Biomass Thermal Heating at California Conservation Camps & Elsewhere

TSS Consultants – January 2017

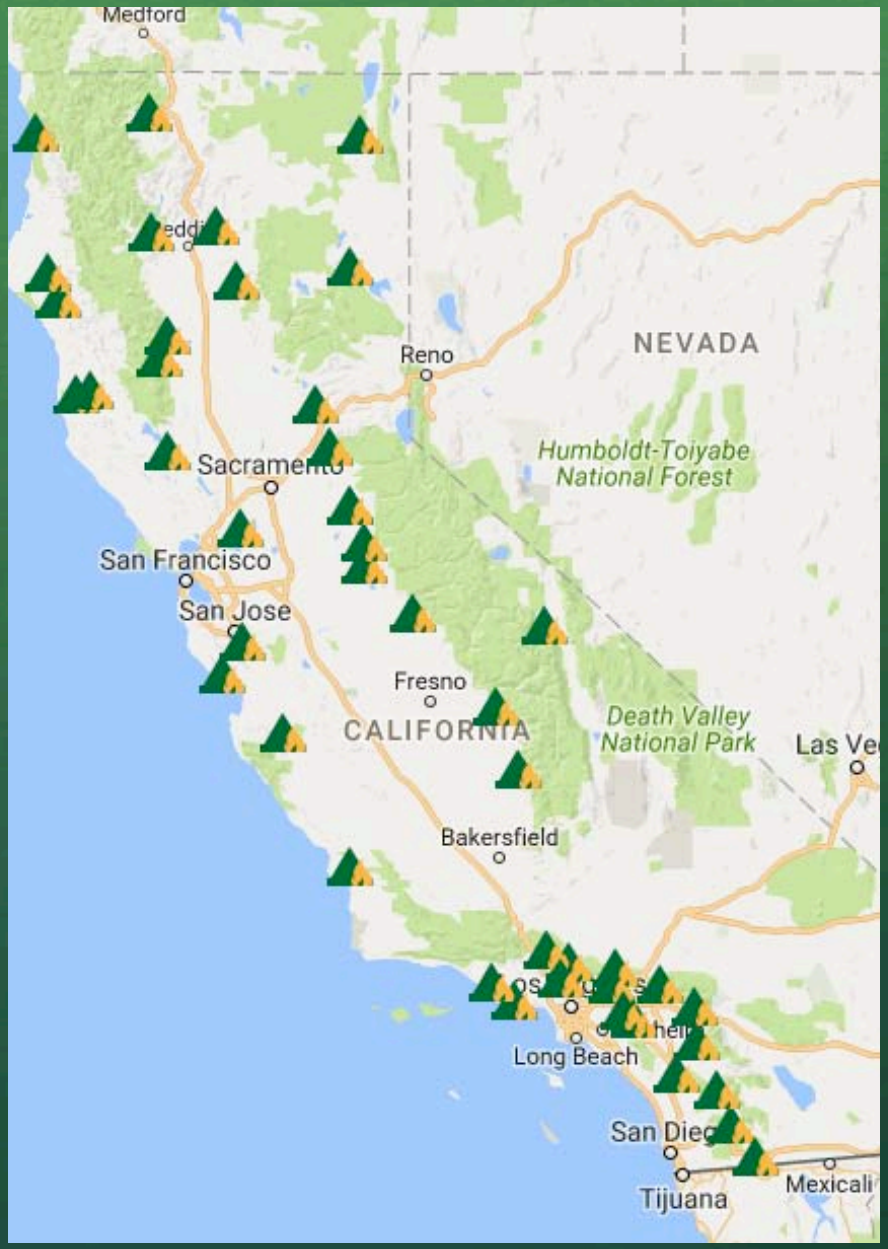
Fuel Cost Comparisons

Energy Type	Current Price		Energy Content		Price per Unit Energy		System Efficiency	All-In Price per Unit Energy	
Propane	2.10	$/gal	91,500	Btu/gal	22.951	$/MMBtu	0.80	28.693	$/MMBtu
Propane	2.65	$/gal	91,500	Btu/gal	28.962	$/MMBtu	0.80	36.208	$/MMBtu
Natural Gas*	0.775	$/Therm	100,000	Btu/Therm	7.754	$/MMBtu	0.80	9.692	$/MMBtu
Electricity @ 12¢	0.12	$/kWh	3,412	Btu/kWh	35.170	$/MMBtu	0.98	35.888	$/MMBtu
Electricity @ 17¢	0.17	$/kWh	3,412	Btu/kWh	49.824	$/MMBtu	0.98	50.841	$/MMBtu
Woody Biomass Feedstock	35	$/BDT	8,500	Btu/lb	2.059	$/MMBtu	0.70	2.941	$/MMBtu
Woody Biomass Feedstock	60	$/BDT	8,500	Btu/lb	3.529	$/MMBtu	0.70	5.042	$/MMBtu

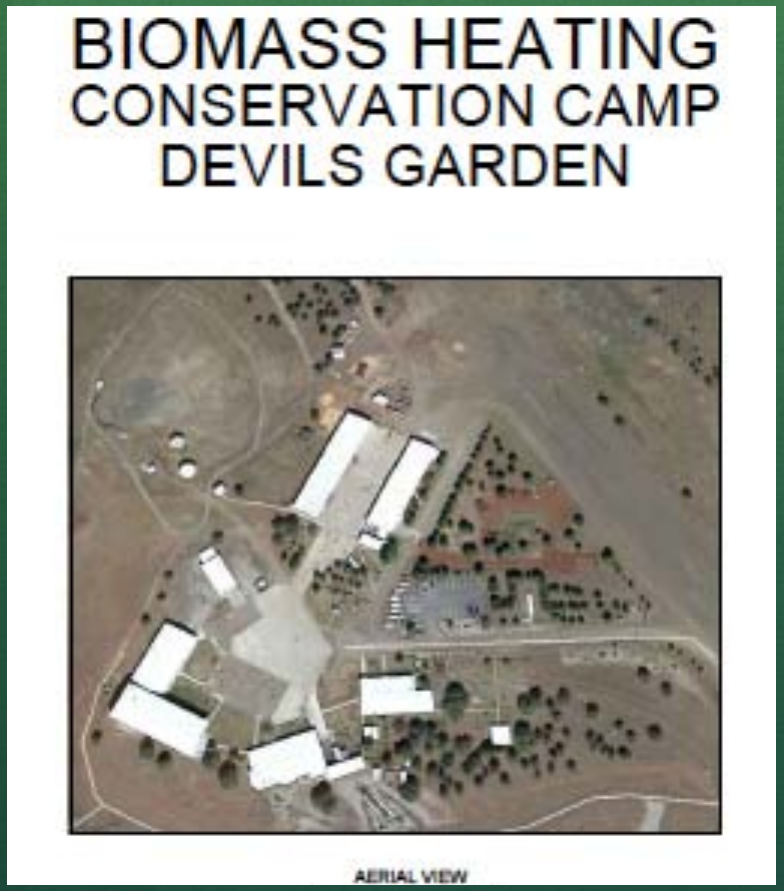
California Conservation Camps – CALFIRE and Department of Corrections

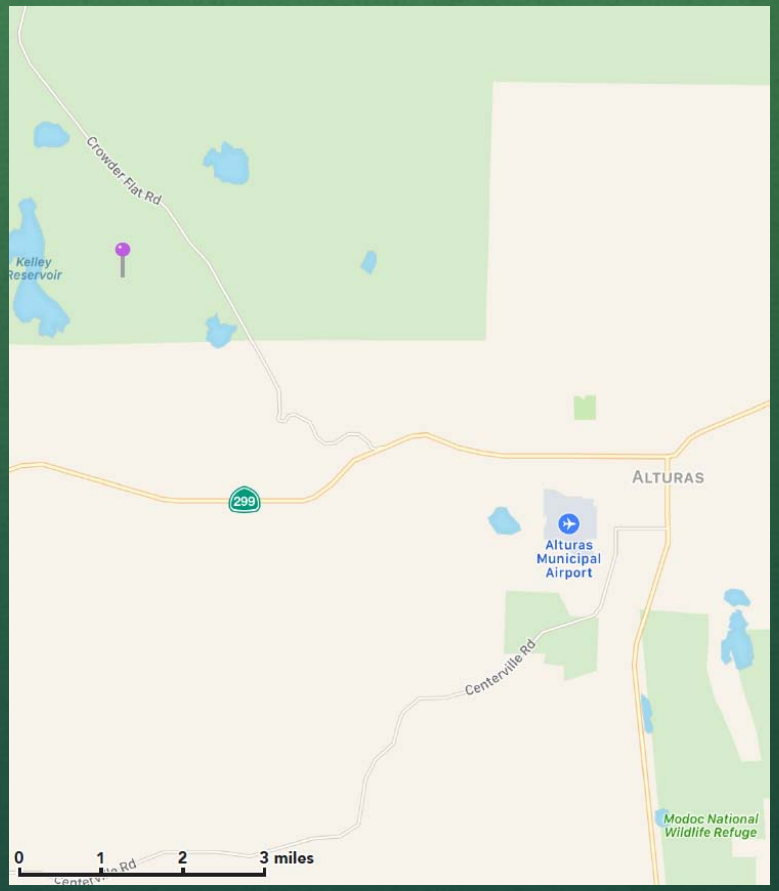
Conservation Camp Locations

There are 44 conservation camps in California in or adjacent to forested lands. Thirty-nine of the camps are jointly managed by CalFire and the Dept. of Corrections



Devil's Garden – Modoc County

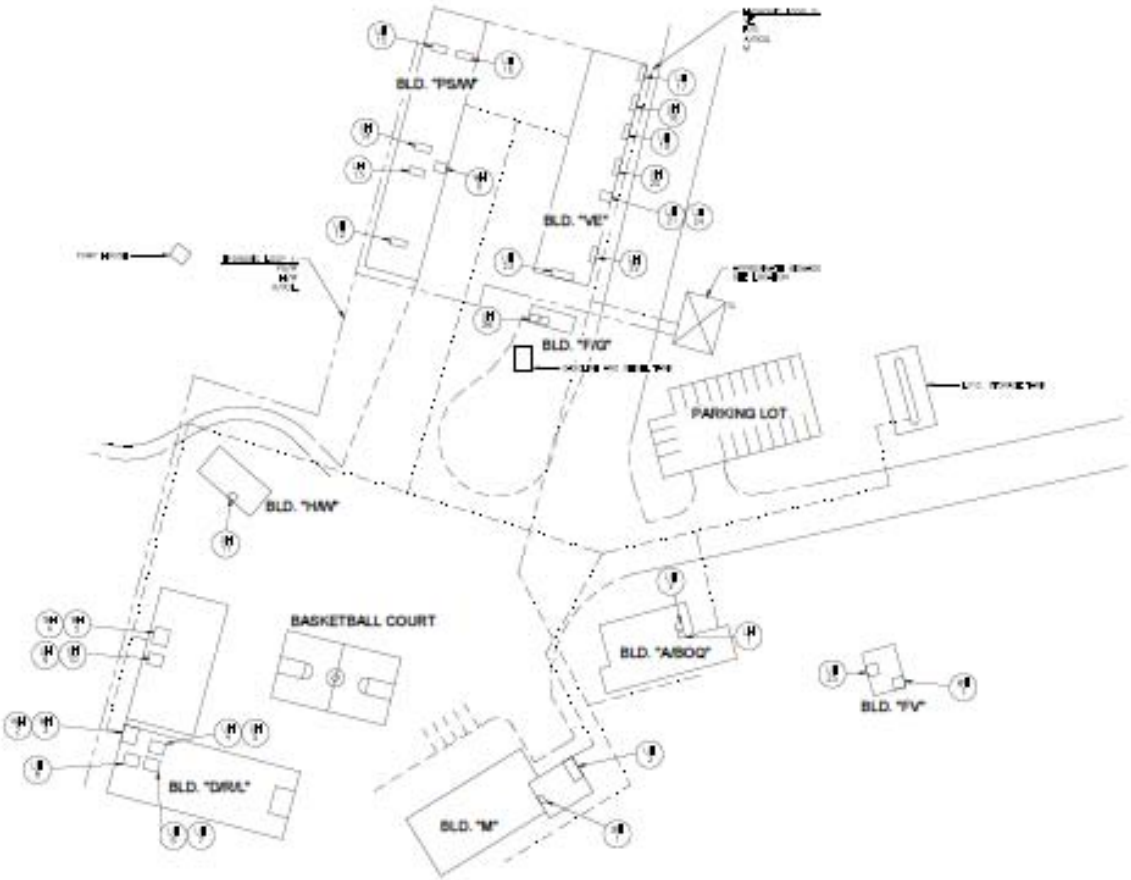




DGCC System Description

- Boiler sized at 1.75 MMBTU/hour heating input
- Boiler building approximately 30 by 40 feet (includes fuel bin)
- Approximately 1,679 feet of hot water distribution piping
- Cyclone separator to control particulate matter

AERIAL VIEW



SITE PLAN

GRAPHIC SCALE

PRELIMINARY

FOR REVIEW AND COMMENT ONLY

NOTE:

PRECISION ENERGY SERVICES INC.

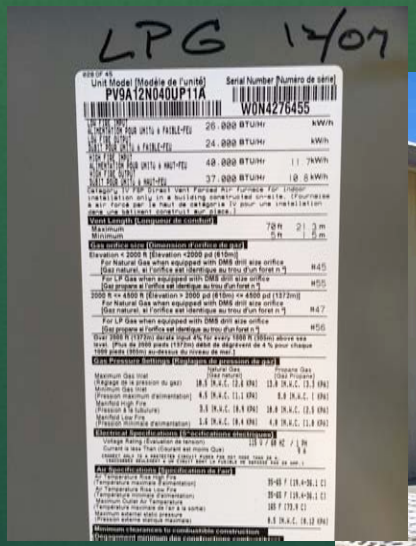
BIOMASS HEATING
CONSERVATION CAMP - DEVILS GARDEN
GENERAL ARRANGEMENT - HEATING LOOP

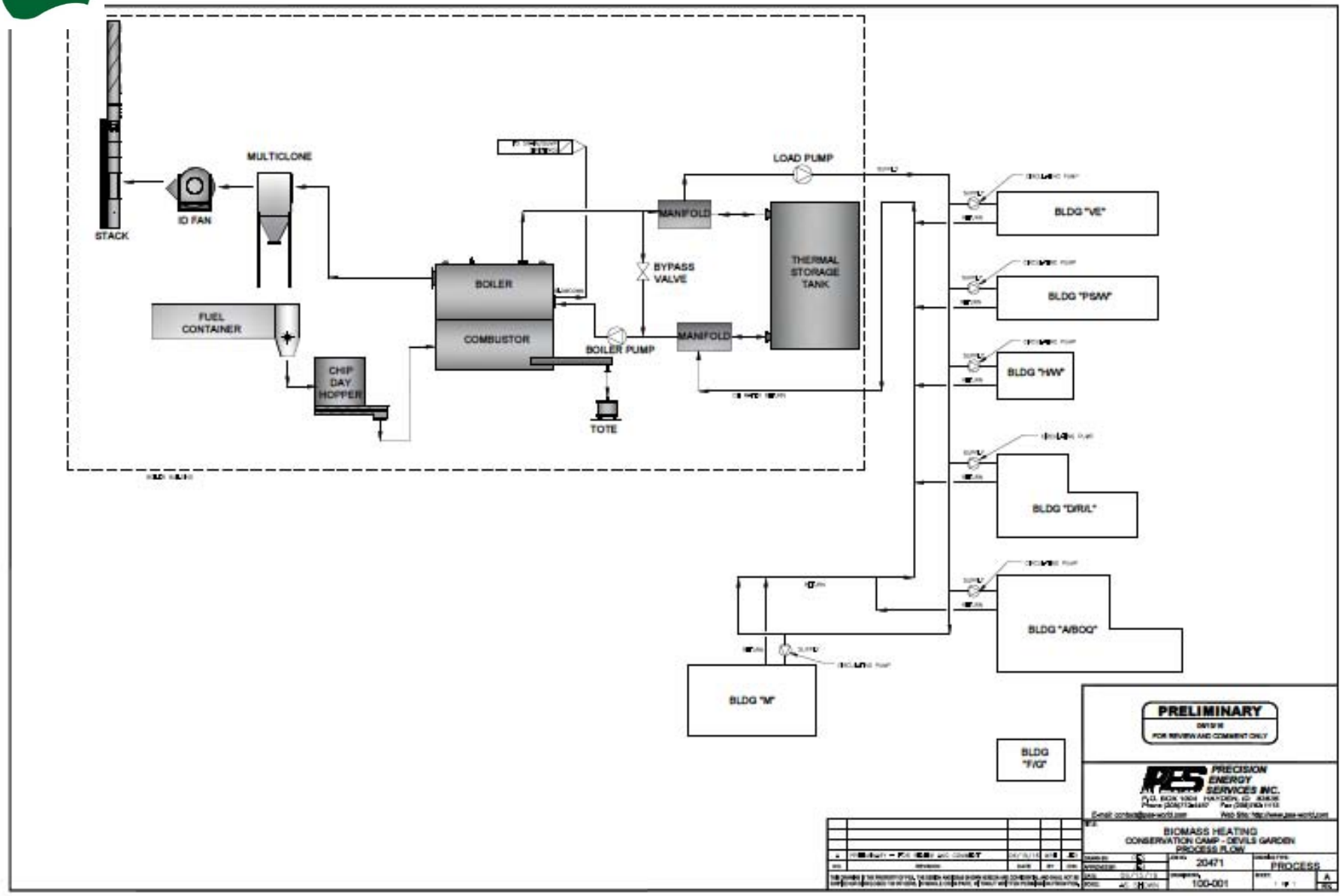
20471

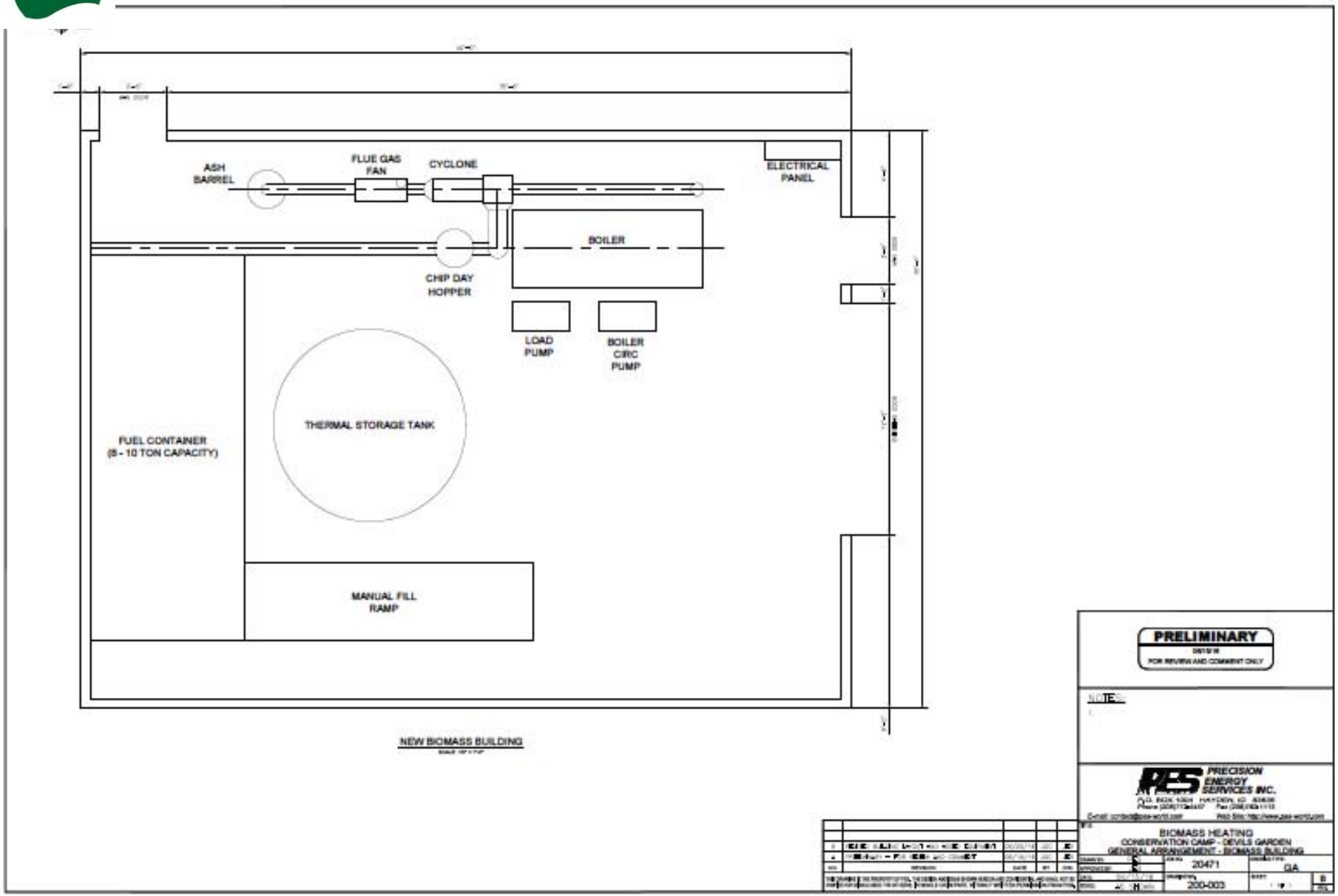
200-002


DEVIL'S GARDEN

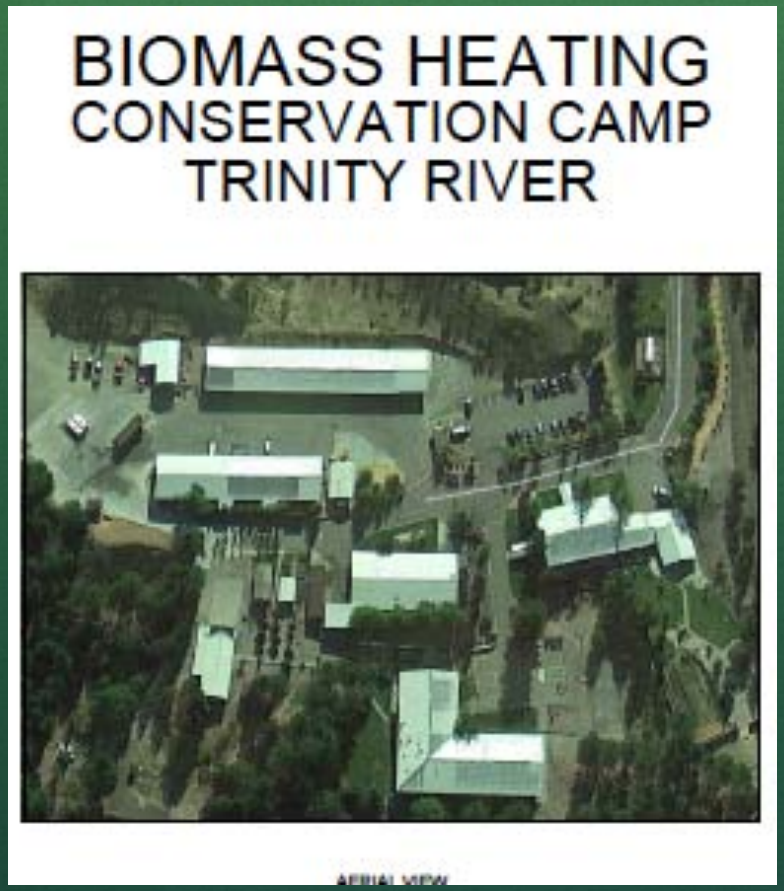

PROPANE

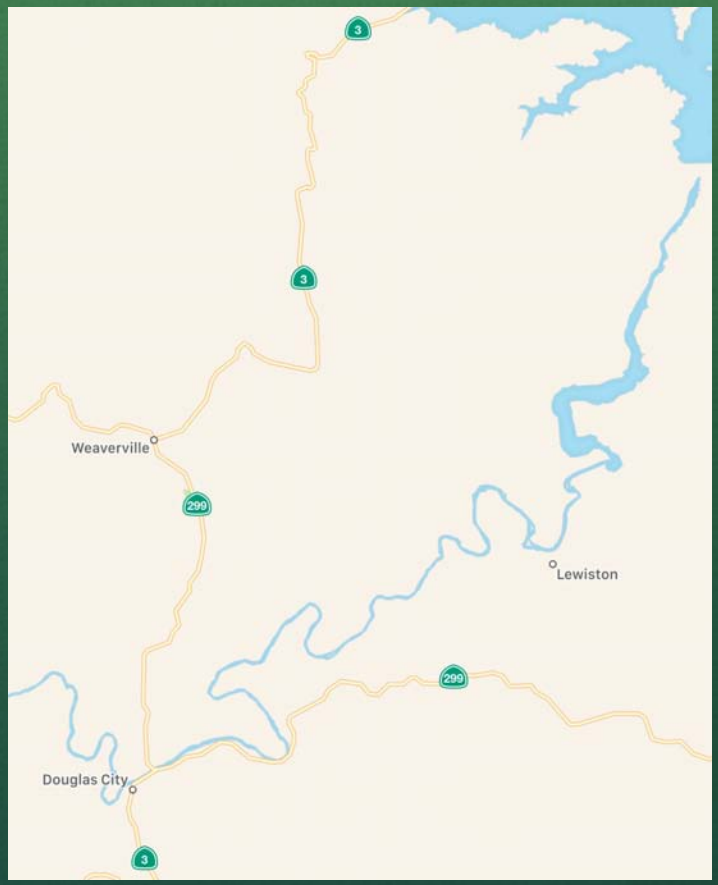

LPG 1407
Unit Model (Modèle de l'unité)
PV9A12N040UP11A
Serial Number (Numéro de série)
W0N4276455


STACK
ID FAN
MULTICLONE
FUEL CONTAINER
CHIP DAY HOPPER
BOILER
COMBUSTOR
BOILER PUMP
TOTE
BYPASS VALVE
MANIFOLD
MANIFOLD
LOAD PUMP
THERMAL STORAGE TANK
BLDG "VE"
BLDG "PSW"
BLDG "HW"
BLDG "DRVL"
BLDG "A/BOQ"
BLDG "M"
BLDG "F/G"
PRELIMINARY
FOR REVIEW AND COMMENT ONLY
PRECISION ENERGY SERVICES INC.
BIOMASS HEATING
CONSERVATION CAMP - DEVILS GARDEN
PROCESS FLOW
20471
PROCESS
100-001


ASH BARREL
FLUE GAS FAN
CYCLONE
ELECTRICAL PANEL
BOILER
CHIP DAY HOPPER
LOAD PUMP
BOILER CIRC PUMP
THERMAL STORAGE TANK
FUEL CONTAINER (8 - 10 TON CAPACITY)
MANUAL FILL RAMP
NEW BIOMASS BUILDING
PRELIMINARY
FOR REVIEW AND COMMENT ONLY
NOTE:
PRECISION ENERGY SERVICES INC.
BIOMASS HEATING
CONSERVATION CAMP - DEVILS GARDEN
GENERAL ARRANGEMENT - BIOMASS BUILDING
20471
GA
200-003

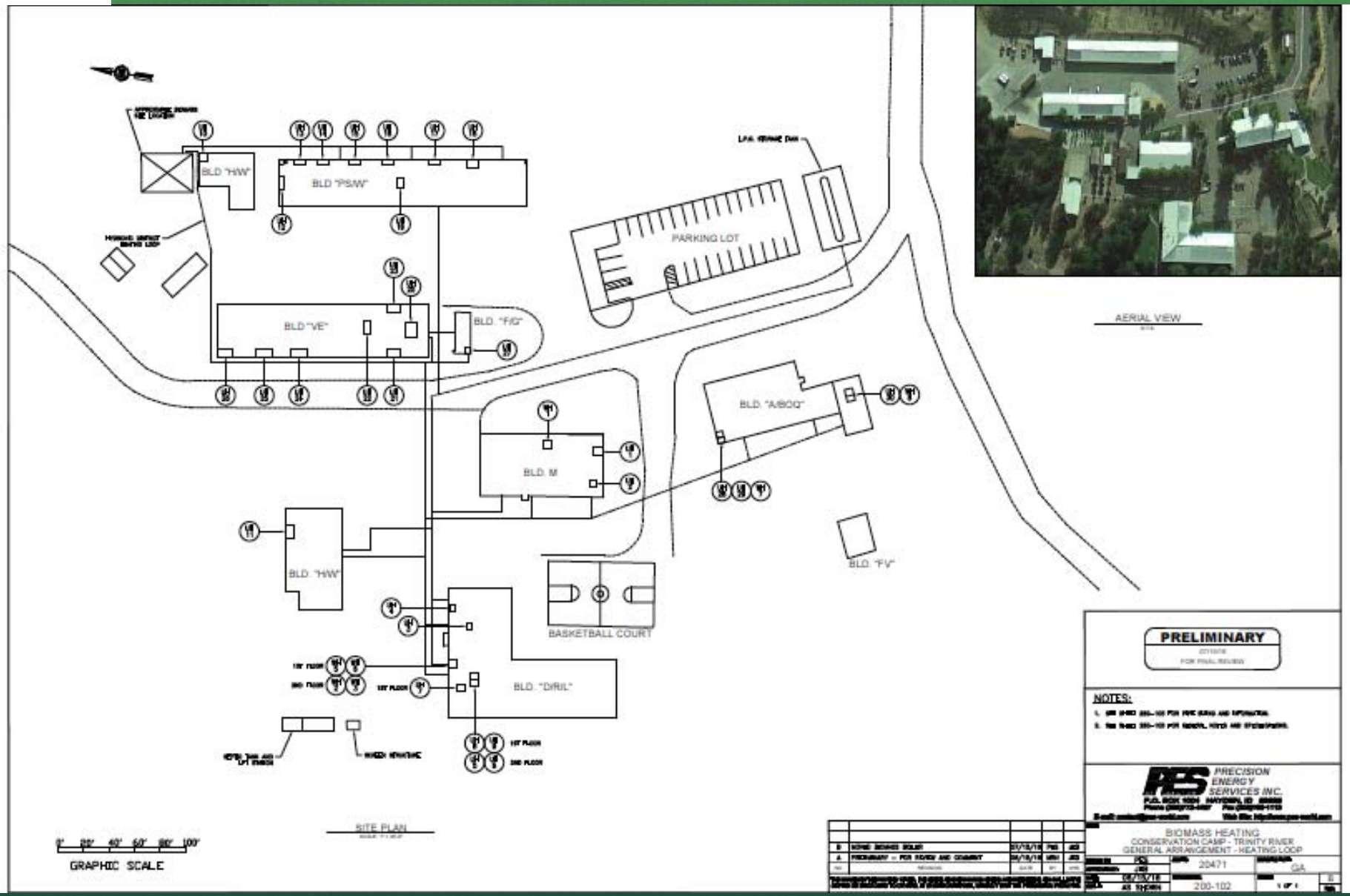
Trinity River – Trinity County

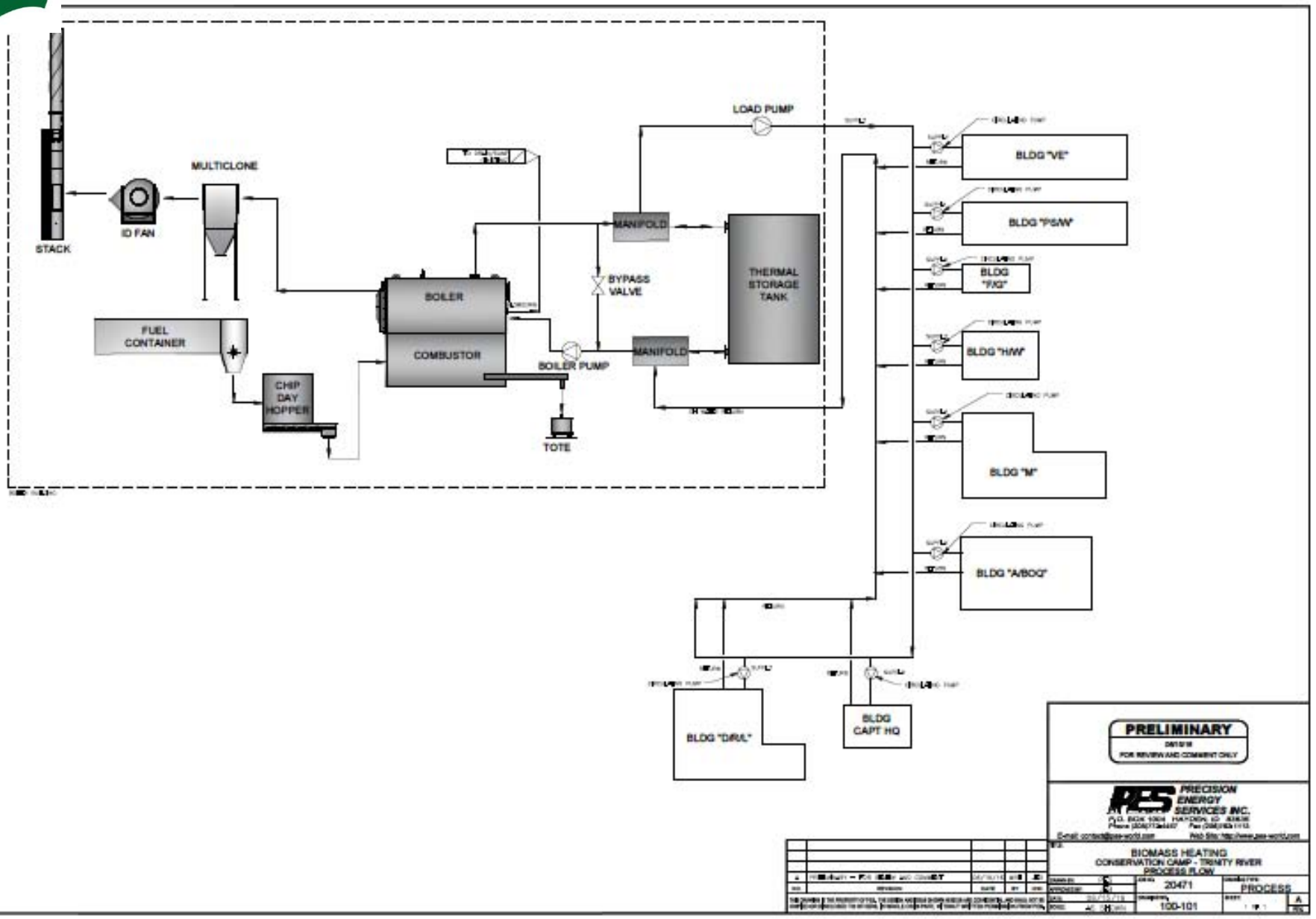


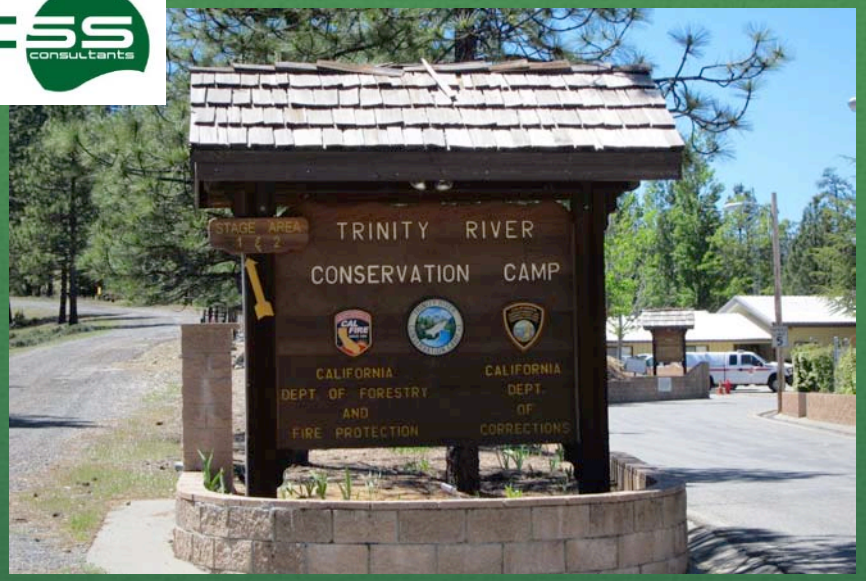


TRCC System Description

- Boiler sized at 1.75 MMBTU/hour heating input
- Boiler building approximately 30 by 40 feet (includes fuel bin)
- Approximately 1,356 feet of hot water distribution piping
- Cyclone separator to control particulate matter


BLD "HW"
BLD "PS/W"
PARKING LOT
BLD "VE"
BLD. "F/G"
BLD. "A/BOQ"
BLD. M
BLD. "HW"
BLD. "F/V"
BASKETBALL COURT
BLD. "D/R/L"
SITE PLAN
0' 20' 40' 60' 80' 100'
GRAPHIC SCALE
AERIAL VIEW
PRELIMINARY
NOTES:
PRECISION ENERGY SERVICES INC.
BIOMASS HEATING
CONSERVATION CAMP - TRINITY RIVER
GENERAL ARRANGEMENT - HEATING LOOP
20471
200-102


LOAD PUMP
MULTICLONE
STACK
ID FAN
BOILER
COMBUSTOR
FUEL CONTAINER
CHIP DAY HOPPER
BOILER PUMP
TOTE
MANIFOLD
BYPASS VALVE
MANIFOLD
THERMAL STORAGE TANK
BLDG "VE"
BLDG "PSW"
BLDG "FIG"
BLDG "HW"
BLDG "M"
BLDG "A/BOQ"
BLDG "D/RJL"
BLDG CAPT HQ
PRELIMINARY
FOR REVIEW AND COMMENT ONLY
PRECISION ENERGY SERVICES INC.
BIOMASS HEATING
CONSERVATION CAMP - TRINITY RIVER
PROCESS FLOW
20471
PROCESS
100-101


STAGE AREA
1 & 2
TRINITY RIVER
CONSERVATION CAMP
CALIFORNIA
DEPT OF FORESTRY
AND
FIRE PROTECTION
CALIFORNIA
DEPT.
OF
CORRECTIONS


RECREATION ROOM


1615E18985
ANSI CERTIFIED

Devil's Garden Energy User New System List

TSS20471

Conservation Camp Biomass Heating

Devil's Garden Energy User List		
	Building	Description
1	A/BOQ	Admin, Headquarters
2	M	Mess, Dining Hall
3	D/R/L	Dorms, Recreation, Laundry
4	H/W	Gym, Weights
5	PS/W	Wood Shop, Garage, etc.,
6	VE	Vehicle, equipment
7	F/G	Fuel, Generator
8	FV	Family Visitor Housing

Loop	Output MBh
Loop 1	1,195
Loop 2	1,557
Total	2,752

ID #	Drawing Schematic	BLDG	Type	Model	HHV Output	Recovery Rate Gal/hr	Piping Loop	Piping Connection Size Dia (in)
UH-1	280-003	A/BOQ	Upflow		71		Loop 2	
UH-2	280-003	A/BOQ	Air heater		91		Loop 2	
UH-3	280-004	A/BOQ	Air heater		661		Loop 2	
UH-4	280-005	A/BOQ	Air heater		71		Loop 1	
UH-5	280-006	A/BOQ	Air heater		71		Loop 1	
UH-6	280-007	A/BOQ	Air heater		37		Loop 1	
UH-7	280-008	A/BOQ	Air heater		37		Loop 1	
UH-8	280-009	A/BOQ	Air heater		71		Loop 1	
UH-9	280-010	A/BOQ	Air heater		71		Loop 1	
UH-10	280-011	A/BOQ	Air heater		71		Loop 1	
UH-11	280-012	A/BOQ	Air heater		53		Loop 1	
UH-12	280-013	A/BOQ	Radiant		20		Loop 1	
UH-13	280-014	A/BOQ	Radiant		80		Loop 1	
UH-14	280-015	A/BOQ	Radiant		80		Loop 1	
UH-15	280-016	A/BOQ	Radiant		80		Loop 1	
UH-16	280-017	A/BOQ	Radiant		56		Loop 1	
UH-17	280-018	A/BOQ	Radiant		80		Loop 2	
UH-18	280-019	A/BOQ	Radiant		80		Loop 2	
UH-19	280-020	A/BOQ	Radiant		80		Loop 2	
UH-20	280-021	A/BOQ	Radiant		80		Loop 2	
UH-21	280-022	A/BOQ	Wood Stove		-		Loop 2	
UH-22	280-023	A/BOQ	Radiant		20		Loop 2	
UH-23	280-024	A/BOQ	Radiant		80		Loop 2	
UH-24	280-025	A/BOQ	Radiant		56		Loop 2	
UH-25	280-026	A/BOQ	Unit Heater		44		Loop 2	
UH-26	280-027	A/BOQ	Air heater		33		Loop 2	
WH-1	280-028	A/BOQ	Water Heater		145	193	Loop 2	
WH-2	280-029	A/BOQ	Water Heater		145	193	Loop 1	
WH-3	280-030	A/BOQ	Water Heater		145	193	Loop 1	
WH-4	280-031	A/BOQ	Water Heater		51	68	Loop 1	
WH-5	280-032	A/BOQ	Water Heater		51	68	Loop 1	
WH-6	280-033	A/BOQ	Water Heater		6	7	Loop 1	
WH-7	280-034	A/BOQ	Water Heater		36	60	Loop 2	

Installation Cost Estimate - Devils Garden

TSS20471

Conservation Camp Biomass Heating

Biomass boiler costs:		
boiler	$ 184,063.95	
fuel system	$ 81,375.00	
building/enclosure	$ 46,095.00	
Subtotal		$ 311,533.95
District Heat system cost		
Building Conversion	$ 66,804.00	
Piping cost	$ 76,171.10	
Thermal Storage	$ 26,250.00	
Subtotal		$ 169,225.10
Installation		
Mechanical	$ 75,309.68	
Mechanical - Piping	$ 64,368.68	
Electrical	$ 29,792.06	
Civil	$ 5,197.50	
Subtotal		$ 174,667.91
Project Management & Misc Costs		
Project Management	$93,715	
Subtotal		$ 93,715.19
Engineering		
Engineering	$39,488	
Subtotal		$ 39,487.86
Contingency		$78,863
TOTAL		$ 867,493.01

Wood Chip Boiler
Devil's Garden Conservation Camp — Alturas, CA
REV A — 6/20/2016

Debt Service	
Total installation cost	$ 867,493.01
Grants	$ -
Total Project Cost	$ 867,493.01

Fuel costs	Propane Cost	Wood Cost	Electricity
Units	MMBTU	MMBTU	KWH
Cost per unit	$ 15.72	$ 3.48	$ 0.07
Escalation rate	6%	3%	$ 20.27

O&M Costs, Exist	labor
Labor (Hr/ wk)	2.50
$/hr	$ 25.00
Wk/ Yr	40.00
Total/ Yr	$ 2,500.00
Annual increase	2%

O&M Costs - Wood	labor
Labor (Hr/ wk)	2.50
$/hr	$ 25.00
Wk/ Yr	40.00
Total/ Yr	$ 2,500.00
Annual increase	2%

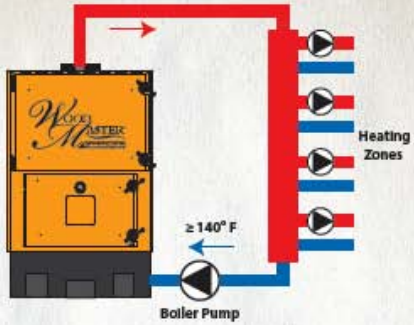
Cost Comparison	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 15	Year 20
Existing heating system operating costs												
Propane Cost	$ 74,732	$ 79,216	$ 83,969	$ 89,007	$ 94,348	$ 100,009	$ 106,009	$ 112,370	$ 119,112	$ 126,259	$ 168,963	$ 226,110
Electric cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
O&M cost	$ 2,500	$ 2,550	$ 2,601	$ 2,653	$ 2,706	$ 2,760	$ 2,815	$ 2,872	$ 2,929	$ 2,988	$ 3,299	$ 3,642
Total	$ 77,232	$ 81,766	$ 86,570	$ 91,660	$ 97,054	$ 102,769	$ 108,825	$ 115,241	$ 122,041	$ 129,246	$ 172,261	$ 229,752
Proposed heating system operating costs												
Propane Cost	$ 3,737	$ 3,961	$ 4,198	$ 4,450	$ 4,717	$ 5,000	$ 5,300	$ 5,618	$ 5,956	$ 6,313	$ 8,448	$ 11,306
Woood cost	$ 15,692	$ 16,163	$ 16,648	$ 17,147	$ 17,662	$ 18,192	$ 18,737	$ 19,300	$ 19,879	$ 20,475	$ 23,736	$ 27,517
O&M cost	$ 2,500	$ 2,550	$ 2,601	$ 2,653	$ 2,706	$ 2,760	$ 2,815	$ 2,872	$ 2,929	$ 2,988	$ 3,299	$ 3,642
Total	$ 21,929	$ 22,674	$ 23,447	$ 24,251	$ 25,085	$ 25,952	$ 26,853	$ 27,790	$ 28,763	$ 29,776	$ 35,483	$ 42,464
Yearly operational savings	$ 55,303	$ 59,092	$ 63,123	$ 67,410	$ 71,969	$ 76,817	$ 81,971	$ 87,452	$ 93,278	$ 99,471	$ 136,778	$ 187,288
Total savings	$ 55,303	$ 114,396	$ 177,518	$ 244,928	$ 316,897	$ 393,713	$ 475,684	$ 563,136	$ 656,414	$ 755,885	$ 1,360,633	$ 2,189,959
Investment	$ 867,493.01											
Annual cash flow	$ 55,303	$ 59,092	$ 63,123	$ 67,410	$ 71,969	$ 76,817	$ 81,971	$ 87,452	$ 93,278	$ 99,471	$ 136,778	$ 187,288
Cummulative cash flow	$ (812,190)	$ (753,097)	$ (689,975)	$ (622,565)	$ (550,596)	$ (473,780)	$ (391,809)	$ (304,357)	$ (211,079)	$ (111,608)	$ 493,140	$ 1,322,466

Devil's Garden CC

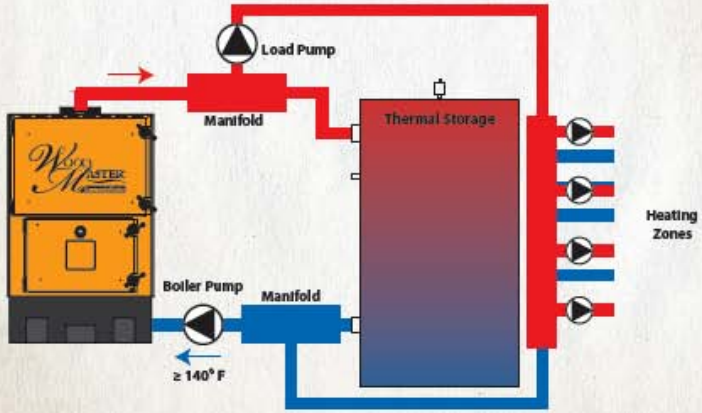
Heating Season	Propane Usage *gal/yr	Propane Cost $/yr	Propane Cost $/gal
2013/2014	66,388.77	$123,321.95	$ 1.86
2014/2015	62,636.01	$71,697.59	$ 1.14
2015/2016	65,929.06	$65,929.06	$1.00

*Amounts are estimated from annual invoices
**2013/2014 Amounts uncharacteristically high.

SCHEMATICS



- The pump is controlled by the WoodMaster Control (standard)
- Variable pump speed based on boiler temp and deltaT



- When the boiler pump is satisfied, BTU can be delivered to load, or thermal storage/buffer tank.
- Pump modulates to load requirements, based on boiler temp and deltaT

* These are generic diagrams for informational purposes only.

EXAMPLES OF SYSTEMS IN OPERATION

Building Installs

Government Office Buildings
Yellowknife, NWT
2,217 MBH

Sussex Elementary School
Sussex, New Brunswick
1,364 MBH

Wolf Ridge Environmental Learning Center
Finland, MN
3,240 MBH

Anna Maria College
Paxton, MA
5,629 MBH

Heat Cabin Installs

Cherry School
Iron, MN
780 MBH

Arrowhead Regional Corrections Facility-NERCC- Saginaw, MN
4,435 MBH

Schaefer's Gardens
Triangle, NY
1,700 MBH

Minnesota Dept. of Natural Resources
Tower, MN
440 MBH

FIND YOUR FUEL TYPE

What type of fuel is best for your system? That depends on a range of factors, including availability, the amount of handling necessary and affordability.

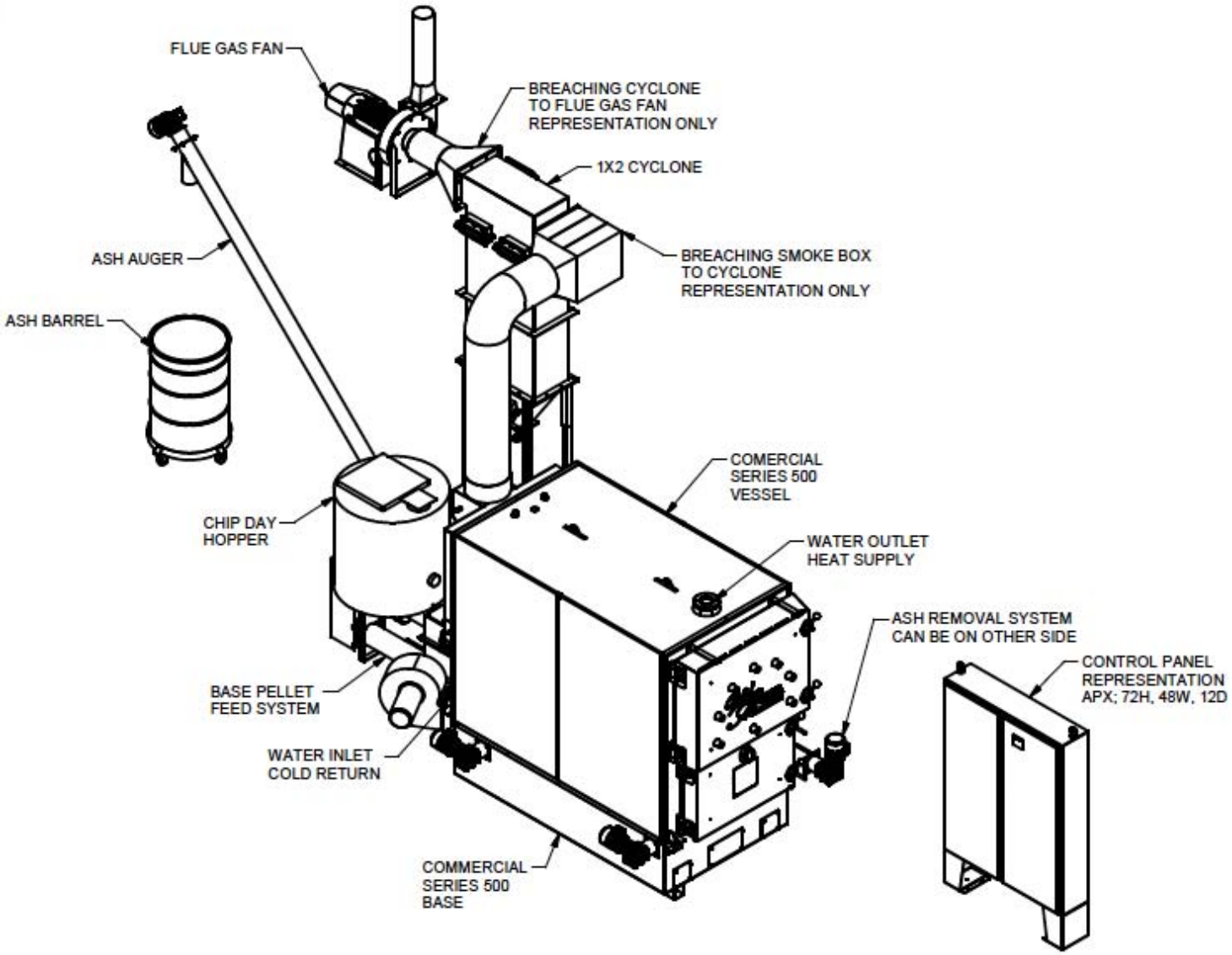
WOOD PELLETS

- Consistent moisture content- 10% or less
- Fully automatic and reliable
- Most efficient BTU use
- Higher price per ton
- Require least amount of handling

PREMIUM CHIPS

- 35% moisture content or less
- Reliable heating and consistent size
- oNorm M7 133 G50, W30 (chip spec)
- A1 or A2 - P16
  - based on CAN/CSA-150 177225 (matchbook size chips)
- Require slightly more handling than pellets

Hungry Mothers Organic
Minden, NV
2,729 MBH

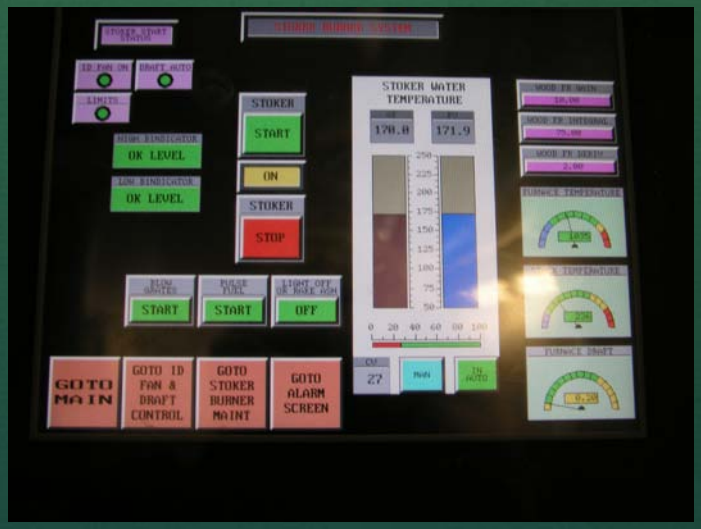


SHEET 1 OF 2

NORTHWEST MFG., INC.
HOME OF THE WOODMASTER
QUALITY OUTDOOR WOOD FURNACE

REV	SCALE	DESIGNER:	DESCRIPTION:
1	1/50	JLK DATE: 9/10/2014	CSA 500 SYSTEM

Boiler Systems



Pre-Configured Insulated Pipe

Heat Transfer

Permitting

- Modoc County Air Pollution Control District
  - Rule 2.2 allows for an exemption of boilers under 5 MMBTU per hour – no permit needed!
- North Coast Unified Air Quality Management District
  - Rule 102 exempts boilers 1 MMBTU per hour or lower – ATC will be needed
- Both facilities will require some CEQA and NEPA review

Other TSS Biomass Thermal Projects

- Mono County Maintenance Facility



- Sierra at Tahoe Ski Resort


Other TSS Biomass Thermal Projects (cont'd)

- Taos Region Biomass Heating

- Sierra Nevada Conservancy Small-Scale Boiler Survey

Air District	County	Town	Building/ Permittee	Fuel Source	MMBtu/h size class	MMBtu/h
Modoc	Modoc	Alturas	County Courthouse	Kerosene	1 to 5	Not specified
Tuolumne	Tuolumne	Sonora	Tuolumne General Medical Facility	Diesel (No. 2)	1 to 5	1.843
Butte	Butte	Oroville	Butte-Glenn Community College	Nat Gas	1 to 5	1.2

For Further Information

Frederick Tornatore
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916.601.0531
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