

REFORESTING DEGRADED LANDS IN CHILE THROUGH THE USE OF MYCORRHIZAL INOCULATION: 2017 MONITORING AND VERIFICATION REPORT

Prepared for Mikro-Tek by TerraCarbon LLC

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Table of Contents

1	Project Details	3
1.1	Summary Description of the Implementation Status of the Project	3
1.2	Sectoral Scope and Project Type.....	8
1.3	Project Proponent	8
1.4	Other Entities Involved in the Project.....	9
1.5	Project Start Date	10
1.6	Project Crediting Period	10
1.7	Project Location	10
1.8	Title and Reference of Methodology	11
1.9	Other Programs.....	12
1.10	Sustainable Development	12
2	Implementation Status.....	12
2.1	Implementation Status of the Project Activity.....	12
2.2	Deviations.....	13
2.3	Grouped Project	14
2.4	Safeguards	24
3	Data and Parameters	26
3.1	Data and Parameters Available at Validation	26
3.2	Data and Parameters Monitored	28
3.3	Monitoring Plan	34
4	Quantification of GHG Emission Reductions and Removals	43
4.1	Baseline Emissions	43
4.2	Project Emissions.....	44
4.3	Leakage.....	47
4.4	Net GHG Emission Reductions and Removals.....	48
	Annex A. Non-Permanence Risk Report	49
	Internal Risk	49
	External Risks	52
	Natural Risks	54
	Overall Non-Permanence Risk Rating and Buffer Determination.....	57
	Overall Risk Rating	57
	Calculation of Total VCUs	57

1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

In 2003, Mikro-Tek initiated the grouped project “Reforestation Degraded Lands in Chile through the use of Mycorrhizal Inoculation”. In this project, Mikro-Tek works with local small and medium-scale land owners, providing an advanced propagation technology, mycorrhizal inoculation, to help restore and convert degraded grassland (Figure 1.1) into productive forests in several regions of Chile. The application of this technology, funded by Mikro-Tek’s investment, permits successful plantation establishment on sites that would otherwise not be sufficiently productive to incentivize afforestation/reforestation efforts by landowners. This grouped project promotes the establishment of forest plantations on land that would remain as degraded grassland in the absence of carbon finance.

In this monitoring report, the language “establishment of forest plantation” is used to refer to the project activity, and encompasses both initial planting (afforestation) and subsequent replanting activities after harvest (reforestation).

During the 2012 – 2017 monitoring period, Mikro-Tek doubled the size of the project area from 3,006.9 ha to 6,013.2 ha with the addition of new grouped project instances. The 2017 cohort of grouped project instances includes 2,636.5 ha planted with *Pinus radiata* plantations and 369.8 ha planted with *Eucalyptus globulus*. During this monitoring period some of the sites were thinned, and some of the Eucalyptus sites were harvested, as per CONAF approved forest management plans. There were also some sites partially damaged by fires that occurred across central Chile in January 2017. The biomass losses due to fire and harvesting were accounted for in the new strata called Burnt / Harvested which totaled 983 hectares (Table 3.3).

Figure 1.1. Photograph of Lote N°4 Fundo Nerquihue, MikroTek0048.



The project is situated in an extremely dry area with degraded soils due to a long history of agriculture. The area included in the 2017 cohort of grouped project instances was previously used for small-scale agriculture production, but production ceased due to soil impoverishment. Prior to inclusion as new grouped project instances, the land was unmanaged abandoned grassland where natural seed sources were lacking and natural regeneration does not occur. The project activity creates forest plantations on land with degraded soil that is currently no longer suitable for agriculture. Although plantation establishment is practiced in Chile, it is not widespread on lands similar to the new grouped project instances sites due to poor soils and the dry climate. Establishment of forest plantation in the project region using traditional planting techniques has a high chance of failure due to poor environmental conditions.

This project involves the application of mycorrhizal inoculants to containerized seedlings prior to planting to reduce mortality and stimulate tree growth by enhancing nutrient and water uptake. Under normal conditions, adequate mycorrhizal formation usually occurs naturally. However, many industrial sites such as forestry cutovers, heavily used agricultural soils (such as these sites), nutrient-poor industrial waste sites, or sites where natural topsoil has been over used, disturbed or eroded away, are deficient in mycorrhizal fungi. In these cases, specifically chosen strains and species of mycorrhizae can be introduced to the soil to enhance the health and growth rates of the target plant community. This technology was not commercially available in Chile prior to Mikro-Tek's initial work to isolate local mycorrhizal species and strains, screen for effectiveness for enhanced nutrient uptake and vigor, and test the species with the most beneficial effect on targeted host tree species, which began in 1999.

The 2017 cohort includes sites where the combination of low rainfall and degraded nutrient poor soils make the application of this mycorrhizal inoculation technology essential to establishment of plantations with sufficient productivity to be financially attractive to landowners. Mikro-Tek has invested its own funds to develop and manufacture the mycorrhizal inoculum in return for the rights to the carbon credits generated by the project (subject to revenue sharing arrangements with the landowners). This initial investment by Mikro-Tek allows for a technological (and investment) barrier to be overcome. Without Mikro-Tek's involvement, strong environmental barriers would continue to prevent plantation establishment on the project lands.

Small and locally operated nurseries were used to produce containerized *Pinus radiata* and *Eucalyptus globulus* seedlings, which were inoculated with mycorrhizae supplied by Mikro-Tek. Mikro-Tek also supplied the inoculation procedures and worked directly with these nurseries to train personnel in quality-control aspects of mycorrhizal inoculation.

Individual land owners are responsible for planting and forest management practices, as approved by Corporacion Nacional Forestal (CONAF). Sub-soiling is carried out using either a tractor or animals (horses or oxen), depending on the slope of the land. The mycorrhizal inoculated seedlings are then planted along the sub-soil plow lines at an overall planting density of 1,250 trees per hectare. Harvesting occurs around year 20 for *Pinus radiata* and year 10 for *Eucalyptus globulus*. As specified in the Law 701 (see Section 1.11 of the project description) which guides CONAF's approval of the forestry plans, each harvested stand must be replanted after harvest according to CONAF guidelines.

The initial project instances enrolled in the Reforesting Degraded Lands in Chile through the use of Mycorrhizal Inoculation grouped project consisted of 3,007 ha comprised of one or several fields planted

for each project instance (see Table 1.1). The 2017 cohort of grouped project instances totaling 3,006 ha are listed in Table 2.1 in Section 2.3 of this report.

Table 1.1. Initial project instance information.

Project Instance-Number	Region	Province	Commune	Owner	Planting Year(s)	Species Planted	Total Area (ha)
MikroTek0001	VI	Colchagua	Lolol	Harris-Correa	2003	Pinus radiata	0.5
MikroTek0002	VI	Colchagua	Lolol	Nitsche	2003	Eucalyptus globulus	0.2
MikroTek0003	VII	Curico	Vichuquen	Toledo	2004 2016	Eucalyptus globulus	48.9
MikroTek0004	VI	Colchagua	Pumanque	Hernandez	2004	Eucalyptus globulus	4.8
MikroTek0005	VI	Colchagua	Pumanque	Hernandez	2004 2013	Eucalyptus globulus	9.7
MikroTek0006	VI	Cardenal Caro	Paredones	Barroiher	2004 2012	Eucalyptus globulus	25.2
MikroTek0007	VII	Curico	Vichuquen	Cuevas	2004	Eucalyptus globulus	26.2
MikroTek0008	VI	Colchagua	Santa Cruz	Harris-Correa	2006	Pinus radiata	28.0
MikroTek0009	VI	Colchagua	Lolol	Garces	2004	Pinus radiata	299.1
MikroTek0010	VI	Colchagua	Lolol	Harris-Correa	2003	Eucalyptus globulus	24.8
MikroTek0011	VI	Colchagua	Lolol	Harris-Correa	2004	Pinus radiata	26.8
MikroTek0012	VI	Colchagua	Lolol	Harris-Correa	2003	Pinus radiata	30.4
MikroTek0013	VI	Colchagua	Lolol	Harris-Correa	2004	Eucalyptus globulus	7.1
MikroTek0014	VI	Colchagua	Pumanque	Harris-Correa	2005	Pinus radiata	17.3
MikroTek0015	VI	Colchagua	Pumanque	Harris-Correa	2005	Pinus radiata	99.0

MikroTek0016	VI	Colchagua	Pumanque	Hernandez	2004	Eucalyptus globulus	14.5
MikroTek0017	VI	Colchagua	Lolol	Giglio	2004	Eucalyptus globulus	58.8
MikroTek0018	VI	Colchagua	Pumanque	Hernandez	2004	Pinus radiata	1.5
MikroTek0019	VI	Colchagua	Lolol	Harris-Correa	2003	Eucalyptus globulus	34.8
MikroTek0020	VI	Colchagua	Lolol	Nitsche	2004 2014	Eucalyptus globulus	16.8
MikroTek0021	VI	Colchagua	Lolol	Harris-Correa	2003	Pinus radiata	72.5
MikroTek0022	VI	Colchagua	Lolol	Giglio	2004	Pinus radiata	51.9
MikroTek0023	VI	Colchagua	Lolol	Nitsche	2004	Pinus radiata	49.3
MikroTek0024	VI	Colchagua	Lolol	Nitsche	2003	Eucalyptus globulus	63.5
MikroTek0025	VI	Colchagua	Lolol	Nitsche	2003	Pinus radiata	185.7
MikroTek0026	VI	Colchagua	Lolol	Harris-Correa	2004	Eucalyptus globulus	13.5
MikroTek0027	VI	Colchagua	Lolol	Nitsche	2003	Pinus radiata	42.1
MikroTek0028	VI	Colchagua	Lolol	Nitsche	2004	Eucalyptus globulus	36.5
MikroTek0029	VI	Colchagua	Lolol	Nitsche	2004	Pinus radiata	133.5
MikroTek0030	VI	Colchagua	Pumanque	Hernandez	2004, 2014	Eucalyptus globulus	12.3
MikroTek0031	VI	Cardenal Caro	Litueche	Bulnes	2009	Eucalyptus globulus	17.4
MikroTek0032	VI	Colchagua	Lolol	Harris-Correa	2004	Pinus radiata	113.1
MikroTek0033	VI	Cardenal Caro	Litueche	Bulnes	2007	Eucalyptus globulus	29.1
MikroTek0034	VI	Cardenal Caro	Paredones	Barroiht	2004 2012	Eucalyptus globulus	0.8
MikroTek0035	VI	Cardenal Caro	Litueche	Bulnes	2007	Eucalyptus globulus	114.2
MikroTek0036	VI	Cardenal Caro	Litueche	Bulnes	2009	Eucalyptus globulus	37.3
MikroTek0037	VI	Cardenal Caro	Litueche	Bulnes	2006	Eucalyptus globulus	103.9

MikroTek0038	VI	Cardenal Caro	Paredones	Catalan	2004 2014	Eucalyptus globulus	70.9
MikroTek0039	VII	Curico	Vichuquen	Cuevas	2006	Eucalyptus globulus	47.7
MikroTek0040	VIII	Bio Bio	Quilleco	Baztan	2009	Pinus radiata	473.7
MikroTek0041	VI	Colchagua	Lolol	Ulloa	2003	Pinus radiata	86.3
MikroTek0042	VI	Cardenal Caro	Litueche	Bulnes	2009	Eucalyptus globulus	6.4
MikroTek0043	VI	Cardenal Caro	La Estrella	Bulnes	2004 2014	Eucalyptus globulus	11.8
MikroTek0044	VIII	Bio Bio	Quilleco	Baztan	2009	Pinus radiata	121.6
MikroTek0045	VI	Cardenal Caro	Paredones	Barroiher	2004	Eucalyptus globulus	0.9
MikroTek0046	VI	Cardenal Caro	La Estrella	Bulnes	2004 2013	Eucalyptus globulus	124.6
MikroTek0047	VI	Cardenal Caro	Paredones	Barroiher	2004	Eucalyptus globulus	34.3
MikroTek0048	VI	Colchagua	Lolol	Ulloa	2003	Pinus radiata	177.8

A schedule of the important aspects of the grouped project is listed in chronological order in Table 1.2, below.

Table 1.2. Schedule of grouped project activities.

Project activity	Date	Source/Notes
Grouped project start date and start of the crediting period	June 1, 2003	Time of planting of the initial project instance.
Validation of the grouped project	May 2, 2013	
Registration of grouped project	May 2, 2013	
Monitoring and Verification	September/October 2012 and November/December 2017	Starting in 2012 and at least every five years thereafter
Expected grouped project longevity	40 years	June 1, 2003 to May 31, 2043
Expected grouped project termination date	May 31, 2043	

The total GHG emission reductions or removals generated in the 2012 - 2017 monitoring period eligible for crediting and before the VCS AFOLU buffer contribution is 1,101,087 t CO₂e.

1.2 Sectoral Scope and Project Type

This project is registered under the Verified Carbon Standard (VCS) as an Afforestation, Reforestation and Revegetation (ARR) project and has been developed in compliance with the Verified Carbon Standard¹ and VCS AFOLU Requirements². The project entitled Reforesting Degraded Lands in Chile through the use of Mycorrhizal Inoculation is a grouped project.

1.3 Project Proponent

The grouped project is implemented by Mikro-Tek in association with the land owners. Mikro-Tek supplies the mycorrhizal inoculum, as well as the associated technologies for their application and management. Mikro-Tek assumes responsibilities for project management, implementation, and registration including budgeting, hiring of project personnel and contractors, as well as implementing the monitoring and verification plan, including the hiring of monitoring/inventory staff, technical consultants and VCS verifiers, as needed. Mikro-Tek ensures that offsets are registered following verification, investor relations, and marketing, and maintains an electronic database of GIS coverages detailing parcel boundaries and plot locations. Raw field measurements and analysis are archived in hard and electronic copies.

Mikro-Tek's Chile Projects Manager assumes responsibility for ongoing management of the project area on the ground in Chile. The Chile Projects Manager supervises contracted monitoring and inventory staff in the field, and serves as a liaison and translator for the landowners and Mikro-Tek, including establishing meetings with landowners and relevant stakeholders, arranging site visits, providing information and documentation such as previous studies, photographs, and satellite images related to the project.

Contact information for the project proponent is supplied in Table 1.3.

Table 1.3. List of project proponents.

Organization name	Mikro-Tek Inc.
Contact person	Mark Kean
Title	President
Address	P.O. Box 2120, 115 Sandy Falls Road, Timmins, Ontario P4N7X8 Canada
Telephone	+705 268 3536
Email	mikro-tek@mikro-tek.com

¹ VCS. 2017 VCS Standard. Version 3.7, 21 June 2017. Verified Carbon Standard, Washington, D.C.

² VCS. 2017 Agriculture, Forestry and Other Land Use (AFOLU) Requirements. Version 3.6, 21 June 2017. Verified Carbon Standard, Washington, D.C.

Organization name	Mikro-Tek Inc.
Contact person	Alfredo Unda
Title	Forester, Manager Chile Projects
Address	Diego de Almagro, 2081, Ste. #64, Providencia, Santiago, Chile
Telephone	+562 899 69931
Email	aunda4@gmail.com

1.4 Other Entities Involved in the Project

Table 1.4. List of other entities involved in the project.

Organization name	TerraCarbon LLC
Role in the project	Develop PDD and design monitoring plan in consultation with Mikro-Tek staff.
Contact person	Erin Swails
Title	Manager Technical and Forestry Services
Address	5901 N. Sheridan Rd., Peoria, Illinois 61614 U.S.A.
Telephone	+434 326 1144
Email	erin.swails@terracarbon.com

Organization name	NA
Role in the project	Owners of project property responsible for managing and conducting all silvicultural and forestry aspects of the project in accordance with the approved CONAF Forestry Plan and the Business Collaboration Agreement with Mikro-Tek, the Project Proponent.
Contact person	Individual property owners
Title	NA
Address	Located in project database in the Business Collaboration Agreement.
Telephone	NA

Email	NA
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1.5 Project Start Date

The grouped project has a project start date of June 1, 2003 marking the start of planting of the first project instance by Mikro-Tek.

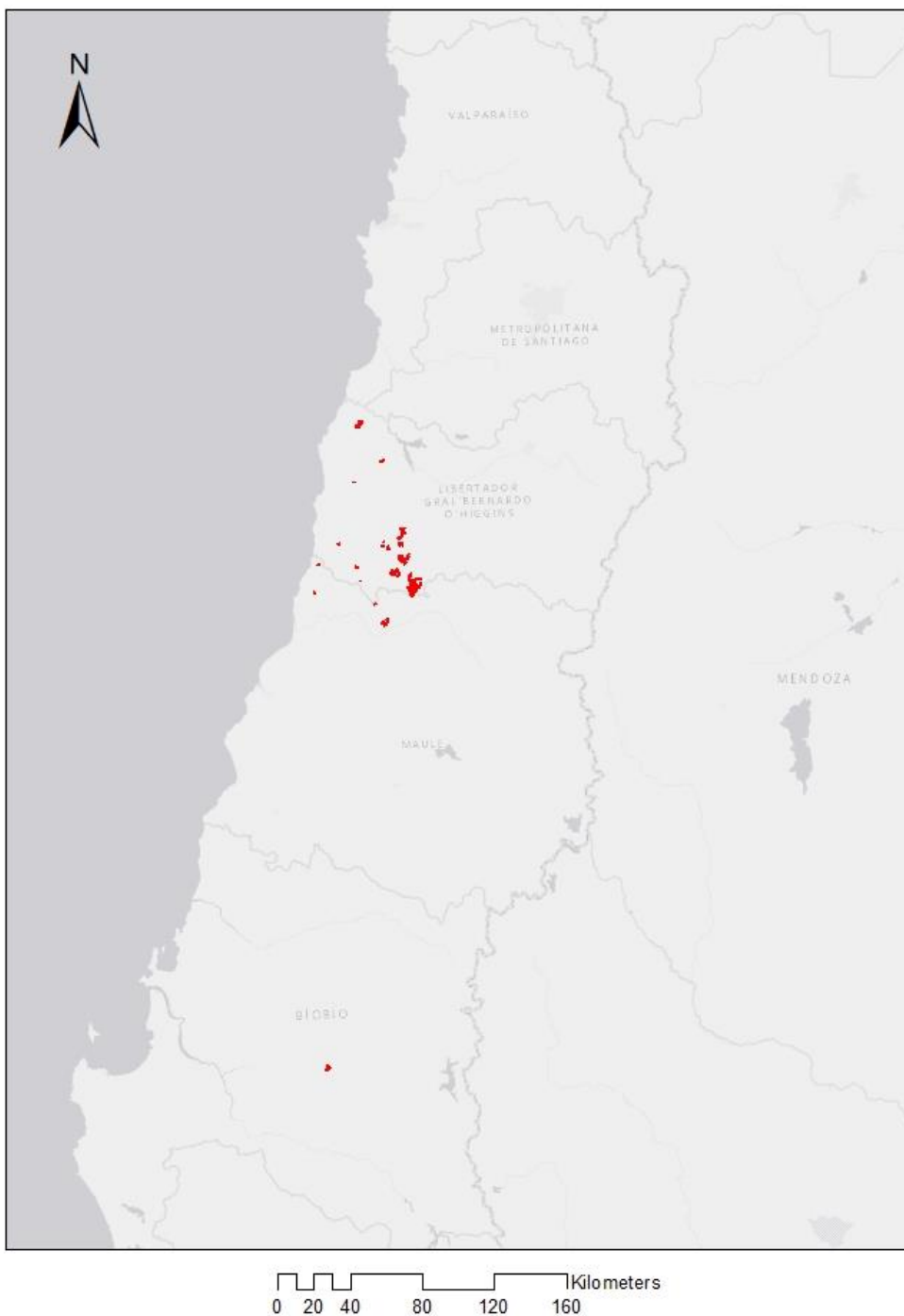
1.6 Project Crediting Period

The Reforesting Degraded Lands in Chile through the use of Mycorrhizal Inoculation project has a crediting period of 40 years. It started June 1, 2003 and will continue through May 31, 2043.

1.7 Project Location

The initial and new grouped project instances are located in Region VI, VII, and VIII in the communes of Lolol, Estrella, Vichuquen, Pumanque, Quilleco, Hualane, Chepica, Pichilemu, and Santa Cruz. The entire grouped project area will be located within Region RM, V, VI, VII, and VIII. An overview of the geographic boundary of the grouped project can be found in Figure 1.2 below. Detailed project instance boundaries for all sites will be archived as GIS files located in the project database.

Figure 1.2. Grouped project geographic region and current project instances (in red) including initial and new grouped project instances.



1.8 Title and Reference of Methodology

This project uses approved Clean Development Mechanism (CDM) afforestation/reforestation methodology AR-ACM0003 "Afforestation and reforestation of degraded land" - Version 1.0, together with the following tools:

- Approved CDM “Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities”, Version 1;
- Approved CDM “Combined tool to identify the baseline scenario and demonstrate the additionality in A/R CDM project activities, Version 1”;
- Approved CDM tool, “Procedures to demonstrate the eligibility of land for afforestation and reforestation CDM project activities”;
- Approved CDM “Guidelines on conservative choice and application of default data in estimation of the net anthropogenic GHG removals by sinks”, Version 2;
- Approved CDM tool “Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity”;
- Approved CDM tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities”; Version 2.1.0; and
- Approved CDM “Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities”, Version 01.1.0.

1.9 Other Programs

As discussed in Section 1.12.3 of the project description, part of the above project area was registered as part of the CDM project³ “Nerquihue Small-Scale CDM Afforestation Project using Mycorrhizal Inoculation in Chile”. While project instances MikroTek0041 and MikroTek0048 have been registered under the CDM, no emission reductions (tCERs or ICERs) have been issued or will be applied for. The project has not sought or received another form of GHG-related environmental credit, including renewable energy certificates, during this monitoring period.

1.10 Sustainable Development

The project does not make any formal contributions to nationally stated sustainable development priorities.

2 IMPLEMENTATION STATUS

2.1 Implementation Status of the Project Activity

The project activity, planting of trees, is ongoing in this grouped project. New project instances to add to the project as part of this monitoring report are detailed below in Section 2.3. Management and implementation of the tree plantings are consistent with that described in the project description and in Section 1.1 of this report.

As described in Section 4.3 of this report there is no leakage expected as no agricultural products are expected to be displaced due to implementation of the project in the initial or new grouped project instances.

³ Bird, D. and M. Kean. 2010. Nerquihue Small-Scale CDM Afforestation Project using Mycorrhizal Inoculation in Chile. Version 7. CDM Executive Board.

A non-permanence buffer withholding of 10% had been calculated and justified in the Non-Permanence Risk Report (Annex A).

2.2 Deviations

2.2.1 Methodology Deviations

No methodology deviations were applied during the 2012 – 2017 monitoring period.

2.2.2 Project Description Deviations

The following deviations to the project description was applied during the 2012 - 2017 monitoring period.

In the 2017 inventory, measurement of trees in sampling plots proceeded by measuring each tree in a row before moving to the next row. Rows downhill of the plot center were measured prior to moving to rows uphill of the plot center. The project SOP states that measurement of trees in plots will proceed in a clockwise or counter-clockwise direction from the point of initiation. Thus the approach to measurement of trees in sampling plots in the 2017 inventory represents a deviation from the project description. This method is an adaptation and improvement on the procedure of measurements of trees in a clockwise or counter-clockwise direction described in the SOP. The clockwise/counter-clockwise approach is typically employed in naturally regenerated forest stands. In forest plantations where trees are planted in rows, such as the eucalyptus and pine plantations in the project, the clockwise/counter-clockwise approach is less efficient. It was discovered that procedure of measurements row by row increased the speed with which plots could be measured by crews and decreased the likelihood that trees were either missed or measured more than once. However, the actual measurement of dbh, the required input for estimating tree biomass, proceeded as described in the SOP. Therefore the row by row approach to plot measurement implemented in the 2012 - 2017 period only affected the order in which trees in a plot were measured, and did not have an impact on the applicability of the methodology, additionality or the appropriateness of the baseline scenario.

The SOP also states that approximately 10% of center plots shall be re-measured during field monitoring events to identify and correct any field measurement issues which arise during implementation of the monitoring plan. Re-measurement of plots did not occur in the 2017 inventory due to the finite nature of time and resources available for the inventory. The 2017 inventory was implemented by the same field crew leaders as the 2012 inventory. In the 2012 inventory re-measurement of plots did occur. The re-measurement procedure as described in the SOP is intended as a training tool. As the 2017 field crew included the same crew leaders, who are both certified foresters in Chile, it was decided that re-training would not be an effective use of time or resources, and re-measurement of plots did not occur. As re-measurement of a subset of inventory sampling plots is not an applicability condition or procedural requirement of the applied methodology AR-ACM0001, lack of re-measurement of plots in the 2017 inventory is a deviation to the project description that does not have an impact on the applicability of the methodology, additionality or the appropriateness of the baseline scenario.

2.3 Grouped Project

Eligibility criteria for new project instances are set out in Section 1.13.1 of the project description and listed below. Project instances meeting these criteria, added to the project after project validation, are eligible for inclusion in this VCS ARR project.

The 2017 cohort of grouped project instances are listed below in Table 2.1. Some of the projects included in this 2017 cohort were planted before the end of the first monitoring event in 2012. As they were deemed to be too small at the time of the first monitoring, and would not have added materially to the biomass volumes, they were not measured at that time, but added into the 2017 cohort.

Table 2.1. New project instance information.

Project Instance-Number	Region	Province	Commune	Owner	Planting Year(s)	Species Planted	Total Area (ha)
MikroTek0049	VI	Cardenal Caro	Pichilemu	Drago	2010	Eucalyptus globulus	3.9
MikroTek0050	VI	Colchagua	Lolol	Arrue	2010	Eucalyptus globulus	4.8
MikroTek0051	VI	Cardenal Caro	Pichilemu	Drago	2010	Pinus radiata	2.1
MikroTek0052	VI	Cardenal Caro	Pichilemu	Drago	2010	Pinus radiata	5.3
MikroTek0053	VI	Colchagua	Chepica	Guzman	2011	Pinus radiata	50.8
MikroTek0054	VII	Curico	Hualane	Marin	2012	Pinus radiata	79.8
MikroTek0055	VII	Curico	Hualane	Videla	2012	Pinus radiata	52.1
MikroTek0056	VII	Curico	Hualane	Videla	2012	Pinus radiata	13.4
MikroTek0057	VI	Colchagua	Chepica	Vera	2009	Eucalyptus globulus	166.9
MikroTek0058	VI	Colchagua	Chepica	Vera	2009	Pinus radiata	504.2
MikroTek0059	VII	Curico	Hualane	Veratria	2009	Pinus radiata	0.9
MikroTek0060	VII	Curico	Hualane	Veratria	2009	Eucalyptus globulus	10.3
MikroTek0061	VII	Curico	Hualane	Veratria	2009	Eucalyptus globulus	17.7
MikroTek0062	VI	Colchagua	Chepica	Guzman	2010	Eucalyptus globulus	13.5
MikroTek0063	VI	Colchagua	Chepica	Guzman	2010	Pinus radiata	222.9
MikroTek0064	VI	Colchagua	Chepica	Guzman	2013	Pinus radiata	3.1
MikroTek0065	VI	Colchagua	Chepica	Vera	2010	Eucalyptus globulus	116.2
MikroTek0066	VI	Colchagua	Chepica	Vera	2010	Pinus radiata	162.4

Project Instance-Number	Region	Province	Commune	Owner	Planting Year(s)	Species Planted	Total Area (ha)
MikroTek0067	VI	Colchagua	Chepica	Vera	2012	Pinus radiata	136.8
MikroTek0068	VI	Colchagua	Chepica	Vera	2013	Pinus radiata	7.9
MikroTek0069	VI	Colchagua	Lolol	Bisquert	2010	Pinus radiata	28.9
MikroTek0070	VI	Colchagua	Lolol	Bisquert	2011	Pinus radiata	4.2
MikroTek0071	VI	Colchagua	Lolol	Bisquert	2011	Eucalyptus globulus	4.2
MikroTek0072	VI	Colchagua	Santa Cruz	Perez	2010	Pinus radiata	42.4
MikroTek0073	VI	Colchagua	Santa Cruz	Perez	2010	Pinus radiata	0.7
MikroTek0074	VII	Curico	Hualane	Veratria	2009	Pinus radiata	4.6
MikroTek0075	VII	Curico	Hualane	Veratria	2009	Eucalyptus globulus	13.6
MikroTek0076	VII	Curico	Hualane	Veratria	2009	Eucalyptus globulus	0.9
MikroTek0077	VII	Colchagua	Chepica	Guzman	2011	Pinus radiata	280.2
MikroTek0078	VI	Colchagua	Lolol	Covarrubias	2010	Pinus radiata	312.7
MikroTek0079	VI	Colchagua	Lolol	Covarrubias	2012	Pinus radiata	18.6
MikroTek0080	VI	Colchagua	Chepica	Vial	2010	Eucalyptus globulus	17.7
MikroTek0081	VI	Colchagua	Chepica	Vial	2010	Pinus radiata	48.0
MikroTek0082	VI	Colchagua	Chepica	Vial	2011	Pinus radiata	53.1
MikroTek0084	VI	Colchagua	Chepica	Guzman	2012	Pinus radiata	171.7
MikroTek0085	VI	Colchagua	Chepica	Guzman	2012	Pinus radiata	159.9
MikroTek0086	VII	Curico	Hualane	Geocapital	2013	Pinus radiata	119.9
MikroTek0087	VII	Curico	Hualane	Geocapital	2013	Pinus radiata	39.7
MikroTek0088	VII	Curico	Hualane	Geocapital	2013	Pinus radiata	109.9

The criteria for addition of new grouped instances cover geographic boundaries, eligibility requirements and applicability conditions, as well as inclusion in the project GHG information tracking system. The new project instances collectively meet all eligibility criteria as demonstrated in italicized text following criteria.

- 1) All project instances will be located on degraded lands within the geographic boundary of the following Chilean Regions RM, V, VI, VII, and VIII.

The new grouped project instances are located in Chilean Regions VI and VII, as displayed in Figure 2.1.

2) New project instances will demonstrate compliance with all eligibility requirements from the VCS AFOLU Requirements document version 3.6, applicability conditions of methodology AR-ACM0003 version 1.0, and conditions permitting accounting for soil carbon using the CDM “Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities”:

- The grouped project instance area was not cleared of native ecosystems within the 10 year period prior to the project start date.
- The grouped project instance area was not forested at the time of planting.
- Implementation of the grouped project instance activity does not violate any law.

Project implementation in the new grouped project instances did not lead to the conversion of any native ecosystems within the 10 years prior to the project start date in 2003 as demonstrated by historical imagery in GoogleEarth from 1993, and does not lead to the violation of any law, as ensured by CONAF approval. Further, no project activities drained native ecosystems or degraded hydrological functions to generate GHG credits. As all project sites have received CONAF subsidies, CONAF has reviewed and approved the forestry plan for all project areas. Part of CONAFs review was to ensure that the land is suitable⁴ for forestry (i.e. it is not currently forested), including limiting the planted areas to areas without native forest cover.

These eligibility criteria were assessed for each new grouped project instance when CONAF ensured the proposed planting location meets the requirements of the Forestry Law 701 (see Section 1.11 of the project description).

All project lands, including new project instances, have received CONAF subsidy, have had their forest management plans approved by CONAF and are in compliance with the Chilean Forestry Law 701.

- Clear title and rights to carbon are demonstrated for each grouped project instance.
- In order to participate in the CONAF subsidized forestry program, each grouped project instance has the title and forestry plan approved by CONAF. This approval process ensures that in part that project lands will be replanted after harvest and thus project lands will be maintained as forest into the future.

The project area of each new grouped project instance is under clear title as outlined in the Business Collaboration Agreement, and land ownership documentation has been reviewed by CONAF as a prerequisite⁵ for the CONAF subsidy. Mikro-Tek has reserved the rights to forest carbon in the project area through a Business Collaboration Agreement between Mikro-Tek and the landowners⁶. Relevant language demonstrating the transfer of carbon rights from the land owner to Mikro-Tek as found in each Business Collaboration Agreement includes:

⁴ Morales, E. 2003. Changing Ownership and Management of State Forest Plantations: Chile. International Institute for Environment and Development (IIED), p14.

⁵ Morales, E. 2003. Changing Ownership and Management of State Forest Plantations: Chile. International Institute for Environment and Development (IIED), p14.

⁶ The owners of each project instance are identified in Table 1.1.

The land owners agree to "To transfer the rights to all Emission Reductions to be generated by the Project to Mikro-Tek" and

Mikro-Tek and the landowners agree that "Mikro-Tek shall have full title to the Emissions Reductions generated by the Project and the exclusive right to sell all or part of these Emission Reductions".

Further, the Business Collaboration Agreement sets forth the terms of the revenue sharing agreement between the land owner and Mikro-Tek.

As a compensation for the joint business activity set forth herein, Mikro-Tek and the [land owner] agree to equally share (50/50%) the Net Proceeds effectively received through the sale of Emissions Reductions generated by the Project.

A copy of the Business Collaboration Agreement and the site map from the CONAF approved forestry plans for each project property is contained in the project database.

- The grouped project instance activity is implemented on degraded lands, which are expected to remain degraded or to continue to degrade in the absence of the project; hence the land cannot be expected to revert to a non-degraded state without human intervention. Degraded status will be demonstrated by applying the CDM tool⁷ for the identification of degraded lands.

The project area is situated in an extremely dry area with degraded soils (Figure 1.3). Rolling hills with intermittent erosion gullies characterize the landscape. The project region is classified as degraded using the CDM tool for the identification of degraded lands. Project instances qualify as degraded under Stage 2a and III (c.ii), of the CDM tool due to the clear "reduction in plant cover or productivity due to overgrazing or other land management practices". As the project instance baseline is grassland, there is a clear "reduction in plant cover" due to "land management practices", as the native vegetation prior to human land management practices was Chilean Matorral including Sclerophyll forests.

- The grouped project instance activity involves machine or hand planting, with or without site preparation. Encroachment of natural tree vegetation that leads to the establishment of forests is not expected to occur.

The new grouped project instances follow management practices outlined in Section 1.1 of this monitoring report using machine or hand planting, with or without site preparation. As demonstrated by the application of CDM tool for the identification of degraded lands, the area included in the new project instances qualify as degraded, and encroachment of natural tree vegetation that leads to the establishment of forest is not expected to occur due to lack of seed sources.

- No project instances will use flooding irrigation as part of the project activity.

The new grouped project instances follow management practices outlined in Section 1.1 of this monitoring report and do not use flooding irrigation as part of the project activity.

⁷CDM Executive Board. 2008. Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities - Version 01. UNFCCC, Bonn, Germany.

- The grouped project instance is not located on organic soils.

The new grouped project instances do not include any organic soils (see Figure 2.2).

- No project instances will lead to a decrease in the availability of fuelwood.

The area inside the boundaries of the new project instances is classified as degraded without adequate existing vegetation to serve as a source of fuelwood.

- The grouped project instance does not fall into the wetland category, as defined by the IPCC⁸.

The new project instance area is not considered to be a wetland as defined by the Intergovernmental Panel on Climate Change. The project instance area prior to the establishment of forest plantation was used for agriculture and thus is not considered to be a wetland, as per the IPCC definition.

- Organic litter from vegetation will remain on site and will not be removed.

The new grouped project instances follow management practices outlined in Section 1.1 of this monitoring report and no litter will be removed from the new grouped project instance areas.

- Any site preparation involving ploughing/ripping/scarification, implemented as part of the grouped project instance activity, will:
 - a. Be done in accordance with appropriate soil conservation practices (e.g., follows the land contour);
 - b. Be limited to the first five years from the year of initial site preparation;
 - c. Not be repeated, if at all, within a period of 20 years; and

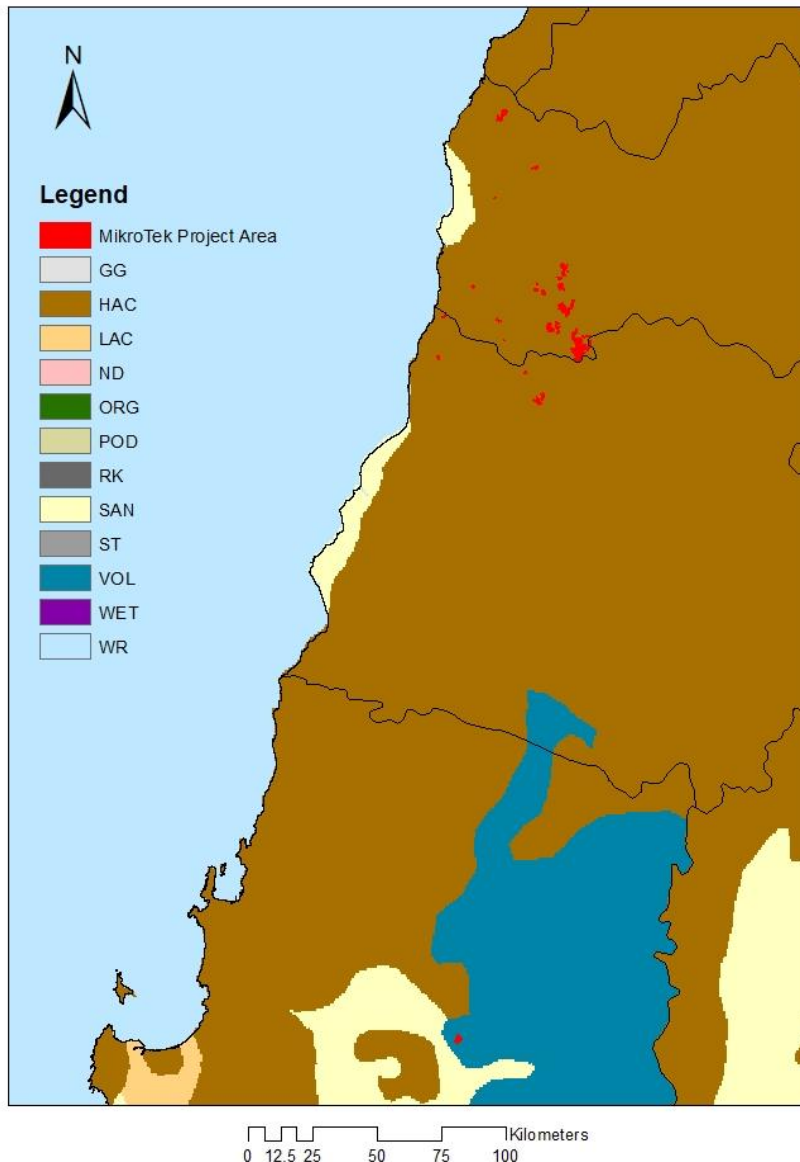
The new grouped project instances follow management practices outlined in Section 1.1 of this monitoring report and sub-soiling occurs prior to planting. As sub-soiling is associated with initial planting, it occurs only once. Where the project area is not uniformly level terrain, all sub-soiling follows the contour of the land. Further, site preparation and planting occur within one year of each other.

- d. Not cover more than 10 per cent of area in each of the following types of land:
 - i. Land containing organic soils; and
 - ii. Land which, in the baseline, is subjected to land-use and management practices and receives inputs as listed in appendices 1 and 2 of AR-ACM0003 methodology.

The new grouped project instances do not include any organic soils (see Figure 2.2).

Figure 2.2. IPCC soil class map of the project area.

⁸ The IPCC describes a wetland as “land that is covered or saturated by water for all or part of the year (e.g., peatland) and that does not fall into the forest land, cropland, grassland or settlements categories.” IPCC 2003. Good Practice Guidance for Land Use, Land-Use Change and Forestry (GPG-LULUCF).



Sub-soiling as described in Section 1.1 of this monitoring report results in an area of disturbance less than 15 cm wide and is done every 3 to 4 meters, resulting in a disturbance of 5% (or less) of the soil surface.

3) Use mycorrhizal inoculated seedlings for planting with specific mycorrhizal inoculum supplied by Mikro-Tek and applied as per their directions.

Containerized seedlings planted in the new grouped project instance areas were inoculated with mycorrhizal inoculum supplied by Mikro-Tek. Production of containerized seedlings is a process that takes place prior to the targeted planting months of June, July and August in an off-site nursery complex. It takes approximately six months to grow the seedlings and during that time, the mycorrhizal inoculum is applied following Mikro-Tek's inoculation procedures. By using mycorrhizal inoculated seedlings, the cost of which is funded by Mikro-Tek in exchange for the resulting carbon credits per revenue sharing

arrangements with the landowner, plantation establishment becomes an attractive land use option to landowners.

4) The pre-existing land use of the grouped project instance area is either pasture/grassland, cultivation, or abandoned nonforest lands which have previously been in agriculture.

As all project sites have received CONAF subsidies, CONAF has reviewed and approved the forestry plan for all project areas. Part of CONAF's review was to ensure that the land is suitable⁹ for forestry (i.e. it is not currently forested), including limiting the planted areas to areas without native forest cover.

Due to climatic and historical factors, the pre-existing land use of the new grouped project instance areas were either pasture/grassland, cultivation, or abandoned nonforest lands which have previously been in agriculture. The climate, typical of Chile's central valley is predominantly a warm temperate Mediterranean-type climate (Csb) with winter rains typically about 450 mm per year. Mean annual temperature is 12.8° C¹⁰. The soils¹¹ in the project region have been classified as Alfisoles and Inceptisoles by the FAO. The planted areas were dry grasslands that were under intensive agriculture in the early 1900s followed by intermittent grazing until the 1990s and early 2000s¹².

While some woody vegetation does occur in the region, it is present in very low stem densities and most often restricted to steeper slopes and ravines. Further, the new project instances been delineated to exclude area with significant woody vegetation. Given the dry climate and the fact that native seed sources are generally lacking across the landscape, natural regeneration is extremely limited. Due to the low rainfall in the region, the existing land use is abandoned pasture.

5) Face investment and/or technological barriers to reforestation, demonstrated through a barriers analysis.¹³

Additionality is demonstrated for the grouped project instances through the use of the approved CDM "Combined tool to identify the baseline scenario and demonstrate the additionality in A/R CDM project activities" as cited in the CDM methodology AR-ACM0003.

STEP 0: Preliminary screening based on the starting date of the project activity

⁹ Morales, E. 2003. Changing Ownership and Management of State Forest Plantations: Chile. International Institute for Environment and Development (IIED), p14.

¹⁰ Average yearly temperatures for weather stations within the project region for the latest period for which data is available, May 2007 through April 2008. From: ANUARIO AGROMETEOROLOGICO REGIONES IV, V, METROPOLITANA, VI Y VII. DIRECTOR RESPONSABLE: ALEJANDRO MUÑOZ M. DIRECCION METEOROLOGICA DE CHILE. CASILLA 140, SUCURSAL MATUCANA, ESTACION CENTRAL. FONO 4364501 Accessed at: http://www.meteochile.gob.cl/agrometeorologia/documentos/Anuario_Agro_%202007-2008%28Agrometeorologia%29.pdf

¹¹ FAO. 2006e. Chile – Suelos. http://www.rlc.fao.org/proyecto/gcp/rla/126/jpn/ciren/chi_soils.htm Accessed 1 April 2006.

¹² Prado, JA, and Weber C. 2003. Facilitating the Way for Implementation of Sustainable Forest Management. The Case of Chile. Instituto Forestal (INFOR), Corporación Nacional Forestal (CONAF), Santiago, Chile.

¹³ Approved CDM "Combined tool to identify the baseline scenario and demonstrate the additionality in A/R CDM project activities, Version 1".

The project started on June 1, 2003, thus meeting requirement of a start date for the establishment of forest plantation after 31 December 1999 as justified in the project document. The new grouped project instances are added after the project start date.

STEP 1: Identification of alternatives to the project activity consistent with current laws and regulations

Table 2.2 uses data derived from the 2007 Agriculture and Forestry Census by the Chilean National Institute of Statistics (INE¹⁴) for Region V, VI, VII, and VIII, and RM indicates the relative abundance of each land use class in the project region. The 2007 census data are the most current information available from INE on land use in the project region.

Table 2.2. Land uses as a percentage of the project region.

Land Uses	Percent of Total Land Use
Cultivated Soils	16.1
Improved Pasture	2.8
Natural Pasture	28.5
Forest Plantation	6.5
Natural Forests	14.1
Mattoral	12.7
Infrastructure	1.6
Barren Land	17.7

Sub-step 1a: Identify credible alternative land use scenarios to the proposed CDM project activity

1. Continuation of the pre-project land use – abandoned (i.e., natural) pasture;
2. Productive agricultural land, including cropland and managed (i.e., improved) pasture; and
3. Establishment of forest plantation without incentives from carbon credits.

None of the above identified land use scenarios are mandated by law. The three scenarios identified above represent credible and realistic land use conversions from abandoned pasture (i.e., natural pasture). Other land use conversions from natural pasture are unlikely. Conversion from abandoned/natural pasture to infrastructure is highly unlikely given the remoteness of the project areas and the steepness of the terrain. Barren land (sandy, rocky, “sterile” land) is unsuitable for plants and trees.

Sub-step 1b: Consistency of credible alternative land use scenarios with enforced mandatory applicable laws and regulations

¹⁴ Instituto Nacional de Estadísticas (INE). 2007. Censo Agropecuario 2007. http://www.ine.cl/canales/chile_estadistico/censos_agropecuarios/censo_agropecuario_07_comunas.php Accessed: 17 July 2012

None of the above identified land use scenarios are illegal, and hence all are considered here as plausible alternatives for consideration.

Step 2 of the tool identifies several barriers preventing the alternative land use scenario of establishment of forest plantation.

STEP 2: Barrier analysis

Sub-step 2a: Identification of barriers that would prevent the implementation of at least one alternative land use scenario

The following barriers, from the approved CDM “Combined tool to identify the baseline scenario and demonstrate the additionality in A/R CDM project activities” are relevant to the project activity:

1. Technological barriers;
2. Barriers due to local ecological conditions; and
3. Investment barrier.

Related to establishment of forest plantation, these barriers are inter-related - constraining ecological conditions can only be surmounted by the application of new technology and practices to improve productivity to a level to incentivize investment in establishment of forest plantation by small property holders. At the root is the technological barrier, which, on application, eliminates, or mitigates, the constraining ecological conditions barrier.

Sub-step 2b: Elimination of land use scenarios that are prevented by the identified barriers.

Continuation of the pre-project land use - abandoned pasture

The only plausible alternative land use scenario which does not face a barrier is the pre-project land-use of abandoned pasture. Therefore without the aid of carbon finance the most likely land use for the project area is continuation of the pre-project land use.

Productive agricultural land, including cropland and managed pasture

Conversion of the project area to productive agricultural land, including cropland and managed pasture, faces two barriers including local ecological conditions and investment. The local ecological conditions, including degraded soils and the dry climate, present a significant risk of failure to these activities, resulting in a strong barrier to all forms of productive agriculture, as it does for establishment of forest plantation. Conversion to productive agriculture consequently faces a significant investment barrier for landowners, such that initiation of these activities in the project region is the exception rather than the norm.

Establishment of forest plantation

At the start of this project in 2003, Sanhueza et al.¹⁵ stated that:

¹⁵ See section 6.5 of Sanhueza et al. 2003. National Strategy Study for the CDM in Chile, GTZ.

Barriers for the implementation of CDM projects exist above all for the forestation of small farms. Farmers usually have a low level of education and a strong agricultural tradition. They use traditional production techniques and have poor technical and commercial knowledge and little access to state-sponsored training systems. The small farmer is generally located in dry lands and mountain slopes, which have serious restrictions for the traditional agricultural crops of the region...small farmers hardly benefited from state incentives in the past. As a consequence, in 1998 Chilean legislation (DL 701) was modified in order to provide a preferential treatment for small farmers. Nevertheless, in practice this appears insufficiently attractive, since forestation rates of small farms are still quite low.

Establishment of forest plantation in the new grouped project instance areas faces ecological and technological barriers, as noted above. The local ecological conditions (degraded soils, no natural seed sources, and dry climate) create a strong barrier to establishment of forest plantation, including natural regeneration and establishment of commercial plantations using standard planting techniques. The local ecological conditions are overcome in the project through the use of an improved technology (i.e., mycorrhizal inoculation), which permits successful plantation establishment on sites that would otherwise not be sufficiently productive to incentivize efforts by landowners to establish forest plantation.

Even where some subsidies have been made available for establishment of forest plantation (see review of Forestry Law 701 in Section 1.11 of the project document), this has not led to significant adoption of this activity by landowners in the project region due to the aforementioned ecological barriers and high risk of failure (and consequent risk of cost recovery as subsidies are paid one year after successful plantings). In a Chilean study for the CDM, Sanhueza et al.¹⁶ states that in respect to establishment of forest plantation deteriorated soils “the simple existence of current forestry incentives is not a sufficient stimulus for landowners to reforest these terrains.” Significant plantation establishment activities in Chile have typically been carried out as industry scale activities, with most of these plantations in regions further south in Chile where higher rainfall lends to conditions more conducive to forest production.

The present analysis of barriers is also supported by a September 21, 2007 communication of the Government of Chile¹⁷ to the Subsidiary Body for Scientific and Technology Advice entitled, “Views on the implications of possible changes to the limit established for small-scale afforestation and reforestation clean development mechanism project activities under decision 6/CMP.1” (p. 3):

Chile has a long tradition in afforestation and reforestation activities that has led to a surface of more than 2 million hectares afforested with planted forests in 2006. Nevertheless, more than 90% of the planted area is owned by big forest enterprises or large land owners. The Chilean government has made efforts to foster the incorporation of small land owners in afforestation activities, but there are several barriers that hinder the participation of small land owners in these activities.

There have been several attempts in order to formulate AR-CDM project activities involving small land owners in Chile, that have been hindered by the barriers related to the limited surface and dispersal of the properties, scarce knowledge of the technical aspects of afforestation and the

¹⁶ See section 6.3.3 of Sanhueza et al. 2003. National Strategy Study for the CDM in Chile, GTZ.

¹⁷ <http://unfccc.int/resource/docs/2007/sbsta/eng/misc19.pdf>

forest business, limited access to loans and other barriers such as the well-known complicated and expensive procedures of the AR-CDM projects formulation.

The technological barrier faced by this land use scenario is the lack of access to mycorrhizal inoculation technology which helps ensure tree establishment and productivity on dry and degraded soils. Local ecological conditions can be overcome through the use of mycorrhizal inoculation, an improved propagation technology, provided by the project proponent.

Furthermore, this assessment is corroborated by previous audit findings. During the validation of the Nerquihue CDM project, part of the project area, Tüv Süd (2010), the validators, stated:

The technological barrier is of elevated relevance for this project, since only the mycorrhizal inoculation enables the [establishment of forest plantation] of the degraded project area. The audit team considers this barrier to be clearly prohibitive in the project context. It is credible that this barrier was only surpassed due to the technological inputs by Mikro-Tek which constitutes the core element of this project activity.

It is demonstrated in the project document with the most up to date INE Agriculture and Forestry Census data currently available (2007) that establishment of forest plantation in the project region is not common practice (Step 4) and thus would not have occurred on these privately owned lands without carbon finance funding the mycorrhizal inoculation and thus overcoming a technological barrier (and related investment barrier).

6) If new project instances are added which use biomass burning during the course of site preparation or as a forest management activity, emissions from biomass burning will be accounted for appropriately using the CDM Tool “Estimation of non-CO2 greenhouse gas (GHG) emissions resulting from burning of biomass attributable to an A/R CDM project activity”.

The new project instances did not use biomass burning during the course of site preparation or as a forest management activity.

7) Each new grouped project instance will be given a unique identifier and incorporated into the overall project accounting tracking system. The project maintains an electronic database of GIS coverages detailing parcel boundaries and monitoring plot locations (once established), and maps archived in both digital and hard copy form. Original field monitoring data sheets, GIS data layers, reports of analyses and supporting spreadsheets will be stored in both hard copy and digital form at the Mikro-Tek Office in Timmins, Ontario for at least 2 years beyond the project crediting period. Given the extended timeframe and the pace of production of updated versions of software and new hardware for storing data, electronic files will be updated periodically or converted to a format accessible to future software applications. Adherence to these procedures will ensure smooth transitions and maintain “institutional memory” in the event of changes in personnel responsible for the monitoring plan.

The new project instances have been added to the project database.

2.4 Safeguards

2.4.1 No Net Harm

No environmental impact assessment was required prior to project implementation. Further, each site has a forestry plan approved by CONAF and is in compliance with applicable laws, see Section 1.11 of the project description.

In March 2003, the Chilean Environmental Agency (CONAMA) commissioned a “National Strategy Study for the CDM in Chile”¹⁸ which provided principals to guide CDM LULUCF activities in the forestry sector. Mikro-Tek has incorporated the environmental criteria outlined in that report. Specifically that the project improves eroded and deteriorated soils; protects waterways and their sources; and uses forest species common in Chile that were known not to present any negative environmental impacts.

Further the project incorporated mycorrhizal inoculation technology, which has been shown to provide additional environmental benefits including:

- enhanced survival and growth of plants on eroded and nutrient-poor sites;
- optimized productivity of land aided by improved water and nutrient-use efficiency;
- improved biological health of the soil, including improved organic content, soil structure, porosity and water holding capacity;
- enhancement of the plants’ resistance to various environmental stresses such as heat and drought; and
- an increase in the forest’s ability to adapt to climate change, and better withstand extreme weather events.

No negative impacts have been envisioned for the project activity, establishment of forest plantation on degraded lands.

2.4.2 Local Stakeholder Consultation

Mikro-Tek’s presence on the ground in Chile enhances communication with local stakeholders. Mikro-Tek’s agent in Chile has been available for answering questions on a regular basis, and personnel from Canada have visited once each year to meet with local stakeholders and to collect updated information as required. Since the first monitoring event in 2012 Mikro-Tek personnel from Canada have traveled to Chile to meet with project stakeholders to update them on the status of the carbon project, and to address any concerns they may have. Mikro-Tek’s full time agent in Chile is in continual contact with the project partners as well as the various forestry contractors who work on the projects to address any new issues that arise.

¹⁸ Comisión Nacional del Medio Ambiente. 2003. “National Strategy Study for the CDM in Chile” Sanhueza, Eduardo, Moldonado, Pedro, and Neuenschwander, Aquiles, <http://www.gtz.de/de/dokumente/en-climate-chile-national-strategy-study-cdm-summary.pdf>, published by Deutsche Gesellschaft für Technische Zusammenarbeit,

3 DATA AND PARAMETERS

3.1 Data and Parameters Available at Validation

The following data and parameters are available prior preparing this monitoring report.

Data / Parameter	CF _j
Data unit	t C t ⁻¹ d.m.
Description	Carbon fraction of biomass for tree species j
Source of data	CDM Tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities”; Version 2.1.0
Value applied	0.5 t C t ⁻¹ d.m.
Justification of choice of data or description of measurement methods and procedures applied	
Purpose of the data	Calculation of project emissions
Comments	None

Data / Parameter	bm _{Pinus}
Data unit	kg
Description	total aboveground biomass for trees
Source of data	Gayoso, J. 2008b. Pinus radiata. Resultados Proyecto FONDEF D98i1076 “Medición y Monitoreo de la Captura de Carbono en Ecosistemas Forestales y Promoción en el Mercado Mundial del Carbono”. Bosque PROCarbono, Universidad Austral de Chile.
Value applied	$bm = -5.0506 + 0.8173*(dbh^2)$
Justification of choice of data or description of measurement methods and procedures applied	
Purpose of the data	Calculation of project emissions
Comments	None

Data / Parameter	bm _{Eucalyptus}
Data unit	kg
Description	Total aboveground biomass for trees

Source of data	Gayoso, J. 2008a. Eucalyptus sp. Resultados Proyecto FONDEF D98i1076 "Medición y Monitoreo de la Captura de Carbono en Ecosistemas Forestales y Promoción en el Mercado Mundial del Carbono". Bosque PROCarbono, Universidad Austral de Chile.
Value applied	$bm = \text{Exp}(2.3177 + 0.1303 \cdot dbh)$
Justification of choice of data or description of measurement methods and procedures applied	
Purpose of the data	Calculation of project emissions
Comments	None

Data / Parameter	$R_{\text{Eucalyptus}}$
Data unit	Dimensionless
Description	Root to shoot ratio for Eucalyptus globulus
Source of data	Gayoso, J. 2008a. Eucalyptus sp. Resultados Proyecto FONDEF D98i1076 "Medición y Monitoreo de la Captura de Carbono en Ecosistemas Forestales y Promoción en el Mercado Mundial del Carbono". Bosque PROCarbono, Universidad Austral de Chile.
Value applied	0.2159
Justification of choice of data or description of measurement methods and procedures applied	
Purpose of the data	Calculation of project emissions
Comments	None

Data / Parameter	R_{Pinus}
Data unit	Dimensionless
Description	Root to shoot ratio for Pinus radiata = 0.2543
Source of data	Gayoso, J. 2008b. Pinus radiata. Resultados Proyecto FONDEF D98i1076 "Medición y Monitoreo de la Captura de Carbono en Ecosistemas Forestales y Promoción en el Mercado Mundial del Carbono". Bosque PROCarbono, Universidad Austral de Chile.
Value applied	0.2543
Justification of choice of data or description of measurement methods and procedures applied	

Purpose of the data	Calculation of project emissions
Comments	None

3.2 Data and Parameters Monitored

The following data and parameters have been monitored in November/December 2017.

Data / Parameter	A
Data unit	ha
Description	Total area of project
Source of data	GIS
Description of measurement methods and procedures to be applied	
Frequency of monitoring/recording	Every five years
Value monitored	6013 ha
Monitoring equipment	
QA/QC procedures to be applied	
Purpose of the data	Calculation of project emissions
Calculation method	
Comments	None

Data / Parameter	LK _{Agric,t}
Data unit	t CO ₂ -e
Description	Leakage due to the displacement of agricultural activities in year t
Source of data	Calculated
Description of measurement methods and procedures to be applied	Approved CDM tool "Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity"
Frequency of monitoring/recording	Every five years
Value monitored	0 t CO ₂ -e
Monitoring equipment	
QA/QC procedures to be applied	

Purpose of the data	Calculation of leakage
Calculation method	
Comments	None

Data / Parameter	D_t
Data unit	Dimensionless
Description	Fraction of the total area of A/R VCS project activity subject to displacement of agricultural activities in year t
Source of data	Calculated
Description of measurement methods and procedures to be applied	Approved CDM tool "Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity"
Frequency of monitoring/recording	Every five years
Value monitored	0 t CO ₂ -e
Monitoring equipment	
QA/QC procedures to be applied	
Purpose of the data	Calculation of leakage
Calculation method	
Comments	None

Data / Parameter	Ad_t
Data unit	Ha
Description	Area subject to pre-project agricultural activities that are displaced during year t since the start of the A/R project activity
Source of data	Calculated
Description of measurement methods and procedures to be applied	Approved CDM tool "Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity"
Frequency of monitoring/recording	Every five years
Value monitored	0 ha
Monitoring equipment	
QA/QC procedures to be applied	
Purpose of the data	Calculation of leakage

Calculation method	
Comments	None

Data / Parameter	ΔC_d_t
Data unit	t C yr ⁻¹
Description	Annual change in carbon stock in all selected carbon pools for year t
Source of data	Calculated
Description of measurement methods and procedures to be applied	Approved CDM tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; Version 2.1.0; and Approved CDM "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities", Version 01.1.0.
Frequency of monitoring/recording	Every five years
Value monitored	
Monitoring equipment	
QA/QC procedures to be applied	
Purpose of the data	Calculation of project emissions
Calculation method	
Comments	None

Data / Parameter	$\Delta C_{t=t_{ver}}$
Data unit	t C
Description	Sum of annual changes in carbon stock in all selected carbon pools since the start of the A/R VCS project activity to the year of verification t _{ver}
Source of data	Calculated
Description of measurement methods and procedures to be applied	Approved CDM tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; Version 2.1.0; and Approved CDM "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities", Version 01.1.0.
Frequency of monitoring/recording	Every five years
Value monitored	
Monitoring equipment	

QA/QC procedures to be applied	
Purpose of the data	Calculation of project emissions
Calculation method	
Comments	None

Data / Parameter	ΔC_d^*
Data unit	t C
Description	Sum of annual changes in carbon stock in all selected carbon pools since the start of the A/R VCS project activity to the year of verification tver attributable to the area subject to pre-project agricultural activities that are displaced during year t since the start of the A/R project activity
Source of data	Calculated
Description of measurement methods and procedures to be applied	Approved CDM tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; Version 2.1.0; and Approved CDM "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities", Version 01.1.0.
Frequency of monitoring/recording	Every five years
Value monitored	
Monitoring equipment	
QA/QC procedures to be applied	
Purpose of the data	Calculation of project emissions
Calculation method	
Comments	None

Data / Parameter	f
Data unit	Dimensionless
Description	Fraction of land covered by forest (according to the national definition of forest) in the region containing the A/R VCS project activity
Source of data	Calculated

Description of measurement methods and procedures to be applied	
Frequency of monitoring/recording	Every five years
Value monitored	
Monitoring equipment	
QA/QC procedures to be applied	
Purpose of the data	Calculation of project emissions
Calculation method	
Comments	None

Data / Parameter	dbh
Data unit	cm
Description	Diameter at breast height of tree
Source of data	Measured
Description of measurement methods and procedures to be applied	Within each sampling plot all planted stems (e.g., <i>Pinus radiata</i>, <i>Eucalyptus globulus</i>, etc.) ≥ 5 cm dbh will be measured. Native woody species, including trees and shrubs if present, are not included in the project and hence will not be measured. Diameter of trees will be measured at breast height (1.3 m above ground level, see Figure 2.1). To avoid either missed trees or double recording, the point of initiation of measurement will be noted, and measurement should proceed in a consistent clockwise or counter-clockwise fashion.
Frequency of monitoring/recording	Every five years
Value monitored	
Monitoring equipment	dbh tape
QA/QC procedures to be applied	Field crews were fully trained in all aspects of the field data collection and adhered to field measurement protocols. Field crew leaders were responsible for ensuring that field protocols were followed to ensure accurate and consistent measurement. Pilot sample plots were measured before the initiation of formal

	measurements to appraise field crews and identify and correct any errors in field measurements. All equipment used in the course of field measurements was calibrated according to the equipment's specifications or national/international standards.
Purpose of the data	Calculation of project emissions
Calculation method	
Comments	None

Data / Parameter	Ai
Data unit	Ha
Description	(a) Area of tree biomass stratum i; (b) Area of SOC stratum i of the land meeting the applicability conditions of the SOC tool
Source of data	Measured
Description of measurement methods and procedures to be applied	Strata boundaries are delineated in GIS. Strata have been delineated based on species type, stand age, harvest regime, and native shrub density.
Frequency of monitoring/recording	Every five years
Value monitored	
Monitoring equipment	
QA/QC procedures to be applied	
Purpose of the data	Calculation of project emissions
Calculation method	
Comments	None

Data / Parameter	a_{pi}
Data unit	Ha
Description	Total area of sample plots in tree biomass stratum i
Source of data	Calculated
Description of measurement methods and procedures to be applied	Calculation of the required sample size referenced data from survival assessment plots gathered in 2017 (TerraCarbon data unpublished). Based on analysis of the referenced data available, a sample size of 80 clusters of five 10-meter radius plots was estimated to

	target a precision of +/-10% of the mean with 90% confidence.
Frequency of monitoring/recording	<i>Every five years</i>
Value monitored	
Monitoring equipment	
QA/QC procedures to be applied	
Purpose of the data	<i>Calculation of project emissions</i>
Calculation method	
Comments	<i>None</i>

3.3 Monitoring Plan

This grouped project uses the Clean Development Mechanism (CDM) approved consolidated afforestation and reforestation baseline and monitoring methodology “AR-ACM0003 Afforestation and reforestation of degraded land (Version 1.0)”.

Over the life of the project, carbon stock and stock change estimates will be derived from direct measurements thus satisfying the IPCC Tier 3 highest level of accuracy criteria. Direct estimates of live and dead biomass have been generated from data collected during the course of a forest biomass inventory. Soil carbon while not monitored has been accounted for using the CDM “Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities”, as permitted by the CDM Methodology AR-ACM0003, Version 1.0.

While the complete monitoring plan is listed in section 4.0 of the project description, this section details the specifics of the monitoring plan and random stratified sampling design as implemented in the 2017 forest inventory.

Mikro-Tek was responsible for all monitoring aspects including planning, fieldwork, reporting, and data archiving.

3.3.1 Monitoring approach

3.3.1.1 Precision target

The monitoring plan was designed to produce biomass stock estimates with a precision level of +/-10% of the mean with 90% confidence. As biomass estimates yielded a precision exceeding $\pm 10\%$ of the mean at a 90% confidence level, an appropriate confidence deduction was applied, as allowed by VCS¹⁹.

3.3.1.2 Carbon pools

Project monitoring measured and quantified carbon stocks in terrestrial carbon pools including aboveground biomass and belowground biomass. Soil carbon stocks were not monitored; changes in soil

¹⁹ VCS. 2017 VCS Standard. Version 3.4, 21 June 2017. Verified Carbon Standard, Washington, D.C.

carbon stocks instead were determined using the approved CDM “Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities”.

3.3.1.3 Definition and delineation of strata

As stratification of the project area can increase the precision of biomass estimation without increasing the cost unduly or reduce the cost without reducing the precision of biomass estimation, the project area has been stratified based on planting year, dominant species, and forest management activities for biomass monitoring (Table 3.3). For the purpose of calculation of changes in SOC, the project area was stratified by planting year and soil type (Table 3.4).

Table 3.3. List of strata for monitoring and quantification of biomass carbon stocks in 2017.

2017STRATA	Live Aboveground and/or Belowground Biomass Monitored	Soil Monitored	Stratum Areas (ha)
Burn/Harvested	Yes	Yes	983
Pine-03-08	Yes	Yes	1257
EUC-03-08	Yes	Yes	334
EUC-09-13	Yes	Yes	394
Pine-09-13	Yes	Yes	3045
Total			6013

Table 3.4. List of strata for quantification of soil carbon stocks.

Planting Year	Area with High Activity Clay Soils (ha)	Area with Volcanic Soils (ha)
2003	718.5	0.0
2004	1192.8	0.0
2005	116.4	0.0
2006	179.6	0.0
2007	143.3	0.0
2008	0.0	0.0
2009	780.3	595.3
2010	981.7	0.0
2011	392.6	0.0
2012	632.3	0.0
2013	280.5	0.0
2014	0.0	0.0
2015	0.0	0.0
2016	0.0	0.0
2017	0.0	0.0
Total	2411.7	595.3

3.3.1.4 Sampling design

The project employed stratified random sampling using permanent 10-meter radius circular (fixed area) plots for live aboveground biomass. Cluster sampling was employed to improve precision.

Calculation of the required sample size referenced data from survival assessment plots gathered in 2017 (TerraCarbon data unpublished). Based on analysis of the referenced data available, a sample size of 80 clusters of five 10-meter radius plots was estimated to target a precision of +/-10% of the mean with 90% confidence.

Sample units were allocated at random within strata using ArcGIS. The location of each primary monitoring plot is detailed in Table 3.5.

Table 3.5. GPS coordinates and location of permanently monumented primary sampling plots.

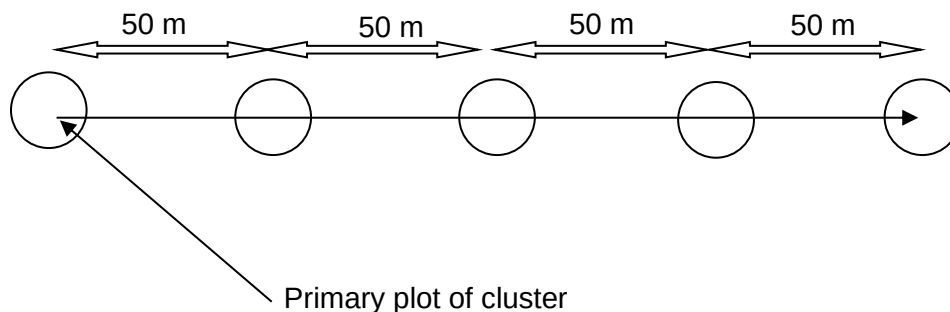
MonitorID	X (WGS 1984 UTM Zone 19S)	Y (WGS 1984 UTM Zone 19S)	F2017STRAT
MT-001	266408.67254500000	6149609.75155000000	Burn/Harvested
MT-002	265952.29755300000	6149377.40315000000	Burn/Harvested
MT-003	265990.69940000000	6150288.54336000000	Burn/Harvested
MT-004	220153.81600700000	6137178.86052000000	Burn/Harvested
MT-005	269428.11978100000	6168378.95305000000	Burn/Harvested
MT-006	269393.70808100000	6168451.12037000000	Burn/Harvested
MT-007	257740.32126800000	6210431.40146000000	Burn/Harvested
MT-009	266920.70400200000	6167208.78761000000	Pine-03-08
MT-011	266952.73542800000	6150059.12831000000	Pine-03-08
MT-012	268776.94922500000	6154690.25058000000	Pine-03-08
MT-013	267762.23169100000	6163929.58812000000	Pine-03-08
MT-014	268790.22603300000	6163403.88462000000	Pine-03-08
MT-015	267744.25132200000	6163919.77030000000	Pine-03-08
MT-016	266734.46671100000	6148709.76339000000	Pine-03-08
MT-017	263976.29710600000	6149393.65350000000	Pine-03-08
MT-018	264418.10593900000	6148617.25199000000	Pine-03-08
MT-019	267120.66306500000	6164685.81314000000	Pine-03-08
MT-020	261705.58661000000	6161293.50983000000	Pine-03-08
MT-021	266553.58084400000	6149512.94910000000	Pine-03-08
MT-022	263158.13745600000	6148573.77473000000	Pine-03-08
MT-023	265854.20258600000	6149495.09431000000	Pine-03-08
MT-024	269763.90110200000	6154041.16715000000	Pine-03-08
MT-026	265270.53019600000	6147200.43643000000	Pine-03-08
MT-027	268157.44410800000	6167831.12798000000	Pine-03-08
MT-028	269091.51705500000	6163047.05191000000	Pine-03-08
MT-029	272095.37593300000	6156711.06035000000	Pine-03-08
MT-030	272244.44159400000	6156095.81633000000	Pine-03-08
MT-031	267418.93102700000	6167600.80510000000	Pine-03-08
MT-032	269947.03863700000	6154455.14839000000	Pine-03-08
MT-034	245403.70311400000	6230604.46600000000	EUC-03-08

MT-035	244020.26189700000	6229125.35745000000	EUC-03-08
MT-036	268434.94333000000	6154779.85146000000	EUC-03-08
MT-037	245002.43316300000	6230600.10877000000	EUC-03-08
MT-038	245283.56112200000	6231147.79666000000	EUC-03-08
MT-039	243465.13719300000	6228966.67745000000	EUC-03-08
MT-040	243720.27604800000	6229498.47617000000	EUC-03-08
MT-041	258694.13268500000	6165279.79946000000	EUC-09-13
MT-042	274816.81487400000	6135538.69374000000	EUC-09-13
MT-043	272952.32470800000	6139980.96785000000	EUC-09-13
MT-044	275901.11202700000	6139860.87624000000	EUC-09-13
MT-045	274837.82674000000	6141083.58286000000	EUC-09-13
MT-046	276011.71811000000	6139751.08457000000	EUC-09-13
MT-047	274092.12138500000	6139273.79504000000	EUC-09-13
MT-048	274252.65680900000	6143121.21488000000	Pine-09-13
MT-050	275951.44054400000	6143295.50703000000	Pine-09-13
MT-052	273257.91164900000	6136048.74998000000	Pine-09-13
MT-053	272985.92978200000	6139938.71013000000	Pine-09-13
MT-054	273671.70604600000	6136138.23383000000	Pine-09-13
MT-055	267517.29540500000	6156881.73988000000	Pine-09-13
MT-056	268974.02815800000	6157027.56136000000	Pine-09-13
MT-057	272693.53952100000	6158498.15379000000	Pine-09-13
MT-058	273173.95351700000	6144147.51104000000	Pine-09-13
MT-059	274744.55064200000	6144102.16578000000	Pine-09-13
MT-060	228660.36380800000	5873375.34169000000	Pine-09-13
MT-061	272854.09890700000	6145609.58087000000	Pine-09-13
MT-062	273052.63405800000	6145869.30050000000	Pine-09-13
MT-063	274136.84029200000	6135618.55721000000	Pine-09-13
MT-064	272650.06626100000	6140079.49600000000	Pine-09-13
MT-065	273403.93327800000	6145421.21847000000	Pine-09-13
MT-066	277644.50606800000	6140829.78565000000	Pine-09-13
MT-067	268118.47625000000	6156623.73532000000	Pine-09-13
MT-068	273624.96683300000	6143961.88560000000	Pine-09-13
MT-069	227832.62391600000	5872956.20604000000	Pine-09-13
MT-070	273355.99385500000	6144417.89095000000	Pine-09-13
MT-071	228941.37705000000	5873021.19975000000	Pine-09-13
MT-072	228383.03559100000	5873989.51908000000	Pine-09-13
MT-073	273590.68963800000	6142945.01653000000	Pine-09-13
MT-074	226876.93467300000	5872661.55767000000	Pine-09-13
MT-075	268315.29381100000	6157525.88690000000	Pine-09-13
MT-076	259043.11950700000	6120268.11364000000	Pine-09-13
MT-077	273207.46477200000	6143104.52988000000	Pine-09-13

MT-078	275311.68151300000	6143974.22570000000	Pine-09-13
MT-079	275556.90823400000	6142200.42395000000	Pine-09-13
MT-080	275465.34200200000	6136045.71600000000	Pine-09-13
MT-081	278185.26653000000	6140742.39039000000	Pine-09-13
MT-082	273180.26587900000	6138466.26096000000	Pine-09-13
MT-083	268521.08035100000	6156239.73312000000	Pine-09-13
MT-084	274344.47781200000	6137007.11425000000	Pine-09-13
MT-085	275665.33443100000	6140647.77440000000	Pine-09-13
MT-086	279376.01027700000	6144924.33760000000	Pine-09-13

Each cluster sample was composed of a string of five ten-meter radius plots, with the first plot permanently monumented (Figure 3.1). The secondary plots were un-marked temporary plots expanding the sample unit to a cluster. Sample units were allocated at random within strata using ArcGIS. GPS coordinates correspond with the center point of the primary plot. The direction of the string cluster was random and was assigned prior to arriving at the sampling plot.

Figure 3.1. Diagram of cluster monitoring plot design with the permanently monumented plot as the initial plot in the cluster.

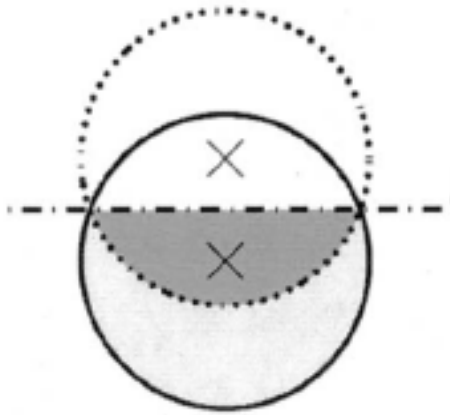


When issues of boundary overlap were encountered in the field, plots that overlap the project boundary were corrected using the mirage method^{20, 21} (Figure 3.2). The solid-lined circle represents the actual plot border. The portion of the circle above the horizontal line is outside of the forest strata being sampled. After sampling all the trees within the sampling circle within the forest strata (e.g. below the line), the trees within the grey shaded area were registered twice on the data sheet to account for the same area which is above the horizontal line and outside the plot.

Figure 3.2. Diagram of mirage method (Avery and Burkhart, 1994)

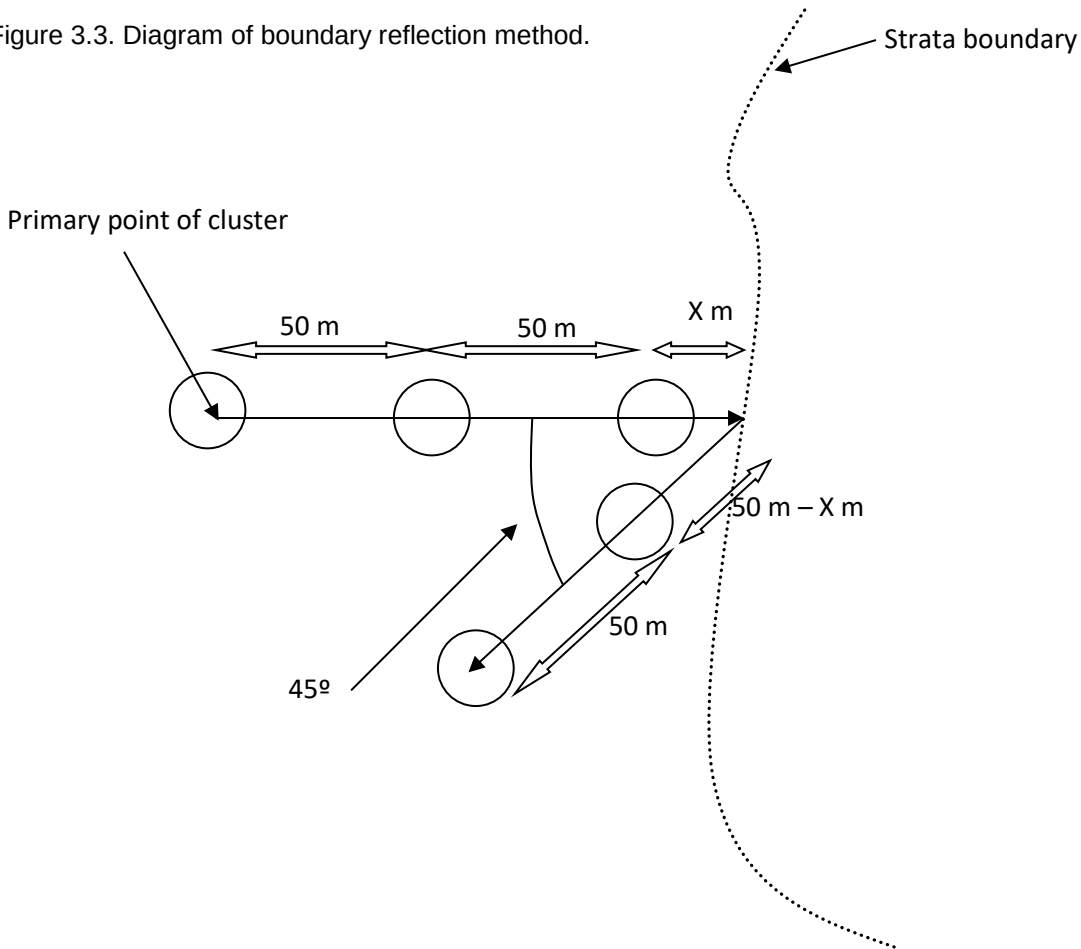
²⁰Avery, T.E. and H.E. Burkhart. 1994. *Forest Measurements*. Fourth Edition. McGraw Hill, Boston, Massachusetts, USA. 408 pp.

²¹Ducey, M.J., J.H. Gove, and H.T. Valentine. 2004. A Walkthrough Solution to the Boundary Overlap Problem. *Forest Science*, 50: 427-435.



Where the 50 meter lines of transit from the direction of the primary plot center crossed the strata boundary prior to terminating, lines were deflected from the boundary back into the project area using a "ricochet" method to complete the 50 m, where the line of transit ricocheted back into the project area to the right of the original bearing at a 45 degree angle.

Figure 3.3. Diagram of boundary reflection method.



3.3.2 Field measurement protocols

Direct field measurements of aboveground biomass followed standard forest inventory best practices outlined in Avery and Burkhart (1994). As allowed under methodology AR-ACM0003 version 1.0, deadwood, litter and soil organic carbon were not measured and monitored.

3.3.2.1 Establishment of measurement plots

Once the plot center location was reached, the plot was marked by hammering a 1 cm diameter metal rebar into the ground. The metal rebar was approximately 1.5 m in length. An aluminum tag, labeled with a unique monitoring plot identification name, was attached to each primary plot center.

Coordinates of all secondary sample plots were recorded with a GPS.

3.3.2.2 Layout of measurement plots

The slope of each monitoring plot (both permanent and temporary plots) was taken using a clinometer and recorded.

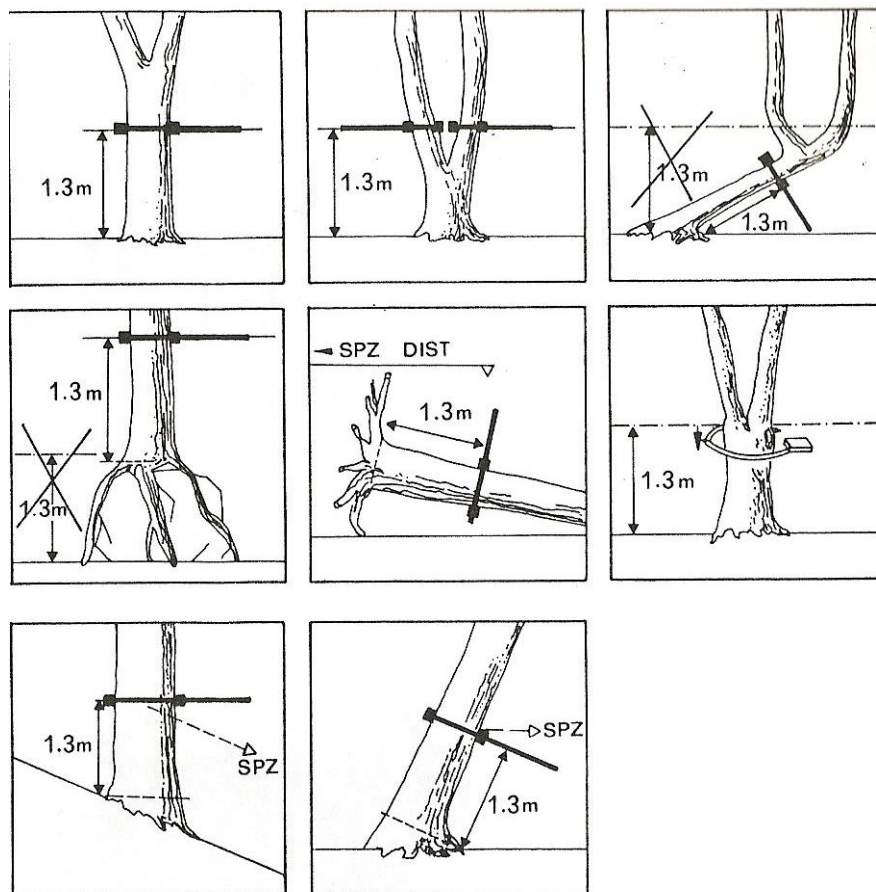
3.3.2.3 Measurement of live trees

Within each sampling plot all planted stems (e.g., *Pinus radiata*, *Eucalyptus globulus*, etc.) ≥ 5 cm dbh were measured. Native woody species are not included in the project and hence were not measured if

encountered in the field. Diameter of trees was measured at breast height (1.3 m above ground level, see Figure 3.4).

To avoid either missed trees or double recording, the point of initiation of measurement was noted, and measurement proceeded in a consistent clockwise or counter-clockwise fashion.

Figure 3.4. Point of measurement of diameter at breast height (from Pancel²², 1993).



3.3.2.4 Measuring distance

When sonic measuring equipment, such as Haglof DMEs, was used in the field (to check plot radii and borderline trees) they were calibrated before each use and allowed 10+ minutes prior to use to equilibrate the unit to ambient conditions.

3.3.3 Data analysis for aboveground and belowground biomass

Field data, including the diameter at breast height and species, were used to generate estimates of biomass stocks in live aboveground and belowground trees. Aboveground live tree biomass was estimated from dbh applying allometric equations found in Gayoso (2008a)²³ for *Eucalyptus globulus* and

²² Pancel, L., ed. 1993. Tropical forestry handbook. Berlin, Germany, Springer-Verlag. Volume 1, 738 pp.

²³ Gayoso, J. 2008a. Eucalyptus sp. Resultados Proyecto FONDEF D98i1076 "Medición y Monitoreo de la Captura de Carbono en Ecosistemas Forestales y Promoción en el Mercado Mundial del Carbono". Bosque

Gayoso (2008b)²⁴ for *Pinus radiata* as found in Section 3.1 of the project description. Root to shoot ratios for calculating belowground biomass are found in Gayoso (2008a) for *Eucalyptus globulus* ($R_{\text{Eucalyptus}} = 0.2159$) and Gayoso (2008b) for *Pinus radiata* ($R_{\text{Pinus}} = 0.2543$), which are also found in Section 3.1.

Belowground biomass was calculated by multiplying the root to shoot ratio by the aboveground biomass. Biomass estimates were converted to carbon stocks using a carbon fraction of 0.5.

3.3.4 Leakage monitoring

Leakage was calculated ex-post using the approved CDM A/R Methodological Tool, “Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity.” Leakage calculations and parameters are detailed in Section 3.3 of the project description.

3.3.5 Quality control and data archiving

During implementation of the monitoring plan QA/QC procedures were applied as outlined here to minimize errors in measurement and data analysis, to provide documentation and consistency in data archiving. The plan covers procedures for: (1) collecting reliable field measurements, (2) documenting data entry and analysis techniques and (3) data maintenance and archiving.

The grouped project maintains an electronic database of GIS coverages detailing parcel boundaries, and will record and archive raw field measurements and analyses to permit independent review of source data over the life of the project.

3.3.5.1 Field measurements

Field crews were fully trained in all aspects of the field data collection and adhered to field measurement protocols. Field crew leaders were responsible for ensuring that field protocols were followed to ensure accurate and consistent measurement. Pilot sample plots were measured before the initiation of formal measurements to appraise field crews and identify and correct any errors in field measurements.

All equipment used in the course of field measurements was calibrated according to the equipment's specifications or national/international standards.

3.3.5.2 Data entry

Data was recorded on field sheets and then transcribed to electronic media. To minimize errors in data entry, where they are not the same, personnel involved in data analysis was consulted with personnel involved in measurement to clarify any anomalous values or ambiguities in transcription.

PROCarbano, Universidad Austral de Chile.

http://www.uach.cl/procarbano/pdf/fichas/ficha_eucalyptus_sp.pdf Accessed 21 July 2011.

²⁴ Gayoso, J. 2008b. *Pinus radiata*. Resultados Proyecto FONDEF D98i1076 “Medición y Monitoreo de la Captura de Carbono en Ecosistemas Forestales y Promoción en el Mercado Mundial del Carbono”. Bosque PROCarbano, Universidad Austral de Chile.

http://www.uach.cl/procarbano/pdf/fichas/ficha_pinus_radiata.pdf Accessed 21 July 2011.

3.3.5.3 Data archiving

Because of the long-term objective of the monitoring plan, data archiving is essential. Field measurement data was recorded on field sheets, which have been duplicated and archived. Field data was entered in an electronic database. Copies of all raw data, reports of analysis and supporting spreadsheets will be stored in a dedicated long-term electronic archive. All documents and records are kept in a secure and retrievable manner for at least two years after the end of the project crediting period. Given the extended timeframe and the pace of production of updated versions of software and new hardware for storing data, electronic files will be updated periodically or converted to a format accessible to future software applications. Adherence to these procedures will also ensure smooth transitions and maintain “institutional memory” in the event of changes in personnel responsible for the monitoring plan.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

As detailed in Sections 2.4 and 2.5 of the project description for the initial project instances, and Sections 2.3 of this monitoring report for the 2017 cohort of new grouped project instances, continuation of the pre-project land use is the most plausible baseline scenario in the project area. Baseline removals in aboveground and belowground woody biomass, dead wood, litter and soil organic carbon are assumed to be in a steady state and thus baseline removals in aboveground and belowground woody biomass can be considered to be zero for the life of the project.

Relevant applicability conditions are met and substantiated in Table 4.1 below.

Table 4.1. Methodology AR-ACM0003 operative assumptions and demonstration that these assumptions are valid for the initial project instances.

Assumptions allowed under AR-ACM0003	Validity of assumptions to project baseline
"Changes in carbon stock of aboveground and belowground biomass of non-tree vegetation may be conservatively assumed to be zero for all strata in the baseline scenario"	Aboveground and belowground non-tree biomass stocks are steady state and are not expected to increase over time.
"It is expected that the baseline dead wood and litter carbon pools will not show a permanent net increase. It is therefore conservative to assume that the sum of the changes in the carbon stocks of dead wood and litter carbon pools is zero for all strata in the baseline scenario"	Dead wood and litter carbon pools are nonexistent or in a steady state in the baseline scenario.

"Changes in carbon stock in soil organic carbon (SOC) may be conservatively assumed to be zero for all strata in the baseline scenario"	Soil organic carbon stocks are expected to remain at a steady state or decrease in the baseline scenario.
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4.2 Project Emissions

The Reforesting Degraded Lands in Chile through the use of Mycorrhizal Inoculation project sequesters carbon in aboveground biomass, belowground biomass, and soil. The amount of carbon sequestered in aboveground biomass and belowground biomass has been assessed directly in 2017. Statistical analysis was performed on measurements collected in the 2017 inventory. Results are found in Table 4.2 and 4.3, below.

Table 4.2. Results of descriptive statistics for biomass carbon stocks in the 2017 forest biomass inventory by stratum.

Strata	Burn/Harvested (t C/ha)	Pine-03-08 (t C/ha)	EUC-03-08 (t C/ha)	EUC-09-13 (t C/ha)	Pine-09-13 (t C/ha)
Mean (t C/ha)	37.7	168.8	20.6	24.2	46.9
Variance	684.0	4459.7	243.9	134.0	557.8
Standard Deviation	26.2	66.8	15.6	11.6	23.6
Coefficient of Variation (%)	69.4	39.6	75.8	47.8	50.4
Standard Error (t C/ha)	9.9	14.2	5.9	4.4	3.9
Number of Samples	7	22	7	7	37

Overall, the inventory produced an estimate of biomass carbon stocks at the project level of 67.93 t C/ha (i.e. 249.08 t CO₂/ha) with a precision level of +/- 9.66% of the mean at the 90% confidence level (Table 4.3). As the 90% confidence interval is less than 10% of the mean biomass carbon stocks at the project level no reduction in the mean is taken. The estimate of biomass carbon stocks is within the allowable error limits (i.e. 10%), and no confidence deduction was applied, as allowed by VCS²⁵.

²⁵ VCS. 2017 VCS Standard. Version 3.7, 21 June 2017. Verified Carbon Standard, Washington, D.C.

Table 4.3. Project level descriptive statistics for total biomass carbon stocks in the 2017 forest inventory employing stratified random sampling.

Descriptive Statistic	Project Level
Mean (t C/ha)	67.93
Standard Error (t C/ha)	3.94
90% Confidence Interval	6.56
90% Confidence Interval as % of mean	9.66%

Table 4.4. Gross estimates of total sequestered biomass carbon due to project implementation.

2017 STRATA	Live Aboveground and Belowground Biomass Monitored	Total Stratum Areas (ha)	Live Aboveground and Belowground Biomass Carbon stocks (t C/ha)	Live Aboveground and Belowground Biomass Carbon stocks (t C)	Metric tonnes of CO₂ in Live Aboveground and Belowground Biomass (t CO₂e)
Burn/Harvested Pine-03-08 EUC-03-08 EUC-09-13 Pine-09-13	Yes	6013.25	67.93	408,480	1,497,760

Reported soil carbon stocks are calculated using the CDM “Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities”, as permitted by the CDM Methodology AR-ACM0003, Version 1. While no monitoring is required to estimate soil carbon accumulation as per the above tool, each project instance was visited during the course of 2017 to assess plantation establishment and stem density thus ensuring the use of the default SOC accumulation rate is appropriate. This above approach allows for reporting 0.57 tonnes C per year for 20 years for grassland with high activity clay soils and 1.05 tonnes C per year for grassland with volcanic soils (as detailed in section 3.2 of the project description). Carbon sequestered in soil is estimated by planting year and soil type in Table 4.5. In initial project instances reported soil carbon stocks include soil carbon accumulation during the current monitoring period from 2012 through 2017. For new grouped project instances, reported stocks include accumulation from the project start date in 2003 through 2017.

Table 4.5. Estimates of soil carbon sequestered due to project implementation during the 2012 – 2017 monitoring period.

Planting Year	Initial Instances				2017 New Instances				Total SOC accumulation (t C)	Total SOC accumulation (t CO2)
	Area Planted (ha)		SOC Accumulation 13 - 17 (t C ha-1)		Area Planted (ha)		SOC Accumulation 03 - 17 (t C ha-1)			
	High Activity Clay soils	Volcanic soils	High Activity Clay soils	Volcanic soils	High Activity Clay soils	Volcanic soils	High Activity Clay soils	Volcanic soils		
2003	718.5	0.0	2,047.7	0.0	0.0	0.0	0.0	0.0	2,047.7	7,508.3
2004	1,192.8	0.0	3,399.5	0.0	0.0	0.0	0.0	0.0	3,399.5	12,464.8
2005	116.4	0.0	331.7	0.0	0.0	0.0	0.0	0.0	331.7	1,216.4
2006	179.6	0.0	511.9	0.0	0.0	0.0	0.0	0.0	511.9	1,876.8
2007	143.3	0.0	408.4	0.0	0.0	0.0	0.0	0.0	408.4	1,497.5
2008	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2009	61.1	595.3	174.1	3,125.3	719.2	0.0	3,279.6	0.0	6,579.0	24,123.0
2010	0.0	0.0	0.0	0.0	981.7	0.0	3,917.0	0.0	3,917.0	14,362.3
2011	0.0	0.0	0.0	0.0	392.6	0.0	1,342.7	0.0	1,342.7	4,923.2
2012	0.0	0.0	0.0	0.0	632.3	0.0	1,802.1	0.0	1,802.1	6,607.5
2013	0.0	0.0	0.0	0.0	280.5	0.0	639.5	0.0	639.5	2,345.0
2014	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2015	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2016	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2017	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	2,411.7	595.3	6,873.3	3,125.3	3,006.3	0.0	10,980.8	0.0	20,979.5	76,925

The total carbon sequestered by the project activity to date (2003 – 2017) including soil carbon and aboveground and belowground biomass is 429,460 tonnes C. When converted to carbon dioxide, the project has sequestered 1,574,685 tonnes of CO₂.

As a grouped project, with new project instances added over time, the long term average GHG benefit at the project level will change relative to composition of species and the total area of the project. For this monitoring report, the long term average GHG benefit at the project level can be computed by calculating the area weighted long-term average per hectare, 259.9 tCO₂e, using the species specific long-term average parameters, LA_{Pinus} = 283.2 tCO₂e/ha and LA_{Eucalypts} = 180.8 tCO₂e/ha, as stated in the project description, and their respective areas at the 2017 monitoring event, 4,646.6 ha and 1,366.6 ha. These areas include initial grouped project instances and new instances in 2017. The area weighted long-term average per hectare (259.9 tCO₂e) is then multiplied by total area 6,013.2 ha to determine the long-term average GHG benefit at the project level, 1,562,830.68 tCO₂e. As the amount sequestered in the project is more than the long-term average, the full amount sequestered that is eligible for crediting is equal to the long-term average GHG benefit at the project level of 1,562,830.68 tCO₂e.

4.3 Leakage

Leakage due to displacement of agricultural activities was calculated using the approved CDM A/R Methodological Tool, “Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity”.

The above CDM tool uses the following equation, as listed in Section 3.3 of the project description, to calculate leakage.

$$LK_{Agric, t} = \frac{44}{12} * \frac{f}{T_{cred}} * \Delta C d_t$$

Equation 4.1.

The values for the above equations are listed below in Table 4.6. Section 3.3 of the project description provides greater detail on these values. As the pre-existing land use in the initial and new grouped project instances is abandoned pasture D_t the fraction of project area subject to displacement is equal to zero.

Table 4.6. Ex post leakage calculation.

Year of verification	Conversion factor (tC to t CO ₂)	Forest cover (% f)	Crediting period (yr, T _{cred})	D _t (fraction of project area subject to displacement)	Delta C _t (t C) sum of annual changes (i.e. stocks) through year of verification 2017	Leakage (t CO ₂)
2017	3.67	0.202	40	0	429,460	0

4.4 Net GHG Emission Reductions and Removals

Net emission reductions are calculated by subtracting the baseline carbon stocks, any emissions from project implementation activities, and leakage from the total amount of carbon sequestered. As of 2012, total net sequestration in forest vegetation and soils due to implementation of the project activity was 461,743 tCO₂-e. By 2017, total net cumulative sequestration in forest vegetation and soils in initial grouped project instances and new project instances had increased to 1,574,685 t CO₂-e. Therefore, during the 2012 – 2017 monitoring period, the project resulted in total net sequestration of 1,112,942 t CO₂-e in forest vegetation and soils as detailed below. Each year in the table below represents the year at the end of the annual project cycle, i.e. 2013 represents December 2012 through December 2013.

Year	Baseline emissions or removals (tCO ₂ e)	Project emissions or removals (tCO ₂ e)	Leakage emissions (tCO ₂ e)	Net GHG emission reductions or removals (tCO ₂ e)
2013	0	222,588.4	0	222,588.4
2014	0	222,588.4	0	222,588.4
2015	0	222,588.4	0	222,588.4
2016	0	222,588.4	0	222,588.4
2017	0	222,588.4	0	222,588.4
Total	0	1,112,942	0	1,112,942

The amount sequestered from the project start date in 2003 to the end of the current monitoring period in 2017 that is eligible for crediting is equal to the long-term average GHG benefit at the project level. Therefore, the amount sequestered during the 2012 – 2017 monitoring period that is eligible for crediting is 1,101,087 tCO₂e (equal to the long-term average of 1,562,830.68 tCO₂e minus the total amount of credits issued in 2012 of 461,743 tCO₂-e). The non-permanence risk rating was calculated using the VCS AFOLU Non-Permanence Risk Tool v3.3 and the amount sequestered during the 2012 – 2017 monitoring period that is eligible for crediting (Annex A). The overall calculated risk rating is 7.5. As the calculated buffer (7.5%) is less than the default withholding percentage (10%), the default non-permanence risk deduction of 10% will be used. Deductions to be depositing in the AFOLU pooled buffer account for the 2012 – 2017 monitoring period are 110,109 t CO₂-e.

ANNEX A. NON-PERMANENCE RISK REPORT

INTERNAL RISK

Project Management		
Risk Factor	Risk Factor and/or Mitigation Description	Risk Rating
a)	Species planted, including <i>Pinus radiata</i> and <i>Eucalyptus globulus</i> , are non-native but are commonly planted in Chile and have been for >50 years and thus their suitability to the agro-ecological zone of the project is proven.	0
b)	There is no ongoing enforcement needed to prevent encroachment by outside actors on any part of the project area. Encroachment by outside actors is not anticipated as the planted areas are in a sparsely populated region and property lines are well marked and respected. Access into many of the project areas is by mountain road, which is steep in sections and sometimes contains water crossings in the rainy season, thus restricting access to 4-wheel drive vehicles.	0
c)	The management team responsible for the day-to-day project management includes Mark Kean, Marilyn Wood, and Alfredo Unda, each with significant experience in their respective fields. Mark Kean founded Mikro-Tek in 1990 and has since led Mikro-Tek in its development of commercial mycorrhizal strains, its application of this biotechnology in both domestic and foreign markets, and use of the technology as an integral part of forest carbon projects. Mark has over 15 years experience managing afforestation/reforestation projects which incorporate the use of mycorrhizal inoculation in Chile. Marilyn Wood has over 25 years experience in small business management. She is responsible for maintenance of Mikro-Tek's strategic organizational plans, accounting and management information systems; development and execution of marketing efforts including licensing and distribution agreements in foreign markets; and, international and domestic project management. Alfredo Unda has been working with Mikro-Tek on projects in Chile since 1998. Alfredo is a Santiago based forester who has an extensive background in environmental consulting, natural resource management, and FSC auditing. Alfredo's primary role is as a project manager for Mikro-Tek's carbon sequestration projects. He acts as a liaison between Mikro-Tek and Chilean forestry partners.	0
d)	Although Mikro-Tek's headquarters are in Timmins, ON, Canada, a branch office has been established in Chile with a local project manager. The branch office is located in Santiago, approximately 200 km to the north of the project areas, and is run by a Chilean forester. The forest management team is local, and visits the project sites to monitor progress several times a year.	0

e)	The management team has experience in AFOLU project design and implementation. Mark Kean of Mikro-Tek has developed a forest carbon project under the CDM, and has been working in the forest carbon arena for over 5 years with experiences including managing the project design, implementation, and financing. The project proponents work alongside and have access to experts in carbon accounting and reporting (i.e., TerraCarbon) who have significant experience in all aspects of AFOLU project design and implementation, carbon accounting and reporting under the VCS Program. TerraCarbon has successfully validated and verified numerous projects under the VCS, including validation and verification of the VCS ARR project "Reforestation Across the Lower Mississippi Valley".	-2
f)	Not applicable	0
Total Project Management (PM) [as applicable, (a + b + c + d + e + f)] Total may be less than zero.		-2

Financial Viability		
Risk Factor	Risk Factor and/or Mitigation Description	Risk Rating
a, b, c, d)	The project cash flow breakeven point (in 2018) is 4 years or less from the current risk assessment, as documented in the project database.	0
e, f, g, h)	Project has secured all necessary funding to cover cash out for plantation establishment, provided by Mikro-Tek and loans administered by CONAF.	0
i)	Not applicable.	0
Total Financial Viability (FV) [as applicable, ((a, b, c or d) + (e, f, g or h) + i)] Total may not be less than zero.		0

Opportunity Cost		
Risk Factor	Risk Factor and/or Mitigation Description	Risk Rating
a, b, c, d, e, f)	The dry climate and degradation of the soil pose a significant ecological barrier. The only credible alternative land use scenario, as identified and substantiated in the additionality analysis, is abandoned pasture, with an equivalent NPV of zero. Hence, NPV from the project activity is expected to be at least 50% more profitable than the most profitable credible alternative land use activity.	-4
g)	Not applicable.	0
h, i)	Project is protected by legally binding commitment (i.e., CONAF approved forest management plan with commitment to replant after each harvest) to continue	-8

	management practices that protect the credited carbon stocks over at least 100 years.	
Total Opportunity Cost (OC) [as applicable, (a, b, c, d, e or f) + (g + h or i)] Total may be less than 0.		0

A net present value (NPV) analysis for the entire grouped project area demonstrates that the NPV of the project activity, is at least 50% more profitable than the most profitable credible alternative land use activity. As identified and substantiated in the combined baseline and additionality analysis of the validated project design and in this monitoring report, abandoned pasture is the baseline scenario and the only credible alternative land use scenario for the initial and new grouped project instances. Therefore the NPV analysis assesses abandoned pasture and the project activity, forest plantation with carbon revenues. As the baseline and project scenarios were the same across all new grouped project instances, the analysis was performed collectively for the entire grouped project area in this risk assessment.

The NPV analysis was conducted using the following steps:

- For the baseline and project scenarios, determine annual net revenue data (\$/acre). For the baseline scenario, the annual net revenue was determined to be \$0, as the lands, as abandoned pasture, would be without animals grazing on them and therefore idle; they do not generate revenues (gross annual revenue equal to \$0) and do not have operating costs. A global assessment by Sills et al. (2016) in a letter to *Science* confirms that the economic value of abandoned pasture is very low worldwide. The annual net revenue for the project scenario was determined based on a conservative estimate of revenue from GHG credit sales and other project revenue streams, and potential price fluctuations of commodities impacted by the project, and project operating costs, detailed in the file "Mikro-Tek Chile Cash Flow Analysis 2018 – 9May2018". The annual net revenue for the project was calculated as the average annual net revenue through the end of the project crediting period.
- Perform investment comparison analysis applying annual cash flow analysis and NPV analysis, using a 6% discount rate over a 99 year net revenue stream, assuming cost and price inflation are equal (i.e., constant nominal net revenue over time).

The NPV of the project activity, at \$2,467, is at least 50% more profitable than the most profitable alternative land use, abandoned pasture.

CONAF Forestry Law 701 Title IV Article 22 covers the legally binding commitment to continue management practices that protect the credited carbon stocks over at least 100 years. The relevant language from Forestry Law 701 Title IV Article 22, found in the first sentence of the article, is translated as "Harvesting plantation forests on lands suitable for reforestation obligates the owner to reforest an area of land at least equal to the area harvested, following the management plan approved by the Corporation [La Corporación Nacional Forestal or CONAF]". The term over which the obligation to reforest applies is not specified, effectively committing landowners to whom the law applies, that is, landowners who receive a subsidy from CONAF to establish forest plantations under Forestry Law 701, to maintain land receiving a subsidy under forest cover as specified in their CONAF approved management plan, in perpetuity. All lands included in the project, including initial and new grouped project instances, were identified as suitable for forestry, as evidenced by the approval of management plans for each

project instance by CONAF. Furthermore all lands received subsidies from CONAF for forest plantation establishment under Forestry Law 701. Therefore, all lands included in the project are under obligation to be reforested following any harvest activity in perpetuity. Thus, there is a legally binding agreement that covers at least a 100 year period from the project start date.

Project Longevity		
a, b)	While the project crediting period is 40 years, on each project parcel there is a legal requirement under CONAF Forest Law 701 to replant and allow re-growth of harvested areas, hence maintaining the areas as forest. As there is a legally binding agreement that covers at least a 100 year period from the project start date, a score of zero is applied.	0
Total Project Longevity (PL) May not be less than zero		0

The relevant language in the CONAF Forestry Law 701 is detailed above under opportunity cost.

Internal Risk	
Total Internal Risk (PM + FV + OC + PL) Total may not be less than zero.	0

EXTERNAL RISKS

Land Tenure and Resource Access/Impacts		
Risk Factor	Risk Factor and/or Mitigation Description	Risk Rating
a)	Not applicable.	0
b)	The project area is under clear private title to the land owners and subject to a legally-binding Business Collaboration Agreement. Mikro-Tek is assigned the carbon rights as mentioned in Section 1.12 of the PD.	2
c)	No dispute over land ownership or land tenure exists for any part of the project area.	0
d)	No dispute over access/use rights exist for any part of the project area.	0
e)	Not applicable.	0
f)	Project area is protected by legally binding commitment to continue management practices that protect carbon stocks over the length of the project crediting period. For each project parcel there is a legal requirement under CONAF Forest Law 701 to replant and allow re-growth of harvested areas.	-2

g)	Not applicable.	0
Total Land Tenure (LT) [as applicable, ((a or b) + c + d + e + f + g)] Total may not be less than zero.		0

Community Engagement		
Risk Factor	Risk Factor and/or Mitigation Description	Risk Rating
a, b)	Community engagement risk has been assessed as zero because no people live or lived within the project area and the population within 20 km of the project area is not reliant on the project area for food, fodder, fuel, medicine, or building materials. The new project instances been delineated to exclude area with significant woody vegetation. Given the dry climate and the fact that native seed sources are generally lacking across the landscape, natural regeneration is extremely limited. The project area is not a source of food, fodder, fuel, medicine, or building material. Furthermore the A/R activities are implemented on private lands.	0
c)	Not applicable.	0
Total Community Engagement (CE) [where applicable, (a + b + c)] Total may be less than zero.		0

Political Risk		
Risk Factor	Risk Factor and/or Mitigation Description	Risk Rating
a, b, c, d, e)	Chile's governance score (1.13) is 0.82 or higher. Calculation of the governance score is documented in the project database.	0
f)	The country has an established Designated National Authority, Comisión Nacional del Medio Ambiente (CONAMA), under the CDM and has at least one registered CDM Afforestation/Reforestation project	-2
Total Political (PC) [as applicable ((a, b, c, d or e) + f)] Total may not be less than zero.		-2

Table A1. Calculation of Chile's average governance score.

Governance Indicator	2012	2013	2014	2015	2016
Voice and Accountability	1.08	0.11	1.06	1.00	1.00
Political Stability/Absence of Violence	0.33	0.36	0.45	0.43	0.51

Government Effectiveness	1.26	1.26	1.16	1.09	1.02
Regulatory Quality	1.54	1.49	1.49	1.35	1.37
Rule of Law	1.39	1.37	1.43	1.34	1.13
Control of Corruption	1.58	1.54	1.49	1.28	1.11
Overall Mean	1.13				

External Risk	
Total External Risk (LT + CE + PC) Total may not be less than zero.	0

NATURAL RISKS

Fire Risk	
Evidence	Statistics on the extent of fire in Region VI, VII, and VIII are shown in Table A1, below. An analysis of these data demonstrates that fire affects on average 3.0% of the area of plantation forest in Region VI, VII, and VIII each year. Over a 100 year period, fire is therefore likely to occur every 33.3 years ²⁶ on any given parcel. Due to the geographic spread of the project instances and the fact that fires rarely affect more than 50% of biomass on site, fires are unlikely to result in greater than a 50% loss of carbon stocks in the project area and the significance has been assessed as major.
Significance	Major
Likelihood	Every 50 to less than 100 years
Score (LS)	2
Mitigation	1
Pest and Disease Risk	
Evidence	Chile is largely a pest free country due in part to its natural conditions and in part to the strict pest control and surveillance program of SAG (Servicio Agrícola y Ganadero), the entity responsible for the permanent monitoring of pests in fruit and forestry plantations. Risks of pests and disease found in plantation forests in the project region are mitigated by correctly siting plantation species and close oversight and management. Further, local foresters have access to pest and disease management expertise at the local SAG office.

²⁶ The return interval is calculated as 100 years divided by 3.0 = 33.3 years.

	Data from the FAO ²⁷ estimate that 1,341,000 ha of forest land were disturbed by pest and disease in Chile in the year 2000. With a total forest area of 16,121,000 ha in 2000, this implies that 8.3% of Chilean forests are affected annually. Assuming all forest is equally likely to be infected by pest and disease, this indicates a return interval of over 12 years ²⁸ . Due to the geographic spread of the project instances and the fact there are no pest species that lead to full stand replacement currently in Chile, pest and disease in the project region are unlikely to affect more than 25% of the carbon stocks in the project area, hence the significance has been assessed as minor.
Significance	Minor
Likelihood	Every 10 to less than 25 years
Score (LS)	2
Mitigation	1
Extreme Weather Risk	
Evidence	Extreme weather risks affecting the project area include blowdown due to strong winds, rain induced flooding and erosion, and drought, A local forester who has worked in Chile's central valley for over 15 years has confirmed that he does not know of any instances of blowdown affecting plantations in the planting region (I. Fazzi, pers. comm.). As such the likelihood of an extreme wind event is thought to be in the range of once in every 100 years or more which corresponds to a score of zero risk. While the risk of severe rain events include flooding and erosion, flooding is not an issue as the project areas are on slopes or the top of mountains and are not prone to flooding. When water is channelized due to natural topography, rain events can lead to erosion and mortality of planted trees. While the return interval of gully erosion is not known, the effect is likely to be insignificant with less than 1% of the project area being affected in a way that leads to tree mortality. In 2011, Núñez et al,²⁹ estimated that significant droughts have a return period of 22 years in the project region. Given that the geographic spread of the project stands and their various ages (with the knowledge that drought effects decrease with stands establishment and development), any drought is unlikely to lead to significant (>50%) loss in carbon stocks.

²⁷ FAO. 2009. Global Review of Forest Pests and Diseases. FAO Forestry Paper 156. Food and Agricultural Organization of the United Nations, Rome

²⁸ The return interval is calculated as 100 years divided by 8.3 = 12 years.

²⁹ Núñez, J. H.; Verbist, K.; Wallis, J. R.; Schaefer, M. G.; Morales, L.; Cornelis, W. M. 2011. Regional frequency analysis for mapping drought events in north-central Chile. Journal of Hydrology, Volume 405, Issue 3, p. 352-366.

	The greatest significance (that of drought) and highest likelihood and was used to assess the risk of extreme weather. A mitigation measure used to lessen the influence of drought has been built into the project design whereby the susceptibility of all trees planted to drought is reduced because of the increased water uptake capacity of the mycorrhizal inoculated seedlings.
Significance	Major
Likelihood	Every 10 to less than 25 years
Score (LS)	5
Mitigation	0.50
Geologic Risk	
Evidence	Geologic risks in Chile include volcanoes, earthquakes, and landslides. Volcanoes in the project region and earthquakes are unlikely to result in a significant loss to the projects carbon stocks due to their distance. The closest volcano to any project instance is the Antuco Volcano which is approximately 65 km from the site MikroTek0040 in Region VIII. While landslides are arguably the most significant natural risk, planted trees are arranged along contours when on sloped ground and project proponents have avoided planting in very steep areas. Further, the project activity is likely to reduce the incidence of landslides as roots of planted trees stabilize slopes and reduce erosion. The significance of geologic risk is estimated as minor with infrequent likelihood estimate as once every 50-100 years.
Significance	Minor
Likelihood	Every 50 to less than 100 years
Score (LS)	1
Mitigation	1

Natural risk is quantified by assessing both the significance (i.e. the damage that the project would sustain if the event occurred, expressed as an estimated percentage of average carbon stocks in the project area that would be lost in a single event) and likelihood (i.e., the historical average number of times the event has occurred in the project area over the last 100 years) of the four primary types of natural risk, including the risk of fire, pest and disease, extreme weather, and geologic hazards. The significance of the risk of fire and extreme weather has been assessed as "Major" as none of these risks, should they occur, result in greater than a 50% loss of carbon stocks in the project area. The significance of pest and disease and geologic risk have been assessed as "Minor" as neither pest and disease, volcanic activity, earthquakes, or landslides, if they occur, would lead to a loss of greater than 25% of the carbon stocks in the project area. The significance of the above natural risks has been assessed as such due the dispersed nature of the planted fields. By planting in three regions, the occurrence of any natural risk is unlikely to affect 50% of the planted areas. Where a natural risk does occur it is unlikely to remove >50% or the carbon stocks in the project area.

It is at times difficult to quantify the likelihood of natural risks when these risks occur infrequently. By definition likelihood is the historical average number of times an event has occurred over the last 100 years. Another term often used when referring to the likelihood of natural risk is the return interval. The return interval is common in literature pertaining to fire and flooding (e.g., the 100 year flood). While the likelihood or return interval would also be useful for geologic risk, a key feature when calculating the likelihood or return interval is that an event has occurred enough times in enough places such that there is sufficient data to calculate the return interval. A review of the literature revealed little data to support a return interval for Chile for geologic risk. For this reason, we have conservatively assigned geologic risk a return interval of every 50 to less than 100 years.

Score for each natural risk applicable to the project (Determined by $(LS \times M)$)	
Fire (F)	2
Pest and Disease Outbreaks (PD)	2
Extreme Weather (W)	2.5
Geological Risk (G)	1
Other natural risk (ON)	0
Total Natural Risk (as applicable, $F + PD + W + G + ON$)	7.5

OVERALL NON-PERMANENCE RISK RATING AND BUFFER DETERMINATION

Overall Risk Rating

The overall risk rating calculated using the VCS AFOLU Non-Permanence Risk Tool is 7.5, as calculated below.

Risk Category	Rating
a) Internal Risk	0
b) External Risk	0
c) Natural Risk	7.5
Overall Risk Rating (a + b + c)	7.5

As the calculated buffer (7.5%) is less than the default withholding percentage (10%), the default nonpermanence risk deduction of 10% will be used.

Calculation of Total VCUs

During the 2012 - 2017 monitoring period, the project resulted in sequestration of 1,112,942 t CO₂-e in forest vegetation and soils, of which 1,101,087 t CO₂-e are eligible for crediting. According to the overall

risk rating of 7.5 calculated in Section 3.1, deductions to be depositing in the AFOLU pooled buffer account for the 2012 – 2017 monitoring period are 10% of 1,101,087 t CO₂-e, equal to 110,109 t CO₂-e. The total number of GHG credits eligible to be issued as VCUs for the 2012 – 2017 monitoring period are 990,978 t CO₂-e.