ALBERTA REGENERATION STANDARDS FOR THE MINEABLE OIL SANDS

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Alberta Government

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1.0 PREFACE

The Alberta Regeneration Standards for the Mineable Oil Sands (MOS ARS) applies to all Disposition Holders operating in the Athabasca Oil Sands Region under an *Environmental Protection and Enhancement Act* (EPEA) Approval for the Construction, Operation and Reclamation of an Oil Sands Mine.

This manual has two general goals for implementation: adaptive management and continuous improvement. Alberta Environment and Sustainable Resource Development (AESRD) is committed to applying these standards in a fashion designed to further these goals.

This manual will be revised as data collection protocols are refined, as understanding of data needs in the Mineable Oil Sands improves, and as the goals and objectives of regeneration surveys are adjusted to reflect improved integration with the overall MOS reclamation process.

1.1 Acknowledgements

The Alternative Regeneration Standards Task Group (ARTG), a task group of the Terrestrial Subgroup (TSG) of the Reclamation Working Group (RWG) of the Cumulative Environmental Management Association (CEMA) contributed to the discussion, review and development of these protocols. The ARTG is a multi-stakeholder group composed of representatives from the oil sands mining industry, aboriginal communities (Fort McKay Industry Relations Corporation) and Alberta Environment and Sustainable Resource Development. The insight of the ARTG into the complexities of oil sands reclamation practices and data needs provided the foundation for this document.

TECO Natural Resource Group Limited is acknowledged for their work to produce the first draft of this manual and conduct the field work pilot program.

2.0 OVERVIEW

2.1 Authority

Environmental Protection and Enhancement Act, Approval Conditions[1] for the Construction, Operation and Reclamation of Oil Sands Mines require that:

> *6.2.1 The Approval Holder shall reclaim the land so that the reclaimed soils and landforms are capable of supporting self-sustaining, locally common boreal forest ecosystems, regardless of the end land use;*
>
> *6.2.2 The Approval Holder shall revegetate disturbed land to target the establishment of self-sustaining, locally common boreal forest ecosystems, integrated with the surrounding area, unless otherwise authorized in writing by the Director; and*
>
> *6.3.26 The Revegetation Plan referred to in subsection 6.3.25 shall comply with the Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region, 2009, as amended.*

EPEA approvals also require that Approval Holders:

> *6.3.33 (a) complete and submit vegetation surveys on all reclaimed areas using survey systems and complying with any applicable standards approved by Alberta Sustainable Resource Development for use at oil sands mines;*
>
> *6.3.33 (b) submit records of activity and performance, in a format and following protocols acceptable to Alberta Sustainable Resource Development, related to the revegetation of reclaimed lands;*
>
> *6.3.33 (d) comply with the requirements of the Alberta Forest Genetic Resource Management and conservation Standards, Alberta Sustainable Resource Development, May 2009, as amended.*

EPEA approvals also require Approval Holders to submit an Annual Reclamation Progress Tracking Report that includes:

> *6.4.48 (h) a summary of revegetation activities, including but not limited to, targeted ecosites consistent with items (f) and (g) of the Life of Mine Closure Plan referred to in subsection 6.2.12, including species selection, seed and plant stock origin, propagation of native plants, provincial tree seed registration identification number, stocking standards, distribution of species, fertilization, infill planting and planned revegetation research.*

2.2 Target Population

This manual applies to areas under Mineral Surface Lease (MSL) as well as Miscellaneous Lease (MLL) areas where similar obligations are embedded in the MLL agreements.

The MOS ARS shall be applied to all permanently reclaimed[2] upland polygons targeting commercial forestry as the end land use. The MOS ARS protocols collect data on

[1] Note that the approval conditions cited here are based on recent approval conditions documents. Wording and numbering may vary slightly from one approval document to the next.

[2] Refer to current AESRD definitions of permanent vs. temporary reclamation

juvenile stand composition and selected growth metrics that are designed to support the assessment of forest commerciality on reclaimed oil sands mine sites. This survey process is recommended for all reclaimed upland forest polygons, as the data collected as part of this process will enable the assignment of likely forest cover types (ecosite phase) and will provide an assessment of forest growth, which can be valuable for polygons not targeting commercial forestry as an end land use. However, only data collected for polygons targeting commercial forestry are required to be submitted to Alberta.

2.3 Purpose

Establishment Surveys

Establishment surveys determine the level of early reforestation success in polygons[3] targeting commercial forestry as the end land use. Site occupancy is the predominant parameter used to determine early reforestation success and reflects the degree to which trees utilize a site's available growing space. Site occupancy is assessed using stocking, which is the frequency or percentage of sample plots within a polygon that contain acceptable tree regeneration. Note that site occupancy or the presence of a vegetation community is also integral to maintaining a healthy ecosystem.

Performance Surveys

The purpose of performance surveys is to determine if established trees have continued to grow, and to verify that these trees are healthy and vigorous and are expected to survive to maturity.

2.4 Objectives

The objectives of regeneration surveys (establishment and performance) are:

1. To assess every polygon at both establishment and performance survey timing to document the reforestation[4] status;
2. To identify homogeneous strata (Sampling Units) within polygons to support the assessment of polygon conditions;
3. To assess the species composition and distribution (i.e., stocking) of established trees with a high potential for survival and future growth;
4. To support efficient data gathering that will result in accurate reforestation assessment metrics (e.g., tree and stand parameters); and
5. To identify areas where the level of regeneration success is less than expected due to underlying biotic or abiotic factors for follow-up assessment by experts (i.e., identification of poorly revegetated areas).

[3] A polygon is an area defined by the Disposition Holder based on, at a minimum, the combination of soil and vegetation attributes within a spatially contiguous area. Polygon is the unit for reforestation management (i.e., regeneration surveys) and each has a unique administrative identification number for a given Disposition Holder. Polygons can be subdivided to refine strata delineation, but outside polygon boundaries cannot be altered, except due to permanent anthropogenic deletions (Table 4-2, NAA=2).

[4] Reforestation refers specifically to the establishment and growth of trees in a reclaimed polygon.

2.5 Timing

The reforestation clock start date is defined as May 1 following the first reforestation treatment for the polygon.

Establishment surveys shall be completed no sooner than 4 years and no later than 8 years after reforestation clock start date. Performance surveys shall be completed no sooner than 11 years and no later than 20 years after the reforestation clock start date (see examples below).

Establishment and performance surveys may be completed any time after herbicide treatments used to control tree competition, provided the treatment efficacy is evident at the time of the survey and surveys are completed within the required survey window.

Performance field surveys must not be completed within 2 growing seasons after a manual tending treatment for polygons located within the Central Mixedwood Natural Subregion.

Example:

A polygon is planted on September 4, 2001. Based on this planting date:

Reforestation clock start date:	*May 1, 2002*
Earliest date that an establishment survey can be completed:	*May 1, 2006*
Latest date that an establishment survey can be completed:	*April 30, 2010*
Earliest date that a performance survey can be completed:	*May 1, 2013*
Latest date that a performance survey can be completed:	*April 30, 2022*

Table 2-1: Survey windows relative to years post reforestation

Reforestation Year		Years Post Reforestation	Description
May 1	April 30		
2001	2002	0	Plant September 2001
2002	2003	1	Reforestation clock start
2003	2004	2	
2004	2005	3	
2005	2006	4	4 years after first reforestation treatment
2006	2007	5	Establishment survey window
2007	2008	6	
2008	2009	7	
2009	2010	8	
2010	2011	9	
2011	2012	10	
2012	2013	11	11 years after first reforestation treatment
2013	2014	12	Performance survey window
2014	2015	13	
2015	2016	14	
2016	2017	15	
2017	2018	16	
2018	2019	17	
2019	2020	18	
2020	2021	19	
2021	2022	20	

2.6 Regeneration Surveyors

2.6.1 Surveyor Qualifications

Alberta deems the following as meeting the requirements for certification of qualified field surveyors:

1. Regeneration surveys shall be completed by Regulated Professionals (RP) from a Professional Regulatory Organization[5] or by those under the direct supervision of an RP; and
2. Qualified surveyors are individuals who have successfully completed regeneration survey training. Both the identification of minimum requirements for regeneration survey training and the provision of adequate training are the responsibility of each Disposition Holder.

Direct supervision by an RP includes the RP:

- Overseeing the surveys as they occur; and
- Overseeing (i.e.: direct authority over) and taking responsibility for the performance of surveyors; and
- Providing direction and feedback to surveyors in a timely manner; and
- Ensuring surveys being conducted under their direct supervision are complete and accurate.

2.6.2 Notification of Qualified Surveyors

Disposition Holders responsible for completing regeneration surveys shall list the names (first and surname) of qualified surveyors on the Ground1 – Unit Header form (Appendix E) and on the Regeneration Survey Checklist (Appendix G).

[5] Regulated Professionals are members in good standing of any of the following professional organizations: Alberta Institute of Agrologists (AIA), Alberta Society of Professional Biologists (ASPB), Association of the Chemical Profession of Alberta (ACPA), Association of Professional Engineers, Geologists and Geophysicists of Alberta (APEGGA), College of Alberta Professional Foresters (CAPF), or College of Alberta Professional Forest Technologists (CAPFT).

3.0 REGENERATION SURVEY SYSTEM

Regeneration survey are comprised of a series of steps:

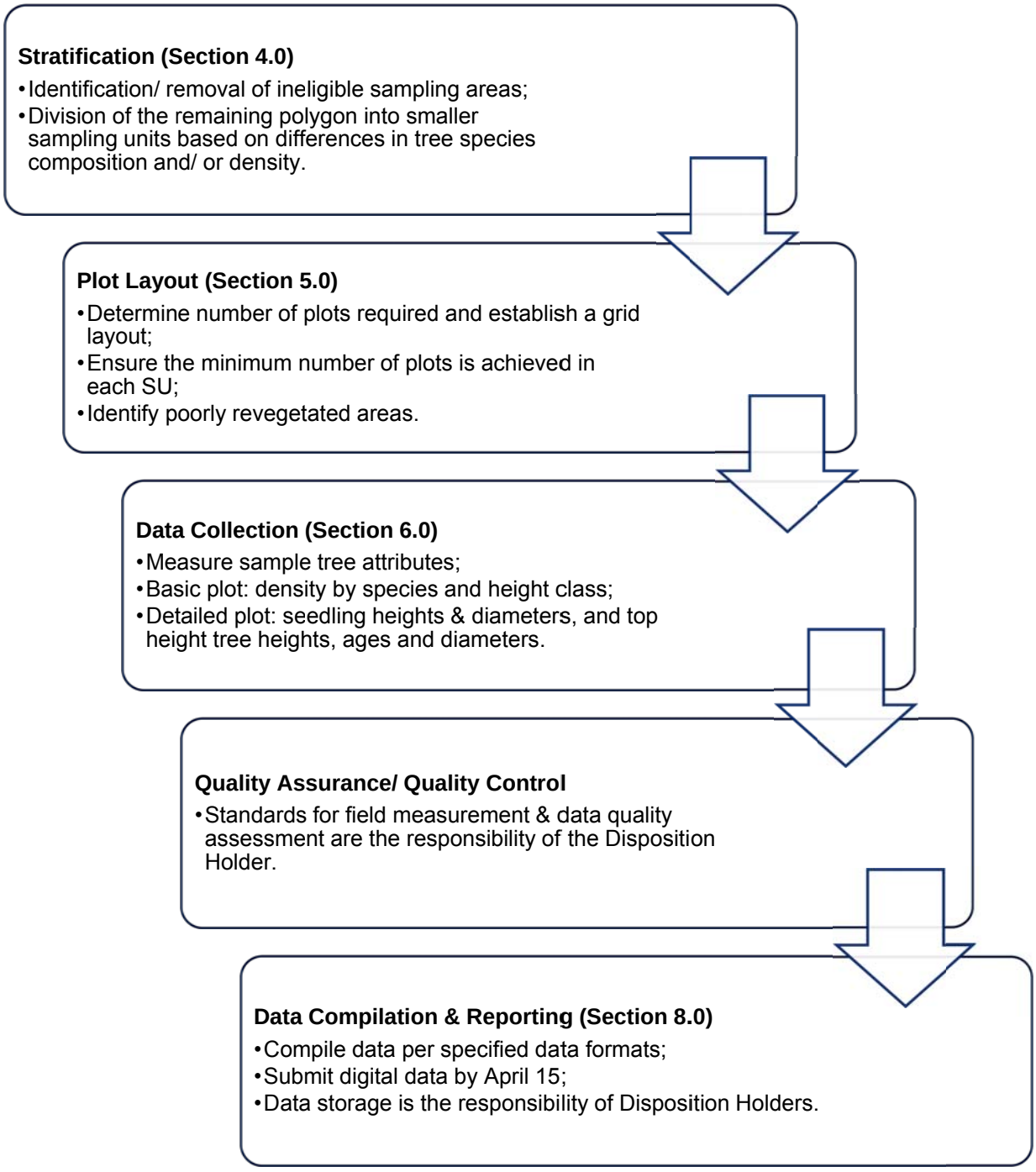


Figure 3-1: Regeneration survey system

4.0 STRATIFICATION

Stratification of polygons is an important step in the MOS ARS regeneration survey procedure. The objectives of stratification are:

- To delineate homogenous strata (Sampling Units) within polygons to increase sampling precision;
- To collect sufficient plot level data to allow evaluation at the sub-polygon level (i.e., the Sampling Units within a polygon); and
- To identify poorly revegetated areas (PRVs) (areas with potentially problematic vegetation growth).

The general stratification procedure for each polygon shall be:

- Determine the Net Assessment Area (NAA) by delineating portions of polygons covered by anthropogenic and/ or natural deletions (Section 4.1);
- Stratify the NAA into Sampling Units (Section 4.2); and,
- Delineate poorly revegetated areas within the NAA (Section 4.3).

Delineating Sampling Units and poorly regenerated areas are two separate exercises:

1. **NAA** → **Delineate Sampling Units**
2. **NAA** → **Delineate Poorly Revegetated Areas**

Initial polygon delineation can be based on either ground traverse or aerial methods (helicopter fly over, aerial photos, etc.). Aerial methods are recommended because they provide a better overview of the polygon.

4.1 Delineating the Net Assessment Area

It is recommended that anthropogenic and natural deletions be removed from the reclamation area prior to field surveying. Where anthropogenic and/ or natural deletions have not been delineated out of the polygon prior to the regeneration survey, the Disposition Holder shall remove these features from the polygon area based on the results of the survey.

There are no minimum area or width requirements for anthropogenic deletions. Natural deletions must be 0.5 ha or larger; however, there is no minimum width requirement.

Anthropogenic and natural deletions must be delineated spatially (i.e., Global Positioning System (GPS), digitizing, or hand-drawn map to scale) and each must have a code assigned indicating the type of deletion (Table 4-1).

The area within the polygon remaining after the delineation of anthropogenic and natural deletions defines the NAA.

Table 4-1: Net Assessment Area codes

Category	Code	Description
Net Assessment Area	0	Area eligible for survey.
Anthropogenic Deletions (no minimum size)	1	Any of: Polygon boundary correction; Road/pipeline right of way; Substations and weirs; Archaeological and historic sites; or Temporary anthropogenic withdrawals[6]: Powerline clearings (disposition holder to provide necessary rules for powerline approach/safety); Permanent sample plots or other research areas unless approved for inclusion by the company representative.
Natural Deletions (0.5 ha or larger)	2	Flooded areas, Areas adjacent to water bodies, subject to seasonal flooding, Uncut patches within the polygon.

4.2 Stratifying the Net Assessment Area into Homogeneous Sampling Units

In order to improve the precision of results, the NAA must be stratified into homogenous strata (Sampling Units). Delineation of Sampling Units (SU) within the NAA shall be based on tree species composition and density classes, at a minimum. Interpretation of species composition and density class may be undertaken using either a ground-based traverse, or (preferably) aerial methods (e.g., photos, helicopter fly-over).

To assist in delineation, the Disposition Holder should provide information on planting history (species, stock type, density, spatial pattern, etc.) and any other management activities that could affect tree species composition and/ or density to the field surveyors.

Table 4-2 describes the eight tree species composition classes and the corresponding Revegetation Manual[7] stand types. Species proportions used to define tree species composition classes are based on tree density (i.e., stems per hectare).

[6] Temporary anthropogenic withdrawals are areas that are excluded from surveys due to concerns regarding safety and/or in order to protect these areas from disturbance. Areas withdrawn from regeneration surveys cannot contribute to assessment of "commerciality" (unless reclamation status can be proven via other data sources) but can still contribute to total reclaimed area.

[7] Reference: Alberta Environment. 2010. Guidelines For Reclamation to Forest Vegetation in the Athabasca Oil Sands Region, 2nd edition. Prepared by the Terrestrial Subgroup of the Cumulative Environmental Management Association, Fort McMurray, AB.

Table 4-2: Tree species composition class definitions

Tree species composition class	Revegetation manual stand type[8]	Coniferous percent (density based)	Leading coniferous tree species (density based)
Hw	Aw	0-20	N/A
MxLx	N/A[9]	30-70	Larch
MxPj	Pj-Aw	30-70	Pine
MxSx	Aw-Sw, Sw-Aw	30-70	Spruce
Sw	Sw, Sw-Sb	80-100	White spruce
Lx	N/A	80-100	Larch
Pj	Pj, Pj-Sb, Pj-Sw	80-100	Pine
Sb	Sb, Sb-Pj	80-100	Black spruce

Table 4-3 describes the three tree density classes. Density classes are defined as the total number of stems per hectare of regenerating trees.

Table 4-3: Tree density class definitions

Density class	Code	Density range (stems per ha)
Low	L	<1,000
Medium	M	1,000 – 5,000
High	H	>5,000

Note that using ground-based methods for dividing areas based on density classes can be difficult, particularly where two areas are similar in density. Improved results are expected when delineation is undertaken using aerial information.

Where two areas could be delineated but are fairly similar in overall density, separate SUs should not be created. As a guideline, approximate tolerances are provided in Table 4-4.

For example, if one area is defined as low density with approximately 900 stems/ha and the adjacent area is defined as medium density with 1100 stems/ha, these two areas should not be separated because the difference is less than 250 stems/ha.

Table 4-4: Tree density class tolerances

Adjacent density classes	Density class transition tolerance (stems per ha)
Low and Medium	250
Medium and High	1,250

[8] Stand types from Revegetation Manual planting density tables

[9] The Revegetation Manual does not reference any larch stand types, mixed or otherwise.

Additional stratification variables may be employed at the discretion of the Disposition Holder based on other variables of interest, including differences in tree height or non-tree ecosystem attributes.

4.2.1 Sampling Unit Stratification Standards

Disposition Holders shall stratify the NAA into Sampling Units based on species composition and density classes (at minimum) to the following standards:

a. Sampling Units shall be a minimum of 2 hectares in size;
b. Sampling Unit widths shall not be less than 50 meters at any point;
c. Only acceptable coniferous and deciduous trees shall be considered; and
d. Stratification shall be hierarchical (i.e., stratify by species composition first, then by density).

Step 1: Stratify the NAA based on species composition:

1. Where tree species composition class (Table 4-2) differs;
2. Where tree species composition of a single species within the composition class differs by more than 20%; and,
3. Where minimum Sampling Unit size (2 ha) and width (50 m) criteria are met.

Step 2: Stratify the NAA based on density:

1. Where total tree density class (Table 4-3) differs;
2. Where total tree density differs by more than 25% (Table 4-4); and
3. Where minimum Sampling Unit size (2 ha) and width (50 m) criteria are met.

Step 3: Stratify the NAA based on additional variables of interest:

1. Where classes differ (as identified by each Disposition Holder); and,
2. Where minimum Sampling Unit size (2 ha) and width (50 m) criteria are met.

A preliminary stratification of NAA into Sampling Units prior to field surveys may be based on:

a. Tree planting records (species, density, extent), previous survey results, and relevant management activities (e.g., fertilization); and/ or
b. A walk-through, fly-over or aerial photography.

Surveyors may make adjustments to the preliminary stratification while traversing the polygon and establishing plots. However, plot level data shall not be used to delineate Sampling Units (i.e., post-stratification of the polygon using plot data is not permitted).

Sampling Units must be delineated spatially (i.e., GPS, digitizing, or hand-drawn map to scale). Each Sampling Unit within a polygon shall be assigned a unique number (Section 4.4).

Examples of stratifying and hierarchical delineation of Sampling Units are provided in Appendix B.

4.2.2 Recording Sampling Unit Attribute Information

For each Sampling Unit, Disposition Holders shall record information for species composition and density classes according to the data dictionary format described in Appendix E.

4.3 Stratifying the Net Assessment Area for Poorly Revegetated Areas

A Poorly Revegetated Area (PRV) is an area at least 0.5 ha in size where trees show significant health issues or mortality relative to the rest of the polygon. Poorly revegetated areas may indicate a problem with reclamation (e.g.: underlying soil conditions), with tree health (e.g.: insect/ disease outbreak) or tree vigour (e.g.: physical damage). PRVs will be used to identify systemic problems extending across all vegetation types, and should be obviously different from the surrounding polygon. When PRVs are identified, an expert practitioner should investigate in order to determine potential causal factors. Generally, if less than 25% of trees are affected, a PRV should not be delineated. However, if two or more 'minor' problems combine to impact more than 25% of the trees, a PRV should be delineated.

There are five key types of PRVs:

1. Dead – mortality of trees is much higher than observed in the remainder of the polygon.
2. Foliage loss/ discoloration – foliage colour or density is noticeably different from trees in the surrounding area.
3. Missing/ low density – density of seedlings is significantly lower than the remainder of the polygon, and differs from expectations (e.g., based on planting records and expected survival rates). Differences in density should not be due to deliberate patterning across the landscape (e.g., clumpy planting).
4. Physical damage – damage to trees caused by either animal or abiotic factors (e.g., frost, soil movement, poor planting, animal browsing). Numerous dead, broken or missing tops or branches relative to the surrounding area indicate physical damage.
5. Poor form/ vigour – trees display poor general growth, height growth suppression, and/ or poor form. Generally, trees would have readily observable differences in growth (i.e., be less than two thirds the height of trees in the rest of the polygon), or a large number of trees would have major form defects (e.g., crooks, forks, or heavy branching).

4.3.1 Poorly Revegetated Area Stratification Standards

Disposition Holders shall delineate poorly revegetated areas within the NAA to the following standards:

a. Poorly revegetated areas shall only be delineated if there is an obvious difference between the trees within the PRV and the trees in the remainder of the NAA (> 25% of trees affected).
b. Poorly revegetated areas shall not be delineated when smaller than 0.5 hectares or when encountered in less than three Basic plots (Figure 4-1).
c. Poorly revegetated areas shall only be delineated within the Net Assessment Area (NAA=0).

Note that delineating poorly revegetated areas shall be an independent exercise relative to the delineation of Sampling Units. For example, a PRV could extend across two delineated SUs as shown in Appendix B.

Poorly revegetated areas will be delineated using the distance traversed between plot locations as line transects. If a suspected PRV area is encountered during survey, field

crews are to mark the boundary into and out of the suspected PRV on the field map (Figure 4-1). Field notes should be taken regarding PRV attributes.

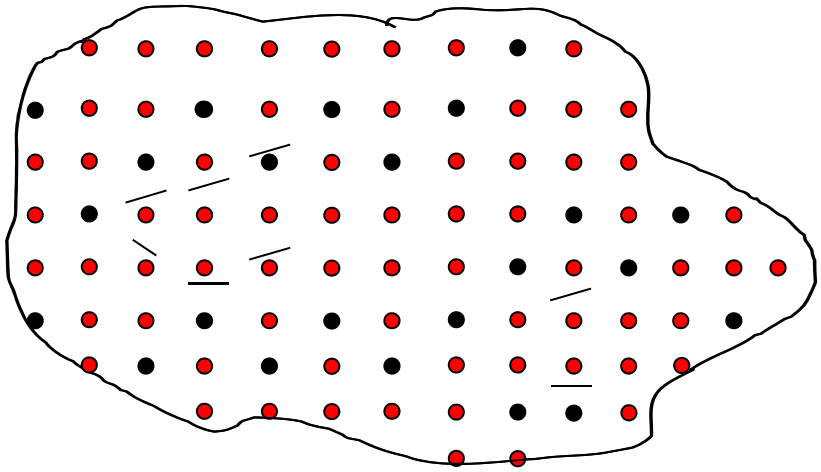


Figure 4-1: Identifying poorly revegetated areas using the plot traverse as line transects

Note: red=basic plots and black=detailed plots; black lines correspond to the approximate edge of the PRV.

Poorly revegetated areas shall be delineated by creating a polygon that joins the line transect intersect locations and is representative of the PRV area (based on field observations and notes). Note that in the example in Figure 4-2, the line transects on the right side of the polygon do not meet criteria for PRV delineation since only two plot centres are encompassed.

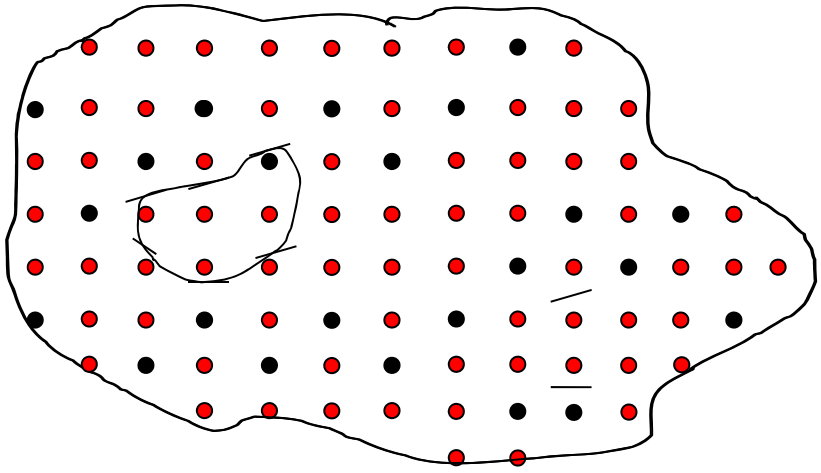


Figure 4-2: Joining line transects to delineate poorly revegetated areas

4.3.2 Recording Poorly Revegetated Area Attribute Information

For each poorly revegetated area, Disposition Holders shall record attribute information according to the data dictionary in Appendix E for:

1. Tree species composition (Table 4-2);
2. Total tree density (Table 4-3);
3. Damage class (Table 4-5);
4. Severity class (Table 4-6); and
5. Damage cause (Table 4-7), where evident.

Each poorly revegetated area must have at least one (and up to two) damage class codes identified. Each damage class code must have a corresponding severity class code (Table 4-6) and causal code (if known, Table 4-7). Causal factors shall only be recorded when field crews are reasonably certain (no guessing).

Table 4-5: Poorly revegetated area damage class codes

Damage Class	Damage Class Code
Dead	DE
Foliage discolouration/ loss	FO
Missing/ low density	MI
Physical damage	PD
Poor growth/ form	PG

Table 4-6: Poorly revegetated area damage severity codes

Damage Class	Severity[10]	Severity Code	Description
Dead	Minimal	1	Dead trees/ vegetation (1-25% stems)
	Moderate	2	Dead trees/ vegetation (26-50% stems)
	Significant	3	Dead trees/ vegetation (51-75% stems)
	Severe	4	Dead trees/ vegetation (76-100% stems)
Foliage discolouration/ loss	Minimal	1	Foliage discolouration/ loss 1-25%
	Moderate	2	Foliage discolouration/ loss 26-50%
	Significant	3	Foliage discolouration/ loss 51-75%
	Severe	4	Foliage discolouration/ loss 76-100%
Missing/ low density	Minimal	1	Density 1-25% less than expected
	Moderate	2	Density 26-50% less than expected
	Significant	3	Density 51-75% less than expected
	Severe	4	Density 76-100% less than expected
Physical damage	Minimal	1	Damaged trees/ vegetation 1-25%
	Moderate	2	Damaged trees/ vegetation 26-50%
	Significant	3	Damaged trees/ vegetation 51-75%
	Severe	4	Damaged trees/ vegetation 76-100%
Poor growth/ form	Minimal	1	Vegetation is expected to recover
	Moderate	2	Growth rate/ form will be reduced by 26-50%
	Significant	3	Growth rate/ form will be significantly reduced
	Severe	4	Vegetation is expected to die

[10] Note that severity class code 1 is highlighted in blue. Generally, PRV areas should not be delineated if the severity code is less than 2, unless more than one factor has affected the area (e.g., there is a combination of dead trees and trees with poor growth that affects > 25% of trees overall).

Table 4-7: Poorly revegetated area damage causal codes

Cause of Damage	Causal Code
Animal Codes	
Bear tearing	AT
Bear, other damage	AU
Beaver felling/ chewing	AC
Horse trampling	AH
Porcupine chewing	AP
Rabbit chewing	AL
Squirrel damage	AS
Ungulate browsing	AB
Ungulate rubbing	AR
Other animal	AO
Disease Codes	
Armillaria root rot	DR
Atropellis canker	DA
Blister rust	DB
Conks	DC
Dieback	DD
Dwarf mistletoe	DM
Hypoxylon canker	DH
Needle rust	DN
Western gall rust	DW
Witches' broom	DI
Other disease	DO
Insect Codes	
Aphid	IA
Defoliator	ID
Larch sawfly	IS
Lodgepole pine terminal	IT
Root collar weevil	IR
Wood borer	IB
Other insect	IO

Cause of Damage	Causal Code
Weather Codes	
Frost bud/ leader kill	WL
Frost crack	WC
Frost heave	WF
Hail	WH
Red belt	WR
Snow/ ice	WN
Wind damage/ blowdown	WB
Human Codes	
Equipment/ machine	HE
Land clearing/ soil	HL
Poor planting	HP
Other human damage	HO
Environment Codes	
Aspect/ exposure	EA
Drought	ED
Fire	FR
Flooding/ seepage/ water	EF
Nutrient deficiency	EN
Pollution	EP
Soil erosion	EE
Other climate extremes	EC
Other soil factors	ES
Unknown Codes	
Unknown	UK

4.3.3 Special Case – Low Density Areas

Low tree stocking can occur for a number of reasons including: planting failures, extreme weather, animal damage and insect/ disease impacts. Additionally, reclaimed polygons can be impacted by debris (gravel, dust, etc.) from nearby roads or other active anthropogenic disturbances. In some cases, this debris can be deposited in sufficient quantities to inhibit tree growth and/ or survival. Unless these areas can be identified and delineated as an anthropogenic deletion (e.g.: area is being actively used for a specific purpose), they are not to be deleted from the NAA. If these areas with low tree densities meet the criteria for delineation as a separate low density SU, they should be delineated as such. If they fail to meet the criteria for SU delineation, they should be evaluated for delineation as a PRV.

4.4 Unique Identifiers

Disposition Holders shall record the Disposition Holder Code (Table 4-8), polygon number, SU number, unique identifier, and area in hectares for each Sampling Unit. The unique identifier is a combination of polygon number and SU number.

Each anthropogenic and/or natural deletion, Sampling Unit and Poorly Revegetated Area shall be assigned a different unique identifier number. Poorly revegetated areas shall be identified with the letters "PRV" at the beginning of the unique identifier.

For example, if polygon 2515AA has one natural deletion, two Sampling Units, and one Poorly Revegetated Area, there would be four unique identifier numbers: 2515AA_001, 2515AA_002, 2515AA_003, and PRV_2515AA_004.

Table 4-8: Disposition holders, project names and associated codes[11]

Disposition Holder – Project Name	Disposition Holder Code
Suncor Energy – Fort Hills	SUNC_FORT
Shell Albian Sands – Jackpine Mine	SHEL_JACK
Canadian Natural Resources – Horizon	CNRL_HOR
Suncor Energy – Base Operations	SUNC_BASE
Total E&P – Joslyn Creek	TOTA_JOS
Imperial Oil Resources – Kearl	IORL_KRL
Syncrude Canada – Mildred Lake	SYNC_MILD
Shell Albian Sands – Muskeg River	SHEL_MUSK
Syncrude Canada – Aurora North	SYNC_AURN
Syncrude Canada – Aurora South	SYNC_AURS

[11] As of October 15, 2012

5.0 PLOT LAYOUT

The MOS ARS survey system uses systematic field surveys to collect data for trees present in 10 m^2 (1.78 m radius) and 100 m^2 (5.64 m radius) plots. The procedures for implementing field surveys are:

1. Determine the sample intensity (i.e., number of plots required) for the NAA of the polygon;
2. Calculate the survey grid line and plot spacing for the NAA;
3. Locate transects and plots in the field or establish plot locations using GIS;
4. Determine tree species, density, top height, and age; and
5. Add plots where necessary to meet minimum Sampling Unit requirements.

5.1 Required Number of Plots

Sample intensity requirements by polygon and SU are described in Table 5-1 and Table 5-2, respectively. The number of plots required varies according to the size of the NAA.

Table 5-1: NAA sample intensity requirements

NAA area (ha)	Number of plots required
< 1.0	Establish 13 Basic plots and 4 Detailed plots
1.0 – 1.9	Establish 21 Basic plots and 6 Detailed plots
2.0 – 4.0	Establish a minimum of 41 Basic plots and 12 Detailed plots
4.1 – 24.0	Establish a minimum of 64 Basic plots and 16 Detailed plots
> 24.0*	Establish 2.77 plots per ha.

* To determine the number of sample plots needed for an NAA larger than 24 ha, multiply the NAA area by 2.77 and round up to the nearest whole number.

Table 5-2: Sampling Unit sample intensity requirements

Sampling Unit area (ha)	Number of plots required
<1.0	Establish a minimum of 13 Basic Plots and 4 Detailed plots per SU
≥ 1.0	Establish a minimum of 21 Basic Plots and 6 Detailed plots per SU

Example:

NAA: 47.0 ha

Before beginning the field survey, the Disposition Holder stratifies the NAA into three strata (Sampling Units) based on treatment records and a field walk-through:

1. Sw stratum – 30.0 ha
2. Hw stratum – 14.0 ha
3. HwSw stratum – 3.0 ha

Because the NAA is 47.0 ha, the required number of plots is 2.77 per hectare (Table 5-1).
47.0 ha x 2.77 plots = 130.2 plots, which is rounded up to 131 plots.
The line and plot spacing for the NAA is 60m x 60m (Section 5.2).

Sw stratum: the 60m x 60m line and plot spacing establishes 84 plots. The minimum number of plots required is 21 (Table 5-2). Therefore, the minimum number of plots requirement is satisfied (i.e.: 84 > 21). All 84 plots should be measured in the Sw stratum.

Hw stratum: the 60m x 60m line and plot spacing establishes 39 plots. The minimum number of plots required is 21 (Table 5-2). Therefore, the minimum number of plots requirement is satisfied (i.e.: 39 > 21). All 39 plots should be measured in the Hw stratum.

HwSw stratum: the 60m x 60m line and plot spacing establishes 9 plots. The minimum number of plots required is 21 (Table 5-2). Therefore, the minimum number of plots requirement is not satisfied (i.e.: 9 < 21). An additional 12 plots must be established and all 21 plots should be measured in the HwSw stratum.

NAA: 131 plots (47.0 ha x 2.77=130.2) are required. 84+39+21=144 plots are established. The minimum number of plots requirement is satisfied (i.e.: 144 > 131).

5.2 Survey Grid Line and Plot Spacing

When calculating line and plot spacing, two methods may be used:

1. Square spacing; or
2. Rectangular spacing.

The survey standard is a square grid pattern where the distance between lines equals the distance between plots. In general, square plot spacing should be used unless the polygon is uniquely sized or shaped (see Section 5.8).

When the total number of plots is determined and the area of the NAA is known, the survey grid (plot and line spacing) can be calculated using the following formula:

$$\text{Plot spacing} = \sqrt{(NAA\,(\text{ha}) \times 10{,}000\,\text{m}^2/\text{ha})/\text{required \# of plots}}$$

Example:

NAA: 12.1 ha, calculate a square survey grid.

A 12.1 ha NAA requires 64 plots be established (Table 5-1).

Calculate plot spacing:

$$\text{plot spacing} = \sqrt{12.1 \times 10{,}000 / 64} = \sqrt{1890.625} = 43.48$$

Round off to the nearest 0.1 m; therefore line spacing = 43.5 m and plot spacing = 43.5 m

NOTE: Appendix C contains calculated square spacing distances for various NAA sizes.

For NAA 24 ha or larger, a 60 m × 60 m square grid shall be used.

Rectangular spacing occurs when the line spacing differs from plot spacing. The line spacing shall not be greater than twice the plot spacing unless approved by Alberta.

To calculate rectangular spacing, the desired line spacing is selected and then the plot spacing needed to achieve the correct number of plots is calculated.

Example:

NAA: 3.9 ha, calculate a rectangular survey grid, assuming a line spacing of 35 m.

A 3.9 ha NAA requires at least 41 plots be established (Table 5-1).

Calculate plot spacing:

$$\text{plot spacing} \times \text{line spacing} = \frac{\text{NAA area (ha)} \times 10{,}000\ (m^2/ha)}{\text{Required \# plots}}$$

$$\text{plot spacing} \times 35m = \frac{3.9\ ha \times 10{,}000\ (m^2/ha)}{41\ \text{plots}}$$

$$\text{plot spacing} = \frac{951.22\ m^2}{35\ m}$$

$$\text{plot spacing} = 27.1777\ m$$

Round off to nearest 0.1 m; therefore, line spacing = 35.0 m and plot spacing = 27.2 m.

5.3 Plot Layout

For each NAA to be surveyed, three methods for locating plots may be used:

1. Compass and horizontal measuring device; or
2. GPS used as a compass and horizontal measuring device; or
3. GPS to navigate to pre-determined plot locations generated using GIS (i.e., waypoints).

Method '3' is the recommended approach; however, field layout methods are also acceptable.

When using a GPS receiver, the standard of accuracy shall be <10 m horizontal distance with 95% accuracy. GPS receivers shall be configured to NAD83.

5.3.1 Field-Based Plot Layout

When locating plots in the field using methods '1' or '2' (above), control line(s) shall be established as follows:

1. Establish one control line parallel to the long axis of the NAA (Figure 5-1). Additional parallel control lines shall be established at 400 m intervals where polygon widths exceed 400 m.
2. The control line is best placed to coincide with the grid to enable points along the control line to be used as plot centres. Reference the control line in relation to the polygon boundary to enable accurate mapping of the sample plot locations.
3. Starting from the polygon edge, the first survey line shall be located at one-half the interline distance. Each additional survey line shall be marked at the exact interline distance.
4. Survey line intervals on the control line shall be double flagged using two different colours. The line and plot number shall be clearly written on the flagging.
5. Beginning at the control line, the remaining individual plots shall be located at the required spacing.

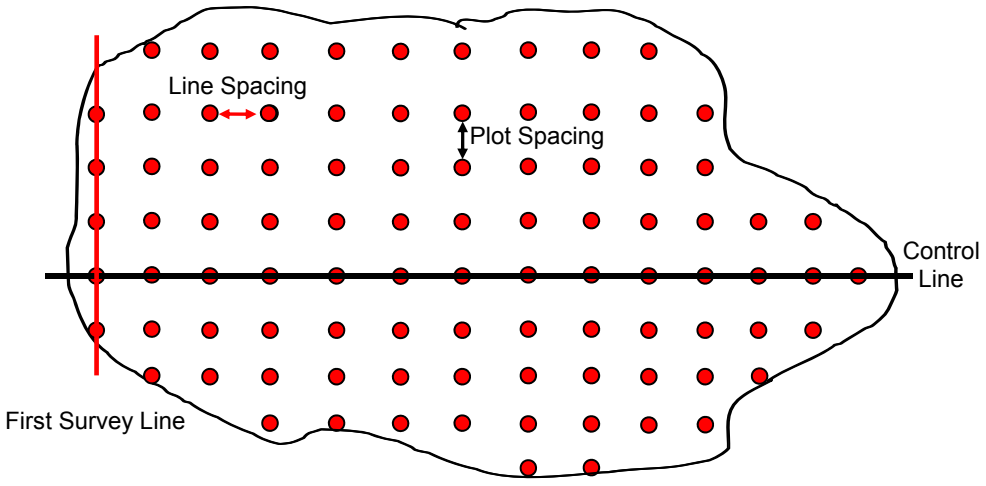


Figure 5-1: Sample plot distribution

When locating plots in the field using method '3' (above), a control line is not required.

5.3.1.1 Adding Plots

Where the minimum number of plot locations within each NAA (Table 5-1) or Sampling Unit (Table 5-2) can be established by the normal grid positions, but the minimum number of Detailed plots is not achieved (by counting every fourth plot starting with the first), then Detailed plot locations shall be randomly assigned to other available locations on the normal grid.

Where the minimum number of plots within each NAA (Table 5-1) or Sampling Unit (Table 5-2) cannot be established from the normal grid positions, additional plots are required. Additional plots shall be allocated as follows:

1. Halfway between every second survey line (i.e., halfway between and parallel to the second and third survey lines, fourth and fifth lines, etc.).
2. Plot spacing shall be the same on additional lines as for the original lines.
3. Where every second line does not add the required number of plots, proceed to add lines between other survey lines until the required number of plots is reached. Lines shall be marked on the control line and numbered sequentially.
4. Where plot spacing does not add the required number of plots, proceed to reduce the plot spacing by half.
5. Every fourth plot added shall be a Detailed plot.
6. Lines added using the compass and distance measuring device method (this also applies to GPS when used as a compass and distance measuring device) shall be given the next number in the sequence. Use numeric or alphanumeric labels but do not use decimals.
7. Plots added using GPS as waypoints shall be given unique numeric or alphanumeric labels. Do not use decimals.

5.3.2 GIS-Based Plot Layout

GIS-based plot layout shall be completed as follows:

1. Initiate a square or rectangular grid using a random starting coordinate (latitude and longitude).
2. Adjust the grid spacing until the required number of sample points for the NAA (Table 5-1) is achieved.
3. If SU delineation is known prior to plot location, add plots until the SU level plot minima (Table 5-2) are achieved[12].
4. If SU delineation is not known prior to plot location, several additional contingency plots should be pre-selected in the event that additional samples are needed. Alternatively, the rules for field-based "adding plots" (Section 5.3.1.1) could be applied as necessary, with additional points GPS'd according to the standards outlined there.

[12] This can be achieved in several ways, including simulating a half intensity grid and randomly selecting grid points from within it until sample size is reached (e.g., if plot spacing is 45 m x 45 m, create a 22.5 m x 22.5 m grid of plots from which to select additional samples).

If pre-locating alternate plots for field crews, a minimum of 20 alternates per SU is recommended; a consistent approach would be to pre-locate contingency plots between each plot location (between plots but not between lines).

5.4 Assigning Basic and Detailed Plot Types

Generally, the first and every fourth plot thereafter should be assigned as a Detailed plot. The first and every fourth plot can be based on the direction of travel (Figure 5-2), or on GIS pre-processing if GPS units are used to navigate to pre-located waypoints.

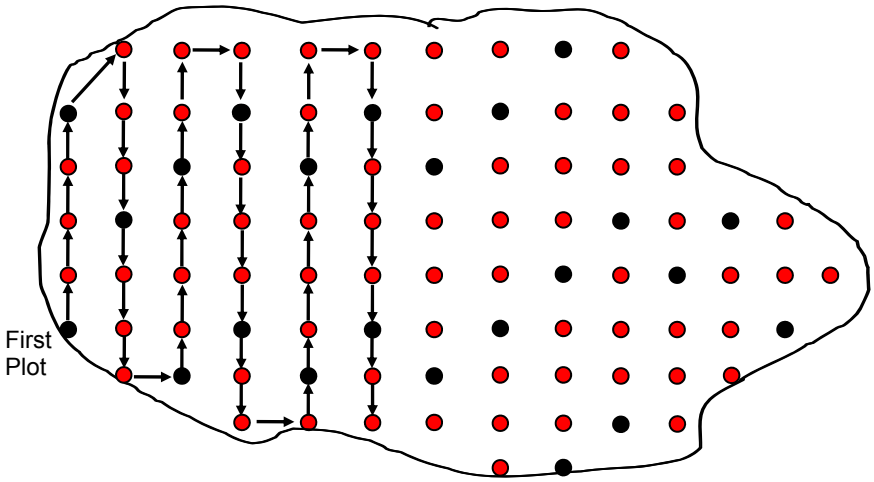


Figure 5-2: Sample layout of Basic (red) and Detailed (black) plots based on direction of travel

However, depending on the SU distribution within a polygon, it is possible that simply walking the polygon and assigning a Detailed plot to every fourth plot location may result in fewer than the minimum number of Detailed plots being established. Figure 5-3 shows a simplistic example of a polygon with two SUs, where the first and every fourth plot was designated as a Detailed plot. In this case, six Detailed plots (the minimum number required per Table 5-2) was not achieved in SU 2.

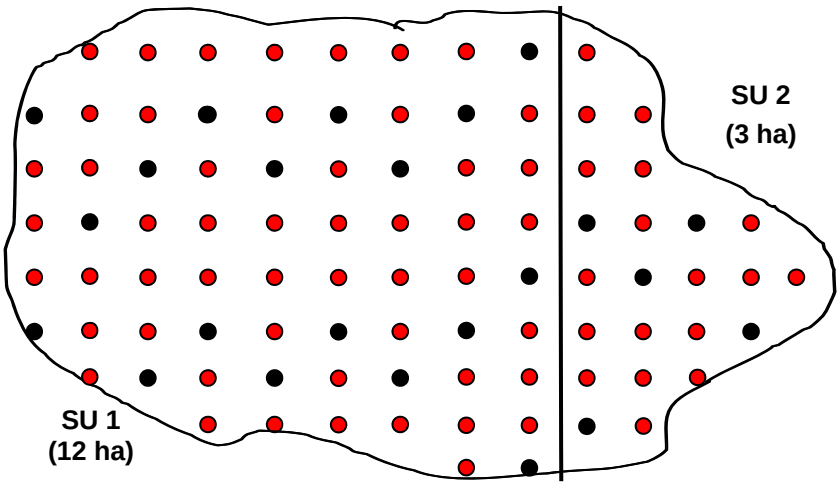


Figure 5-3: Polygon where minimum number of Detailed (black) plots is not achieved

If the Detailed plot numbering is restarted when surveyors cross into different SUs, the minimum number of detailed plots can often be achieved (Figure 5-4).

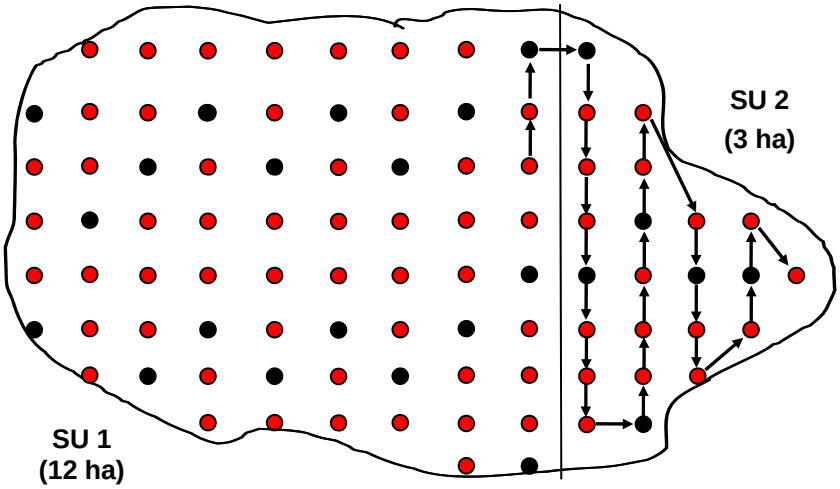


Figure 5-4: Polygon where minimum number of Detailed (black) plots is achieved

5.5 Field Map Preparation

Where possible, Disposition Holders should provide field crews with maps that show the following:

1. Polygon boundaries;
2. Aerial photography (at highest resolution possible);
3. Plot locations (preferably with pre-assigned plot type - Detailed vs. Basic); and
4. Contingency plot locations.

If possible, aerial photography or helicopter fly-over should be used to provide an initial stratification of the polygon into Sampling Units, and to tentatively identify poorly revegetated areas for field follow-up.

5.6 Temporary and Permanent Plot Markers

Establishment survey plot locations can either be temporarily or permanently[13] marked in the field. Permanently marking plot locations can increase the utility of data as the same physical area would be assessed at both the establishment and performance surveys. As such, the growth and survival of specific trees would be tracked over time. However, permanently marking establishment survey plot locations is optional.

If plots are to be temporarily marked, a post or pin can be used to indicate the plot centre. If plots are to be permanently marked, a metal post should be used to mark plot centre.

5.7 Basic and Detailed Plots

Two types of plots shall be established when conducting regeneration field surveys:

1. Basic Plot

a. The Basic plot measurement protocol shall be completed at every plot location, including where Detailed plots occur;

b. The area of the plot shall be 10 m^2;

c. The shape of the plot shall be circular and have a radius of 1.78 m;

d. All plot centres shall be clearly marked in the field using a post or pin[13] and shall be GPS'd using appropriate standards;

e. Plot numbers shall be recorded on plot centre markers.

- For pins or posts, all weather flagging shall be attached to the centre marker and the plot number shall be legibly written using a black waterproof marker.
- Metal posts with high visibility protective caps used to mark permanent plot locations should be identified by writing the plot number on the cap with a black waterproof marker.

2. Detailed Plot

a. The Detailed plot measurement protocol shall be completed on the first plot and every 4th plot thereafter (regardless of plot numbering);

b. The area of the plot shall be 100 m^2;

c. The shape of the plot shall be circular[14] and have a radius of 5.64 m; and

d. The centre of the plot shall share a centre with the Basic plot (i.e.: the Basic plot shall be nested within the Detailed plot).

If plots were not permanently marked at the establishment survey, a new plot grid shall be established for performance surveys.

[13] If plots are to be permanently marked, a metal or plastic post or should be used.

[14] In very small or unusually shaped polygons, it may occasionally be necessary to modify the shape of the 100 m^2 plot to fit within the polygon boundaries. See Section 5.9.

If plots were permanently marked at the establishment survey, plot centres shall be relocated using GPS coordinates and/ or metal detectors. Centre markers should be checked and replaced (if necessary) if Disposition Holders intend to monitor the plots beyond the performance survey.

5.8 Plots to Delete

Plots shall be deleted if, based on field observations, the 1.78 m plot radius obviously falls outside the NAA boundary. Plots shall not be deleted if the 1.78 m plot radius extends into an adjacent SU within the NAA of the polygon. Contingency (alternate) plots shall be used as replacements for any deleted plots. Contingency plots shall be added using the rules described in Section 5.3.1.1, or by using points selected randomly from a half intensity grid in GIS.

For Detailed plot locations, if the 1.78 m radius is within the NAA, but the 5.64 m radius is not, the plot shall not be deleted. In this case, the Detailed plot would be sampled as a Basic plot and the next Basic plot would become a Detailed plot, as long as the replacement Detailed plot falls within the same SU.

For instance, note the plot near the lower polygon boundary in Figure 5-5 (A). In this example, the entire 1.78 m radius Basic plot falls within the polygon boundary, but the 5.64 m radius Detailed plot does not. Therefore, the Basic plot location is valid, but the 5.64 m radius Detailed Plot is not. In this scenario, the plot location would be sampled as a Basic plot, and the next plot location would become the Detailed plot (Figure 5-5(B)). In order to ensure that enough Detailed plots are completed in the polygon/ SU, the surveyor would then move only three plots to the next Detailed plot (as opposed to the usual 4). This would return the surveyor to the original Detailed plot every fourth plot pattern (Figure 5-5(B)).

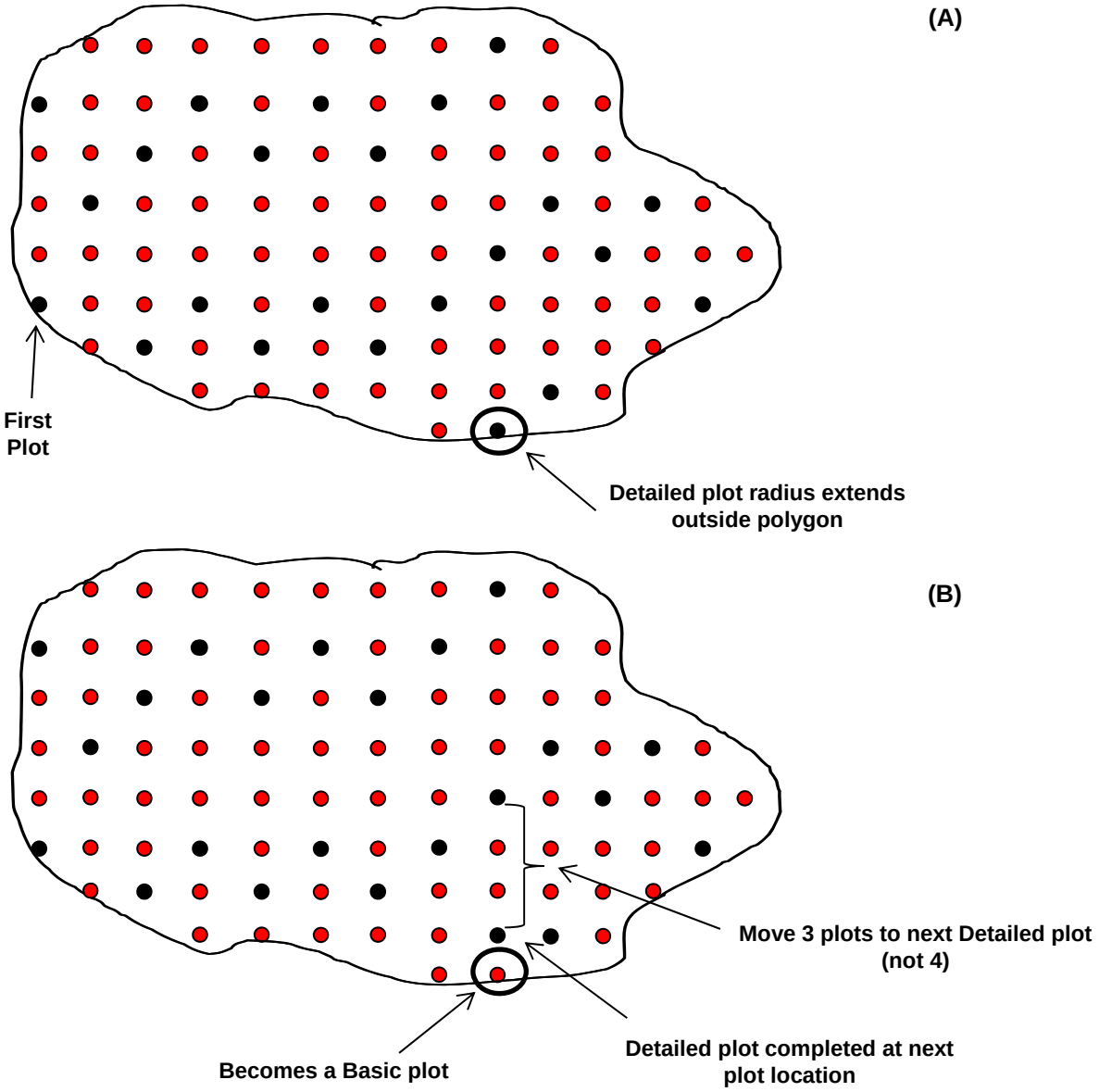


Figure 5-5: Moving Detailed plots

5.9 Unique Polygon Sizes and Shapes

The nature of reclamation in MOS areas means there will be polygons that are very small (< 1 ha) and/ or uniquely shaped (e.g.: linear, narrow, curved, etc.). In these situations, it may not be feasible to establish a centreline and a grid of plot locations. Therefore, it is recommended that GIS-based methods be used to pre-locate plots within very small and/ or uniquely shaped polygons. Alternatively, Disposition Holders may develop their own plot location methodology, but any alternative methodologies must be approved by Alberta prior to use.

It is possible that circular Detailed plots (5.64 m radius) may not fit within the boundaries of some very small and/ or uniquely shaped polygons. Under these circumstances, alternate plot shapes may be used (e.g., rectangular), provided the total plot size is 100 m^2. As a general rule, Disposition Holders should start with a rectangular plot that runs parallel to the polygon boundaries and is centred on the 10 m^2 plot. The length and width of the plot should be adjusted until the Detailed plot fits within the NAA. It is recommended that the plot be kept as close to square as is feasible to minimize the occurrence of long narrow Detailed plots.

5.10 Adding Plots at Performance Survey – Permanently Marked Plot Locations

It is possible that polygon conditions may change from the time of establishment survey to performance survey. If conditions change significantly, additional stratification could be required. In polygons with permanently marked plot locations, it may be necessary to add more plots to ensure minimum plot numbers are achieved in each SU. If additional plots are required, Disposition Holders shall follow the rules for adding plots outlined in Section 5.3.1.1. Any new plot locations shall be marked in the field per Section 5.7.

6.0 DATA COLLECTION

6.1 Acceptable Trees

For either a Basic or Detailed plot, an acceptable tree for measurement is an individual seedling or sucker that:

1. Is alive and expected to survive to maturity;
2. Is an acceptable tree species (Table 6-1);
3. Originated from seed, suckering or coppice[15] but not from layering; and
4. Is 30 cm or taller.

In addition, coniferous trees shall have:

1. A well-defined stem;
2. Two or fewer stems originating at the base of the tree; and
3. A live crown ratio[16]of 0.33 or greater (applies to white spruce, Engelmann spruce and fir trees only).

Table 6-1: Acceptable tree species and species codes

Latin Name	Common Name	Species Code	Mineable Oil Sands	Alberta-Pacific
Picea glauca	White spruce	Sw	Y	Y
Picea mariana	Black spruce	Sb	Y	Y
Picea spp.	Non-native spruce	Sx	**	N
Pinus contorta	Lodgepole pine	Pl	Y	Y
Pinus banksiana	Jack pine	Pj	Y	Y
Pinus spp.	Non-native pine	Px	**	N
Larix laricina	Tamarack	Lt	Y	N
Larix siberica	Siberian larch	Ls	**	N
Abies balsamea	Balsam fir	Fb	Y	Y
Abies lasiocarpa	Alpine fir	Fa	Y	N
Populus tremuloides	Trembling aspen	Aw	Y	Y
Populus balsamifera	Balsam (Black)	Pb	Y	Y
Betula papyrifera	White birch	Bw	Y	Y
Populus spp.	Hybrid poplar	Ah[17]	**	N
Populus spp.	Non-native deciduous	Ax	**	N

[15] Each stem originating from coppice growth may be considered a separate acceptable tree

[16] Live crown ratio is the proportion of total stem length covered by living branches and is expressed as a percentage or decimal of the total tree height

[17] Several variants of hybrid poplar may be present in the MOS. Codes should be coordinated between companies and added to this document as encountered.

Species highlighted in blue will not be considered an acceptable species for polygon evaluation if they were planted after the cutoff date as approved by the Executive Director of the Forest Management Branch[18]. However, Disposition Holders may wish to collect data from all species for their own purposes.

6.2 Basic Plot Measurements

Tally the number of acceptable trees within each 1.78 m radius (10 m^2) Basic plot by species and height class. This includes the 10 m^2 plot at each Detailed plot location. Height classes are:

- 30-79 cm;
- 80-129 cm; and
- 130 cm +.

For conifers, an optional "underheight" class of 15-29 cm may be used where Disposition Holders wish to capture the presence of underheight trees. Pine with western gall rust (WGR) that encircles ≥50% of the main stem must be tallied separately.

To determine if a tree is inside the plot, surveyors are to measure from the plot centre marker to the base of the stem (point of germination at ground level). If any part of the stem is within the plot radius, the tree shall be considered inside the plot.

6.3 Detailed Plot Measurements

6.3.1 Height and Diameter

At every fourth plot, a subsample of trees ≥30 cm tall will be measured for height and diameter at breast height (DBH) where trees are >1.3 m tall. These trees shall be measured within the 1.78 m radius (10 m^2) plot and five trees of each species shall be measured. To select the trees for height and diameter measurements, the surveyor shall start sampling at North (360°), move in a clockwise direction and select the first five trees encountered of each species that are at least 30 cm tall.

Height shall be measured to the tip of the main leader (regardless of whether or not the growing season is complete) and recorded to the nearest cm. DBH shall be measured and recorded to the nearest mm. If trees are <130 cm tall, diameter measurements are not required.

6.3.2 Top Height

6.3.2.1 Selection and Marking

One 'top height' tree per species shall be measured for height, age, diameter (optional) and dominance class at each Detailed plot location. A 'top height' tree is the largest diameter[19] tree of each species within the 5.64 m radius (100 m^2) Detailed plot. Top height trees must be at least 30 cm tall.

If the largest diameter tree has a lost or broken top that has not yet been replaced by a new leader, then the next largest diameter tree of that species shall be selected.

Trees classified as having WGR (≥50% of the stem encircled by WGR) are not eligible as top height trees.

[18] Cutoff date varies by Disposition Holder.

[19] Diameter shall be measured at breast height (1.3 m) unless the tree is <1.3 m tall. The diameter of trees <1.3 m tall shall be measured at stump height (30 cm above the point of germination).

All measured top height trees must be marked with all-weather flagging tape in each Detailed plot to facilitate field checking. Flagging tape should be tied to branches, not the main stem, to avoid girdling. If the Disposition Holder has elected to mark trees with aluminium tags, refer to Section 6.3.2.6 for guidelines.

Top height data collection is optional at the establishment survey (4 – 8 years), but mandatory at the performance survey (11 – 20 years).

6.3.2.2 Age and Height Measurements:

Height and age shall be measured on every top height tree at each Detailed plot. If surveys are conducted during the period of active height growth (May, June, and July), age and height measurements shall not include the current year's growth. Height measurements taken during this period must correspond with the correct aging point on the stem, which is at the point of terminal bud set the previous year. If surveys are conducted on or after August 1, the current year's growth shall be included in the determination of age and height.

Height shall be recorded to the nearest cm.

Total age (from germination) shall be determined as follows:

1. Count the number of branch whorls on coniferous trees or bud scars on deciduous trees from the current season's growth (i.e.: terminal leader) down to the root collar node;
2. Add one year (germination to cotyledon); and
3. Record tree age.

For any seedlings planted prior to June 20, the growing season in the year the seedling was planted may be counted as one year.

All surveyors shall be trained to recognize and distinguish lammas growth, false whorls, and hidden whorls in coniferous trees.

Surveyors should be provided with the following information in order to reliably determine the age of top height trees:

1. Planting and fill planting dates;
2. Planted species; and
3. Stock type (as relevant to tree age assessment e.g., 1+0).

Total age of top height trees shall not exceed the number of growing seasons since planting (plus age at out-planting for planted stock) unless emergents are present (seedlings regenerated from soil seedbank or aerial seeding before planting).

Because surveyors often rely on planting records for tree age calibration, whether or not a tree was planted will affect the confidence in age estimates. Field crews shall record tree source (P-planted; N-natural; U-unknown). Surveyors should use 'U' only as a last resort.

Surveyors should also record their confidence (High, Medium or Low) in the age estimates for each top height tree. Confidence shall be recorded as:

- High – confident that estimate is within one year;
- Medium – fairly confident, but if planting records are incomplete could be out by more than one year (likely 2-3 years); or

- Low – an educated guess (general should only be used if destructive sampling is not carried out).

6.3.2.3 Optional: Diameter Measurements

Record the diameter (mm) at breast height (1.3 m above the point of germination) for each selected top height tree.

6.3.2.4 Tree Dominance Assessments

Each top height tree shall be assigned a dominance code based on its crown position, per Table 6-2:

Table 6-2: Tree dominance codes

Crown Position	Code	Description
Dominant	D	Crown extends above the general level of the canopy
Co-dominant	C	Crown forms the general level of the canopy
Intermediate	I	Crown is below the general level of the canopy, but extends into the bottom to middle portion of the canopy layer
Supressed	S	Crown is entirely below the general level of the canopy

6.3.2.5 Optional: Destructive Sampling

In some situations, there may be uncertainty around tree aging, particularly if planting records are incomplete or there has been significant ingress from nearby residual stands. Also, aging deciduous trees using bud scars can be difficult once trees are older than 5 – 6 years. As such, destructive sampling can be used in order to help calibrate field crews. The general rules are:

- DO NOT destructively sample trees without the approval of the Disposition Holder.
- It is expected that conifers can be accurately aged using whorl counts; permission to destructively sample conifers must also be obtained by the Disposition Holder.
- When using permanent plot markers, DO NOT cut down top height trees inside the Detailed plot. Destructive sampling of a similarly sized tree outside the plot is recommended.
- In general, try to minimize the number of trees that are destructively sampled; a few (2-3) trees of each species should be sufficient for a polygon.

To destructively sample trees, cut the tree down at the base so that total age is captured. Attach flagging tape to the tree and write “ARS destructive sample” and the date on the flagging tape.

6.3.2.6 Optional: Tree Tagging

If directed by the Disposition Holder, surveyors can mark top height trees with aluminium tags. Surveyors should attach tags loosely around a branch close to breast height (1.3 m) and ensure that sufficient slack is left in the loop to allow for branch growth; it may be another 10-15 years before the tree is re-measured.

During the establishment survey, tree tags shall be imprinted with the species and tree number (e.g.: AW-1, SW-1, PJ-1, etc.). At the performance survey, it is possible that the previous top height tree is no longer the largest diameter tree. In this case, the new top height tree should receive a new tag and number (e.g.: AW-2, PJ-2, etc.) and both the new and old top height trees should be measured for height, age, diameter (optional) and crown dominance and all data is to be recorded and reported.

7.0 REGENERATION SURVEY TALLY SHEETS AND MAPS

7.1 Tally Sheets

Disposition Holders may develop and use their own datasheets for recording survey data in the field. However, Regeneration Survey Tally Sheets are provided (Appendix D) to assist Disposition Holders with field data collection. These tally sheets approximate the format required by the data dictionaries (Appendix E).

Disposition Holders may choose to add columns to the Regeneration Survey Tally Sheets to record additional information that they feel is relevant to collect while conducting field surveys. Any data recorded in added columns do not form part of the requirements of the survey, so are not required to be submitted to Alberta.

7.2 Field Maps

Disposition Holders are required to submit a field map along with their regeneration survey results. Disposition Holders may use the Regeneration Survey Field Map Sheet provided (Appendix D) or produce a digital field map.

Required elements of a field map are:

a) Polygon number;
b) Name of Disposition Holder;
c) Disposition Number;
d) Original polygon boundary;
e) Updated polygon boundary (if applicable) with annotation describing reason(s) for the update (e.g.: road right-of-way within polygon boundary);
f) Location of any deletion areas annotated with type (NAA 1 or 2) and brief description (e.g.: NAA 1, new pipeline construction);
g) SU boundaries;
h) PRV boundaries, annotated with health, severity and causal (if known) codes;
i) Any research installations and/ or permanent sample plots encountered during the survey;
j) Location of points of commencement and tie points;
k) Locations of established and measured plots and associated plot identification numbers;
l) North arrow; and
m) Scale.

The following standards also apply to field maps:

a) All boundary adjustments, deletions, and SU boundaries shall be drawn using solid lines;
b) All PRV boundaries shall be drawn using dashed lines and shall be shaded using diagonal lines;
c) Any planned plot locations that were not sampled shall be identified with an ‘x’;
d) Any contingency plots that were sampled shall be circled; and
e) The route taken by the surveyors shall be drawn on the map.

8.0 DATA FORMATS AND QUALITY STANDARDS

8.1 Spatial Data Format Standards

The format for the spatial data (stratification line-work) shall be either Environmental System Research Institute® (ESRI) Arc compatible format or non-digital map.

The following are acceptable ESRI Arc compatible formats:

1. Shape file (*.shp, *.shx, *.dbf, *.prj);
2. Geodatabase; and,
3. Coverage file (ESCI ARC/INFO® export file format *.e00. Projection and tolerances must be defined).

All digital data shall have associated metadata that describes:

1. The digital file structure;
2. Data accuracy; and,
3. Any deviations from the accepted standards.

The projection shall be Universal Transverse Mercator (UTM; zone, easting, and northing) in meters.

The Datum shall be:

1. NAD83 CSRS98 for ArcView shape files;
2. NAD83 CSRS98 for geodatabase files; and,
3. NAD83 CNT for ArcInfo coverage files.

The format for non-digital maps is described in Section 7.2.

8.2 Stratification Quality Assessment and Control Procedures

Disposition Holders shall have documented quality assessment and control procedures. These procedures shall be maintained and be provided to Alberta upon request.

8.3 Plot Data Quality Assessment and Control Procedures

Data input accuracy and consistency are the responsibility of the submitting Regulated Professional (RP). Relational quality control, extreme value identification, and/ or other pertinent attribute checks to ensure accurate data are the sole responsibility of the Disposition Holder.

9.0 REPORTING REQUIREMENTS

For each reclaimed polygon targeting an end land use of commercial forestry, the Disposition Holder shall ensure that all required data, as described in Sections 9.1 to 9.5 and summarized in Figure 9-1, is submitted to Alberta.

Submissions shall be made every year following a regeneration survey program and shall be due on or before April 15. If no surveys were completed during the previous year, a notation reflecting that fact shall be made in the Annual Reclamation Progress Tracking Report.

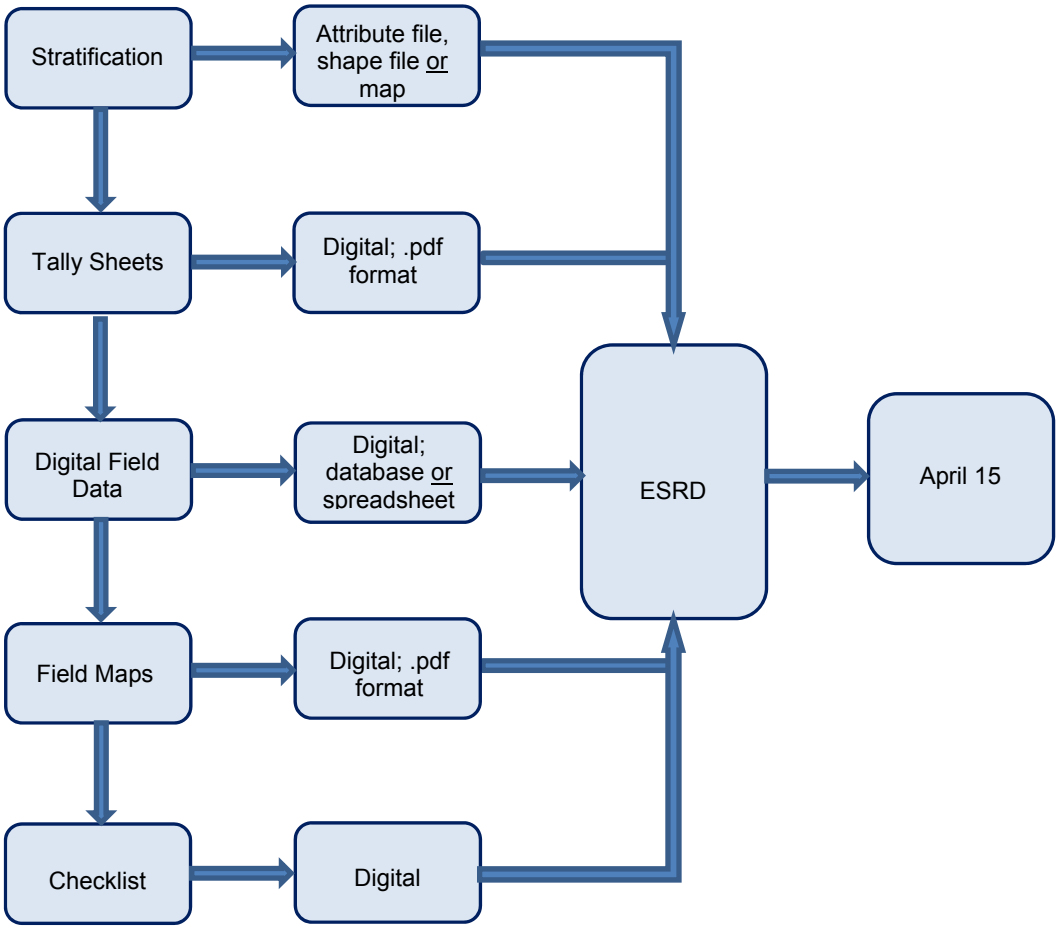


Figure 9-1: Summary of MOS ARS reporting requirements

All reporting components described below are required to be submitted to the Director on or before April 15 the year following the year of field sampling (i.e.: plots completed during the summer of 2013 are required to be submitted by April 15, 2014). All digital data must follow the paper submission within one month.

9.1 Stratification

The reporting requirements for the stratification component of regeneration surveys are:

1. Stratification line work spatial data; and
2. Attribute data:
    i. Sampling Unit attribute data (Appendix E, Table E-2); and
    ii. Poorly Revegetated Areas attribute data (Appendix E, Table E-3).

Where Sampling Units and Poorly Revegetated Areas were delineated spatially using GPS or digitizing, shape file, geodatabase or coverage files are acceptable formats (Section 8.1).

If neither GPS nor digitizing were used to delineate the NAA, then a hand-drawn map to scale is acceptable.

9.2 Tally Sheets

If paper tally cards were used by surveyors, the Disposition Holder shall submit a digital copy of the cards (scanned to digital .pdf).

9.3 Digital Field Data

Disposition holders are required to submit a Microsoft Access® database (*.mdb file) or a Microsoft Excel® spreadsheet (*.xls or *.xlsx file) that contains the following tables:

- Polygon1 – Master Polygon List;
- SU1 – Sampling Unit attribute data;
- PRV1 – Poorly Revegetated Areas attribute data;
- Ground1 – Unit Header;
- Ground2 – Plot Header;
- Ground3 – Basic Plots;
- Ground4 – Detailed Plots, Top Height; and
- Ground5 – Detailed Plots, Height and Diameter (if applicable).

Data dictionaries describing the contents of each table are located in Appendix E.

9.4 Field Maps

Field maps for each polygon sampled shall also be submitted (requirements are described in Section 7.2).

9.5 Reporting Checklist and Validation

A Reporting Checklist is provided to ensure all mandatory reporting elements are accounted for (Appendix F). Disposition Holders shall ensure that each appropriate element is reported by initialling beside each element and by signing and dating the Reporting Checklist. By initialling, signing and dating the checklist, Disposition Holders are stating that the report is complete, accurate and on time.

Reporting Checklists must be validated by a Regulated Professional[5] (RP). The validating RP must have done the work, contracted the work or supervised those who did the work and is accountable for ensuring the reporting of regeneration survey information is complete and accurate.

Completed checklists must accompany all regeneration survey submissions to Alberta. Completed checklists must be digital (scanned to .pdf).

APPENDIX A
GLOSSARY

Term	Definition
Acceptable Tree:	A tree that meets the following criteria: Acceptable tree species (Table 6-1); and Is alive and expected to survive to maturity; and Originated from seed, suckering or coppice, but not from layering (note: each stem originating from coppice growth may be considered a separate acceptable tree); and Is 30 cm or taller. Additional acceptable tree criteria specific to coniferous tree species include: A well-defined stem with not more than two stems originating at the base; and, A live-crown ratio of 0.33 or greater (applies to white spruce, Engelmann spruce, and fir trees only).
Alberta:	The Department of Environment and Sustainable Resource Development, or as amended from time to time.
Basic Plot:	A plot that is 1.78 m in radius (10 m^2) where tree tallies by species and height class are recorded. Basic plots are completed at every valid plot location.
Buffer:	An area of forest or vegetative cover usually intended to provide protection for some natural feature or serve as a wildlife corridor.
Commercial Forest:	For the purposes of regeneration surveys - a polygon being managed to target a C or D crown closure class at maturity and a minimum site index equivalent to the midpoint of the 'fair' Timber Productivity Rating class for a given species. Under the *Environmental Protection and Enhancement Act* Approvals, commercial forests are defined as "land characterized by all of the following in the Alpac Forest Management Agreement area: (i) meets minimum merchantable thresholds for coniferous and deciduous trees species, as defined in the *Forest Management Agreement between the Government of Alberta and Alpac*, 1998, as amended; (ii) meets the tree species requirements of the *Alpac Forest Management Plan*, 2007, as amended and the *Alberta Forest Genetic Resource Management and Conservation Standards*, May 2009, as amended; and (iii) would be deemed to be contributing toward the operable landbase as prescribed by the mandatory and discretionary landbase exclusions listed within the *Alpac Forest Management Plan*, 2007, as amended; or (iv) other characteristics specified in writing by the Director."
Coniferous tree:	Needle-leafed trees which produce cones (includes larch spp.)
Control Line:	A line established at 400 m intervals for control of plot location. The control line runs across the long axis of the polygon and is marked at points where survey lines cross it.
Coppice:	A natural regeneration process similar to suckering where the seedling or sapling regenerates from the cut or damaged stump. A number of healthy stems may be observed coming from one stump. Found primarily in birch, but also in other deciduous species.
Deciduous tree:	Broadleaved tree species that lose their leaves in the fall.
Detailed Plot:	A plot that is 5.64 m in radius (100 m^2) where a subsample of tree heights and diameters are measured and top height tree ages, heights and diameters are assessed. The first and every 4^{th} Basic plot is also measured as a Detailed plot.
Disposition:	The legal document that provides the rights to operate mining activities to the Disposition Holder.

Term	Definition
Disposition Holder:	The company that holds the rights to operate mining activities. For regeneration surveys, the Disposition Holder is based on the disposition in effect at the time of reclamation.
Establishment Survey:	The first survey required 4 – 8 years after reforestation clock start.
False Whorl:	Similar to lammas growth, where there appears to be a whorl on the bole but this is not the actual demarcation of a season's growth.
Field Number:	An unofficial 'working' number assigned to a polygon by the Disposition Holder.
Forest Ecosystem:	The sum of the plants (predominantly trees and other woody vegetation), animals, environmental influences, and their interactions.
Horizontal Projection:	A flat view of the ground that is corrected for the additional land area created by topographic features.
Hybrid:	The offspring of two plants of different varieties. Hybrids can occur naturally or can be the result of tree improvement programs to improve the growth or other characteristics of the native varieties.
Lammas Growth:	An additional whorl of branches or a second flush of leader growth occurring late in the growing season[20].
Live Crown Ratio:	The proportion of total tree stem length covered by living branches. It is expressed as a percentage or decimal of the total tree height (e.g.: 0.3 or 30%). Live crown ratio is a useful indicator of tree vigour and photosynthetic leaf area; is inversely related to stocking density.
Missing Whorl:	Cases where a whorl is not clearly visible, and may result in an underestimate of the number of elapsed growing seasons.
Natural Subregion:	A geographic area, containing sites with similar characteristics, and defined by plant species composition and abundance of reference ecosites.
Net Assessment Area:	Net area available for regeneration surveys, excluding disturbances that are "permanent" (e.g., roads, pipeline rights-of-way) and/ or unharvested areas (areas with standing mature trees not impacted by oil sands development).
Polygon:	An area defined by the Disposition Holder based on, at a minimum, the combination of soil and vegetation attributes within a spatially contiguous area. A polygon is the unit for reforestation management (i.e., regeneration surveys) and each polygon must have a unique administrative identification for a given Disposition Holder. Polygons can be subdivided to refine strata delineation, but outside polygon boundaries cannot be altered, except due to permanent anthropogenic deletions (Table 4-2, NAA=2).
Poorly Revegetated Area (PRV):	An area within a reclaimed polygon that is ≥ 0.5 ha in size where trees show significant health issues or mortality relative to the rest of the polygon. PRVs may indicate a problem with reclamation (e.g.: underlying soil conditions), tree health (e.g.: insect/ disease outbreak) or tree vigour (e.g.: physical damage).

[20] Reference: Dunster, J., and K. Dunster. 1996. Dictionary of Natural Resource Management. UBC Press, Vancouver, BC.

Term	Definition
Professional Regulatory Organization (PRO):	In reclamation and remediation work, the Professional Regulatory Organizations represent over 6000 licensed environmental professionals. The PROs are: Alberta Institute of Agrologists (AIA), Alberta Society of Professional Biologists (ASPB), Association of the Chemical Profession of Alberta (ACPA), Association of Professional Engineers, Geologists and Geophysicists of Alberta (APEGGA), College of Alberta Professional Foresters (CAPF), and College of Alberta Professional Forest Technologists (CAPFT).
Reclamation:	The stabilization, contouring, maintenance, conditioning, reconstruction, and revegetation of the surface of the land to a state that permanently returns a disturbed area to a land capability equivalent to its pre-disturbed state.
Reforestation Clock Start Date:	May 1 following the first reforestation treatment for the polygon.
Regulated Professional (RP):	A member in good standing of any of the Professional Regulatory Organizations (PROs).
Riparian Area:	A terrestrial area where the vegetation and microclimate are highly influenced by perennial and/or intermittent water associated high water tables and soils that exhibit some wetness characteristics.
Sampling Unit (SU):	A homogenous stratum within a reclaimed polygon that is delineated to increase sampling precision and the accuracy of evaluation relative to targets. Delineation of Sampling Units is based on (at a minimum) tree species composition and tree density classes.
Self-Sustaining:	Able to support various land uses after land conservation and reclamation is complete without requiring the use of fertilizers or any other special treatment.
Site Index:	A relative measure of site quality based on the height of dominant trees in a stand at some reference age.
Soil Placement Date:	The year in which soil placement is completed. Does not define the regeneration survey clock start; see Reforestation Clock Start Date.
Stocking (%):	The sum of all the satisfactorily restocked Basic plots on the polygon, divided by the total number of valid plots, multiplied by 100 to express term as a percent.
Stratum/ Strata:	The label assigned to a Sampling Unit to characterize the reasons it was delineated as a separate unit. The stratum label is a combination of the tree species composition class (Table 4-2) and tree density class (Table 4-3). Examples include: “Hw-L”, “MxLx-M” and “”Sw-H”.
Survey Line:	Survey lines run perpendicular to the control lines, parallel with each other and at a calculated spacing. Plots are located along the survey line if a field-based plot establishment method is followed.
Tree Height (General):	The height of the tree is measured from the base of the tree at the average ground level to the tip of the leader. Refers to height and diameter measurements taken in the 10 m^2 plots.
Tree Height (Top Height):	The height of the tree is measured from the base of the tree at the average ground level. The height of coniferous trees measured prior to August 1st shall be measured to the base of the current year’s growth. On or after August 1st, height shall be measured to the top of the terminal bud or the furthest reaching living bud. For deciduous trees, the current season’s growth is to be measured. The point of measurement for height and age shall correspond.

Term	Definition
Under-height Tree:	Conifer trees that are 15-29 cm tall. These trees are below the height threshold of a regeneration survey and cannot be counted as part of the Basic Plot measurements. However, Disposition Holders may wish to note the presence of these trees for other purposes.
Whorl:	Circular demarcation around the bole of a tree, generally indicating the point of commencement of a new growing season (growth from the bud at the tip of the leader).

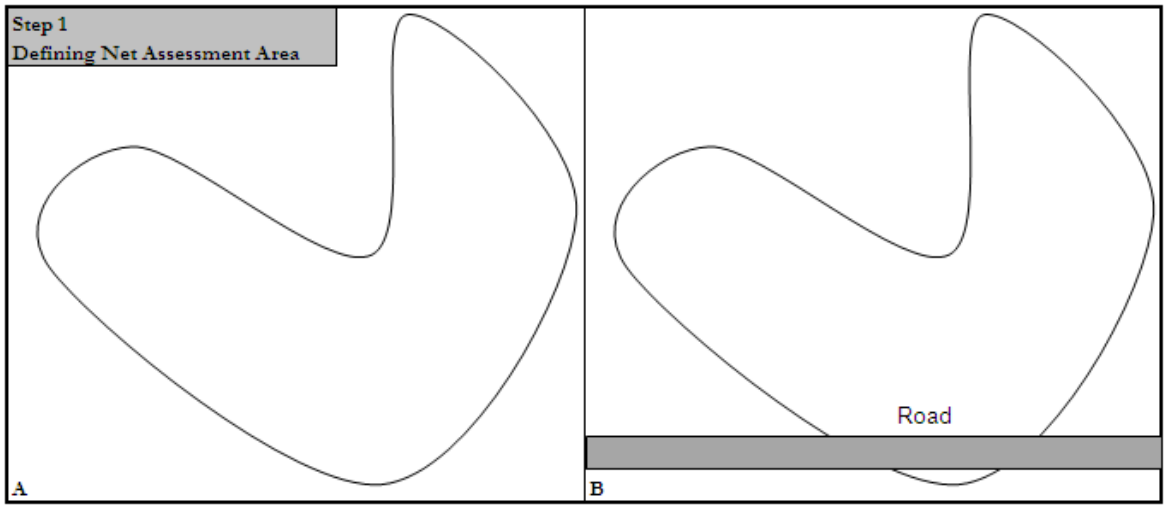
APPENDIX B
DELINEATION OF SAMPLING UNITS

Examples of Evaluating NAA Deletions, SUs, and PRVs

Step 1: Define the Net Assessment Area (NAA).

This step nets out any land use dispositions or natural deletions as outlined in Section 4.1.

For example, Graphic A shows the original polygon boundaries prior to delineation. Graphic B shows the NAA after a road is removed from the NAA.

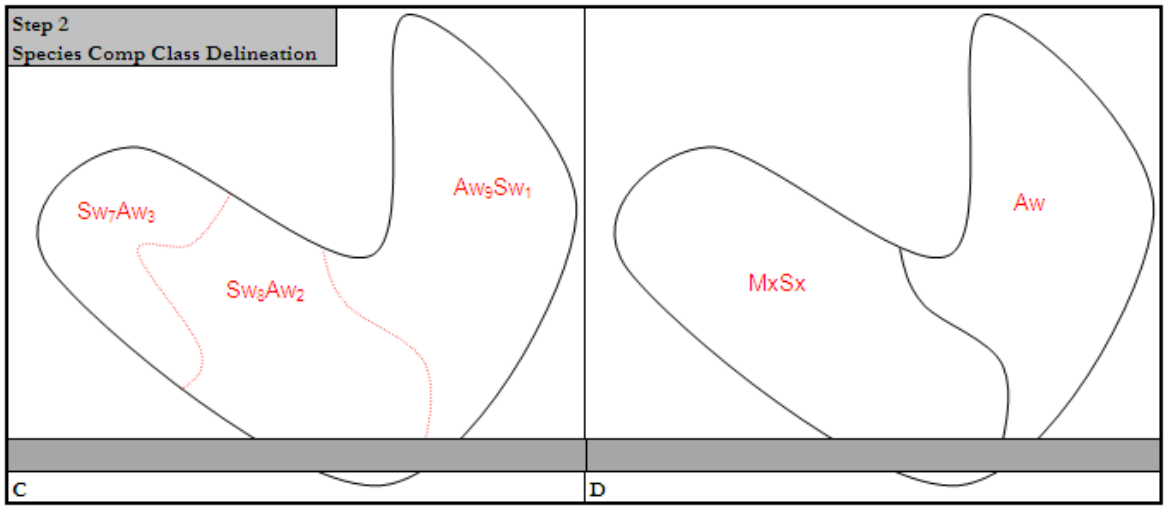


Step 2: Delineate the Sampling Units within the NAA based on species composition:

1. Where tree species composition class (Table 4-2) differs; and
2. Where the tree species composition percentage of a single species within the cover type differ by more than 20%; and
3. Where minimum Sampling Unit size (2 ha) and width (50 m) criteria are met.

For example, Graphic C shows the preliminary line work based on differences in species composition class. Graphic D shows the final line work for species composition. The line between Sw_8Aw_2 and Sw_7Aw_3 was not drawn because the tree species composition did not differ by at least 20% (criterion 2 above). In general, field crews will not be able to pick up differences of 20% in species composition during ground surveys, but this may be picked up using aerial of helicopter methods. QC tolerances should reflect the difficulty of ground-based delineation.

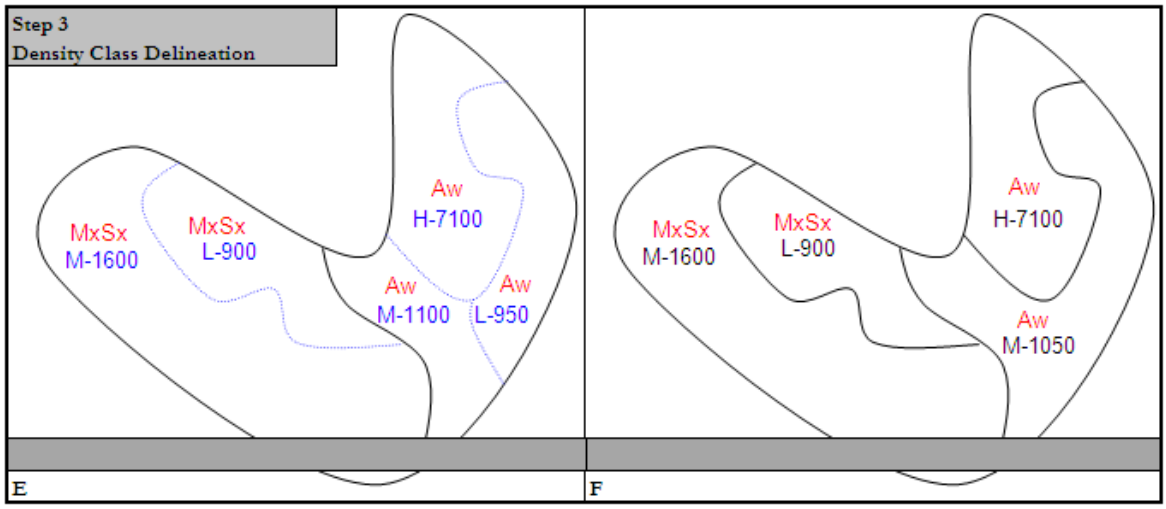
The small portion of the polygon south of the road is < 2 hectares in size and was only separated from the remainder of the polygon due to land use (road right-of-way). In order to prevent creating SUs under 2 ha, this piece should be associated with an adjacent SU (i.e., the MxSx), rather than sampling as a separate entity. In this case, it would have the same SU number as the MxSx polygon.



Step 3: Delineate the Sampling Units based on tree density:

1. Where total tree density class differs (Table 4-3); and
2. Where total tree density differs by more than the minima outlined in Table 4-4; and
3. Where minimum Sampling Unit size (2 ha) and width (50 m) criteria are met.

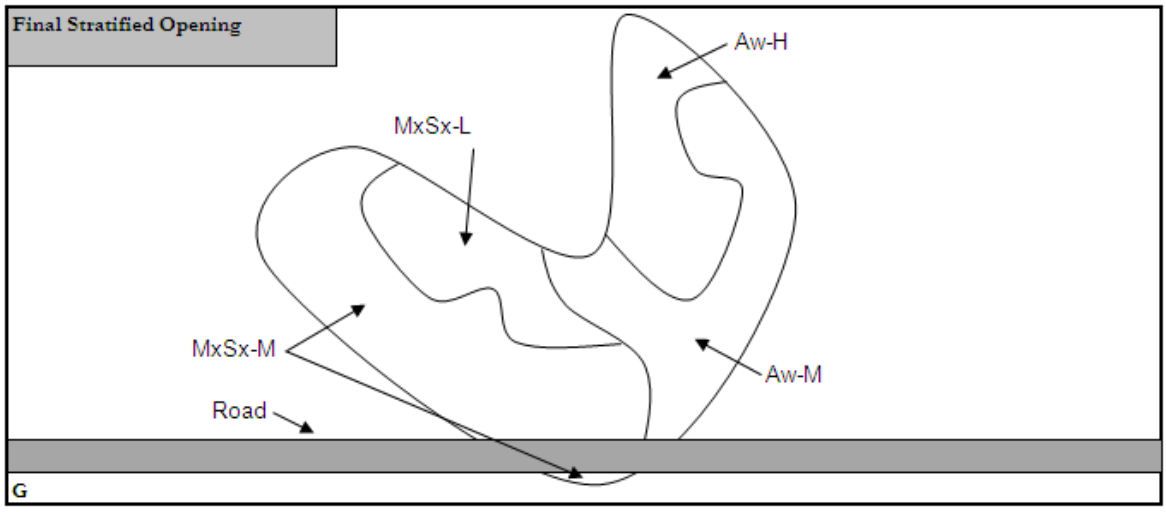
For example, Graphic E shows the preliminary line work based on total tree density class differences. Graphic F shows the final line work for density class. The line between M-1100 and L-950 is excluded because it did not meet the second density delineation criterion (i.e., densities did not differ by more than 250 stems per hectare). Again, QC tolerances should reflect the difficulty of ground-based delineation.



Step 4: Delineate the Sampling Units based on additional (company-specific) criteria:

1. Where defined classes differs; and
2. Where minimum Sampling Unit size (2 ha) and width (50 m) criteria are met.

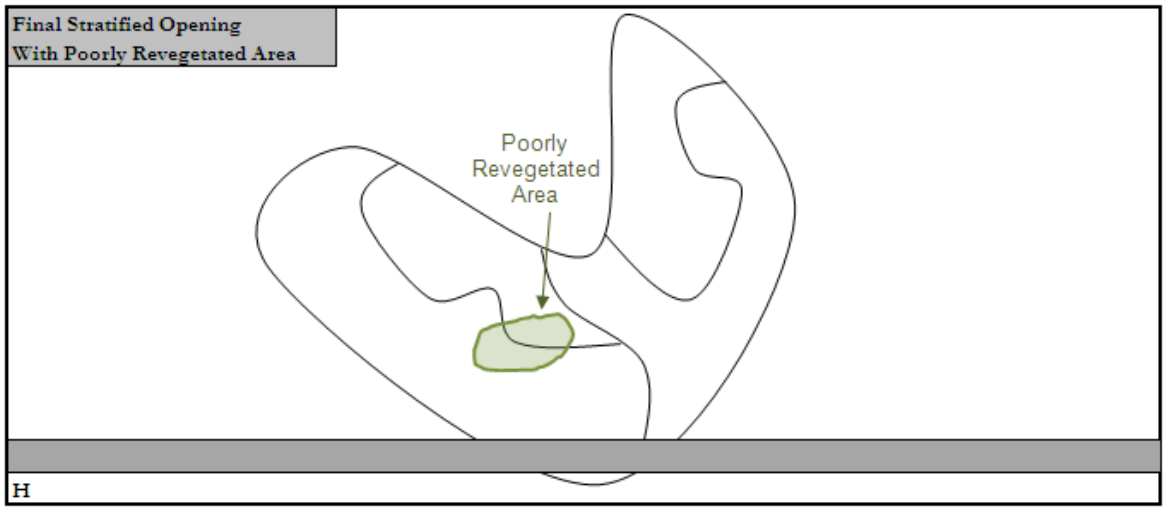
Graphic G shows the final stratification for the polygon where no additional user-defined classes were used.



Step 5: Delineate any Poorly Revegetated Areas:

1. Where tree growth/ health/ survival (Table 4-5) is obviously different from the rest of the polygon; and
2. Where minimum PRV size (0.5 ha or encountered in ≥3 basic plots) criteria are met; and
3. Where they are located within the NAA.

Graphic H shows a stratified polygon with the delineation of a poorly revegetated area. Note that PRVs may extend across multiple SUs. In this example there would be five SUs, including one PRV.



APPENDIX C
LINE AND PLOT SPACING

Hectares	Square Metres per plot	Square Spacing in Metres	Plots/Ha	Number of Plots
0.5	384.62	19.61	26.00	13
1.0	769.23	27.74	13.00	13
1.5	714.29	26.73	14.00	21
2.0	487.80	22.09	20.50	41
2.5	609.76	24.69	16.40	41
3.0	731.71	27.05	13.67	41
3.5	853.66	29.22	11.71	41
4.0	975.61	31.23	10.25	41
4.5	703.13	26.52	14.22	64
5.0	781.25	27.95	12.80	64
5.5	859.38	29.32	11.64	64
6.0	937.50	30.62	10.67	64
6.5	1015.63	31.87	9.85	64
7.0	1093.75	33.07	9.14	64
7.5	1171.88	34.23	8.53	64
8.0	1250.00	35.36	8.00	64
8.5	1328.13	36.44	7.53	64
9.0	1406.25	37.50	7.11	64
9.5	1484.38	38.53	6.74	64
10.0	1562.50	39.53	6.40	64
10.5	1640.63	40.50	6.10	64
11.0	1718.75	41.46	5.82	64
11.5	1796.88	42.39	5.57	64
12.0	1875.00	43.30	5.33	64
12.5	1953.15	44.19	5.12	64
13.0	2031.25	45.07	4.92	64
13.5	2109.38	45.93	4.74	64
14.0	2187.50	46.77	4.57	64
14.5	2265.63	47.60	4.41	64
15.0	2343.75	48.41	4.27	64
15.5	2421.88	49.21	4.13	64
16.0	2500.00	50.00	4.00	64
16.5	2578.13	50.78	3.88	64
17.0	2656.25	51.54	3.76	64
17.5	2734.38	52.29	3.66	64
18.0	2812.50	53.03	3.56	64
18.5	2890.63	53.76	3.46	64
19.0	2968.75	54.49	3.37	64
19.5	3046.88	55.20	3.28	64
20.0	3125.00	55.90	3.20	64
20.5	3203.13	56.60	3.12	64
21.0	3281.25	57.28	3.05	64
21.5	3359.38	57.96	2.98	64
22.0	3437.50	58.63	2.91	64
22.5	3515.63	59.29	2.84	64
23.0	3593.75	59.95	2.78	64
23.5	3671.88	60.60	2.72	64
24.0	3750.00	61.24	2.67	64
24.5	3610.11	60.08	2.77	68

Hectares	Square Metres per plot	Square Spacing in Metres	Plots/Ha	Number of Plots
25.0	3610.11	60.08	2.77	69
25.5	3610.11	60.08	2.77	71
26.0	3610.11	60.08	2.77	72
26.5	3610.11	60.08	2.77	73
27.0	3610.11	60.08	2.77	75
27.5	3610.11	60.08	2.77	76
28.0	3610.11	60.08	2.77	78
28.5	3610.11	60.08	2.77	79
29.0	3610.11	60.08	2.77	80
29.5	3610.11	60.08	2.77	82
30.0	3610.11	60.08	2.77	83
30.5	3610.11	60.08	2.77	84
31.0	3610.11	60.08	2.77	86
31.5	3610.11	60.08	2.77	87
32.0	3610.11	60.08	2.77	89
32.5	3610.11	60.08	2.77	90
33.0	3610.11	60.08	2.77	91
33.5	3610.11	60.08	2.77	93
34.0	3610.11	60.08	2.77	94
34.5	3610.11	60.08	2.77	96
35.0	3610.11	60.08	2.77	97
35.5	3610.11	60.08	2.77	98
36.0	3610.11	60.08	2.77	100
36.5	3610.11	60.08	2.77	101
37.0	3610.11	60.08	2.77	102
37.5	3610.11	60.08	2.77	104
38.0	3610.11	60.08	2.77	105
38.5	3610.11	60.08	2.77	107
39.0	3610.11	60.08	2.77	108
39.5	3610.11	60.08	2.77	109
40.0	3610.11	60.08	2.77	111
40.5	3610.11	60.08	2.77	112
41.0	3610.11	60.08	2.77	114
41.5	3610.11	60.08	2.77	115
42.0	3610.11	60.08	2.77	116

APPENDIX D
TALLY SHEETS AND FIELD MAP SHEET

HEADER SHEET - MOS ARS											
Polygon Information			Planting Information (complete prior to survey)								
Polygon Information	Disposition Holder		Year	Month	Day	Species	Stock	Density	Distrib'n	Pattern	
	Disposition Number										
	Field Number										
	Polygon Number										
	Reclaimed Area (ha)										
	Net Assessment Area (ha)										
	Reforestation Year (YYYY)										
	Reforestation Month (1-12)		Optional Measurements Information (complete prior to survey)								
	Reforestation Day (1-31)		Permanent Plot Marking (Y/N):				Estab. Only - Top Height (Y/N):				
Survey Information	Surveyor ID #1		Tag Top Height Trees (Y/N):				Top Height DBH (Y/N):				
	Surveyor ID #2		Polygon Comments:								
	Company										
	Survey Year (YYYY)										
	Survey Month (1-12)										
	Survey Day (1-31)										
	Req'd Number of Plots										
	Line/ Plot Spacing										

Sampling Unit Information					
SU #	NAA Type (0, 1, or 2)	SU Area (ha)	Stratum	Number of Basic Plots	Number of Detailed Plots

Poorly Revegetated Area Information								GPS Unit Information	
PRV #	PRV Area (ha)	Trees				Causal Factors		Make:	
		DAM1	SEV1	DAM2	SEV2	CAUS1	CAUS2	Model:	
								Coord. Sys:	
								LL Format:	
								UTM Zone:	
Total PRV Area:									

Poorly Revegetated Area Comments:

Figure D-1: Header Information Tally Sheet

Refer to Appendix E for data dictionaries.

Sheet 1 - MOS ARS: DENSITY AND TOP HEIGHT																	
Polygon Number:			Survey Year:			Survey Month:				Survey Day:			Page: ____ of ____				
SU INFORMATION			BASIC PLOT - All plots (1.78 m radius)						DETAILED PLOT - every 4th plot (5.64 m radius)							
SU	Plot ID	Plot Type (B or D)	Species	WGR (Y or blank)	Tree Tally by species Height Class (cm)				Species	Height (cm)	DBH* (mm)	Total age (yrs)	Tree Type (P/N/U)	Confidence (H/M/L)	Crown Class (D/C/I/S)	Tag ID*
					15-29	30-79	80-129	130+								
*optional at the discretion of the Disposition Holder																	

Figure D-2: Basic Plot Tree Counts and Detailed Plot Top Height Tree Tally Sheet

Refer to Appendix E for data dictionaries.

Sheet 2 - MOS ARS: DIAMETER AND HEIGHT

Polygon Number:		Survey Year:		Survey Month:		Survey Day:		Page: ________ of ________

SU INFORMATION		DETAILED PLOT - every 4th plot (1.78 m radius)				SU INFORMATION		DETAILED PLOT - every 4th plot (1.78 m radius)				SU INFORMATION		DETAILED PLOT - every 4th plot (1.78 m radius)			
SU	Plot ID	Species	WGR[1] (Y or blank)	DBH (mm)	Height (cm)	SU	Plot ID	Species	WGR[1] (Y or blank)	DBH (mm)	Height (cm)	SU	Plot ID	Species	WGR[1] (Y or blank)	DBH (mm)	Height (cm)

[1] assign 'Y' to WGR if gall encircles ≥50% of the stem

Figure D-3: Detailed Plot Tee Heights and Diameters Tally Sheet

Refer to Appendix E for data dictionaries.

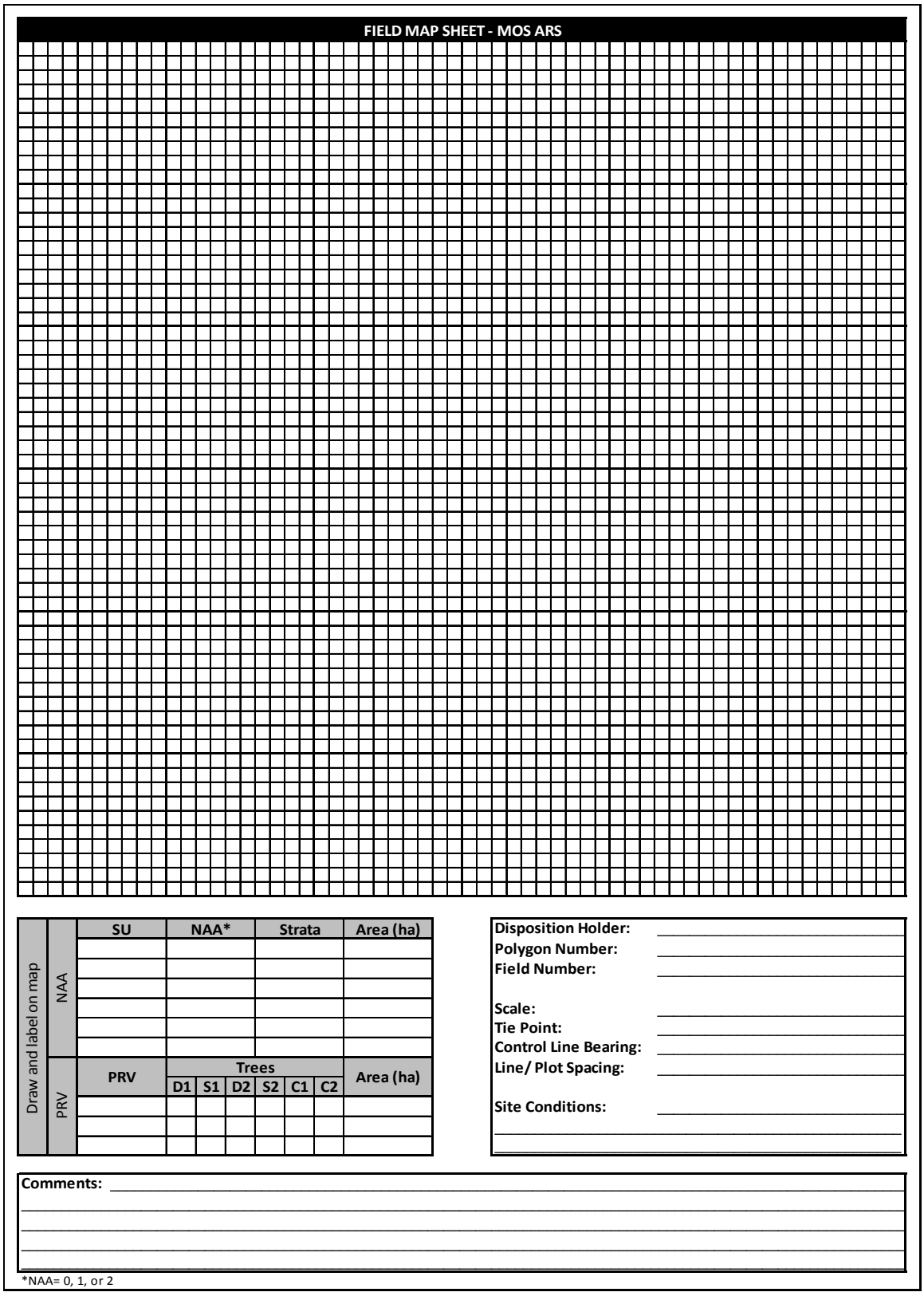


Figure D-4: Map Sheet

APPENDIX E
STANDARDIZED REPORTING DATA DICTIONARIES

A standardized data format must be used to record and report on polygon attributes. The field names, descriptions, and allowable codes are provided in Tables E-1 to E-8. Attributes shall be recorded in a flat file format with one row per polygon.

Fields are mandatory unless otherwise noted.

Table E-1: Data dictionary for Polygon1 – Master polygon list

Field Name	Format[21]	Description	Note
DISPOSITION_HOLDER	$28.0	The disposition holder code (Table 4-8) associated with the Disposition Holder that is responsible for reclamation.	E.g.: "SUNC_FORT", "SHEL_JACK", etc.
DISPOSITION	$10.0	The legal document that grants the rights to operate an oil sands mine. Refers to the disposition in effect at the time of reclamation.	E.g.: "151000-00-01" etc.
FIELD_NUMBER	$12.0	Internal polygon number used by the Disposition Holder.	E.g.: "1234" Optional field
POLYGON	$11.0	Unique number assigned by the Disposition Holder to identify the area.	E.g.: "2515AA" (no blanks allowed)
NET_RECL_HECTARES	7.2	Original reclaimed area of the polygon based on Disposition Holder records.	Eligible codes: 0.01 to 9999.99
UPDATE_AREA	7.2	Updated reclaimed area based on Disposition Holder records and changes that have occurred since reclamation.	Eligible codes: 0.01 to 9999.99
REFOR_YEAR	4.0	Year of first reforestation treatment.	Eligible codes: 1960 to 2058
REFOR_MONTH	2.0	Month of first reforestation treatment.	Eligible codes: 1 to 12
REFOR_DAY	2.0	Day of first reforestation treatment.	Eligible codes: 1 to 31
PRV_AREA	7.2	Total poorly revegetated area (hectares)	Eligible codes: 0.01 to 9999.99
COMMENTS	$255.0	Comments for individual polygons.	Optional field

[21] Formats for data are either characters or numerals. The character format is identified by the '$' and refers to a combination of alphabet and number (alphanumeric) characters. The numeric format (no $) is to contain numbers only. The number of characters/ numerals allowed (including the decimal) is indicated by the number to the left of the decimal and the number of decimal places allowed is indicated by the number to the right of the decimal. For example, a format of 7.2 indicates there can be up to 7 numbers (including the decimal) in this field, with a maximum of 2 decimal places and characters could not be entered into this field.

Table E-2: Data dictionary for SU1 – Sampling Unit attribute data

Field Name	Format	Description	Note
POLYGON	$11.0	Unique number assigned by the Disposition Holder to identify the area.	E.g.: “2515AA” (no blanks allowed)
SU	$3.0	Unique Sampling Unit number within a polygon.	E.g.: “001”, “002”, “003”, etc. (no blanks allowed)
UNIQUE_ID	$16.0	Unique identifier is made up of polygon number and SU.	E.g.: “2515AA_001”, “2515AA_002”, etc. (No blanks allowed)
AREA_HA	7.2	Area (hectares) of the SU.	Eligible codes: 0.01 to 9999.99
NAA	2.0	Net Assessment Area indicator	Eligible codes: 0, 1, or 2
SP_CL	$4.0	Species composition class	Eligible codes: blank, “Hw”, “MxLx”, “MxPj”, “MxSx”, “Sw”, “Lx”, “Pj”, “Sb”
DEN_CL	$2.0	Density class	Eligible codes: blank, “L”, “M”, “H”

Table E-3: Data dictionary for PRV1 – Poorly Revegetated Area attribute data

Field Name	Format	Description	Note
POLYGON	$11.0	Unique number assigned by the Disposition Holder to identify the area.	E.g.: “2515AA” (no blanks allowed)
SU	$3.0	Unique Sampling Unit number within a polygon.	E.g.: “001”, “002”, “003”, etc. (no blanks allowed)
UNIQUE_ID	$16.0	Unique identifier is made up of polygon number and SU.	E.g.: “2515AA_001”, “2515AA_002”, etc. (no blanks allowed)
AREA_HA	7.2	Area (hectares) of the SU.	Eligible codes: 0.01 to 9999.99
DAMAGE1	$3.0	Code to identify the type of tree health issue.	Eligible codes: “DE”, “FO”, “MI”, “PD”, “PG”. Table 4-5
SEVERITY1	2.0	Code to identify the severity of tree health issue.	Eligible codes: 2, 3, 4. Table 4-6
DAMAGE2	$3.0	Code to identify the type of tree health issue.	Eligible codes: “DE”, “FO”, “MI”, “PD”, “PG”. Table 4-5
SEVERITY2	2.0	Code to identify the severity of tree health issue.	Eligible codes: 2, 3, 4 Table 4-6
CAUSAL1	$3.0	Potential causal factor for observed PRV.	Eligible codes: see list in Table 4-7
CAUSAL2	$3.0	Potential causal factor for observed PRV.	Eligible codes: see list in Table 4-7

Table E-4: Data dictionary for Ground1 – Unit Header

Field Name	Format	Description	Note
POLYGON	$11.0	Unique number assigned by the Disposition Holder to identify the area.	E.g.: “2515AA” (no blanks allowed)
SU	$3.0	Unique Sampling Unit number within a polygon.	E.g.: “001”, “002”, “003”, etc. (no blanks allowed)
AREA_FINAL	7.2	Area (hectares) of SU following field assessment.	Eligible codes: 0.01 to 9999.99
STRATA	$16.0	Label assigned to an SU to characterize why it was delineated as a separate unit, a combination of tree species composition class and tree density class.	Eligible codes: “Hw-L”, “MxLx-L”, “Mx-Pj-L”, “MxSx-L”, “Sw-L”, “Lx-L”, “Pl-L”, “Sb-L”, “Hw-M”, “MxLx-M”, “Mx-Pj-M”, “MxSx-M”, “Sw-M”, “Lx-M”, “Pl-M”, “Sb-M”, “Hw-H”, “MxLx-H”, “Mx-Pj-H”, “MxSx-H”, “Sw-H”, “Lx-H”, “Pl-H”, “Sb-H”,
SURVEYOR_ID1	$30.0	Name (first and surname) of primary qualified surveyor.	E.g.: “James Smith” (no blanks allowed)
SURVEYOR_ID2	$30.0	Name (first and surname) of qualified surveyor.	E.g.: “Nancy Simpson”
SURVEY_YEAR	4.0	Year of field survey	E.g.: 2009, 2012, etc.
SURVEY_MONTH	2.0	Month of field survey	Eligible codes: 1 to 12
SURVEY_DAY	2.0	Day of field survey	Eligible codes: 1 to 31
N_BASIC_PLOTS	3.0	Number of Basic Plots (defined as total number of basic + detailed plots)	Eligible codes: 1 to 999
N_DETAILED_PLOTS	3.0	Number of Detailed Plots	Eligible codes: 1 to 999
GPS_MAKE	$10.0	GPS receiver make	E.g.: “Garmin”, blank if GPS not used
GPS_MODEL	$20.0	GPS receiver model	E.g.: “GPSmap 76CSx”, blank if GPS not used
GPS_COOR_SYS	$3.0	Identifies the GPS coordinate system used: longitude and latitude (LL) or Universal Transverse Mercator (UTM). Use “NA” if GPS was not used.	Eligible codes: “LL”, “UTM”, “NA”
GPS_LL_FORM	$13.0	GPS coordinate system format when reporting plot locations using longitude and latitude (LL). Three common formats are: 1. degrees, minutes and seconds; 2. degrees and decimal minutes; and 3. decimal degrees.	Eligible LL formats: “hdddºmm’ss.s””; “hdddºmm.mmm’”; “hddd.ddddº” Blank if UTM is recorded in the GPS_COOR_SYS field or if GPS was not used.
GPS_UTM_ZONE	$3.0	Identifies the GPS UTM Zone when recording plot locations using the UTM coordinate system.	Eligible codes: “12N” or blank if “LL” was recorded in the GPS_COOR_SYS field or GPD was not used.

Table E-5: Data dictionary for Ground2 – Plot Header

Field Name	Format	Description	Note
POLYGON	$11.0	Unique number assigned by the Disposition Holder to identify the area.	E.g.: “2515AA” (no blanks allowed)
SU	$3.0	Unique Sampling Unit number within a polygon.	E.g.: “001”, “002”, “003”, etc. (no blanks allowed)
PLOT_ID	$8.0	Unique plot identifier, not more than 8 characters.	no blanks allowed
PLOT_TYPE	$1.0	Identified the type of plot as Basic (B) or Detailed (D)	Eligible codes: “B” or “D”
PLOT_X_COOR	$14.0	GPS X coordinate for the plot: • If the GPS_COOR_SYS is LL, then the X coordinate is longitude (negative with west longitude). • If the GPS_COOR_SYS is UTM, then the X coordinate is a measurement of the East-West position in metres (Easting; mE). • If the GPS_COOR_SYS is NA, then the X coordinate is blank.	LL examples: “-W114°47’14.8” “-W114.7874°” UTM examples: “0569842” “630084”
PLOT_Y_COOR	$14.0	GPS Y coordinate for the plot: • If the GPS_COOR_SYS is LL, then the Y coordinate is latitude (negative with south latitude). • If the GPS_COOR_SYS is UTM, then the Y coordinate is a measurement of the North-South position in metres (Northing; mN). • If the GPS_COOR_SYS is NA, then the Y coordinate is blank.	LL examples: “N043°38’33.24” N043.6425°” UTM examples: “4282182” “4833438”

Table E-6: Data dictionary for Ground3 – Basic Plot

Field Name	Format	Description	Note
POLYGON	$11.0	Unique number assigned by the Disposition Holder to identify the area.	E.g.: “2515AA” (no blanks allowed)
SU	$3.0	Unique Sampling Unit number within a polygon.	E.g.: “001”, “002”, “003”, etc. (no blanks allowed)
PLOT_ID	$8.0	Unique plot identifier, not more than 8 characters.	no blanks allowed
SPECIES	$2.0	Tree species code (Table 6-1). Where no tree species are present in basic plot enter “No”.	Eligible codes: “Sw”, “Sb”, “Pj”, “Pl”, “Lt”, “Ls”, “Fb”, “Fa”, “Aw”, “Pb”, “Bw”, “Ax”, “Ah”, “Px”, “Sx”, “No”
WGR	$1.0	“Y” if WGR encircles ≥50% of the main stem diameter.	Eligible codes: “Y”, blank
HT_CLASS_1	2.0	Height class for density tallies (1=30-79 cm; 2=80-129 cm; 3=130 cm+; 4=underheight 15-29 cm)	Eligible codes: 1, 2, 3, 4
TALLY_1	3.0	Tally of the number of acceptable trees in the corresponding height class.	Eligible codes: 0 to 999
HT_CLASS_2	2.0	Height class for density tallies (1=30-79 cm; 2=80-129 cm; 3=130 cm+; 4=underheight 15-29 cm)	Eligible codes: 1, 2, 3, 4
TALLY_2	3.0	Tally of the number of acceptable trees in the corresponding height class.	Eligible codes: 0 to 999
HT_CLASS_3	2.0	Height class for density tallies (1=30-79 cm; 2=80-129 cm; 3=130 cm+; 4=underheight 15-29 cm)	Eligible codes: 1, 2, 3, 4
TALLY_3	3.0	Tally of the number of acceptable trees in the corresponding height class.	Eligible codes: 0 to 999
HT_CLASS_4	2.0	Height class for density tallies (1=30-79 cm; 2=80-129 cm; 3=130 cm+; 4=underheight 15-29 cm)	Eligible codes: 1, 2, 3, 4
TALLY_4	3.0	Tally of the number of acceptable trees in the corresponding height class.	Eligible codes: 0 to 999

Table E-7: Data dictionary for Ground4 – Detailed Plot, Top Height

Field Name	Format	Description	Note
POLYGON	$11.0	Unique number assigned by the Disposition Holder to identify the area.	E.g.: “2515AA” (no blanks allowed)
SU	$3.0	Unique Sampling Unit number within a polygon.	E.g.: “001”, “002”, “003”, etc. (no blanks allowed)
PLOT_ID	$8.0	Unique plot identifier, not more than 8 characters.	no blanks allowed
SPECIES	$2.0	Tree species code (Table 6-1). Where no tree species are present in basic plot enter “No”.	Eligible codes: “Sw”, “Sb”, “Pj”, “Pl”, “Lt”, “Ls”, “Fb”, “Fa”, “Aw”, “Pb”, “Bw”, “Ax”, “Ah”, “Px”, “Sx”, “No”
TOPHT	4.0	Height (cm) of the largest diameter tree (i.e.: top height tree)	Eligible codes: 30 to 9999, where species is “No”, leave blank
TH_DBH	3.0	Diameter at breast height of the largest diameter tree (mm) (i.e.: top height tree)	Eligible codes: 1 to 999, where species is “No”, leave blank. Optional field
TOTAL_AGE	2.0	Total age of the largest diameter tree (years) (i.e.: top height tree)	Eligible codes: 1 to 20, where species is “No”, leave blank
TREE_TYPE	$1.0	Tree origin (planted, natural, unknown)	Eligible codes: “P”, “N”, “U”
CONFIDENCE	$1.0	Surveyor confidence in the age estimate (Low, Medium, High)	Eligible codes: “L”, “M”, “H”
CROWN_CL	$5.0	Tree social position (dominant, co-dominant, intermediate or supressed)	Eligible codes: “D”, “C”, “I”, “S”
TAG_ID	$5.0	Tree tag identifier for top height tree.	E.g.: “AW-1”, “AW-2”, “PL-1”, “SB-1”, etc. Optional field

Table E-8: Data dictionary for Ground5 – Detailed Plot, Height and Diameter

Field Name	Format	Description	Note
POLYGON	$11.0	Unique number assigned by the Disposition Holder to identify the area.	E.g.: “2515AA” (no blanks allowed)
SU	$3.0	Unique Sampling Unit number within a polygon.	E.g.: “001”, “002”, “003”, etc. (no blanks allowed)
PLOT_ID	$8.0	Unique plot identifier, not more than 8 characters.	no blanks allowed
SPECIES	$2.0	Tree species code (Table 6-1). Where no tree species are present in basic plot enter “No”.	Eligible codes: “Sw”, “Sb”, “Pj”, “Pl”, “Lt”, “Ls”, “Fb”, “Fa”, “Aw”, “Pb”, “Bw”, “Ax”, “Ah”, “Px”, “Sx”, “No”
TREE_NUM	2.0	Unique tree identifier by species. Can be auto-generated during data entry.	
WGR	$1.0	“Y” if WGR encircles ≥50% of the main stem diameter.	Eligible codes: “Y”, blank
DBH	3.0	Sample tree diameter at breast height (mm).	Eligible codes: 1 to 999, where species is “No”, leave blank
HEIGHT	4.0	Sample tree height (cm).	Eligible codes: 30 to 9999, where species is “No”, leave blank

APPENDIX F
REGENERATION SURVEY REPORTING CHECKLIST AND VALIDATION

ALBERTA REGENERATION STANDARDS FOR THE MINEABLE OIL SANDS
Reporting checklist and validation

Disposition Holder (company name + project)		**Reporting date:**	
		Alberta Use Only	
		Received by:	
		Date:	
Name(s) of company reps:		**Name(s) of qualified surveyors:**	

INSTRUCTIONS

The regeneration survey elements listed below must be reported to Alberta in order for the submission to be deemed complete. Please initial in the box beside each element if the element has been enclosed at the time of reporting.

REQUIRED REPORTING ELEMENTS

Element		Initials	
Stratification line-work spatial data			
Attribute data	Sampling Units		
	Poorly Revegetated Areas		
Field Tally Sheets (if applicable)			
Digital Field Data (*.mdb file)			
Field Map Sheet or Digital Field Map			

DECLARATION

I (We) do hereby declare that this report:

Includes only surveys that have been conducted according to the methods detailed in the Alberta Regeneration Standards for the Mineable Oil Sands;

Complies with the requirements for content and format; and,

Is complete, accurate, and on time.

Printed name	Title	RP number or Seal
Signature	Date	

Printed name	Title	RP number or Seal
Signature	Date	

Alberta reviewer's printed name	Alberta reviewer's title	RP number or Seal
Alberta reviewer's signature	Date	