FINAL

ENVIRONMENTAL ASSESSMENT

FOR A

COMBINED POWER AND BIOMASS HEATING SYSTEM
FORT YUKON, ALASKA

APPENDIX C

DRAFT FORT YUKON WOODY BIOMASS FUEL IMPLEMENTATION PLAN
(RBEGR 2011)

-DRAFT- Fort Yukon Woody Biomass Fuel Implementation Plan

March, 2011

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Introduction

Harvesting locally owned forest resources for heating fuel faces unique opportunities and challenges in rural Alaska. Rural Alaska has some of the highest energy costs in North America inside of local economies that can least afford it. Displacing high cost heating oil with locally produced wood fuel has the potential to reduce heating costs, produce local jobs, and give hope to the possibilities that these communities may become more sustainable economically.

These lofty goals face very real challenges however. Significant investment is required to purchase the harvest system and wood boiler components necessary for a community based woody biomass program. By the time this project is operational over $5,000,000 will have been infused into this prototype program. Most of the investment in the Fort Yukon project comes in the form of grants from either the State or Federal government. Significant but smaller sums will come from the ANCSA Village Corporation for Fort Yukon, the Gwitchyaa Zhee Corporation.

Another challenge comes in the form of uncertainty about a biomass program from within the community itself. Few if any community members will argue the desire for sustainable local jobs and reasonable heating fuel, but these same members will also have to embrace the change that local harvesting brings to the landscape. The harvest of forest acreage at this scale will be new to the community and it will take some time for the villagers to become accustomed to these activities. There is also the issue of skepticism that the program can be operated dependably and economically by potential customers.

It is therefore necessary for the community to invest of itself in a woody biomass program to the point of insuring that the supply and demand of woody biomass is developed simultaneously at quantities that are economically practical. To be a success over time, the stakeholders of the program will have to develop a process that is not only capable of identifying the challenges that the wood fuels program has, but can also produce solutions that work.

The project as a whole must be sustainable biologically, economically, and socially.

Designing a heating system that is both practical for the community and economical to operate requires careful thought. Those issues are being addressed by others on the rural Alaska biomass team. Similar care must be taken when designing the harvest system.

The woody biomass harvest program must not only encompass the mechanics and business of harvesting wood fuel from local forests, it must also fit nicely into the requirements for a sustainable long term forest and land management vision that is appropriate for this part of Alaska.

Biomass Project History

A woody biomass heating program for Fort Yukon has been developing for over 5 years. Hundreds of hours of field investigations, feasibility discussions, legal agreement work, and boiler configuration analysis have been invested in the project. Several useful documents have been produced during this period.

A Forest Stewardship Plan was finalized for the Gwitchyaa Zhee lands in 2007. That Plan discusses a broader range of issues related to Forest utilization opportunities, but a central theme of the plan was to outline the possibilities of utilizing the forest for the purpose of a wood fuels program. The Plan also documents the long standing recognition by the community of the need for sustainable alternative energy and local jobs. This Harvest Plan is one of the items identified in the Forest Stewardship 10 Year Action Plan.

A report funded by the USDA Rural Development in 2009 for the Fort Yukon Woody Biomass Project provides a Harvest Equipment Assessment, a Transportation Systems Analysis, and Contract Agreement Formulation. The report has preliminary thoughts on harvest processes and equipment, much of which has been embraced in this document.

Greenhouse owner demonstrating wood chip boiler

In 2009 a workshop title "Breaking the Chip Barrier for Wood Heat in Rural Alaska" was held in Anchorage to address the concerns and misconceptions about wood chip fueled boilers. There had been, and to a lesser degree continues to be reluctance to embrace wood chip fueled boilers for application in rural Alaska due to their cost and complexity as compared to wood stick fueled boilers. The organizers of the workshop hold that wood chip boilers are advantageous for larger commercial applications for at least 5 reasons:

2. Particularly in larger applications the wood chip system is much more convenient than stick fired systems during the coldest times of year, which are also the most important periods the boilers will be used. The automated wood fuel feeding features keeps the boiler burning properly throughout the night, and eliminates the need to manually feed the boiler during odd hours in the cold and dark.

3. Wood chip boilers are available in much larger sizes than stick fired systems. This provides the opportunity to employ district heating distribution systems, and thus simplifies the overall system.

4. Much of the forest resource in interior Alaska, including Fort Yukon, is in tree species that are suitable only for the production of wood chips. Willow, poplar, and aspen comprise a greater percentage of the available wood fiber in most of interior Alaska than White or Black Spruce. Stick fired systems have less potential to displace significant amounts of imported fuel oil than chip fired systems.

5. Highly reliable wood chip systems are available "off the shelf" today. These systems have been in use throughout Europe for several decades. This technology and hardware are experiencing dramatic growth in the U.S.

Small wood chip boiler heating a greenhouse

The type of wood boiler system that the harvest program will feed has a direct and significant impact on the types of harvest machinery the program will need. The wood chip boiler feed system has chip size specifications that the harvest program must meet.

A forest inventory assessment for a portion of the project area has been produced by the Tanana Chiefs Conference Forestry Department. Detailed forest biomass inventory information is largely unavailable for rural Alaska forests. Fortunately, for many rural communities a very good starter GIS system can be constructed at a reasonable cost with existing satellite imagery, digital scanning technology, and judicious estimates from foresters who are familiar with the project. The Forestry Program at the Tanana Chiefs Conference is uniquely qualified to create such a system and has recently produced its initial report on biomass availability on over 25,000 acres of forest land within 5 miles of Fort Yukon.

The digital imagery and forest typing from these efforts are invaluable to the project planning efforts and allow non-technical individuals to develop a sense for the distribution of the forest resources around the community. The existing woody biomass volume estimates for each area defined in the mapping system is a good starting point for planning purposes. Careful accounting of biomass harvest during the early stages of the project will provide an opportunity to improve the precision of these initial estimates by experience. In the meantime allowances will be made for deviations from the projected quantities of biomass that will be experienced in the early stages of the program.

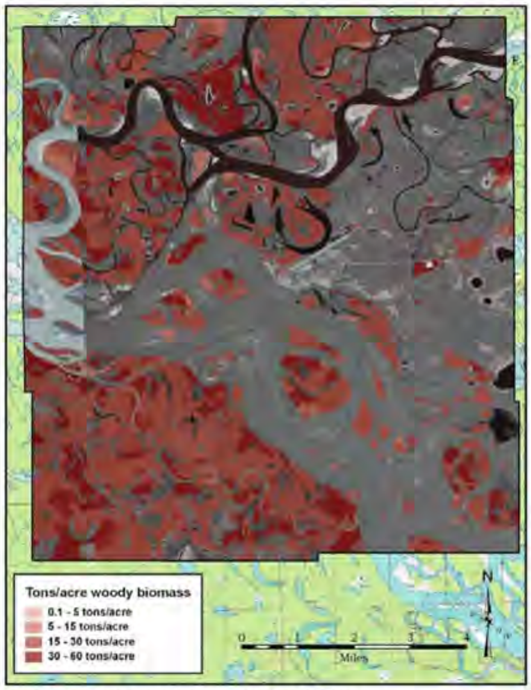


Figure 7. Fort Yukon project area woody biomass tons/acre.

The product of these research and planning efforts is a fully funded project that will displace _______ gallons of heating oil annually.

Fuel Production Ends Policy

An ends policy describes the "end result" of the program or action the policy is applied to. The entire harvest system and plan are designed around this policy goal:

> "Approximately 1,800 tons of wood chip fuel meeting the specifications of the wood boiler and its feed system will be produced annually from Gwitchyaa Zhee Corporation lands in a timely, efficient, and economic manner."

Annual Harvest

The Fort Yukon heat project design utilizes significant amounts of heat from the diesel power generation engines. A wood fueled boiler is added to the heat distribution lines to supplement the heat drawn from the generators. As a result, approximately 70% of the heat produced from the project is from wood combustion. Approximately 1,800 tons of wood chips are needed on an annual basis for the wood boiler to perform as designed. In order to produce this tonnage, approximately 80 to 100 acres will be harvested annually.

The majority of this wood fuel will be consumed during the cold winter months of November through March. All harvest and delivery scheduling must make the fuel available throughout this period. A 4 month supply of wood fuel will be maintained at the boiler facility in the event weather or mechanical related delivery delays are experienced.

The startup of the harvest program must anticipate when the wood boiler will come on-line and be able to feed the boiler system from that point on. For purposes of discussion, this plan assumes that the harvest operations will begin in the summer of 2011, and that the boiler will be operational by the fall of 2012.

Poplar stand along Yukon River

Moisture Content Management

Like seasoned firewood, wood chips produce more heat when the moisture content of the chips is reduced. In an effort to burn the wood chips as cleanly as possible, and to minimize the acreage needed to provide for the annual needs to the project the wood must be seasoned as well as possible before it is burned.

Moisture content of standing trees is approximately 50% wet basis. It is desirable then that the trees be handled and processed in a systematic approach that reduces moisture content from natural drying processes. One method is to fell the trees and loosely stack them in the field for a certain drying period before running the whole tree through the chipper. European biomass producers sometimes refer to this approach as "sour felling".

Sour felling involves felling trees and leaving them intact (whole tree) on the forest floor or in stacks at roadside. Significant research has been carried out on sour felling as a drying method, principally in the UK, the Nordic countries and Canada. Sour felling research experiments have reached the following conclusions:

- Leaving limbs and foliage on felled trees significantly increases moisture loss through transpiration compared to removing the limbs.
- This enhanced drying effect lasts for a limited period of time, typically between 6-18 months. Some Swedish studies report an optimum transpirational drying period of between 4 and 6 weeks.
- During the drying period foliage (needles or leaves) will drop from the limbs. If whole tree chipping for wood fuel is being considered, the loss of this foliage increases the calorific content of the fuel and reduces the ash content. Leaving the foliage on the forest floor returns a proportionate amount of nutrients to the forest cycle.
- The effectiveness of sour felling as a drying method is dependent both on the seasonal timing of the felling and the density of the remaining canopy.
- Sour felled logs will be lighter to remove from the forest, but MC's will be variable throughout the crop. The research carried out into sour felling proves that an enhanced drying effect will be experienced if foliage remains on the tree following its demise.

This system fits naturally into a schedule where the trees are felled in the late winter/spring of each year. The whole trees would be loosely stacked and allowed to dry throughout the summer. Prior to snowfall, all of the trees felled earlier that year would be whole tree chipped and covered in the field. Although there is no certain way to predict the moisture content (MC) of the wood chips using this system, a target of 25% MC seems achievable.

Morooka working on ice in Norton Sound

Harvest Equipment

The economic and physical parameters that influence the equipment selection process are as unique as the Fort Yukon project itself. Although the vast majority of the funding for this project comes in the form of grants from various state and federal funding sources, the goal of establishing an economically sustainable program dictates that the costs of creating and operating the project are less than the economic benefits that are produced.

Equipment Capital Parameters

For a project of this size, preliminary economic analysis indicates that a capital budget for harvesting equipment should be approximately $750,000. This budget would include all of the necessary equipment to fell, pile, chip, and deliver the fuel to the boiler. It does not include boats or storage facilities.

Equipment Weight and Size

Physically, the water depths and ice thicknesses at the project location limit the maximum weight that any piece of equipment can be. This analysis assumes that a landing craft capable of hauling a maximum of 30,000 pounds or similar will be employed to transport harvest equipment during the ice free season. Remote loading and offloading sites during the ice free season will each have characteristics that will need to be well understood by the operator. Some sites may only be accessible during high water flows for example. Lighter equipment will make working these types of sites possible for a wider range of river flow conditions.

Ice thickness measurements

Ice thicknesses must be sufficient to safely provide the transport equipment and wood fuel loads during the winter months. Great care must be taken to correctly measure the ice conditions that are to be traveled upon prior to use. The biomass harvest operators should seek to acquire ice thickness data on anticipated travel routes over time. Knowing when a particular travel route will likely be available for ice hauling will be invaluable to the ongoing planning process for future harvest. Generally speaking the ice will need to be a minimum of 18 inches thick to support the weight of the equipment and wood chip loads according to published ice strength tables. Depending on the site and local weather patterns, sufficient thicknesses would typically be present from December through April.

Landing craft suitable for hauling 30,000# in Fort Yukon

Given these parameters, use of conventional timber harvesting systems used elsewhere in coastal Alaska and throughout Canada will have a limited role in remote small scale biomass harvesting programs.

5 Year Harvest Plan Progression

The woody biomass harvesting process is a relatively simple one. The fundamentals of producing wood chips are practiced throughout much of the United States and Canada. Harvesting 1,800 tons of woody biomass annually in Fort Yukon utilizes the same fundamentals as elsewhere, but has to do so in a remote Alaskan taiga forest environment. The remote site and harsh winter environments create challenges that are unique to this area. Consequently there will be some details that cannot be fully addressed until field activities are under way and an adaptive management approach utilized as the program matures.

Most of the unique challenges to a biomass operation in Fort Yukon are related to the newness of harvesting biomass to the Fort Yukon community, the severe winter temperatures, and remoteness of the project.

This plan assumes that all of the harvesting will occur on Gwitchyaa Zhee Corporation lands within a 5 mile radius of the community. Very little of the forest has road access, and thus will utilize a system that operates regularly in a very remote setting. Lack of infrastructure means transporting equipment and hundreds of tons of biomass over rivers and forest land. It also means regularly operating equipment off road. Working productively and safely in these conditions requires diligent adherence to workplace protocols and a strong sense of teamwork.

Winter landscape near Fort Yukon

Typical low temperatures of 30 degrees Fahrenheit below zero or colder can last for 10 weeks or longer. These severe winter temperatures limit the types of harvesting activity that can take place between early January and the end of March. Working during the ice free season means skiff and landing craft usage when harvesting tracts are located away from the community.

An efficient harvest program in this setting requires operators and administrators to develop the necessary acumen to carry out the respective parties tasks in concert with each other. This will require that all parties take a "can do" approach to solving the details of each challenge as they come before the program.

For these reasons the harvest program will initially work closer to the community in higher volume stands where there are fewer challenges to overcome, and then gradually work towards the more remote locations. The 5 year harvest plan will begin with harvest activities within a mile of the village and are accessible completely by land or with only short river crossings. The plan then progressively becomes more challenging by increasing river crossing usage and harvesting lower volume stands.

18,000# Kubota excavator with Advanced Forest Equipment mulching head

Annual Harvest Sequence
- Late Winter Start Up -

The annual harvest sequence will begin mid-spring for those areas accessible without river crossings and just after breakup as soon as river transport is possible for those areas requiring access by river. The intent is to begin felling and stacking as early in the year as possible. When possible, the felling may start as soon as temperatures have warmed enough to be able to operate the felling head efficiently and safely (snow depth and temperature), which may be as early as March. In some cases these activities may have to be completed after break up.

The risk of flooding the harvest site during breakup needs to be assessed on a case by case basis. Equipment and felled inventory should not be left in a situation or location where it could be damaged or lost due to flooding during this part of the year.

Fecon tractor with log grapples

The felling and stacking operation entails the use of the Kubota excavator with AFE felling/mulching head and the Fecon forest crawler with brush grapple attachment. Trees inside the harvest unit cutting line with diameters between 4" and 16" will (in most cases) be felled during this stage of the operation. The Kubota will fell trees with the felling head, leaving a stump height suitable for the Kubota and Fecon to work over. The felling operation is projected to be capable of felling 1.5 to 2 acres each full day, depending on the stand structure and operator efficiency.

The Fecon will be fitted with a grapple rake and work behind the Kubota and stack the trees in loose stacks so as to facilitate air drying of the trunk and limbs. The stacks size should take into consideration the machine capability, as well as air circulation in the stack.

For operator safety purposes, the piling will be carried out simultaneously by the Fecon working in the same general vicinity. It is important to consider that the tree stacks will later be fed through a chipper whole tree. The configuration and juxtaposition of the stacks should facilitate efficient feeding of the chipper, which will be carried out later in the season. The larger the stacks, the fewer times the chipper will have to be moved and thus increasing chipping production. The stacks will not be handled from this point until the chipping operation begins.

For initial scheduling purposes, 100 acres of felling and stacking is projected to take 12 weeks to complete using the Kubota excavator and Fecon tractor. Two operators will be employed full time during this period working 8 to 10 hours a day.

Morbark M20R chipper with tracks

Whole Tree Air Drying

Once the stacking is completed the trees will be left to air dry. The goal of the drying process is to reduce the moisture content to as little as 25% wet basis or less. There is much to learn about how to carry this process out. Specifics such as stack configuration and size will undoubtedly influence the drying rate, as well as length of time allowed for the drying process.

Due to the importance of drying the felled trees, diligence should be taken to record the dates of felling. Wood moisture content readings should be scheduled and recorded at least every two weeks to establish a drying schedule database. This information will be valuable in future harvest years for predicting how long it will take to dry felled and stacked trees.

Whole Tree Chipping in the Field

Whole tree chipping in the field for biomass fuels is a growing trend in the woody biomass world. New equipment configurations are being developed for various applications in an effort to make the harvest process efficient and affordable. Most of the development of these harvest systems is occurring in Europe where many communities are dependent on wood fuels for their heating systems.

The experimental nature of these types of machines, lack of capacity to handle a wider range of stem diameters, and overall weight preclude the use of these machines in Fort Yukon. The principle of chipping in the field however can be accommodated using proven existing machinery in a configuration appropriate for this project.

Morooka outfitted with a hook-lift

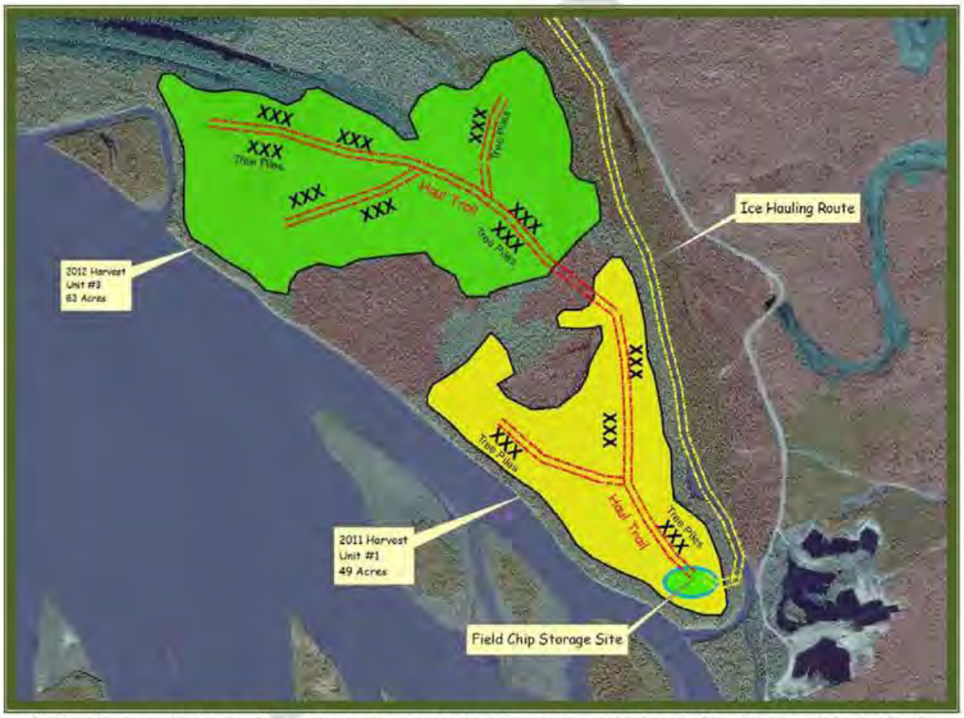
The chipper will be a self-propelled, remotely controlled tracked whole tree chipping unit with a drum chipping head capable of chipping up to a 20 inch diameter stem. A Morbark Beever M20R model chipper is a 325 horsepower unit specifically designed for field chipping. It is designed to chip multiple whole trees at a time for biomass production and is capable of chipping stems up to 20" in diameter. It also has a 5 foot in-feed bed to facilitate efficient loading of the trees into the chipper. Machines of this size are capable of chipping up to 40 tons per hour of operation.

Morooka outfitted with a hook-lift showing an off loaded box. The chip box would be considerable larger than the box shown

The chipper will be fed and controlled from the excavator as it feeds the stacks created previously by the felling process. As each stack is consumed the chipper and excavator will reposition to the next stack. The chipper will directly feed a 15 yard hooklift configured chip bin set in place in the field by the Morooka carrier. The M20R chipper will blow the wood chips into the bin container and fill it every 10 to 15 minutes. Once the chip bin is filled, the Morooka will remove the filled bin and replace it with an empty one. The Morooka will then transport the loaded bin and dump it at either a field chip storage site or possibly at the boiler yard. The process will repeat itself until all of the stacks have been processed and delivered.

The haul trails that the Morooka will travel over should be cleared of high stumps and logs. The stumps may be ground with the felling head or pulled with either the excavator or Fecon to facilitate quicker hauling times and to reduce wear and damage to the Morooka's rubber tracks.

Detailed Harvest and Haul Plan Map – Units 1 and 3



Notice the general pattern of tree piles as they are stacked along a planned haul trail. The chipper with be fed by the excavator/Fecon from the tree piles and load the bins on the haul trail. The chips will be hauled to the field storage site and covered until they are hauled to the boiler yard after ice thickens. The yellow dashed line shows the haul route over ice.

The field stored chips will be covered in either a heavy tarp, or in a portable fabric covered temporary building to keep the wood chips free of snow. Field chip storage sites that will be used over longer periods may warrant the use of a portable building, whereas a site that may be used only once may justify using only a large tarp. The chips will remain at the field storage site until they are hauled to the boiler site. It may be advantageous to clear the storage pad free of vegetation to provide for a storage floor free of unwanted material that could get mixed into the wood chips during loading.

With two operators working full time the chipping and hauling activities are projected to produce 50 to 80 tons per day depending on the distance to the storage site.

Winter Loading and Hauling

Much of the 1,800 ton annual harvest will be hauled in the cold winter months of November through early March. For those harvest areas that require crossing water, the delivery schedule must take into account the ice thicknesses for the particular haul route and time of the winter.

It will be important to do any necessary preparation of the access points along the rivers and embankments during the summer period. In some cases it will be necessary to rough in a ramp that provides an efficient traversing point for equipment.

Temporary buildings suitable for use as temporary field chip storage facilities come in a variety of economical sizes and configurations

Loading of the wood chip bin in the winter can be with either the excavator or Fecon tractor outfitted with a quick-attach bucket suitable for this purpose.

Hauling distances will vary and thus each site will have a different haul schedule. The loaded chip bins will be hauled by the Morooka to the boiler yard or to a location along a road where a transfer can take place where the bin is off loaded from the Morooka and loaded by a single axel hooklift truck. Hauling efficiencies can be added to the Morooka by towing a simple sled capable of handling one or more wood chip bins.

In the first 5 years of harvest, a Morooka only hauling configuration is projected to be able to haul 80 tons of wood chips to the boiler yard from the field chip storage sites.

Biomass Harvest Equipment Cost List

WOOD HARVEST EQUIPMENT TO BE PURCHASED		Condition	Cost
Fecon FTX100L		NEW	$117,257
Fecon Attachments			
	Bucket	NEW	$2,500
	Brush Rake	NEW	$4,800
	Grapple	NEW	$5,800
	Dozer Blade	NEW	$4,700
	Pallet Forks	NEW	$900
18,000 # Excavator w/harvester head and guarding		Low Hour	$118,000
Log Grapple for Excavator		NEW	$11,500
Arbro Stroke Harvester		NEW	$28,000
Hooklift Truck 25,500 GVWR		USED	$40,000
Morooka 1500VD w/guarding 2005		Low Hour	$110,000
Hooklift Installed on Morooka		NEW	$36,000
Hooklift Bins (4)		NEW	$18,000
Hooklift Flatbed (2)		NEW	$5,000
Hooklift Log Bunks (2)		NEW	$8,000
Morbark M20R Track Chipper		NEW	$160,000
Equipment Prep and Guarding			$20,000
Hooklift Tool Trailer w/assorted tools		NEW	$8,000
Freight			$45,000
Total Equipment Cost			$743,457

5 Year Harvest Plan Unit Descriptions

Harvest Year 2011 Unit Number	Gross Acres	Gross Tons Per Acre	Total Tons	Site Description
1	49	14	686	Larger cottonwood pole timber. Water/ice access. Cut bank access may need ramp work.
2	27	43	1161	Mixed diameter spruce poletimber. Land access with ROW permission needed from allotment owner.
Year Total	76		1847	

Harvest Year 2012 Unit Number	Gross Acres	Gross Tons Per Acre	Total Tons	Site Description
3	83	18	1494	Larger cottonwood pole timber. Water/ice access. Cut bank access may need ramp work.
4	35	20	700	Mixed diameter spruce poletimber. Land access with ROW permission needed from allotment owner.
Year Total	118		2194	

Harvest Year 2013 Unit Number	Gross Acres	Gross Tons Per Acre	Total Tons	Site Description
5	29	22	638	Mixed diameter spruce poletimber. Land access with ROW permission needed from allotment owner.
6	31	5	155	Mixed diameter cottonwood pole timber. Water/ice access.
7	42	32	1344	Mixed diameter spruce poletimber and hardwoods. Water/ice access.
Year Total	102		2137	

Harvest Year 2014 Unit Number	Gross Acres	Gross Tons Per Acre	Total Tons	Site Description
8	30	15	450	Mixed diameter spruce poletimber and hardwoods. Water/ice access.
9	55	15	825	Mixed diameter cottonwood pole timber. Water/ice access.
10	14	32	448	Mixed diameter cottonwood pole timber. Water/ice access.
11	20	24	480	Mixed diameter cottonwood pole timber. Water/ice access.
Year Total	119		2203	

Harvest Year 2015 Unit Number	Gross Acres	Gross Tons Per Acre	Total Tons	Site Description
12	48	29	1392	Larger diameter spruce and hardwood poletimber. Water/ice access.
13	32	28	896	Larger diameter spruce and hardwood poletimber. Water/ice access.
Year Total	80		2288	

Land Ownership Issues

The harvest activities occur on lands owned by the Gwitchyaa Zhee Corporation. Interspersed throughout the GZ holdings are numerous privately owned Native Allotments. Some of the Allotments have been surveyed and all have been documented using GIS mapping systems. Care must be taken to not conduct unauthorized activities on these Native Allotments. It will be necessary to obtain permission from the owner to access harvest units that involve crossing an Allotment.

Sustainable Forest Management

A sustainable forest management program requires that the forest is growing at least as much wood fiber as is harvested or lost to natural causes. The forest within a 5 mile radius around Fort Yukon has an estimated allowable harvest of over 9,500 tons annually according to the Fort Yukon Biomass Resource Assessment produced by the Tanana Chiefs Conference Forestry Department.

Cover Type Class	Acres	Standing Green Tons	Green Tons AAC
Black spruce	395	860	56
Cottonwood poletimber	2,296	29,238	562
Cottonwood sawtimber	227	3,895	78
Hardwood poletimber	211	4,063	55
Mixed poletimber	3,773	105,010	1,631
Mixed sawtimber	281	7,516	150
Reproduction	8,155	0	1,223
White spruce poletimber	7,853	229,971	4,134
White spruce sawtimber	2,639	82,404	1,627
Totals:	**25,829**	**462,958**	**9,517**

Table 4. Woody biomass tonnage and Annual Allowable Cut (AAC) by cover type class.

The biomass forest harvest plan is to harvest no more than 1,800 tons annually, and thus will capture less than 20% of the AAC under current plans if the harvested acres are kept producing biomass at the historical rates.

Reforestation strategies for both the white spruce and hardwood components that will be harvested must re-establish these sites in a timely manner in order for the program to remain sustainable over time.

The hardwood component of the harvest program will employ coppice regeneration. This process relies on the natural response of species such as willow, poplar, and aspen to cutting, which typically is a vigorous sprouting of one or more stems from the stump.
The spruce reforestation strategy is to scarify the harvest sites to promote natural seedling establishment from windblown seed. Seed trees will be left in the surrounding stands of a harvest unit. Scarification will be carried out with the excavator and Fecon tractor. Tests using light, medium, and heavy scarification will be conducted early in the harvest program to determine the most effective scarification treatment.

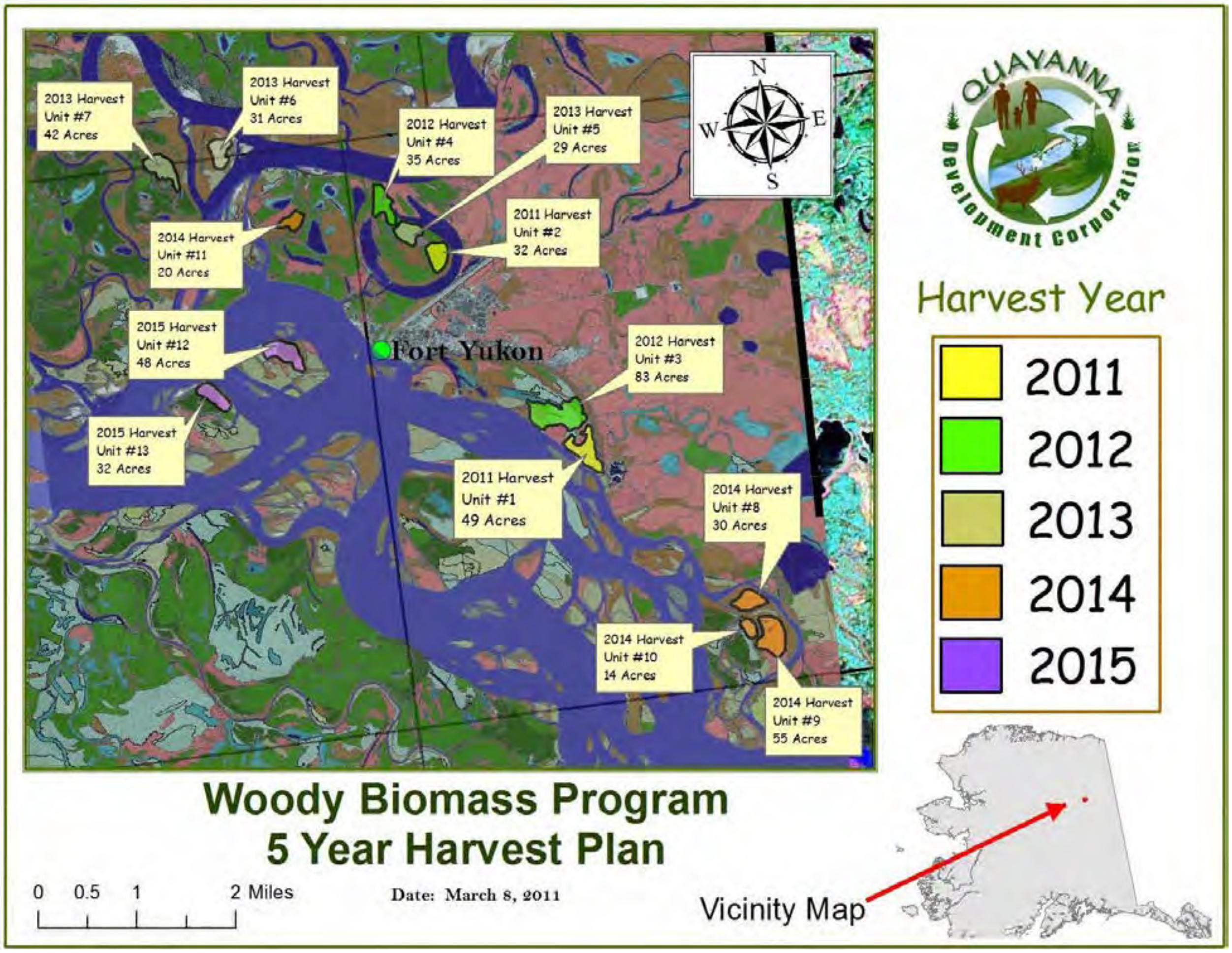
Care must be taken to observe the cyclical snowshoe hare populations that occur naturally in this region. Periods of high hare populations will likely require measures that deter the hare from clipping the spruce seedlings. It may be necessary on occasion to plant seedlings with tree protectors installed at time of planting in order to reduce the hare population's negative influence on the reforestation efforts.

The costs associated with these reforestation strategies are embedded in the operations themselves and will be borne by the owner of the land and harvest operation, Gwitchyaa Zhee. In the event extraordinary needs arise for reforestation efforts, GZ Corporation shall pursue outside help such as an EQIP contract with the Natural Resource Conservation Service.

Annual Update of Plan

This Plan is intended to be dynamic. As the processes and needs of the plan become well understood by the program administrators, they will develop the capacity to update this plan to fit their needs themselves. Oversight and Plan implementation, including updating, should be possible by GZ Corporation within 3 years of project initiation with proper mentoring.

Annual consulting services costs for Plan monitoring should not exceed $10,000 plus expenses for the first two years of the harvest program.


2013 Harvest
Unit #7
42 Acres
2013 Harvest
Unit #6
31 Acres
2012 Harvest
Unit #4
35 Acres
2013 Harvest
Unit #5
29 Acres
2011 Harvest
Unit #2
32 Acres
2014 Harvest
Unit #11
20 Acres
2015 Harvest
Unit #12
48 Acres
Fort Yukon
2012 Harvest
Unit #3
83 Acres
2015 Harvest
Unit #13
32 Acres
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Unit #8
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Woody Biomass Program
5 Year Harvest Plan
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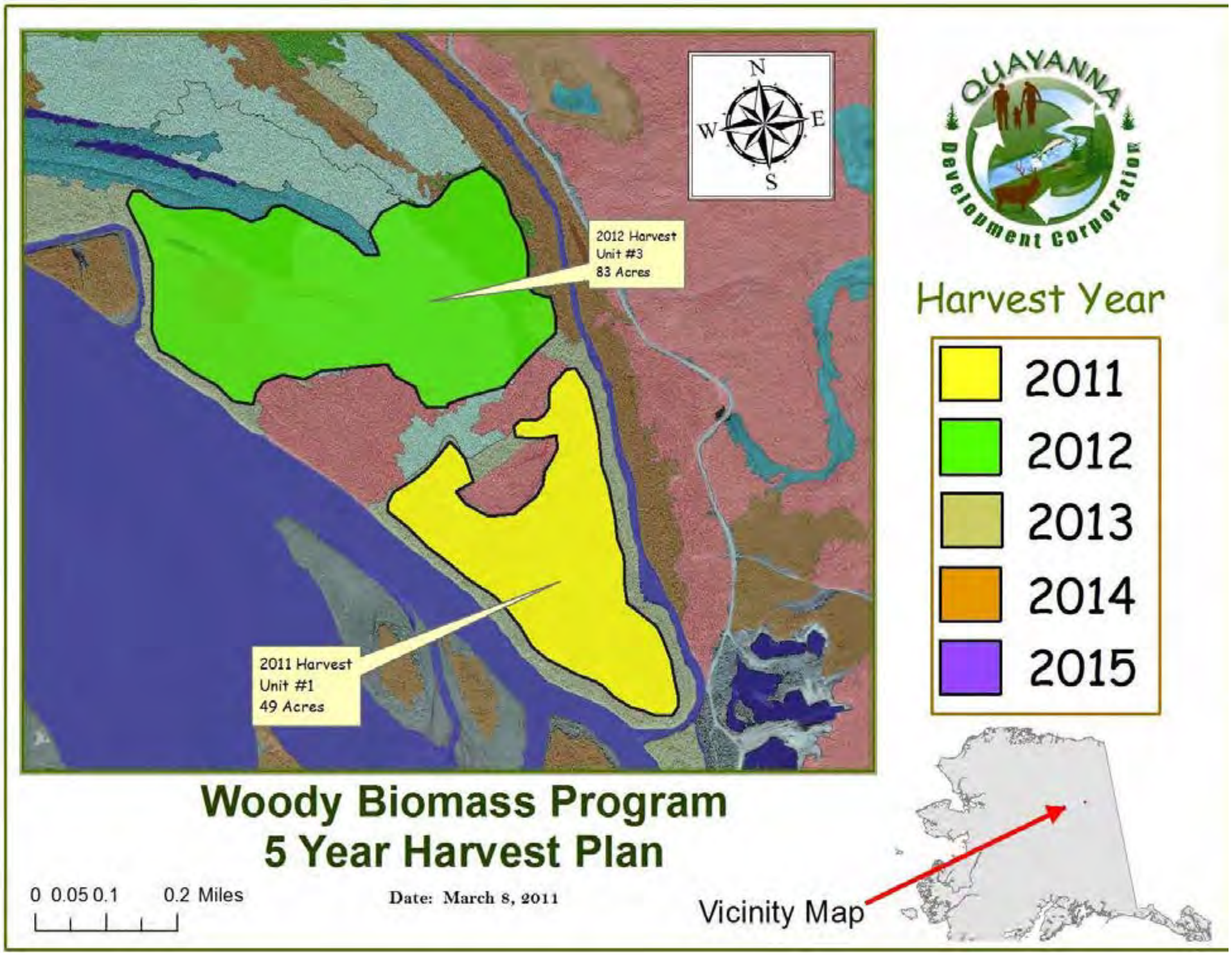
Vicinity Map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Development Corporation
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5 Year Harvest Plan
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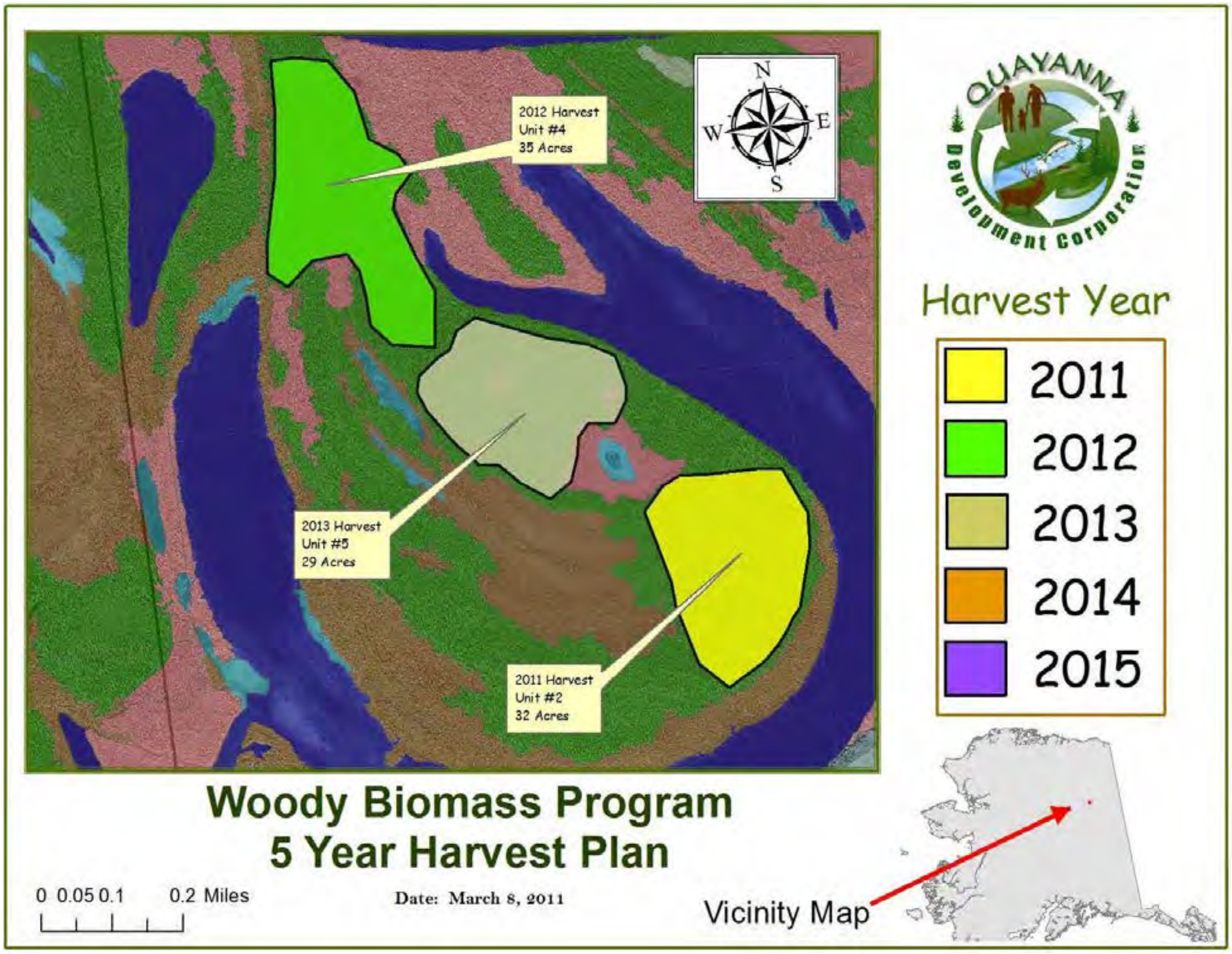
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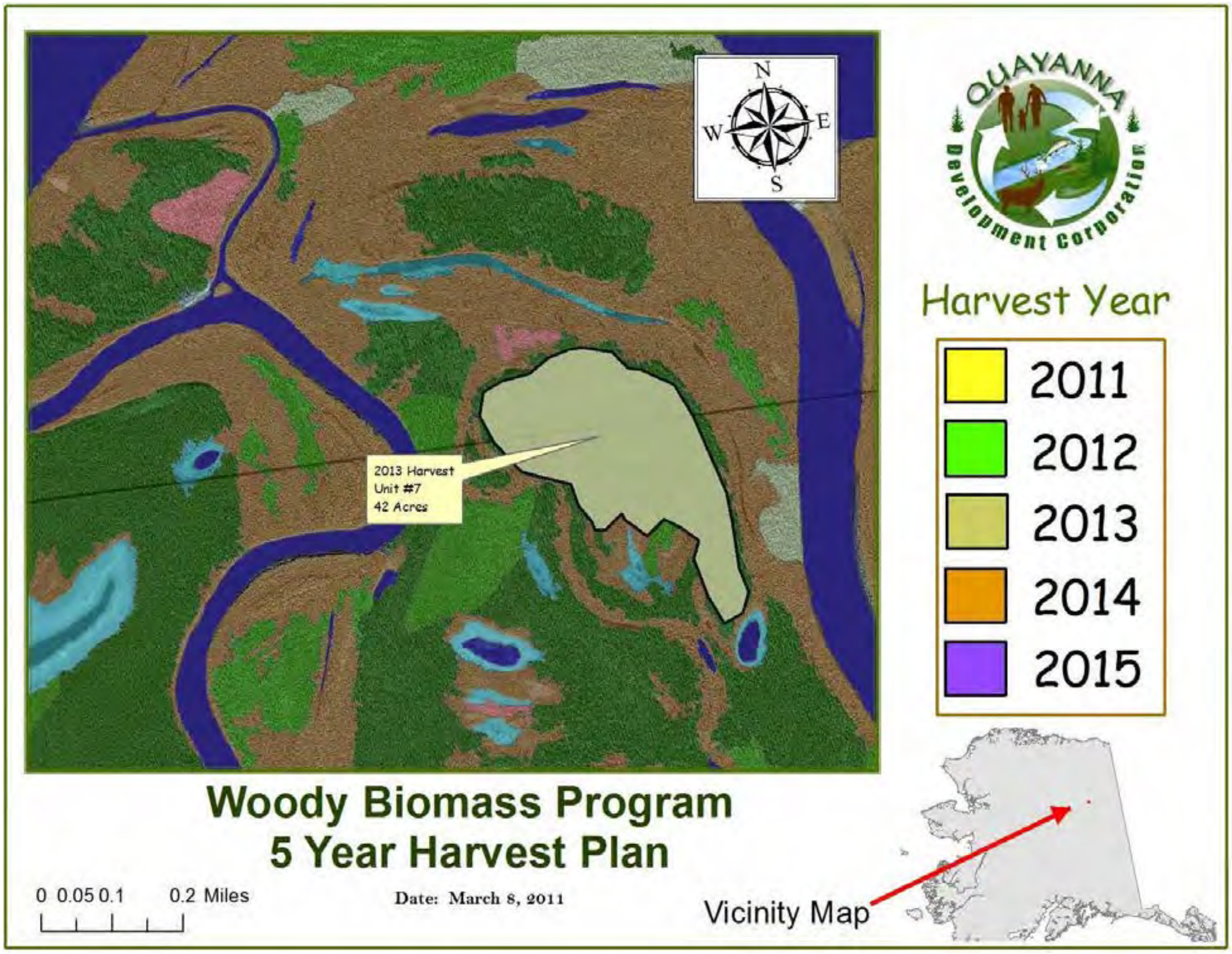
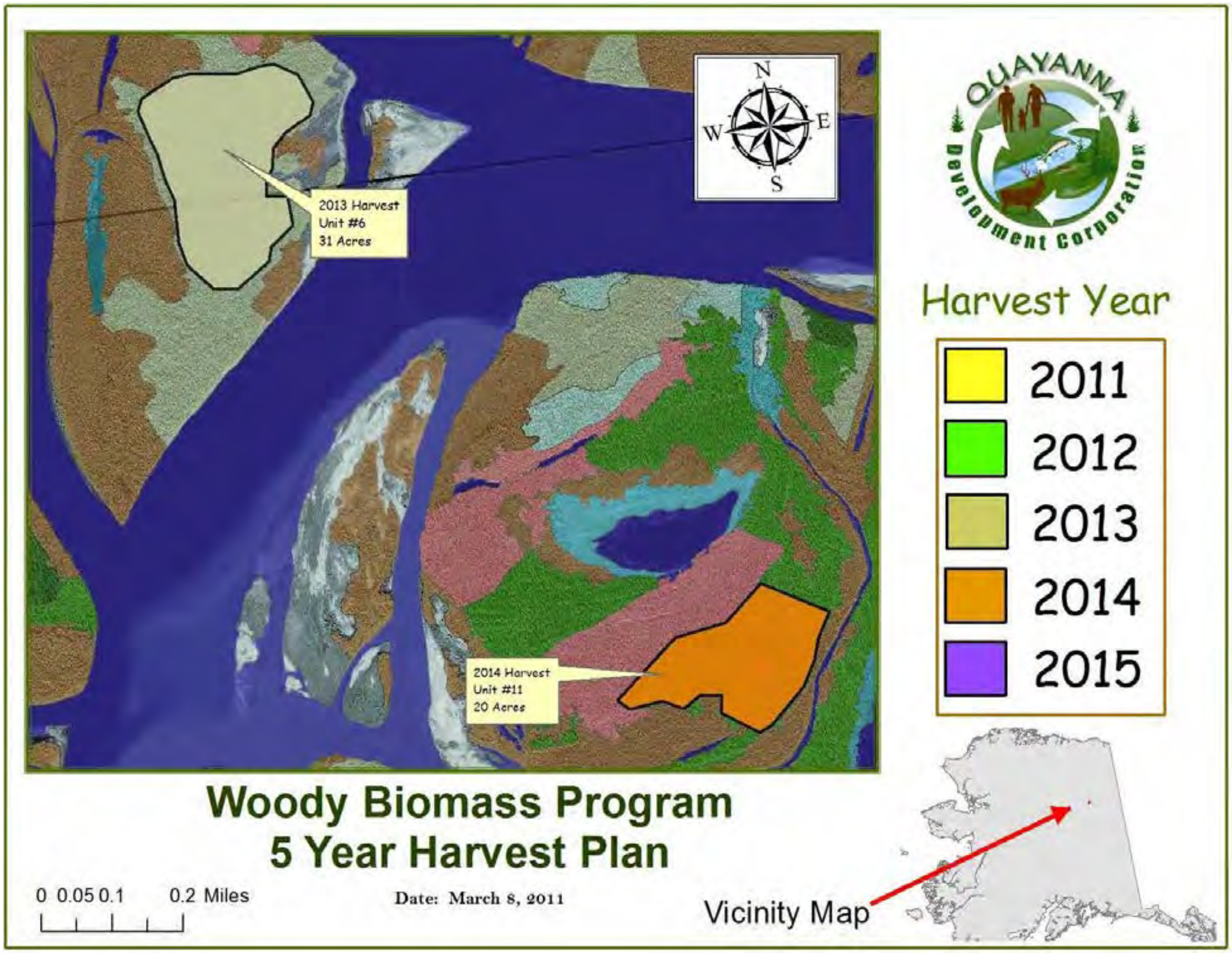
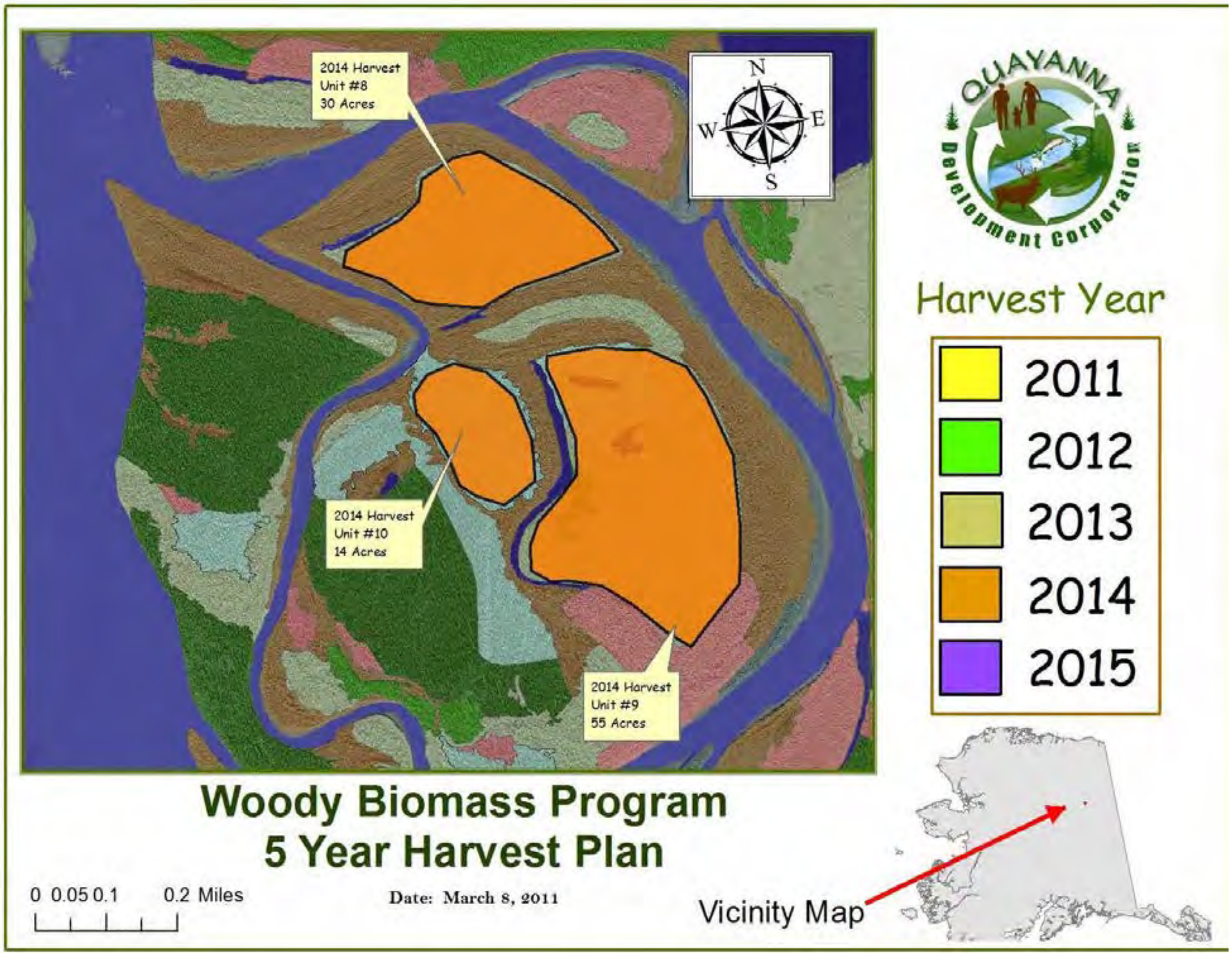
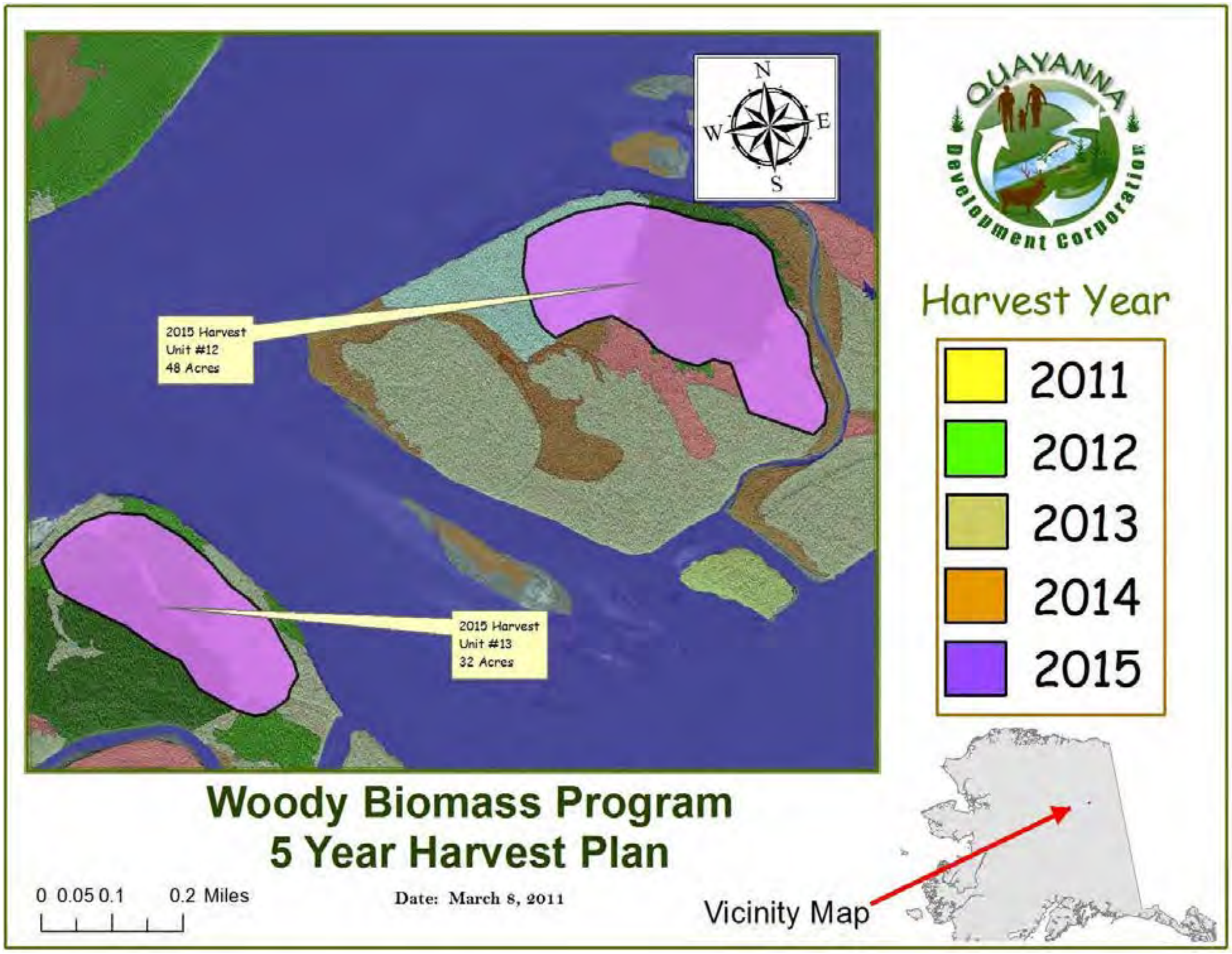
Date: March 8, 2011
Vicinity Map



N
W
E
S
QUAYANNA Development Corporation
Harvest Year
2011
2012
2013
2014
2015
2013 Harvest
Unit #7
42 Acres
Woody Biomass Program
5 Year Harvest Plan
0 0.05 0.1 0.2 Miles
Date: March 8, 2011
Vicinity Map


2013 Harvest
Unit #6
31 Acres
2014 Harvest
Unit #11
20 Acres
N
W
E
S
QUAYANNA
Development Corporation
Harvest Year
2011
2012
2013
2014
2015
Woody Biomass Program
5 Year Harvest Plan
0 0.05 0.1 0.2 Miles
Date: March 8, 2011
Vicinity Map


2014 Harvest
Unit #8
30 Acres
2014 Harvest
Unit #10
14 Acres
2014 Harvest
Unit #9
55 Acres
N
W
E
S
QUAYANNA
Development Corporation
Harvest Year
2011
2012
2013
2014
2015
Woody Biomass Program
5 Year Harvest Plan
0 0.05 0.1 0.2 Miles
Date: March 8, 2011
Vicinity Map



2015 Harvest
Unit #12
48 Acres
2015 Harvest
Unit #13
32 Acres
N
W
E
S
QUAYANNA
Development Corporation
Harvest Year
2011
2012
2013
2014
2015
Woody Biomass Program
5 Year Harvest Plan
0 0.05 0.1 0.2 Miles
Date: March 8, 2011
Vicinity Map