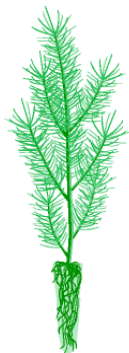
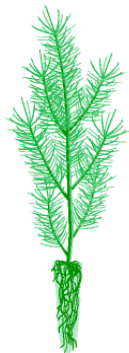


# Planting Quality Inspection

**Guide to Completing the FS 704**

Effective April 2012



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Effective April 2012



Ministry of Forests, Lands and Natural Resource  
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## INTRODUCTION

Planting quality inspections are carried out to ensure that planting contractors meet the agreed-upon contract specifications, and to determine contractor payment for each planting unit. These inspection procedures standardize the process and thereby enable a fair and equitable evaluation.

This field booklet is designed to assist planters, planting contractors, and inspectors in understanding the planting quality inspection procedure. It does not replace the planting chapter of the Ministry's *Silviculture Manual*, which should be consulted for further details.

These procedures are to be followed on planting projects funded by the Ministry of Forests, Lands and Natural Resource Operations, including BC Timber Sales. On planting projects funded by the forest industry, the planting quality inspection procedures may differ.

## **CONTRACTING SYSTEM**

Most planting takes place during spring and summer, but the majority of contracts are tendered the previous fall. In general, contracts funded by the Ministry of Forests, Lands and Natural Resource Operations, including BC Timber Sales are advertised on the BC Bid website, however, planting contracts under the Forests For Tomorrow and Land Based Investment Programs may be exclusively advertised on the Program Administrator's website.

Planting contract tenders may require contractors to attend a mandatory information meeting, in the office, field or both, prior to submitting a tender. At the very least, contract coordinators should schedule a mandatory office meeting in order to provide details on contract specifications and expectations. Contracts are bid either by the tree, by the hectare, or as a lump sum for the whole unit. Contract payment is based on the outcome of the planting quality inspection.

## **PRE-WORK CONFERENCE**

The contract coordinator and planting contractor must meet prior to the commencement of planting to discuss contract specifications. If the contract coordinator will not be doing the quality inspections, the inspector must be present at the pre-work conference. At the pre-work, planting quality is defined and acceptable limits are set for faults such as air pockets, shallow planting or inadequate planting spot preparation. Since what constitutes an acceptable microsite varies from site to site, it is important that this be clearly defined for each planting, unit both in the contract and at the pre-work. The expectations of both the planting inspector and the contractor must be made clear before the work progress plan is signed and planting begins, especially on sites with difficult access (e.g., helicopter access).

A detailed example of a pre-work conference checklist is provided in Appendix 3 of the planting chapter in the *Silviculture Manual*.

## **CONTRACT REQUIREMENTS**

Once notified of the starting date, the contractor will commence work according to the provisions outlined in the notice to commence. Failure to commence work on time may result in contract cancellation. The contractor will maintain a high level of planting quality, achieve planting densities within specified limits, complete the contract on time, and abide by all other contract requirements. The contractor is also responsible for completing internal quality inspections and must provide proof of such if requested by the contract coordinator or inspector.

During planting, the contractor must ensure that unplanted seedlings are kept in good condition. Planting stock must always be kept in a suitably cool location. Seedlings are alive and must be treated with care.

The FS 704 Planting Inspection Report has a section for recording stock transportation conditions, on-site storage, and other contract requirements regarding handling of seedlings. Payment reductions for contravention of these requirements are stated in Schedule A (FS767A) of the Planting Contract.

The selection of microsite by the planter is critical. Microsite selection will have a greater effect on seedling survival and growth than spacing so it is important that the contractor and inspector have agreed on what defines an acceptable microsite for each species prior to the start of planting.

The prescribed contract spacing and the minimum inter-tree spacing (minimum spacing) are specified in Schedule B of the contract. The planting density establishes the maximum number of plantable spots per plot, as shown in the table in Appendix 1.

<p>When determining the minimum inter-tree spacing, the contract coordinator must consider that minimum inter-tree spacing must be greater than or equal to that specified in the site plan for the trees to be tallied at the regeneration delay or free growing assessment.</p>
---

Most contracts state a minimum acceptable (well spaced) density. Ordinarily, the minimum acceptable density should be less than or equal to the lower confidence limit of the number of plantable spots determined by a plantability survey. Where there are inspection plots below the minimum acceptable density, corrective action, such as a re-work of the low density area, may be required. Non-payment or initiation of procedures leading to contract cancellation may occur depending on the seriousness and reasons for the problem.

Prior to imposing a penalty for not meeting the minimum acceptable density requirement, the availability of plantable spots in the low density area must be confirmed by the inspector, and the area must be definable as specified at the pre-work conference.

Contract specifications are designed to ensure that seedlings are planted with the best chance for survival and maximum growth. The planting quality inspection system evaluates compliance with these contract standards.

## **SURVEY METHODS**

Inspections are based on systematic sampling methods. The level of statistical error recommended for planting quality inspection surveys is 10% or less for trees planted, and 5% or less for planting quality. The survey and plot assessment methodologies described in this guide work very well when planting densities are greater than 800 stems per hectare (sph). When planting densities are lower, it becomes more difficult to accurately assess planting quality and density, especially if the inspection plot size is not increased as recommended.

A sample of one 3.99m radius (50 m<sup>2</sup>) plot per hectare is usually sufficient to meet the statistical error for units larger than 20 hectares. On smaller units sample accuracy is improved by increasing the number of plots per hectare to a maximum of four. Small planting units with similar planting prescriptions may be combined into a single payment unit.



While the number of plots on any payment unit should never be less than 20, it must be sufficient to address the variability in density and quality present on the unit(s), and meet the statistical error.

When planting densities are 800 sph and lower, the use of a 5.64 m radius (100 m<sup>2</sup>) sample plot is **strongly recommended**. Using a larger plot size will increase the number of trees sampled in each plot and help address the higher variability in density that generally characterizes low density planting blocks. Because more planted trees are sampled in each plot, the effect of excess trees on the excess percentage may also be reduced. The same plot size must be used throughout the survey of the entire unit. With the larger plot size, the number of plots may be reduced. A minimum of 15 plots per payment unit is recommended but this will depend on variability and meeting statistical error.

Establishment of density plots, that tally only trees planted, is recommended if an acceptable sampling error has been achieved for planting quality but not for number of trees planted.

The FS 704 plot data can often be used to demonstrate that regeneration delay has been met. For this to happen, certain conditions must be met as defined in the *Silviculture Survey Procedures Manual*, Section 9.4.3. Even if these conditions aren't met, it may still be practical to collect the additional data during the planting quality inspection in order to declare regeneration delay as being met on completion of planting.

The primary goal of the planting quality inspection is to determine planting quality and payment due to the planting contractor. When combining the planting quality inspection with the regeneration delay survey on low planting density units, the contract coordinator must consider the trade-off between using a larger plot size (5.64 m) to improve the accuracy of the planting quality inspection versus using the standard 3.99 m radius plot to increase the efficiency of the regeneration delay survey.

## ASSESSING THE PLOT

The following five main steps outline the basic process of locating and assessing a planting quality inspection plot. Planting quality inspection plots should be established for monitoring purposes as soon as planting starts in order to address problems with the contractor as they occur. Payment plots should be completed as soon as the contractor provides notification that the block is complete.

Example plots beginning on page 9 further clarify the process and explain how the inspector assesses certain situations including; site prepared ground, unplantable ground, close and wide spacing and acceptable naturals.

Plot No.	No. of Trees Planted	Plantable Spots	Excess Trees	Credit Satis. Planted Trees	Unsatis. Planted Trees & Code	Comments/ Instructions
Step1	Step 2	Step 3	Step 3	Step 4	Step 4	Step 5

### Step 1: Plot Location

Plot lines begin from an identifiable point of commencement (POC) on the planting unit. Plots are established to meet the required sampling intensity. A pre-determined grid pattern allows both full coverage of the area and maintains the requirement for random plot location.

Sample plots must be located within the net area to be reforested (NAR). Roads and landings must not be sampled unless they have been rehabilitated or site prepared. It is important to sample the entire NAR, including timber edges, and slash or brush areas, to avoid biasing the results. In planting units with significant timber edge (e.g., irregular boundaries, retention areas) it becomes even more important to sample the entire NAR. In these situations, the inspector must also consider whether the sampling intensity is adequate to address the increased variability.

### Step 2: Number of Trees Planted

Once plot center has been located, the inspector establishes a 3.99 m or 5.64 m radius plot. The inspector flags trees inside the plot and does a tree count while looking for obvious problems. The number of trees planted is tallied.

### **Step 3: Plantable Spots**

A Plantable Spot is defined as a planting location that is both an acceptable microsite and correctly spaced from other planted or acceptable natural trees.

The maximum plantable spots per plot (M) is derived from the planting prescription and is equal to the planting density divided by the plot multiplier. M is also specified in the planting contract.

The number of trees planted is used as the starting point in determining the number of plantable spots. Once the number of trees is tallied, spacing of the trees is examined to determine if there is wide spacing, close spacing in relation to both planted trees and acceptable naturals, or missed plantable spots, ignoring the influence of the plot boundary. If all trees are planted within the contract spacing latitude, the number of plantable spots generally equals the number of trees planted to M. If there are spacing faults, the number of plantable spots will be either higher or lower than the number of trees planted. If the number of trees planted exceeds the plantable spots, excess trees are tallied.

### **Step 4: Credit Satisfactory Planted Trees**

Despite the obvious nature of spacing faults, the most important aspect of inspecting planting quality is the assessment of how the trees were planted and on what microsites. These factors are the most critical to the survival and growth of the plantation.

The number of credit satisfactory planted trees, the number of unsatisfactory planted trees, and fault code(s) are tallied.

For a planted tree to be credited as satisfactory, it must meet three criteria:

1. Be planted on an acceptable microsite for that species;
2. Be properly planted and not damaged in the process; and
3. Meet the spacing requirements of the contract within the latitude allowed.

In order to determine if trees are properly planted on acceptable microsites, and because most faults occur below ground, the inspector must excavate a sample of seedlings within the plot (recommended Root Excavation procedures are described in the glossary). Initially, all trees in each plot are excavated and carefully examined. If more than two planting faults are consistently recorded in each plot, the inspector will continue to excavate all trees in each plot. Otherwise, excavation of a minimum of two trees in each plot is generally sufficient to ensure that quality standards are being maintained.

When tallying the plot results, the number of unsatisfactory, satisfactory, and excess must equal the number of planted trees. This must be checked at each plot and with unit totals. Where the number of trees planted exceeds the number of plantable spots, the difference between the two must equal the number of excess for that plot. This cannot be checked on a unit basis as plantable spots sometimes exceed trees planted.

There is sometimes more than one way to assess a plot. When this happens, the method that is to the advantage of the contractor is used.

### **Step 5: Comments/Instructions**

Comments on the number of acceptable naturals, unsatisfactory tree fault codes, plot conditions, and instructions of a minor nature to contractors are noted here.

## **PLANTING INSPECTION REPORT**

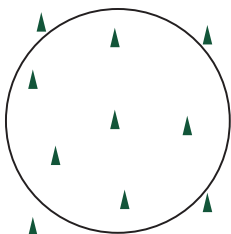
Plot data is recorded and summarized on the Planting Inspection Report (FS 704) (page 33 and 34). An assessment of stock handling practices is also recorded on the Inspection Report. Calculations at the bottom of the form (page 34) produce the planting quality percent and excess results.

## EXAMPLE PLOTS

The plots shown in this booklet are drawn to scale. All examples are based on a target planting density of 1200 trees/hectare with a plot size of 1/200 ha – 3.99 m radius. Contract spacing is 3.1 m with a 1.0 m latitude, giving a minimum spacing of 2.1 m. The maximum allowable plantable spots per plot (M) is 6.

### Normal “No Fault” Plots

#### Plot #1 - 6 Trees



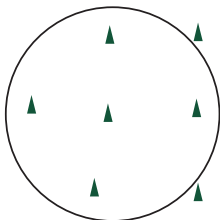
#### ▲ Planted trees

Acceptable naturals?	No
Unplantable ground?	No
Too wide?	No
Too close?	No
Missed plantable spot(s)?	No
Fault trees?	No
M	=6
Plantable spots	=6
Satisfactory trees	=6

Plot No.	No. of Trees Planted	Plantable Spots	Excess Trees	Credit Satis. Planted Trees	Unsatis. Planted Trees & Code	Comments/ Instructions
1	6	6	0	6	0	

All trees are properly planted and within spacing requirements of the contract. This is a normal plot.

## Plot #2 - 5 Trees



### ▲ Planted trees

Acceptable naturals?	No
Unplantable ground?	No
Too wide?	No
Too close?	No
Missed plantable spot(s)?	No
Fault trees?	No
M	=6
Plantable spots	=5
Satisfactory trees	=5

Plot No.	No. of Trees Planted	Plantable Spots	Excess Trees	Credit Satis. Planted Trees	Unsatis. Planted Trees & Code	Comments/ Instructions
2	5	5	0	5	0	

As a result of random spacing, this plot can occur from time to time on any well-planted area.

## Acceptable Naturals/Residuals

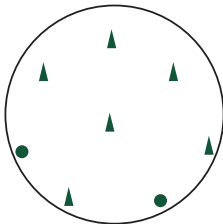
Acceptable naturals may be either coniferous or broadleaved species as defined in the planting contract and at the pre-work conference. They are considered to be the same as planted trees and are allowed the same spacing.

A cluster of naturals will not necessarily have a one-to-one relationship to plantable spots. To determine the number of plantable spots lost to groups of naturals, choose the best acceptable natural and measure from it at contract spacing to identify subsequent acceptable naturals within the plot. The number of plantable spots occupied by acceptable naturals within the plot will equal the number of acceptable naturals that are at least contract spacing from each other.

**This process of determining the number of plantable spots lost to naturals does not preclude the requirement for a planted tree to be at least the minimum spacing from any acceptable natural inside the plot or out.** Trees planted less than the minimum spacing from any acceptable natural will be tallied as fault trees (B1-Too Close) or as excess trees.

When planting around residual trees, contract specifications may require that seedlings be planted outside the drip line of residual trees. Trees planted within the drip line will be tallied as fault trees (B1-Too close) or as excess.

**Plot #3 - Acceptable Naturals**



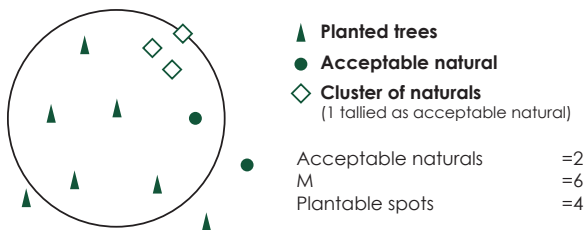
▲ Planted trees  
● Acceptable natural

Acceptable naturals =2  
M =6  
Plantable spots =4

Plot No.	No. of Trees Planted	Plantable Spots	Excess Trees	Credit Satis. Planted Trees	Unsatis. Planted Trees & Code	Comments/ Instructions
3	6	4	2	4	0	2 acceptable naturals

Acceptable naturals require the same spacing as planted trees and will take up a plantable spot.

## Plot #4 - Cluster of Naturals

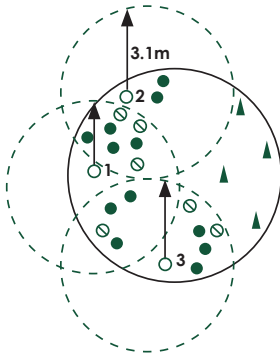


Plot No.	No. of Trees Planted	Plantable Spots	Excess Trees	Credit Satis. Planted Trees	Unsatis. Planted Trees & Code	Comments/ Instructions
4	5	4	1	4	0	2 acceptable naturals

Some clusters of naturals will be closer than contract spacing and will not take up a plantable spot on a 1:1 ratio. To avoid excess trees when planting in and around clusters of naturals, the planter should be instructed to plant at contract spacing if the microsite distribution allows. Alternatively, if spacing closer to the minimum is required for microsite selection, the planter will have to compensate by planting the next tree at greater than contract spacing to avoid excess.



**Plot #5** - Cluster of Naturals - Assessing Plantable Spots



- ▲ **Planted trees**
  - **Acceptable natural**
  - **Acceptable natural  $\geq$  contract spacing**
  - ⊗ **Unacceptable natural due to species/health, etc.**
- Acceptable naturals  $\geq$  contract spacing =3  
 M =6  
 Plantable spots =3

Plot No.	No. of Trees Planted	Plantable Spots	Excess Trees	Credit Satis. Planted Trees	Unsatis. Planted Trees & Code	Comments/ Instructions
5	4	3	1	3	0	3 acceptable naturals

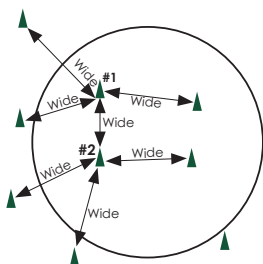
Example Plots #3-#5 are characteristic of low density fill planting units where the use of a 5.64m radius inspection plot is strongly recommended to address variability, increase sample size, and reduce the impact of a few excess trees potentially creating significant excess charges for the contractor.

## Wide Spacing

Planters may space trees widely, on occasion, to move past obstacles or compensate for trees planted at minimum spacing. A single widely spaced tree is not considered a fault, however, a plot is classified as having wide spacing when there is a group of two or more trees, inside the plot, spaced further than contract spacing from each other and all their neighbours, inside or outside the plot.

The inspector ignores the widely spaced trees and re-assesses the plantable spot count for the area of the plot that they occupied, in relation to how they should have been planted; that is, normally spaced between contract and minimum spacing. This number, plus the number of properly spaced planted trees, is recorded as the plantable spots for the plot.

### Plot #6 - Wide Spacing



#### ▲ Planted trees

M = 6  
Plantable spots = 6

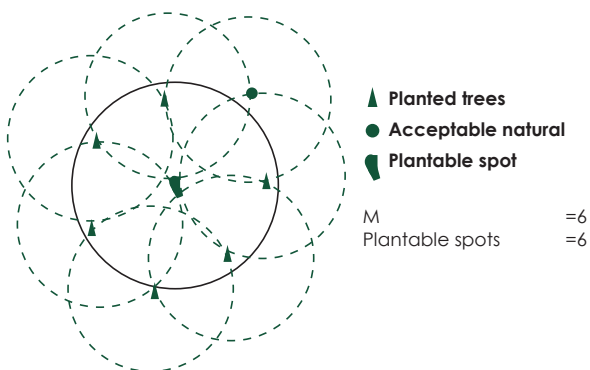
Plot No.	No. of Trees Planted	Plantable Spots	Excess Trees	Credit Satis. Planted Trees	Unsatis. Planted Trees & Code	Comments/Instructions
6	4	6	0	4	0	Wide spacing

The inspector should question if there is any reason to disagree with the planter's spacing. In this example, trees 1 and 2 are too widely spaced. A re-check of plantable spots, ignoring the position of trees 1 and 2, reveals that there are 6 plantable spots.

## Missed Plantable Spots

A missed plantable spot is defined as an acceptable microsite within the plot where a tree could be have been successfully planted, that is at contact spacing from all other planted trees or acceptable naturals (inside or outside the plot). The missed spot is included in the plantable spot count.

### Plot #7 - Missed Plantable Spot

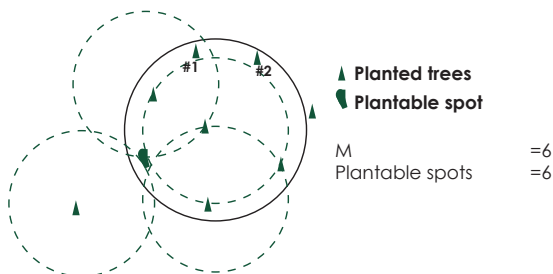


Plot No.	No. of Trees Planted	Plantable Spots	Excess Trees	Credit Satis. Planted Trees	Unsatis. Planted Trees & Code	Comments/ Instructions
7	5	6	0	5	0	Missed plantable spot

## Close Spacing

Close spacing occurs when a tree is planted at less than the minimum spacing from another planted tree or acceptable natural. If this tree can be moved to any available plantable spot within the plot such that there is no other planted tree or acceptable natural (inside or outside the plot) within the spacing latitude of that plantable spot, then the tree is classed as a fault tree and coded B1-Too close. Otherwise, if no plantable spot is available, it is tallied as excess. Any tree classed as "too close" is not on a plantable spot and must be ignored when assessing the number of plantable spots in the plot.

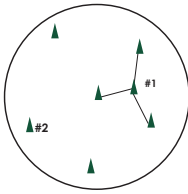
**Plot #8** - Close Spacing - Too Close



Plot No.	No. of Trees Planted	Plantable Spots	Excess Trees	Credit Satis. Planted Trees	Unsatis. Planted Trees & Code	Comments/ Instructions
8	6	6	0	5	1-B1	Too close

Trees #1 and #2 are planted at less than the minimum spacing from each other. Tree #2 will be classified as a fault tree (*B1-Too close*) if it can be moved to a plantable spot within the plot that is within the spacing latitude from all of its neighbours (both inside and outside the plot). If there are no plantable spots within the plot, tree #2 will be classified as excess and the number of plantable spots must be adjusted.

**Plot #9** - Close Spacing - Excess



▲ **Planted trees**

M =6  
Plantable spots =6

Plot No.	No. of Trees Planted	Plantable Spots	Excess Trees	Credit Satis. Planted Trees	Unsatis. Planted Trees & Code	Comments/ Instructions
9	7	6	1	6	0	Excess = B1

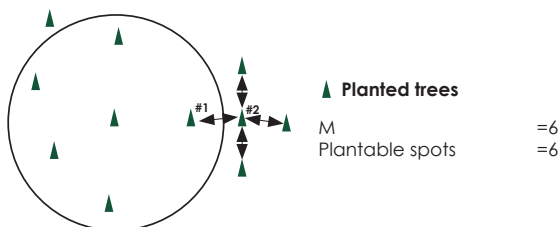
Tree #1 is too close to neighbouring trees. Clearly it is an extra tree that should not have been planted. There is no available plantable spot. Therefore, it is tallied as "Excess."

Note that if tree #1 had an additional planting fault (e.g., C4-Exposed plug) it would still be recorded as excess. However, if tree #1 had no planting fault and tree #2 had the C4 planting fault, tree #2 would be recorded as an unsatisfactorily planted tree. The rule that "the fault tree is considered the one in excess" is only applied when the excess tree has an additional planting fault (see page 22).

## Close Spacing – Inside or Outside the Plot

Two situations can occur when a tree inside the plot is planted at less than minimum spacing from an adjacent tree that is located outside the plot. Plot #10 and #11 illustrate these two different situations.

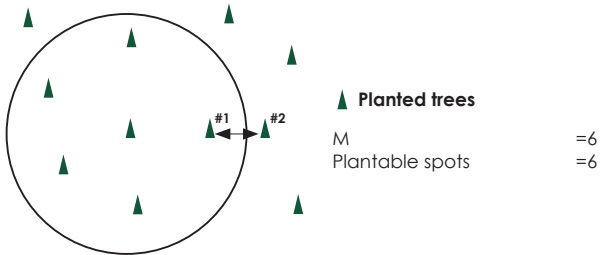
### Plot #10 - Close Spacing - Inside or Outside the Plot



Plot No.	No. of Trees Planted	Plantable Spots	Excess Trees	Credit Satis. Planted Trees	Unsatis. Planted Trees & Code	Comments/ Instructions
10	6	6	0	6	0	

If the tree outside the plot is located at less than minimum spacing from one or more of the surrounding trees outside the plot, this outside tree should not have been planted. In this situation, tree #2 is the fault tree. There is no effect on the plot calculations.

**Plot #11** - Close Spacing - Inside or Outside the Plot



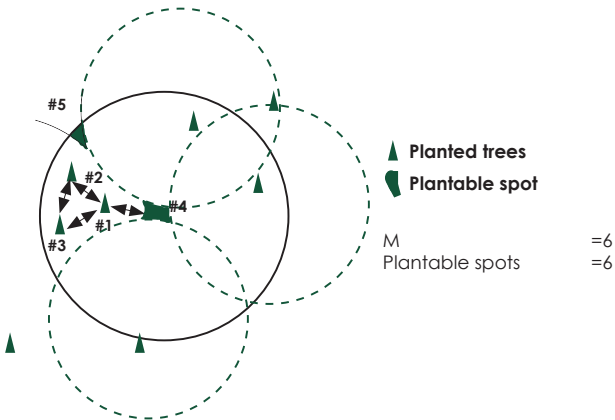
Plot No.	No. of Trees Planted	Plantable Spots	Excess Trees	Credit Satis. Planted Trees	Unsatis. Planted Trees & Code	Comments/ Instructions
11	6	6	0	6	0	

Trees #1 and #2 are less than the minimum spacing from each other. All of the neighbouring trees that surround #1 and #2 are at an acceptable spacing. The removal of either #1 or #2 would solve the problem. When it is not clear which tree is incorrectly spaced, the tree outside the plot is the fault tree.

## Close Spacing – Groups

Situations arise where there is a group of neighbouring trees that are all spaced at less than minimum from one another. In these situations, the inspector begins evaluating each tree in the group to determine if it could have been planted at another point inside the plot where no other planted tree or acceptable natural would be less than minimum spacing from that point. Through this process, the inspector can determine the minimum number of trees that have been planted in the wrong place. If a close tree could have been planted within the spacing latitude, the tree is coded as a fault tree – B1-Too close. If it could not be moved within the spacing latitude, it becomes an excess. The inspector continues to evaluate each tree until the spacing problem is solved (i.e., it has been identified where and how many trees should have been planted in order to meet all of the rules).

**Plot #12** - Close Spacing - Groups





Plot No.	No. of Trees Planted	Plantable Spots	Excess Trees	Credit Satis. Planted Trees	Unsatis. Planted Trees & Code	Comments/ Instructions
12	6	6	0	4	2-B1	

Trees #1, #2, and #3 are all at less than minimum from one another. Trees #1 and #2 could have been planted in the spots marked #4 and #5 to have been considered acceptably spaced. Since they were not, two trees are classified as fault trees, B1 Too close.

### Excess Trees

If more trees are planted than "plantable spots," the extras are coded "excess trees," regardless of any other faults they may have. Once the inspection is complete, excess trees are added and compared to the total trees planted to determine the percent excess for the unit. A 7% tolerance is applied before any charges are calculated for excess (page 36). An exception to this occurs on low density ( $\leq 800$  sph) planting units, where a 10% tolerance is applied before any charges are calculated for excess (page 36).

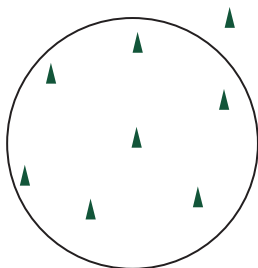
When assessing excess trees, acceptable naturals must be identified. The number of acceptable naturals spaced at contract spacing or greater will reduce the number of plantable spots (see page 10, *Acceptable Naturals/Residuals*).

Planting near or at minimums can create an excess situation where extra trees are planted and the M value for the plot is exceeded. The minimum spacing is designed to facilitate optimum microsite selection and cannot be used all the time.

In plots with excess trees and faults, where the excess tree(s) cannot be identified, the fault tree is considered the one in excess and is recorded as such. A comment is recorded that it was also faulted (e.g., "Excess = C4").

There may be situations where both fault and excess trees are tallied in a plot.

### Plot #13 - Excess Trees



▲ **Planted trees**

M = 6  
Plantable spots = 6

Plot No.	No. of Trees Planted	Plantable Spots	Excess Trees	Credit Satis. Planted Trees	Unsatis. Planted Trees & Code	Comments/ Instructions
13	7	6	1	6	0	

The contract maximum (M) is six plantable spots. There is one excess tree.

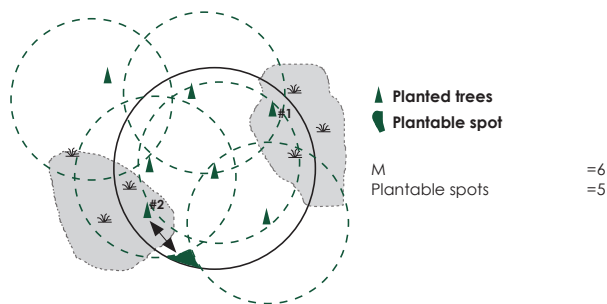
The excess tree cannot be identified. Therefore, if there were any fault trees in the plot, the first one would be tallied as "Excess."

## Unplantable Ground

Unplantable areas reduce the number of plantable spots only when the trees, planted up to the edge of the unplantable area, cannot fully occupy the plot with their combined contract spacing areas.

A tree located on an unacceptable microsite is classed as excess, unless it can be moved to an acceptable plantable spot within the plot such that it fits within the spacing latitude from any other planted tree or acceptable natural. In the latter case it would be coded as a fault tree.

### Plot #14 - Unplantable Ground



Plot No.	No. of Trees Planted	Plantable Spots	Excess Trees	Credit Satis. Planted Trees	Unsatis. Planted Trees & Code	Comments/ Instructions
14	6	5	1	4	1-B6	Excess = B6

Tree #1 is located on an unacceptable microsite and could not be moved to an acceptable microsite within the spacing latitude. It is coded as an excess tree and is noted as "Excess = B6" in the comments section.

Tree #2 could have been placed on an acceptable microsite within the spacing latitude, as indicated. It is coded as a fault, B6-Too wet.

## **Prepared Ground – Mounding**

Two approaches to planting mounds can occur; plant all acceptable mounds, or plant all acceptable mounds as well as any plantable non-mounded ground.

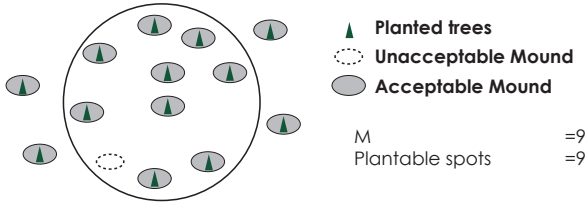
### **Plant All Acceptable Mounds**

Where the contract specifies that all mounds of acceptable quality be planted, all mounds are planted regardless of the inter-mound spacing or the M value – each mound becomes a plantable spot.<sup>1</sup> In this situation the M value equals the number of acceptable mounds. The contract specifications for acceptable mounds and tree placement must be reviewed prior to planting, preferably at the pre-work conference.

As mounds can settle over time, it is often important that seedlings be planted a little deeper. Prior to assessing a C10 fault (trees planted too deeply), the contract specifications should be reviewed.

<sup>1</sup> Unless the minimum inter-tree distance in the applicable stocking standards for that site is amended, trees planted on mounds closer than the minimum inter-tree distance specified in the applicable stocking standards for that site cannot be tallied as acceptable well-spaced or free growing trees.

**Plot #15** - Prepared Ground - Mounding



Plot No.	No. of Trees Planted	Plantable Spots	Excess Trees	Credit Satis. Planted Trees	Unsatis. Planted Trees & Code	Comments/ Instructions
15	9	9	0	9	0	site prepared

Inter-tree spacing – N/A.

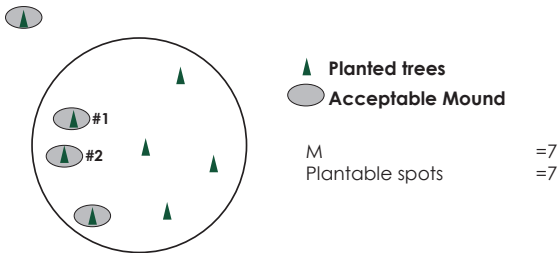
**Plant Mounded and Unmounded Plantable Sites**

For areas that are partially mounded or where the spacing of mounds is not uniform, the planting contract may require that both mounded (prepared) and unmounded areas be planted. In this situation, the following procedures should be followed.

If the contract requires all acceptable mounds to be planted, the inspector considers each acceptable mound to be a plantable spot regardless of inter-mound distance. Contract and minimum spacing is used for the trees planted on unmounded areas. To evaluate plots that contain both mounded and unmounded sites, the inspector must first determine the number of plantable spots that exist on the unmounded sites. To do this, the inspector determines the number of mounds that exist at contract spacing. The M value minus the number of mounds at contract spacing equals the maximum number of plantable spots that exist on the unmounded sites,

assuming the unbounded ground is fully plantable. The maximum number of plantable spots that exist on unbounded ground will be reduced if any of the acceptable mounds are at less than contract spacing, so as not to exceed M.

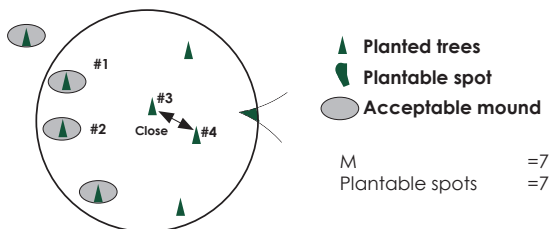
**Plot #16** - Partial/Non-uniform Mounding



Plot No.	No. of Trees Planted	Plantable Spots	Excess Trees	Credit Satis. Planted Trees	Unsatis. Planted Trees & Code	Comments/ Instructions
16	7	7	0	7	0	2 mounds < min.

Mounds #1 and #2 are less than minimum apart and therefore only two spots are lost to mounds. Because each acceptable mound is considered a plantable spot, it was therefore correct to plant four trees on unbounded ground so as not to exceed M.

**Plot #17** - Partial/Non-uniform Mounding

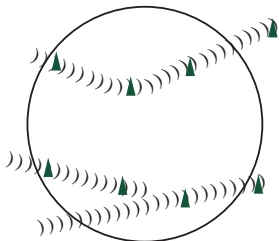


Plot No.	No. of Trees Planted	Plantable Spots	Excess Trees	Credit Satis. Planted Trees	Unsatis. Planted Trees & Code	Comments/ Instructions
17	7	7	0	6	1-B1	Too close

Although trees #1 and #2 are less than minimum from each other, neither is coded excess or too close since both are planted on acceptable mounds. Trees #3 and #4 are less than minimum from each other. Since tree #4 could have been planted on a spot in the plot such that it would have fit within the spacing latitude, it is faulted as B1 – Too Close.

## Prepared Ground – Trench Scarified

### Plot #18 - Trench Scarified



#### ▲ Planted trees

When spacing between trenches exceeds the contract spacing, reduce spacing along the trench to the minimum allowable.

Plot No.	No. of Trees Planted	Plantable Spots	Excess Trees	Credit Satis. Planted Trees	Unsatis. Planted Trees & Code	Comments/ Instructions
18	6	6	0	6	0	



## **PLANTING FAULT CODES**

There are three basic types of faults listed on the front of the FS 704 plot card. The faults listed on the FS704 and described below are common and applicable to most planting contracts:

- A. Damage to seedlings
- B. Planting spot selection
- C. Planting quality
- D. D (and E) fault codes may be added where the contract includes special procedures such as; planting different species on specific microsites, fertilizer placement, and installation of seedling barriers.

An optional list of subcodes is printed on the back of the FS704 form to aid the inspector in describing planting faults to the contractor.

### **A. Damage to Seedlings**

- 1. Broken, cut or damaged roots
- 2. Broken top
- 3. Scarred stem
- 4. Wasted tree (include discarded good trees but not obvious cull trees)
- 5. More than one in a hole (code each tree as a fault).

Damage to seedlings that may have been caused prior to receipt by the planting contractor will not be recorded as a damage fault code.

## **B. Planting Spot Selection**

Planting spot selection must be thoroughly discussed at the pre-work conference.

1. Too close (to other acceptable seedlings or acceptable naturals)
2. Too wide (A single widely spaced tree is only a warning, not a fault. The impact of wide spacing in a plot is a reduction in planting quality because the number of satisfactory trees is less than the number of plantable spots.)
3. Overhead obstacles
4. Planting medium too shallow
5. Too dry (usually on a dry mound or loose gravel)
6. Too wet (usually in a depression or creek bed)
7. Poor microsite selection
8. Poor planting medium (as defined in the contract and at the pre-work conference)

Seedlings must be planted where they have the best chance of growing into mature trees. If a seedling has been planted in a spot defined by B3-B8, the inspector must determine if a plantable spot exists within the spacing latitude. If a plantable spot exists, the tree is given a fault (eg. B4). If no plantable spot exists, the number of plantable spots is adjusted and the tree is excess.

### C. Planting Quality

Planting quality must be discussed at the pre-work conference and planting quality faults clarified.

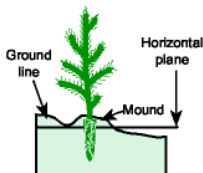
1. Inadequate planting spot preparation as defined in the contract
2. Tree improperly positioned on a prepared spot or mound
3. Improper root or plug placement – J or U roots
4. Exposed roots or plug
5. Tree not straight
6. Improper shading as defined in the contract
7. Air pocket (Any air channel from the surface to the root zone that may potentially cause the plug to dry out. Air pocket faults must be clearly defined at the pre-work and they should only be assessed through proper root excavation.)
8. Too loose
9. Too shallow
10. Too deep
11. Unacceptable backfill (backfilling planting hole with litter layer, or snow)

Further explanation of planting faults and normally accepted standards may be found in the planting chapter of the *Silviculture Manual*.

## SOME COMMON PLANTING FAULTS



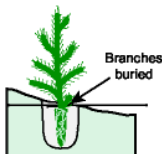
Planted in depression, could be excessive moisture. Code B6



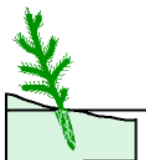
Planted on mound, roots apt to dry out. Code B5



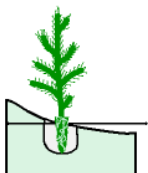
Planted in shallow soil above rock. Code B4



Planted too deeply. Code C10



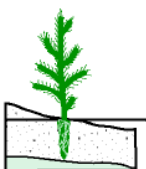
Not planted vertical to the horizontal plane. Code C5



Too shallow, roots exposed. Code C4



Planted in unsuitable rooting medium. Code B8



Planted in loose duff or debris, drying likely. Code B8



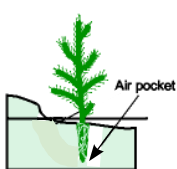
Overhead debris will restrict growth. Code B3



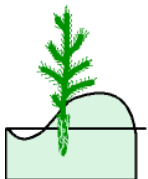
Roots jammed in J, L or U shape. Code C3



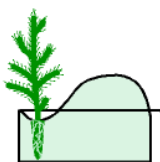
Too shallow, root end jammed, often exposed to air. Code C4



Air Pocket from surface to root zone. Code C7



Mound or prepared spot, tree improperly positioned. Code C2



Mound or prepared spot, tree improperly positioned. Code C2

## SAMPLES FS 704



Ministry of  
Forests, Lands and  
Natural Resource Operations

## PLANTING INSPECTION REPORT

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ADMIN. NO.	CONTRACTOR		
OPENING NO.	UNIT	ABC Ent.	
		EXAMINER <i>J. Smith</i>	

AREA (UNIT)	25 ha	CONTRACT SPACING	3.1 m	MINIMUM SPACING	2.1 m	PLOT SIZE	3.99 sq. m
-------------	-------	------------------	-------	-----------------	-------	-----------	------------

SEEDLOT	21257	AGE & TYPE	1+0PSB410	SPECIES	Pli	CONDITION	Good
---------	-------	------------	-----------	---------	-----	-----------	------

SEEDLOT	AGE & TYPE	SPECIES	CONDITION
---------	------------	---------	-----------

SEEDLOT	AGE & TYPE	SPECIES	CONDITION
---------	------------	---------	-----------

LINE NO.	PLOT NO.	TO	LINE NO.	PLOT NO.	TO
----------	----------	----	----------	----------	----

TRANSPORT: <input checked="" type="checkbox"/> SAT. <input type="checkbox"/> UNSAT.	FAULT CODES (SUBCODES ON REVERSE)  A - DAMAGE B - PLANTING SPOT C - PLANTING QUALITY D - _____
STORAGE: <input type="checkbox"/> SAT. <input checked="" type="checkbox"/> UNSAT. Replace worn silvacoal tarps	
HEEL IN: <input checked="" type="checkbox"/> SAT. <input type="checkbox"/> UNSAT.	
PLANTING BAGS: <input checked="" type="checkbox"/> SAT. <input type="checkbox"/> UNSAT.	
PLANTING TOOL: <input checked="" type="checkbox"/> SAT. <input type="checkbox"/> UNSAT.	
HANDLING: <input checked="" type="checkbox"/> SAT. <input type="checkbox"/> UNSAT.	

PLOT NO.	NO. OF TREES PLNTD.	PLANT-ABLE SPOTS	EXCESS TREES	CREDIT STATIS. TREES	UNSATISFACT PLANTED TREES	COMMENTS OR INSTRUCTIONS
1	6	6	0	6	0	
2	5	5	0	5	0	
3	6	4	2	4	0	2 acceptable naturals
4	5	4	1	4	0	2 acceptable naturals
5	4	3	1	3	0	3 acceptable naturals
6	4	6	0	4	0	wide spacing
7	5	6	0	5	0	missed plantable spot
8	6	6	0	5	1-B1	too close
9	7	6	1	6	0	excess = B1
10	6	6	0	6	0	
11	6	6	0	6	0	
12	6	6	0	4	2-B1	
13	7	6	1	6	0	
14	6	6	1	4	1-B6	excess = B6
15	9	9	0	9	0	site prepared
16	7	7	0	7	0	2 mounds < minimum

PLANTING QUALITY CALCULATION:  $\frac{\text{Satis. Trees}}{\text{No. Plant Spots}} \times 100 = \text{Plant Quality} \% \quad \text{Pay Rate} \% \text{ (See reverse)}$

ABOVE CALCULATION FOR: EXCESS CALCULATION  $\frac{\text{No. Excess Trees}}{\text{No. Trees Planted}} \times 100 = \text{Excess}$

WHOLE PROJECT \_\_\_\_\_ CONTRACTORS SIGNATURE

UNIT \_\_\_\_\_ FOREST OFFICERS SIGNATURE

PART UNIT \_\_\_\_\_ FOREST OFFICERS SIGNATURE

FS704D HFP 2011/09

The figures shown in this sample FS 704 are from the example plots used in this booklet.



Ministry of  
Forests, Lands and  
Natural Resource Operations

### SAMPLES FS 704

## PLANTING INSPECTION REPORT

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12	05 27

ADMIN. NO.	CONTRACTOR		
OPENING NO.	UNIT	EXAMINER	ABC Ent. <i>J. Smith</i>
AREA (UNIT)	CONTRACT SPACING	MINIMUM SPACING	PLOT SIZE
25 ha	3.1 m	2.1 m	3.99 sq. m
SEEDLOT	AGE & TYPE	SPECIES	CONDITION
21257	1+0PSB410	Pji	Good
SEEDLOT	AGE & TYPE	SPECIES	CONDITION
SEEDLOT	AGE & TYPE	SPECIES	CONDITION

LINE NO.	PLOT NO.	TO	LINE NO.	PLOT NO.	TO
TRANSPORT: <input checked="" type="checkbox"/> SAT. <input type="checkbox"/> UNSAT. STORAGE: <input type="checkbox"/> SAT. <input checked="" type="checkbox"/> UNSAT. Replace worn silvacool tarps HEEL IN: <input checked="" type="checkbox"/> SAT. <input type="checkbox"/> UNSAT. PLANTING BAGS: <input checked="" type="checkbox"/> SAT. <input type="checkbox"/> UNSAT. PLANTING TOOL: <input checked="" type="checkbox"/> SAT. <input type="checkbox"/> UNSAT. HANDLING: <input checked="" type="checkbox"/> SAT. <input type="checkbox"/> UNSAT.					

FAULT CODES  
(SUBCODES ON  
REVERSE)

A - DAMAGE  
B - PLANTING SPOT  
C - PLANTING QUALITY  
D - \_\_\_\_\_

PLOT NO.	NO. OF TREES PLNTD.	PLANT-ABLE SPOTS	EXCESS TREES	CREDIT STATIS. TREES	UNSATISFACT PLANTED TREES	
17	7	7	0	6	1-B1	too close
18	6	6	0	6	0	
	108	104	7	96	5	TOTAL

PLANTING QUALITY  $\frac{96}{104} \div \frac{104}{104} \times 100 = 92.31\%$   $\frac{99.7}{99.7} \times 100 = 99.7\%$  (See reverse)

CALCULATION: Satis. Trees No. Plant Spots Plant Quality Pay Rate

ABOVE CALCULATION FOR: EXCESS CALCULATION  $\frac{7}{108} \div \frac{108}{108} \times 100 = 6.5\%$

No. Excess Trees No. Trees Planted Excess

WHOLE PROJECT \_\_\_\_\_

UNIT \_\_\_\_\_

PART UNIT \_\_\_\_\_

CONTRACTORS SIGNATURE *Z. Jones*

FOREST OFFICERS SIGNATURE *J. Smith*

## PAYMENT CALCULATIONS

The calculations presented here are based on the plots shown on the sample FS 704 form.

### Planting Density

A calculation is made to determine if the minimum planting density, as specified in the contract, was attained. Planting density is equivalent to the average number of trees per hectare. This is found by dividing the total number of trees planted in the plots by the total number of plots.

$$\frac{108 \text{ trees}}{18 \text{ plots}} = \text{average } 6.0 \text{ trees per plot}$$

Since plot size is 1/200th hectare; the 6.0 average trees per plot X 200 = 1200 trees per hectare.

### Planting Quality

Planting quality is determined by dividing the total satisfactorily planted trees by the number of plantable spots, converted to a percentage.

$$\text{PQ}(\%) = \frac{96 \text{ satisfactory trees}}{104 \text{ plantable spots}} \times 100 = 92.31\%$$

## Planting Payment

The unit price payable (PAY %) is determined by the following formula, or as defined in the planting contract:

$$\text{PAY \%} = (\text{PQ \%} \times 1.08) - \frac{([100 - (\text{PQ \%} \times 1.08)]^2)}{8}$$

The Planting Payment Quick Reference Guide (FS 767-T) estimates pay rate percent without the use of a calculator (Appendix 2).

## Excess Charges

Percent excess is calculated by dividing the excess trees by the total trees planted.

$$\frac{7 \text{ excess trees}}{108 \text{ trees planted}} \times 100 = 6.5\%$$

Excess charges are calculated using the following table for all units, with the exception of low density ( $\leq 800$  sph) planting units, or as specified in Schedule A of the planting contract. **Note that charges are cumulative once excess has exceeded 12%;**

% Excess	Charge
0 - 7%	No charge.
7.1% - 12%	$(\text{Excess \%}/100-0.07) \times \text{total trees for payment area} \times \text{price per tree.}$
>12%	$(\text{Excess \%}/100-0.12) \times \text{total trees for payment area} \times \$0.20$

On low density ( $\leq 800$  sph) planting units a 10% tolerance is applied before charges are levied for excess trees and the following table is used to calculate excess charges. **Note that charges are cumulative once excess has exceeded 15%.**



% Excess	Charge
0 - 10%	No charge.
10.1% - 15%	$(\text{Excess \%}/100-0.10) \times \text{total trees for payment area} \times \text{price per tree.}$
>15%	$(\text{Excess \%}/100-0.15) \times \text{total trees for payment area} \times \$0.20$

## GLOSSARY

**Acceptable Microsite** – A specific spot best suited for the survival and growth of the planted tree. Several general default descriptions of acceptable and unacceptable planting are listed in the Schedule A of the planting contract. To reflect specific conditions of a given planting site, additional or different descriptions may be written into the Schedule C "Other Conditions" of the contract or provided at the pre-work conference. Acceptable microsites and planting medium will also be described in the planting prescription and at the pre-work conference.

**Acceptable Naturals** – Natural trees of the preferred and/or acceptable species (*and which may include broadleaved species if they are included in the stocking standards for the unit*), of sufficient size and quality to be treated the same as planted trees.

**Contract Inter-tree Spacing** – Specifies normal planting distance between trees (listed in Schedule B of the planting contract).

**'M' – Maximum Spots per Plot** – Maximum number of plantable spots allowable in any one plot according to contract specifications.

**Minimum Inter-tree Spacing** – Minimum allowable distance between trees.

**Plantable Ground** – An area of many acceptable microsites.

**Planting Density** – Number of planted trees per hectare.

**Plantable Spot** – A planting location that is both an acceptable microsite and correctly spaced from other planted trees or acceptable naturals.

**Root Excavation** – Carefully excavating planted trees with a small shovel or trowel to check on the placement and condition of roots, and the planting medium. This should be done in such a way as to carefully and fully expose the plug and the surrounding planting medium. In this way planting faults such as air pockets and j-roots can be clearly identified.

**Spacing Latitude** – The allowable variation between the contract spacing and the minimum spacing. Spacing latitude allows for the maximum use of plantable microsities, represents the maximum allowable deviation from the contract spacing, and provides the flexibility for altering the strict contract spacing as dictated by specific site conditions. The planter is expected to use this latitude to make use of the most appropriate planting microsite.

**Screening** – Removing organic material to a specified depth. This may be as simple as removing only the litter (L) layer to reach the fermenting (F) layer of the forest floor prior to planting a seedling. Screening requirements will be specified in the contract.

## APPENDIX 1

Planting Density and Plantable Spots

### Triangular Spacing

Planting Density (trees/ha)	Contract Spacing (metres)	Allowable Plantable Spots (3.99 m plot)	Allowable Plantable Spots (5.64 m plot)
2400	2.2	12	24
2200	2.3	11	22
2000	2.4	10	20
1800	2.5	9	18
1600	2.7	8	16
1400	2.9	7	14
1200	3.1	6	12
1000	3.4	5	10
800	3.8	4	8
600	4.4	3	6

### Square Spacing

For row site preparation (e.g., disc trenching).

In-row Contract      Number of Planting Spots/ha  
 Spacing (m)      1000    1200    1400    1600    1800

	Number of Rows per 100 metres				
1.9	19	23	27	30	34
2.1	21	25	29	34	38
2.5	25	30	35	40	-
2.7	27	33	38	-	-
3.0	30	36	-	-	-

## Appendix 2

### PLANTING PAYMENT QUICK REFERENCE GUIDE

This table estimates the percentage of the contract price (PAY %) payable under Article 5 of the Ministry of Forests, Lands and Natural Resource Operations Planting Contract, Schedule A (FS 767). Other clauses may affect the final payment. The calculations are based on the Planting Quality Percent (PQ %) for the payment area, as measured using the Ministry's Planting Quality Inspection System and the following contract formula:

$$\text{PAY \%} = (\text{PQ \%} \times 1.08) - \frac{([\text{100} - (\text{PQ \%} \times 1.08)]^2)}{8}$$

PQ%	PAY%	PQ%	PAY%	PQ%	PAY%
100.00	100.00	90.20	96.58	86.70	88.57
99.00	100.00	90.10	96.40	86.60	88.29
98.00	100.00	90.00	96.22	86.50	88.01
97.00	100.00	89.90	96.03	86.40	87.72
96.00	100.00	89.80	95.85	86.30	87.43
95.00	100.00	89.70	95.66	86.20	87.14
94.00	100.00	89.60	95.46	86.10	86.84
93.00	100.00	89.50	95.27	86.00	86.54
92.90	100.00	89.40	95.07	85.90	86.24
92.80	100.00	89.30	94.86	85.80	85.94
92.70	100.00	89.20	94.66	85.70	85.63
92.60	100.00	89.10	94.45	85.60	85.32
92.50	99.90	89.00	94.24	85.50	85.01
92.40	99.79	88.90	94.02	85.40	84.69
92.30	99.67	88.80	93.81	85.30	84.37
92.20	99.55	88.70	93.59	85.20	84.05
92.10	99.43	88.60	93.36	85.10	83.72
92.00	99.31	88.50	93.14	85.00	83.40
91.90	99.18	88.40	92.91	84.00	79.96
91.80	99.05	88.30	92.68	83.00	76.22
91.70	98.92	88.20	92.44	82.00	72.20
91.60	98.78	88.10	92.21	81.00	67.89
91.50	98.65	88.00	91.96	80.00	63.28
91.40	98.50	87.90	91.72	79.00	58.38
91.30	98.36	87.80	91.48	78.00	53.19
91.20	98.21	87.70	91.23	77.00	47.71
91.10	98.06	87.60	90.97	76.00	41.94
91.00	97.91	87.50	90.72	75.00	35.88
90.90	97.75	87.40	90.46	74.00	29.52
90.80	97.60	87.30	90.20	73.00	22.87
90.70	97.43	87.20	89.94	72.00	15.93
90.60	97.27	87.10	89.67	71.00	8.70
90.50	97.10	87.00	89.40	70.00	1.18
90.40	96.93	86.90	89.13	69.00	0
90.30	96.76	86.80	88.85	0	0



BRITISH  
COLUMBIA

Ministry of Forests, Lands and Natural Resource  
Operations, Resource Practices Branch