if all lessees meet the 25% requirement; this is assuming that there will be no decline in the extent of agricultural land use on leases that have already met or exceeded the minimum requirement. To meet the 80% land use requirement, 19,899 hectares or 83% of the arable land would need to be put into production. For the Prince George SSA, the analogous figures are 2,725 hectares or 38% of the arable land to meet the 25% requirement, and 5,774 hectares or 80% to meet the 80% requirement.

The cost of reforestation (1227 \$ ha<sup>-1</sup>) in the Dawson Creek SSA would be between 8.0 and 10.5 million dollars after having met the 25% requirement described in Table 7 above and from 0 to 4.9 million for the 80% requirement. In the Prince George SSA the analogous costs (1192 \$ ha<sup>-1</sup>) would be 2.7 to 3.5 million (25%) and 0.1 to 1.9 million (80%) dollars.

#### 4.0 DISCUSSION and CONCLUSION

The objective of this study was to determine the potential for reforestation on agricultural lease lands within the Dawson Creek and Prince George Special Sale Areas. We were able to draw conclusions with respect to the current land use status as described in Table 5. However, this information did not provide any indication of how lessees will manage their agricultural lease lands in the future. In attempting to evaluate the future behaviour of lessees, we considered the impact of contractual obligations requiring that a certain proportion of arable land be put into agricultural land use. However, without knowing the proportions pertaining to each and every lease agreement (related to the issuance date), it is difficult to derive a specific number of hectares with potential for reforestation with any

degree of confidence. A maximum figure for each SSA is described in Table 7 under the 0% scenario, the area as of June 1991. Table 6 describes the 1991 cost of reforesting the maximum area with potential for reforestation.

The methods used in this study could have been improved:

- The changes in land use from one category to the next could have been more specifically identified. Trends in changes in land use would have been more apparent had this procedure been used.
- A specific relationship could have been established between land use categories and the arable/non-arable portions of the landscape.
- Aspen should have been recognized as an acceptable crop species contributing towards SR lands where overall densities were sufficient (e.g. 5000 stems per hectare or more) and the area of ground covered was of a manageable size (e.g. 1 hectare or more).

With regard to the last comment, we believe that accounting for aspen would have reduced the potential area for reforestation to a minor extent. Treatment groups 1 and 3 would not have been affected in terms of the amount of area observed within these. It seems that in most instances where aspen did occur, clumps of acceptable density were too widely dispersed, or the densities were well below the minimums established by the Ministry of Forests.

The major conclusions relating to the results of this study are presented in the Executive Summary and are not reiterated here.

The methods used in this study have considerable potential for monitoring of land use changes on both Private and Public lands. The process could be automated using digital mapping procedures (second order stereoscopes) and incorporated into a Geographic Information System format. The information would be useful to policy makers concerned about influencing the behaviour of land holders for the purpose of maintaining or improving the economy and environment. Our study cost \$25,000 or \$0.65 per hectare, which could be reduced substantially if it were automated and applied routinely. Therefore, the methods used herein should be considered (by the Ministry of Lands) for more routine and broader applications.

## 6.0 REFERENCES

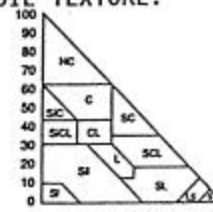
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## APPENDIX

### THE FIELD DATA COLLECTION FORMAT

# AGRICULTURAL LEASE ASSESSMENT

|                                           |                                                                                                            |                                                                                                                                                                                                                                                                    |                       |                          |              |  |  |     |     |     |
|-------------------------------------------|------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|--------------------------|--------------|--|--|-----|-----|-----|
| <b>ADMINISTRATION</b>                     | JOB NO: 910240    DATE: _____    EXAMINER: _____                                                           |                                                                                                                                                                                                                                                                    |                       |                          |              |  |  |     |     |     |
| LEASE/LOT NO.: _____                      |                                                                                                            | LOCATION: _____                                                                                                                                                                                                                                                    |                       |                          |              |  |  |     |     |     |
| SSA: P.G. F.S.J.    PHOTO NO.: _____      |                                                                                                            | AREA: _____                                                                                                                                                                                                                                                        |                       |                          |              |  |  |     |     |     |
| <b>SITE</b>                               | ECOSYSTEM CLASSIFICATION: _____                                                                            |                                                                                                                                                                                                                                                                    |                       |                          |              |  |  |     |     |     |
| SLOPE: _____                              |                                                                                                            | SLOPE COMPLEXITY: Simple    Complex                                                                                                                                                                                                                                |                       |                          |              |  |  |     |     |     |
| ASPECT: _____                             |                                                                                                            | ARABLE: _____                                                                                                                                                                                                                                                      |                       |                          |              |  |  |     |     |     |
|                                           |                                                                                                            | NON ARABLE: _____                                                                                                                                                                                                                                                  |                       |                          |              |  |  |     |     |     |
| <b>SOIL/TERRAIN</b><br>(Upper 20 cm)      | <b>SOIL TEXTURE:</b><br> | <b>COARSE FRAGMENTS:</b><br><table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td colspan="3">Total = 100%</td> </tr> <tr> <td style="width: 33%;">GR%</td> <td style="width: 33%;">CB%</td> <td style="width: 33%;">ST%</td> </tr> </table> |                       |                          | Total = 100% |  |  | GR% | CB% | ST% |
| Total = 100%                              |                                                                                                            |                                                                                                                                                                                                                                                                    |                       |                          |              |  |  |     |     |     |
| GR%                                       | CB%                                                                                                        | ST%                                                                                                                                                                                                                                                                |                       |                          |              |  |  |     |     |     |
| <b>TERRAIN CLASSIFICATION:</b>            |                                                                                                            |                                                                                                                                                                                                                                                                    |                       |                          |              |  |  |     |     |     |
| SOIL ORDER: _____                         |                                                                                                            | HUMUS FORM: Mor    Moder    Mull                                                                                                                                                                                                                                   |                       |                          |              |  |  |     |     |     |
| DRAINAGE:    R    W    MW    I    P    VP |                                                                                                            | ROOTING DEPTH: >20cm    <20cm                                                                                                                                                                                                                                      |                       |                          |              |  |  |     |     |     |
| <b>COMMENTS</b>                           |                                                                                                            |                                                                                                                                                                                                                                                                    |                       |                          |              |  |  |     |     |     |
| <b>REQUIRED TREATMENT:</b>                |                                                                                                            |                                                                                                                                                                                                                                                                    |                       |                          |              |  |  |     |     |     |
| <b>LAND USE</b>                           | <b>CROP &amp; PASTURE</b>                                                                                  | <b>MERCH. TIMBER</b>                                                                                                                                                                                                                                               | <b>NON-PRODUCTIVE</b> | <b>NON-MERCH. TIMBER</b> |              |  |  |     |     |     |
| Timber Label:                             | Photo                                                                                                      |                                                                                                                                                                                                                                                                    |                       | SR/NSR    FG/NFG         |              |  |  |     |     |     |
| Non-Merchantable Label:                   | Field                                                                                                      |                                                                                                                                                                                                                                                                    |                       | Other:                   |              |  |  |     |     |     |
| <b>GRAZING</b>                            | Y / N                                                                                                      | Y / N                                                                                                                                                                                                                                                              | Y / N                 | Y / N                    |              |  |  |     |     |     |