# Pinyon-Juniper Biomass Utilization Study

For Lincoln County, Nevada

August 2004

**Cost Documentation Report** 

Prepared For:

LINCOLN COUNTY REGIONAL DEVELOPMENT AUTHORITY C/O MIKE BAUGHMAN P.O. BOX 851 CALIENTE, NEVADA 89008

Prepared By:

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LINCOLN COUNTY REGIONAL DEVELOPMENT AUTHORITY C/O Mike Baughman P.O. Box 851 Caliente, Nevada 89008

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# 1.0 INTRODUCTION

# 1.1 Objectives

Several fuel reduction and ecological restoration projects are currently being implemented or have been proposed on federally managed pinyon pine and juniper woodlands in the Great Basin (BLM, 2001a; BLM, 2001b; BLM Color Country Fuels Projects website). The Lincoln County Pinyon-Juniper Research Project has been implemented to provide additional information to the Lincoln County Regional Development Authority regarding the following:

- Vegetation community composition and structure, and biomass response to chip application treatments.
- Treatment implementation costs for mechanical tree removal including felling, skidding, chipping, chip spreading, and seeding.
- Comparable treatment implementation costs for mechanical tree removal including felling, skidding, and chipping from other agencies and Great Basin locations.
- Baseline inventory of tree biomass and vegetation community composition and structure.

# 1.2 **Project Collaboration**

The Lincoln County Regional Development Authority and the Bureau of Land Management (BLM), Ely Field Office funded construction of the study plot in conjunction with the Mount Wilson Fuel Reduction Project (United States District Court, 2002). The contractor for the Mount Wilson project, was hired to cut, skid or forward, and chip material for specified treatment blocks within the study plot. The University of Nevada, Reno (UNR) provided the labor for seeding the plot. The BLM, the Nevada Division of Forestry (NDF), and the Natural Resources Conservation Service (NRCS) Plant Materials Program donated seed for the project. A local contractor applied chips to the appropriate treatment areas and the NDF Pioche Conservation Crew completed spreading the chips to a depth of one to two inches. The chip spreading treatment was funded through the Lincoln County Regional Development Authority.

#### 1.3 Site Description

The site is approximately 80 miles south of Ely and 20 miles north of Pioche, Nevada. The study site is located in Township 5 N. Range 66 E. Section 20 (M.D.M.), approximately 0.5 miles west of U.S. Highway 93 and 2.8 miles south of the Pony Springs rest area. The study site is 20 acres in size and lies within the Wilson Creek grazing allotment (BLM grazing allotment shapefile), managed by the BLM (Figure 1). The BLM will fence the project area to exclude livestock grazing from the treatment area.



# 2.0 Treatment Application Methods

Tree cutting, skidding and forwarding, chipping, seeding, and chip application treatments were installed on the study plot. A harvest plan was developed in order to minimize project site disturbance during the implementation of the study treatments (Appendix A). Additional information regarding treatment implementation is explained below. Treatments were installed according to the experimental design schematic shown in Figure 2.

# 2.1 Mechanical Cutting and Piling

Trees were cut on approximately 12 acres of the project site including eight acres of treatment blocks and four acres of access corridors, chip stockpile areas, and landings. Most trees were mechanically removed using two Valmet® rubber-tired feller-bunchers. One feller-buncher was equipped with a 15-inch hydraulic shear and the other was equipped with a 16-inch hydraulic shear (Appendix B, Photo 1). Stumps were cut to an approximate six-inch height by the feller-bunchers. The trees were placed in bunches to facilitate the skidding and forwarding operations. Trees larger than 16 inches in diameter were hand-cut with chain saws, leaving stump height ranging from 12 to 24 inches. The NDF Pioche Conservation Crew cut very small trees with chain saws from the tree removal plots receiving chips.

# 2.2 Skidding and Forwarding

The skidding and forwarding operations were accomplished with a rubber-tired grapple skidder (Photo 2) and a rubber-tired front-end loader with forks and a grapple (Photo 3). The front-end loader and skidder used the designated skid roads (travel lanes) as much as possible to move the felled trees to the chipper, in an effort to minimize soil compaction and disturbance within the treatment areas.

# 2.3 Chipping

Whole trees were chipped using a Precision® 27-inch whole-tree chip-harvester (Photo 4). Two landings were created for the chipper at the east side of each of the cut plots. Chips were stockpiled at each landing until they could be spread onto the designated treatment plots.

# 2.4 Seeding

The seed mixture used in this experiment is included in Appendix C and includes native grass, forb and shrub species. Crested wheatgrass, a non-native species was also included due to its extensive availability, establishment success, and widespread use in seed mixtures throughout the Great Basin. The seed mixture was broadcast onto 16 of the half-acre plots using a whirlybird-type seeder. An ATV equipped with a drag bar trailing weighted chains passed twice over the seeded areas in perpendicular directions to ensure a light incorporation of the seed into the seedbed.



## Figure 2. Lincoln County Pinyon-Juniper Field Study Site Experimental Design

# 2.5 Chip Spreading

After seeding, two 10-cubic yard dump trucks and two backhoes were used to haul the chips from the landing to the designated treatment areas (Photo 5). A local contractor provided the equipment and the labor for the spreading operation. On the study plot, four acres received chips piled at a rate of 20 truckloads per acre. This resulted in a total of 80 truckloads deposited on the site (Photo 6). The chip piles were first bulk spread with a backhoe and then hand spread by members of the NDF Pioche Conservation Crew to ensure spreading to the specified depth of one to two inches using hand rakes, shovels, and wheelbarrows (Photo 7). Excess chips at the study plots were deposited in small piles along the edges of the plots. Remaining chips at the landings were spread by backhoe on the landings and along the access road.

# 3.0 Treatment Cost

## 3.1 Cost Monitoring Methods

Costs for each stage of the treatment implementation were compiled by recording actual implementation times. Some of the costs are reported from contractor bid prices, while others were calculated using contractor hourly rates or contractor whole-project bids. Costs per hour were determined by dividing the contracted price per acre by the total implementation time per acre. Total times for implementation include down time for equipment maintenance and repairs, an inevitable occurrence in completing the job. The cost per hour for thinning the small treatment blocks on the study plot are likely higher than per hour costs incurred for larger projects, such as the Mount Wilson project, due to increased time for implementing a more complex treatment design, the increased number of trees removed per acre, and a smaller economy of scale.

The total cost for implementing the treatments on the study plot is the sum of the costs attributed to cutting and piling, skidding and forwarding, chipping, seeding, chip application, and spreading operations. Costs for these operations are summarized below. Cost calculations are presented in more detail in Appendix D.

## 3.2 Mechanical Cutting and Piling

The cost established for cutting and piling was \$260.00 per acre, based on the contract price for the BLM Mount Wilson project. The cutting and piling on the study plot was completed in 17.25 hours with both feller-bunchers working simultaneously. Total cost for cutting and piling trees on the study plot was \$3,120.00.

Table 1. Mechanical Cutting and Piling Cost for the Lincoln County Study Plo	Table 1	I. Mechanical	<b>Cutting and</b>	<b>Piling Cost for</b>	the Lincoln	<b>County Study Plot</b>
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Acres	Machines	Total Time	Time/acre/machine	Cost per hour, per machine
12	2	17.25 hours	2.9 hours	\$89.66

#### 3.3 Skidding and Forwarding

The cost established for skidding and forwarding was \$145.00 per acre, based on the contract price for the BLM Mount Wilson project. The total time for skidding trees to the chipper was 20.25 hours using a grapple skidder and a front-end loader with forks. The total cost for skidding the study plot was \$1,740.00.

#### Table 2. Skidding and Forwarding Cost for the Lincoln County Study Plot

				Cost per hour,
Acres	Machines	Total Time	Time/acre/machine	per machine
12	2	20.25 hours	3.4 hours	\$42.65

## 3.4 Chipping

The cost established for chipping was \$285.00 per acre, equivalent to the contract price given for the BLM Mount Wilson project. The total time for chipping treatment plot material was 20.25 hours. Total estimated cubic yard yield from the site was 1,415 cubic yards or 118 cubic yards per acre. Using a standard weight of 351 pounds per cubic yard for pine chips, the estimated tonnage was 20.6 tons per acre for a total of 248 tons harvested. The total cost for chipping the study plot was \$3,420.00.

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Acres	Machines	Total Time	Time/acre/machine	Cost per hour, per machine
12	1	20.25 hours	1.69 hours	\$168.63

Table 4. Cost of Chipping Biomass by Cubic Yard Produced on the Lincoln County Study Plot

Acres	Volume	Chipping Cost	Cost per cubic yard of chips
12	1,415 cu. yd.	\$3,420.00	\$2.42

#### 3.5 Seeding

A rate of \$50.00 per hour for labor and equipment costs was established to complete the seeding operation. The retail cost of the seed mixture used on the study plot was quoted at \$115.00 per acre. The total time required for seeding eight acres was 7.5 hours. An ATV was contracted at \$50.00 per hour to pull a drag designed to simulate the incorporating effect that skidding harvested trees has on a site seeded prior to harvest.

 Table 5. Cost of Seeding on the Lincoln County Study Plot

Acres	Total Time	Total Cost	Cost per acre
8.0	7.5 hours	\$1,295.00	\$161.88*

\* The Ely BLM, NRCS, and NDF donated seed for this project and the cost reflected is the quoted cost at the time of seed donation. Seed prices vary with availability and demand.

#### 3.6 Chip Application

Chips were applied to a total of four acres on the study plot. The total time for completing the chip application was 102 hours in labor and equipment hours. A detailed description of chip application costs is included in Appendix D. The total cost for spreading chips on the study plot was \$5,982.04. Total estimated cubic yard yield of chips from the site was 1,415 cubic yards or 118 cubic yards per acre. It was estimated that 80 percent of this cubic yardage was directly applied to the study plot.

Acres	Cubic	Mechanically Spread cost per acre	Hand Spread	Hand Spread	Cost per cubic
	74.45				
4	1,415	\$1,235.00	\$521.02	\$40.07	\$4.96

## 3.7 Total Treatment Cost Summary

The total cost for implementing the mechanical treatments on the study plot is the sum of the cutting and piling, skidding and forwarding, chipping, and spreading operations. Costs for these operations are summarized below. A more detailed cost summary is provided in Appendix D.

 Table 7. Summary of Total Operational Costs for the Lincoln County Study Plots

Operation	Total Cost	Acres	Cost per Acre	Cost per hour, per machine
Cutting and Piling	\$3,120.00	12	\$260.00	\$89.66
Skidding	\$1,740.00	12	\$145.00	\$42.65
Chipping	\$3,420.00	12	\$285.00	\$168.63
Seeding	\$1,295.00	8	\$161.88	\$50.00
Chip Spreading	\$7,025.08	4	\$1,756.27	\$65.00
Total	\$16,600.08		\$2,608.15	

#### Table 8. Summary of Total Chip Production and Spreading Costs for the Lincoln County Study Plots

Contractor Items	Total Cost per acre	Average Cost per cubic yard
Chip Production	\$690.00	\$5.85
Chip Spreading	\$1,756.27	\$4.96

# 4.0 Comparable Treatment Costs from Other Projects

The costs provided below were obtained for projects completed by state and federal agencies throughout Nevada and Utah. The costs were provided via telephone interviews with agency representatives and contractors. Quotes provided by agencies may not be complete, as costs because they may be separated by funding source or may exclude administration, construction, and inspection time.

#### 4.1 Mount Wilson Project - Lincoln County, Nevada (BLM)

The Mount Wilson Fuels Reduction project was implemented and administered by the BLM during fiscal year 2004. 740 acres were included in the contract. The treatment involved thinning dense stands of pinyon and juniper trees, and leaving a density of approximately 25 large trees per acre. Rubber-tired feller-bunchers were used to cut the trees and bunch trees for skidding and forwarding. A rubber-tired grapple skidder and front-end loader with forks and skidder with grapple were used to complete the skidding. A Precision® 27-inch whole-tree chip-harvester was used to chip trees. Wood chips were hauled to an old airplane landing strip to be stockpiled for future use. Average haul lengths were between two to three miles. Contract items included cutting, skidding, chipping, and hauling.

Contract Item	Total per acre cost
Cutting	\$260.00
Skidding (yarding)	\$145.00
Chipping	\$285.00
Hauling (with chip van)	\$115.00
Total per acre cost	\$805.00

 Table 9. Summary of the Contract Items for the Mt. Wilson Fuel Reduction Project

In the fall of 2003, RCI visited the Mount Wilson site to observe the tree cutting operation. The contractor was thinning approximately eight to 10 acres per day, per feller-buncher. At a rate of 10 acres per 10-hour day, the cutting cost equates to \$260.00 per hour. When eight acres are cut in a 10-hour day, the cutting cost equates to \$325.00 per hour. Contractor tree cutting efficiency was better on the Mount Wilson project than it was on the Lincoln County Study Plot, likely due to simpler treatment specifications that were more easily implemented, cutting fewer trees per acre, and a more favorable economy of scale.

Due to soil moisture conditions at the time of RCI's site visit, chipping operations had not yet commenced. RCI did observe at the time the whole-tree yield from one and one-half to two acres of felling activity. Felled trees were pre-bunched, forwarded, and stockpiled near the chipper in 45 to 60 minutes using the front-end loader with forks and grapple. The average turn time for the 200 to 300 yard roundtrip was about four minutes. The BLM reports the average tonnage per acre on the Mount Wilson site was estimated at five to seven tons per acre on the lower fans (mostly juniper) and 10 tons per acre on the steeper terrain (pinyon and juniper complex) (BLM (a), pers. comm.). The skidding, forwarding and chipping operations on the Mount Wilson project are completed, however BLM has yet to determine total chip volumes and trucking times.

## 4.2 Ward Mountain Project – Ely, Nevada (BLM)

The Ward Mountain Fuels Reduction project was implemented during fiscal year 2004 through contract with the BLM, Ely Field Office. The fuels reduction contract covered the thinning, physical removal, and chipping of pinyon and juniper material from of 345 acres of federal land. The thinning prescription was carried out on 82 acres by BLM crews felling with hand tools, chainsaws, and a mechanized shear owned by the BLM. Privately contracted crews and equipment removed the resultant slash and completed the thinning prescription on the remaining 345 acres, leaving a density of approximately 25 of the larger trees per Rubber-tired feller-bunchers were used for the thinning and biomass removal acre. operations, and a front-end loader with forks and a grapple forwarded the material to the chipper. A Bandit® model 3680 waste recycler was used to chip the trees, which were then loaded into 20 cubic yard belly dumps and transported off site (Photo 8). Average haul length was 26 miles round trip. Total time for implementing the project was three months. Contract items included cutting and piling, slash removal, and hauling at the costs listed in Table 10. The slash removal items were added to cover the costs of collecting and chipping woody residue left by the BLM hand crews.

Contract Item	Total per acre costs
Cutting and piling	\$800.87
Slash Collection	\$12.87
Slash Chipping	\$12.87
Whole-tree Chipping	\$249.29
Hauling (with chip van)	\$179.71
Total per acre cost	\$1,255.61

Table 10. Summary of the Contract Items for the Ward Mountain Fuel Reduction Project
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According to the contractor, the per acre costs above are artificially high for the cutting and piling operation and artificially low for the remaining items due to the need to realize increased cash flow early in the project. However, the total per acre cost should be accurate.

Average tonnage produced from chipping material from two, one-acre plots at the site was estimated to be 8.5 tons per acre. At 345 acres, total yield from the project was estimated to be approximately 2,932 tons of biomass. However, lighter tree densities at the south end of the project and the 80 hand-cut acres opened to the public for fuel wood removal prompted a correction in this figure. The contractor removed a total of 4,000 cubic yards of chipped material from the project area, in 200 truckloads of 20 cubic yards each. At 500 pounds per cubic yard of chips, wet weight, approximately 1,000 tons of chipped materials were removed from the site.

#### 4.3 Hand Crews

Hand crews are generally utilized on projects where slope or access limits use of mechanized equipment. Small private land parcels are also more conducive to treatment with hand crews than large parcel acreages. The BLM and the U.S. Forest Service (USFS) may decide to utilize hand crews, rather than submitting projects for contract, when they have the

available labor on-hand. On the Ward Mountain project, hand crews cut approximately 70 of the 345 contracted acres (BLM (a), pers. comm.).

#### *4.3.1 Great Basin Institute*

The Nevada Fire Safe Council has been using hand crews from the Great Basin Institute (GBI) to provide fuel reduction services on private land projects throughout Nevada. The GBI crews perform cutting, removal, grinding, and trucking operations on fuel reduction treatment areas. After cutting, all slash and debris is moved to a central location where it is ground with a tub grinder and transported to an appropriate disposal facility. The total cost to implement fuel reduction a treatment in this manner currently ranges between **\$2,000.00 and \$3,500.00 per acre** depending upon site characteristics (Nevada Fire Safe Council, pers. comm.).

#### 4.3.2 Nevada Division of Forestry

The NDF Pioche Conservation Crew created fuelbreaks along roads on private land parcels in the Mount Wilson Community. Completion of this project involved hand cutting, chipping, and chip spreading. Specifications for a 20-foot wide fuelbreak on both sides of the private roads included reducing tree densities to 10 trees per acre. Fuel reduction treatment was specified for an additional 40 feet on both sides of the road for a tree density of 25 trees per acre. Pre-treatment tree densities ranged from less than 300 trees per acre to 600 trees per acre. The total project acreage was estimated at 90 acres. Art Cameron, Pioche Conservation Crew Supervisor, provided the costs below. The crew completed an average of half an acre per day.

Contract Item	Number	Units	Cost/Unit	Total Cost	Cost per Acre
12 man crew with	1	Day	\$402.22	\$402.22	\$804.44
Supervisor					
Mileage	65	Miles	\$1.98	\$128.70	\$257.40
(to and from site)					
Chainsaws (5)	5	Hours	\$3.75	\$93.75	\$187.50
Chipper	5	Hours	\$18.36	\$91.80	\$183.60
Portable Toilet	1	Day	\$11.45	\$11.45	\$22.90
Total Cost per Day			\$727.92	\$1,455.84	

Table 11. Hand Crew Costs for Fuel Reduction Projects

# 4.4 Mastication

Tree mastication projects are becoming more common as a means of reducing fuel loads in pinyon and juniper woodlands. The masticators grind trees from top to bottom, leaving piles of small sized aggregated chip-type material on the ground around the original tree location. Mastication treatments generally leave one to four inches of ground fuels with areas of bare mineral soil between masticated areas.

#### 4.4.1 Forest Service

The USFS completed a 110-acre project area around the Holbrook Junction community in Douglas County, Nevada. One rubber-tired and one tracked masticator, both with Fecon® masticator heads were used to reduce the fuels by grinding pinyon pine from tree top to ground level (Photos 9 and 10). A total of 51 acres were treated in a 300-foot wide fuelbreak that reduced tree cover from 60 percent to 15 to 25 percent. A 59-acre fuel reduction treatment increased the minimum distance between tree crowns to 30 feet and reduced tree cover to between 25 and 35 percent. The project was completed in an estimated 160 to 180 hours (1 month) with both masticators working. The contracted cost for completing the project was **\$740.00 per acre** for a total project cost of \$81,400.00 (USFS, pers. comm.).

	Table 12.	Mastication	Costs for	the Holbrook	Junction	Project
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Acres	Machines	Total Time	Time per acre, per machine	Cost per hour, per machine
110	2	170 hours	3.09 hours	\$239.48

#### 4.4.2 Bureau of Land Management

The BLM Carson City Field Office initiated a project to complete approximately 500 acres of fuel removal using masticators in the Brunswick Canyon area. The project target was to decrease tree cover to less than 20 percent (Photos 11 and 12). The contract was awarded to Snowy Range, Inc. from Evanston Wyoming at a price of \$213.00 per acre. BLM project planning costs were estimated at \$2,000.00. The cultural resource inventory cost was \$20.00 per acre (for 1,000 acres), and the contract administration cost was estimated at \$4,000.00. The Carson City Field Office completed one other mastication project that went out for contract in Hungry Valley, Nevada. The contract price for this project was **\$150.00 per acre** for a Bullhog® masticator (BLM (b), pers. comm.).

The BLM Cedar City Field Office in Utah began implementation of the 40,000-acre, 5-year Greenville Bench Enhancement Project in May of 2003. 4,000 acres of the project are scheduled to receive hand cutting and tree mastication treatments. Tree mastication is completed using a chipper/shredder known as the Fecon Bullhog® that is owned by the Utah BLM. Because they own the Bullhog®, the BLM has not calculated the costs associated with this project. The Cedar City Field Office has contracted one 6-month mastication job for **\$133.00 per acre**, but the BLM believes the contractor took the project at a loss (BLM(c), pers. comm.).

#### 4.4.3 Alpine County Fire Safe Council

The Alpline County Fire Safe Council in California completed a 25-acre mastication project near Markleeville, California. Due to the presence of homes in the area, the 25 acres received a non-contiguous mastication treatment. The contractor involved used a Slash-buster® head to remove brush and small trees less than 10 inches in diameter, at a rate of \$125.00 per hour. The total project cost was estimated to be **\$1,000.00 per acre** (Alpine Fire Safe Council, pers. comm.).

#### 4.5 Chipping

The Lake Tahoe Basin Management Unit (LTBMU) of the USFS has several fuels reduction projects within the Lake Tahoe Basin. Although the species being removed are very different

from the pinyon and juniper trees focused on in this project, the chipping and spreading costs may provide useful comparisons. In the LTBMU projects, trees are felled and the slash and non-merchantable trees are chipped, leaving down logs greater than 24" diameter breast-height on site for wildlife purposes. Typical fuel loads range between 10 and 50 tons per acre. The average cost of running a Mobark® 3060 mobile chipper on four different subunits was estimated at \$650.00 per acre in 2003 (Photos 13 and 14) (USFS, LTBMU, pers. comm.).

Acres	Machines	Total Time	Time per acre, per machine	Cost per hour, per machine
165	1	600 hours	3.6 hours	\$178.75

#### 4.6 Seeding

The Ely Field Office of the BLM provided the following average costs for seeding projects. These costs reflect the realistic cost to the agency for completing all the work associated with conducting a rangeland seeding, whether it is for fire restoration or other purposes. Cost may vary depending upon project location, size, species seeded, contract company or equipment used (BLM (d), pers. comm.).

Line Item	Cost	Unit
Seed (non-wilderness area)	\$38.00	Acre
Seed (wilderness or wilderness study area)	\$141.00	Acre
Seed Handling		
Storage	\$3.00	100 lbs.
Transportation	\$17.00	100 lbs.
Transportation	\$25.00 +	Day
	\$0.30	Mile
Seed Testing	\$200.00	Species
Seed Mixing	\$0.25	Pound
Aerial Seeding	\$8.00	Acre
Ferry Cost	\$70.00	Hour
Dispatch Cost	\$32.00	Hour
One-way Chaining	\$55.00	Acre
Equipment Repair	\$2.00	Mile
Transportation to site	Varies	
Drill Seeding	\$50.00	Acre
Transportation	\$2.00	Mile

Table 14. Seeding Costs for the Ely BLM Field Office

Line Item	Cost	Unit
Transportation to site	Varies	
Equipment Repair	\$2.00	Acre
Cultural Resources	\$30.00	Acre

Table 15. Seeding Costs for the Elko BLM Field Office

Line Item	Cost	Unit
Seed (non-native)	\$12 to \$15.00	Acre
Disking	\$12 to \$13.00	Acre
Aerial Seeding	\$8.00	Acre
Drill Seeding	\$12.00	Acre
Cultural Resources	\$15 to \$20.00	Acre

# 5.0 Biomass Utilization

The Lincoln County pinyon-juniper study plot is currently being utilized to measure the effects of chip reapplication as they relate to site vegetative structure and rehabilitation rates. In the case that the chips are not deposited back onto the harvest site for any reason (e.g. wildland fuel load concerns or ecologically adverse impacts), they can be sold as feedstocks for energy, compost production purposes, specialty wood products, firewood, fence posts, or any use where a market exists.

Biomass energy is derived from the conversion of organic material into useful energy: typically thermal, electrical, or chemical energy (CTA and USFS, 2003). Biomass utilization has the potential to be an economically viable means of disposing of the harvested biomass off-site; expanding capacity for biomass conversion activities would contribute to the economic growth and diversity at the community and county levels.

## 5.1 Factors Influencing Economic Viability

There are many factors that influence the local or regional viability of biomass energy.

#### 5.1.1 Biomass Sources and Supplies

Biomass can be derived from many places within a community. Landfills bury hundreds of tons of biomass every year, and with extensive fuels reduction projects on the horizon there will potentially be a major source of biomass throughout the west. On public lands, there must be a mandate to perform biomass harvest, whether it is to provide for economic stability, ecologic health, or public safety. Cooperation and consensus among agencies, public representatives, and private individuals will determine the extent and stability of a wood biomass source. A sustainable and perpetual supply of biomass must be demonstrated to exist within an economically effective hauling distance before any physical investment in biomass energy facilities can be considered.

#### 5.1.2 Petroleum Prices

The cost of petroleum-based fuels directly impacts the cost and benefits of utilizing biomass for energy production. Fuel prices relate to the cost of shipping the biomass from the harvest site to the energy production facility or other end user. An increase in fuel costs reduces the economic benefit of using biomass-derived energy over the traditional energy sources. In addition, increased fuel prices reduce the effective range from which biomass could be hauled. This adverse impact would be offset by the increased prices of heating oil, if the producer was using the biomass to create thermal energy. An increase in heating oil prices would increase the economic benefit of using the biomass-derived energy over the traditional energy services.

#### 5.1.3 Local Agreements

Many communities, land management agencies, and private landowners are under mandate to reduce wildland fuel loads within the wildland-urban interface. These fuels treatment operations are often performed on a mixture of public and private lands, and can produce hundreds of tons of biomass per project. Private landowners and public land management agencies can form agreements to donate or sell this biomass at a set price, so that the facilities utilizing the biomass can remain perpetually viable, thus benefiting local and regional economies.

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## 5.1.4 Biomass Condition

The amount of energy that is produced per unit mass depends on the type of biomass and the water content of the particular biomass material being converted. Dried pinyon and juniper wood can produce more BTUs per pound than most western tree species (between 274,000 and 289,000 BTU/cubic foot) (Barger and Folliott, 1972) but they both are below the BTU production potential of oak (CTA and USFS, 2003). The energy production potential is closely correlated with the percent moisture content of the biomass at the time of conversion.

#### 5.1.5 Infrastructure

The market for the biomass will not exist without investment in the construction of a facility that can convert the biomass into usable energy. The investment in the construction of a facility will only be made when all of the factors (5.1.1 through 5.1.4) are present to exist in a way that allows a sustainable source of biomass that can be converted into energy at a cost two to eight times less expensive than traditional energy sources (CTA and USFS, 2003).

#### 5.2 Local Biomass Utilization Examples

The following locations in Nevada and California are researching the applicability and feasibility of utilizing local biomass sources for energy production.

#### 5.2.1 White Pine County School District

Two schools within the White Pine County School District in Ely, Nevada are undergoing evaluations of integrating biomass heating systems into the buildings. The Forest Service commissioned CTA Architects and Engineers to assess the technical and economic feasibility of incorporating biomass utilization for thermal energy production in the schools. Below are the major factors that were incorporated into the analysis.

- These systems are projected to use 300 tons of biomass per year to heat the buildings.
- The NDF Ely, Pioche, and Tonapah Conservation Camps would provide 100 tons per year of the biomass at no charge for the first three years. The biomass that the NDF donates comes from pinyon and juniper slash that will be produced by fire hazard reduction agreements held by the NDF and Nevada Division of Corrections.
- The remaining 200 tons per year would be purchased from local sources at \$29.00 per [green] ton, delivered inside a storage facility.
- The biomass was projected to have an average water content of 40 percent (6,600 BTUs per pound) upon conversion to thermal energy, and produce 6,600 BTUs per pound at this moisture content.
- Fossil fuel prices were calculated at current rates with a four percent annual price escalation, natural gas at six percent price escalation, and biomass was calculated with a two percent annual price escalation.

• An additional cost of 80 to 160 hours of operational and maintenance time was factored in for additional demands of the new system.

#### 5.2.2 Loyalton, CA

Sierra Pacific Industries has seven cogeneration plants in California, which burn wood waste to create boiler steam and produce electricity. The closest plants to Nevada are those in Loyalton, Susanville, Quincy, and Lincoln. The Sierra Pacific Industries Loyalton cogeneration plant quoted a price of \$32.00 per bone dry ton that they would pay for pinyon and juniper wood chips (Sierra Pacific Industries, pers. comm.). The quoted price was given in June of 2004 and is only applicable as a point-in-time estimate of wood biomass value.

# 6.0 Conclusion

Treatment plot installation cost results show that the costs are generally comparable to other fuel reduction project costs, with the exception of the costs for spreading chips. The chip spreading cost in this case was greater due to the requirements of the research component of the project, the treatment plot design and even chip layer distribution was more time consuming than a non-research application of the same activities. Allowing the chipper to distribute the chips was not feasible due to the size of the area affected by the chipper as well as the difficulty in moving the chipper around the plot. Without the constraints imposed by the research objectives, the chip application process would likely have a much lower cost per acre, and could be compared more directly against other similar treatments such as mastication, mobile chipping, or hand crews.

A summary table is provided below to demonstrate the comparable cost items between the Lincoln County study plot and other fuels reduction projects. When comparing treatment costs, it is important to keep in mind the influence that factors such as tree density (before and after treatment), slope, rockiness, access, and proximity to homes have on cost variability.

Operations	Study Plot Cost/acre	Comparative Projects Cost/acre
Cutting and skidding/piling	\$405.00	\$800.08 (Ward Mountain)
Chipping	\$285.00	\$249.29 (Ward Mountain)
Chipping, skidding, and applying		
chips – equivalent to mobile	\$2,186.27	\$650.00 (LTBMU)
chippers		
Cutting, skidding, and chipping,		\$150.00 (Hungry Valley)
<ul> <li>roughly equivalent to</li> </ul>	\$690.00	\$740.00 (Holbrook Junction)
Masticating*		\$1,000.00 (Alpine County)
Cutting, skidding, chipping, and		\$1,455.84 (Mt. Wilson)
applying chips – equivalent to	\$2,446.27	\$2,000.00 (GBI)
Hand Crews		\$3,500.00 (GBI)

Table 16. Summary of Total Project Costs Comparisons

\*Mastication leaves piles of small sized aggregated chip-like material on the ground around the original tree location instead of chips spread in a uniform pattern.

# 7.0 References

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- Bureau of Land Management. 2001a. Environmental Assessment: Ely Urban Interface Project. EA-NV-040-01-66.
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- Bureau of Land Management (b). Personal communication with Tim Roide, BLM Project Leader with the Carson BLM Field Office. May 4, 2004.
- Bureau of Land Management (c). Personal email communication with Melanie Mendenhall, Rangeland Management Specialist with the Cedar City BLM Field Office. May 4, 2004.
- Bureau of Land Management (d). Personal email communication with Karen Prentice, Rangeland Management Specialist with the Ely BLM Field Office. May 3, 2004.
- CTA Architects Engineers (CTA) and United States Department of Agriculture, Forest Service (USFS), Region One. 2003. Preliminary Assessment for Integration of Biomass Energy Systems for White Pine County School District: Ely, Nevada
- Nevada Division of Forestry. Personal communication with Art Cameron, Pioche Conservation Camp Supervisor. May 5, 2004.
- Nevada Fire Safe Council. Personal communication with Pat Murphy, Project Coordinator for the Nevada Fire Safe Council. May 3, 2004.
- Sierra Pacific Industries. Personal communication with Jim Turner, Plant Manager for the Loyalton cogeneration plant. June, 2004.
- USDA, Forest Service. Personal communication with Stuart Volkland, Fuels Specialist with the Bridgeport Ranger District of the Humboldt-Toiyabe National Forest. May 3, 2004.

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- USDA, Forest Service. Personal communication with Robert Guebard, Vegetation Management with the Lake Tahoe Basin Management Unit. May 5, 2004.
- United States District Court, Reno, Nevada, 2002. Settlement Agreement. American Lands Alliance et al. vs. Ely Field Office BLM et al.





#### LINCOLN COUNTY REGIONAL DEVELOPMENT AUTHORITY BIOMASS MANAGEMENT AND UTILIZATION PROJECT STUDY PLOT TREATMENT HARVEST PLAN

- 1. Landowner: BLM, Ely District.
- 2. <u>Logging Contractor</u>: Warner Enterprises Redding, California

#### 3. Location of Study Plot:

The study plot is located approximately 2.8 miles south of the Pony Springs rest area on US Hwy. 93. The site is approximately 80 miles south of Ely and 20 miles north of Pioche, Nevada. The site is approximately 0.5 miles west of US Hwy. 93 and is located in Township 5 N., Range 66 E., Section 20 M.D.M. The study site is 20 acres in size.

#### 4. Description of Area:

The study plot is positioned on the east-facing slope of an alluvial fan, just below the Fairview Range in an area called "The Cedars." The terrain is gently sloping (<10%) and ranges in elevation from 6,300 to 6,350 feet. Present vegetation consists of primarily Utah juniper, pinyon pine, sagebrush, antelope bitterbrush, Indian ricegrass, bottlebrush squirreltail, buckwheat, and lupine. Cheatgrass was observed to be very infrequent in the interspaces between trees, but prevalent under the tree canopies. No noxious weeds have been observed. The understory vegetation is sparse throughout the site. The surface soil is very sandy with very little rock fragment greater than 2mm in size. There are a few drainage patterns on the site, but otherwise there is very little evidence of sheet or rill erosion.

The 1978 BLM aerial photo indicates that portions of the site may have been in a historical burn. However, no indication of a burn can be seen on the 1994 aerial photo and the tree canopy appears homogeneous.

#### 5. <u>Project Description</u>:

The Lincoln County Pinyon-Juniper Research Project has been implemented to provide additional information to the Lincoln County Regional Development Authority regarding the following:

- 1) Vegetation community composition and structure, and biomass response to chip application treatments.
- 2) Treatment implementation costs for mechanical tree removal including felling, skidding, chipping, spreading chips and seeding.
- 3) Comparable treatment implementation costs for mechanical tree removal including felling, skidding, and chipping from other agencies and Great Basin locations.
- 4) Baseline inventory of tree biomass and vegetation community composition and structure.

The study plot is approximately  $180m \times 400m$ , and is divided into four equal blocks, each measuring  $180m \times 90m$ . Each of these blocks will be further divided into eight units,  $45m \times 45m$  in size. All treatment blocks and block subdivisions have been staked on site. The study includes a 30-foot lane between each block and a 20-foot lane around the perimeter of the plot for movement of equipment during the cutting and skidding. The perimeter lane will be used for fence construction upon completion of treatment implementation.

A. Silvicultural Methods to be Employed:

Each of the four main blocks are approximately four acres in size. Two acres of each of the four blocks (8 total acres) will be cleared of all existing trees. The lanes between blocks and the lane or road around the study plot will also be clear-cut. Tree cutting and removal will not include shrub removal. The Contractor shall take every precaution to carefully maneuver equipment around existing shrubs

B. Cultural Clearance:

The Ely BLM Field Office has completed the cultural clearance and other NEPA requirements for the project to proceed.

- C. Harvesting, Chipping, and Chip Application Methods:
  - 1. The trees will be felled by rubber-tired feller-bunchers. The height of stumps will be less than six inches above the ground. Any trees that cannot be cut by feller-bunchers will be cut by chain saw.
  - 2. Once the trees have been cut, grapple equipped rubber-tired skidders will move into the cutting units and skid the trees to the landing. The landing will be located on the East Side of the study plot and just west of the two-track road that provides access to the site. The 30-foot wide lanes running east-west between the blocks will provide access for equipment to skid trees and move between the individual cutting units. This will reduce the number of times equipment will pass through the treatment plots. Equipment shall not cross one block to access another block. The equipment must use the corridors. The corridors shall be clearly flagged to control the movement of equipment.
  - 3. A whole-tree chip-harvester will process the trees into chips both at the landing and in the 30-foot lanes between blocks (see plot layout). The chips stockpiled on the lanes will be used for later reapplication onto the study plots.
  - 4. Upon completion of cutting and skidding, the designated blocks will be broadcast seeded with prescribed seed mix. **The Contractor will not be responsible for seeding.** Upon completion of broadcast seeding, the seeded areas will be lightly raked or harrowed to bury seed approximately ½ to ½ inch deep. **The Contractor will not be responsible for raking or harrowing.**
  - 5. Upon completion of seeding and raking, biomass chips in the lanes will be applied to the appropriate treatment blocks as shown on the plot diagram and

staked in the field. The following are options are approved for handling the chips:

- a) The chips could be moved from the lanes and spread over the units designated to receive chips with a front-end loader or backhoe.
- b) The chips could be blown into a dump truck as the trees are chipped and then spread across the designated blocks following seeding. This would help reduce the chance of picking up seeds and other plant debris that might be found at the landing.
- c) A dump truck or a manure spreader could be used to move the chips onto the plots. A front-end loader would be required to load the chips.

All of these options will require some hand raking to achieve the proper depth of chips on the designated plots.

D. Slash Disposal:

Whole tree skidding will be used and should minimize the amount of slash on the ground. Brush piling and burning is not being proposed for this project. Any slash that is not chipped will be scattered on the landing (following seeding) and in the lanes and then run over with the skidders or a front-end loader to push the slash into the ground.

E. Erosion Control:

Operation of heavy equipment will be limited to dry ground conditions. Damp but firm ground that can support equipment without creating ruts or frozen ground covered with a bed of chips may be approved if necessary. Any residual biomass chips that remain on site upon completion of application to the designated treatment blocks may be spread over the lanes between blocks and around the perimeter of the study area, or may be removed from the site. The landing should be seeded and covered with chips (less than 1 inch in depth). The site will not require construction of water bars for erosion control.

F. Fire Prevention:

The contractor should be operating under an existing fire plan for the work on the Mt. Wilson fuelbreaks and should continue to keep the same plan in force on this project as long as there is a threat of a wildfire in the area.

G. Hazardous Materials:

The contractor shall be responsible for all hazardous materials used on the job site including, but not limited to, gasoline, fuel oils, lubricants, paints and antifreeze. In the event contaminants are spilled on the ground, such spillage will be cleaned up and the contaminated soil disposed of in accordance with applicable local, state and federal laws and regulations.

#### H. Inspection:

A pre-construction meeting is required on site with a representatives from Resource Concepts, Inc., Warner Enterprises, and the Bureau of Land Management prior to initiating any cutting or skidding. Chip application methods, landing location, and location of chipping operations, or other aspects of this plan may change according to decisions made during the pre-construction meeting.





Photo 1. A three-wheeled, rubber-tired, feller-buncher equipped with a 15 or 16-inch blade on anvil shear felled and bunched trees on the Lincoln County Study Plot project.



Photo 2. A rubber tired grapple skidder moved bunched trees down a skid road to the chipper at the landing on the Lincoln County Study Plot Project.



Photo 3. A rubber tired front-end loader equipped with a tong-on-forks attachment forwarded bunches from the cutting-site to the landing at the Lincoln County Study Plot project.



Photo 4. A Precision  $\circledast$  whole-tree chipper chipped trees that were skidded and forwarded to the landing at the Lincoln County Study Plot project.



Photo 5. The two loaders filled dump trucks with chips from the landing piles at the Lincoln County Study Plot project.



Photo 6. The trucks dumped loads of chips on specific treatment areas of the plot, at the Lincoln County Study Plot project.



Photo 7. A backhoe, operated by the local contractor, and the NDF work crew with hand tools spread the chips at the Lincoln County Study Plot project.



Photo 8. A Bandit  $\ensuremath{\mathbb{R}}$  model 3680 waste recycler was used to chip trees and load them in 20 cubic yard belly dumps for transportation offsite at the Ward Mountain Project site.



Photo 9. A rubber-tired, three-wheeled tractor equipped with a masticating head was used to masticate trees for a fuelbreak at Holbrook Junction in Douglas County, Nevada.



Photo 10. A cat equipped with a masticating head was used to masticate trees for a fuelbreak at Holbrook Junction in Douglas County, Nevada.



Photo 11. Masticators are being used to implement the 500-acre Brunswick Canyon Fuel Reduction Treatment that the Carson City BLM Field Office is administering in Carson City, Nevada.



Photo 12. 120 acres of the 500-acre Brunswick Canyon treatment area have been treated with masticators to reduce tree cover to 20 percent (Carson City, Nevada).



Photo 13. A tracked Mobark B 3060 mobile chipper was used to chip logging slash and understory brush for the Lake Tahoe Basin Management Unit fuel reduction projects.



Photo 14. The mobile chipper produces chips and small slash material that is distributed on forest floor.



Common Name	Scientific Name	Seed Source	Seeding Rate PLS Pounds/ acre	Percent of Mix
'Nezpar' Indian ricegrass	Achnatherum hymenoides	USDA- NRCS	2.7	25%
`Ephraim' Crested wheatgrass*	Agropyron cristatum	USDA- NRCS	1.6	11%
Wyoming Big Sagebrush	Artemisia tridentata var. wyomingensis	NDF	0.05	3%
Bottlebrush squirreltail	Elymus elymoides	BLM	2.7	20%
`Arriba' Western wheatgrass	Pascopyrum smithii	BLM	1.1	5%
Sandberg bluegrass	Poa sandbergii	NDF	0.7	25%
Antelope Bitterbrush	Purshia tridentata	NDF	0.5	1%
Sulfur Buckwheat	Eriogonum umbellatum	BLM	0.25	2%
Globemallow	Sphaeralcea coccinea	BLM	0.25	8%
		Total	9.6 lbs/acre	100%

# Seed Mixture and Rates for the Lincoln County Pinyon-Juniper Study Plot

\*Crested wheatgrass is a non-native species included in the seed mix at a low rate for its high germination rates. Hilaria jamesii can be used as a substitute for crested wheatgrass at the same seeding rate of 2.0 pounds per acre. This seed mix equates to a seed rate of 57 seeds per sq.ft.



# **Treatment Cost Calculations – Lincoln County Pinyon-Juniper Study Plot**

#### MECHANICAL CUTTING AND PILING

The cost for cutting and piling was \$260.00 per acre, equivalent to the contract price for the BLM Mount Wilson project. The cutting and piling on the study plot was completed in 17.25 hours with both feller bunchers working. Total cost for cutting and piling the study plot was \$3,120.00.

- Average acres cut: 12 acres/2 feller bunchers = 6 acres/feller buncher
- Average time to cut and pile: 17.25 hours/12 acres = 1.4 hrs/acre for two machines
- Average time for one machine to cut and pile: 17.25/6 acres = 2.9 hours/acre
- Cost per hour (cutting and piling): \$260.00/2.9 hours = \$89.66 per hour for one machine

#### SKIDDING

The cost for skidding was \$145.00 per acre (contract price for the BLM Mount Wilson project). The total time for skidding trees to the chipper was 20.25 hours using both a grapple skidder and front-end loader with forks. The total cost for skidding the study plot was \$1,740.00.

- Average time to skid trees from 1 acre: 20.25 hours/12 acres = 1.69 hours per acre per two machines
- Average time to skid trees from 1 acre for 1 machine: 20.25 hours/ 6 acres = 3.4 hours
- Average cost per hour per machine to skid trees from 1 acre: \$145.00 per acre/3.4 hour per machine: \$42.65 per hour per machine

#### CHIPPING

The cost for chipping was \$285.00 per acre (contract price given for the BLM Mount Wilson project). The total time for chipping treatment plot material was 20.25 hours. Total estimated cubic yard yield from the site was 1,415 cubic yards or 118 cubic yards per acre. Using standard weights for pine chips, one cubic yard weighs 351 lbs. At this weight the estimated tonnage on the site was 20.6 tons/acre for a total of 248 tons harvested. The total cost for chipping the study plot was \$3,420.00.

- Average cost to produce a cubic yard of chips:
  - \$8,280.00 (cutting, skidding and forwarding, chipping)/1,415 cubic yards = \$5.85 per cubic yard of chips
- Total cost to spread a cubic yard of chips:

\$7,024.08/1,415 cubic yards = \$4.96 per cubic yard of chips

Total weight of chips produced:

1,415 cubic yards x 351 lbs. = 496,665 pounds or 248 tons of chips 248 tons / 12 acres = 20.6 tons per acre

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#### SEEDING

A rate of \$50.00 per hour was used for labor and equipment costs to complete the seeding operation. The retail cost of the seed mixture used on the study plot was quoted at \$115.00 per acre. The total time required for seeding eight acres was 7.5 hours. An ATV at \$50.00/hour was used for pulling a drag designed to partially bury the seed.

Item	Hours	Rate	Total
Labor	7.5	\$50.00	\$375.00
Equipment	2.0	\$50.00	\$100.00
Seed*	8 acres	\$115.00/acre	\$920.00
		Total	\$1,295.00

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<sup>t</sup> The Ely BLM donated seed for this project and the cost reflected is the quoted cost at the time of seed donation. Seed prices vary with availability and demand.

#### CHIP SPREADING

The total time to complete the chip spreading operation was 102 hours. The contractor equipment cost was \$65.00 per hour for each backhoe and each dump truck. Fifty hours was backhoe time for loading trucks and spreading chips on the treatment areas. 26 of the 102 total hours was trucking time for moving chips from the piles at the landing to the treatment areas. The 26 hours of truck time is reported as total running time, which included time for loading. Total cycle time for each truckload was between 10 and 15 minutes. 26 hours of the time was hand spreading by the NDF Conservation Crew, however two days time or 13 hours were donated to the project by the Camp Supervisor.

- Average cost per acre for mechanical spreading of chips: 76 hours x \$65.00 per hour = \$4,940.00 \$4,940.00/ 4 acres = \$1,235.00 per acre
- Average cost per acre for hand spreading of chips with donation: \$1,042.04 for 26 hours/ 4 acres = \$260.51 per acre \$1,042.04/ 26 hours = \$40.07 per hour
- Average cost per acre for hand spreading chips without donation: \$2,084.08 for 26 hours/ 4 acres = \$521.02 per acre \$2,084.08/ 26 hours = \$80.15 per hour
- Total cost to spread a cubic yard of chips:
  - \$1,235.00 per acre x 4 acres = \$4,940.00 \$ 521.02 per acre x 4 acres = \$2,084.08 Total = \$7,024.08

7,024.08/1,415 cubic yards = 4.96 per cubic yard of chips

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