6 Rock-Tenn Biomass/Refuse Derived Fuel Facility

This section provides the description, estimated energy outputs, potential energy revenues, capital and operating cost estimates for the Rock-Tenn Biomass/RDF Facility. The descriptions and various assumptions are provided for the purpose of this feasibility analysis and will be subject to refinement during future project stages.

6.1 Description and Site

The Biomass/Refuse Derived Fuel (RDF) fired steam/turbine generator plant is assumed to be constructed in the southwest corner of the Rock-Tenn Company's paper mill located at 2250 Wabash Avenue, St. Paul, Minnesota, (Refer to Layout Drawing Figure 6-1).

RDF and biomass fuel would be received by truck and off-loaded into a 40,000 square foot storage and mixing building. The building is sized to provide one (1) day storage of fuel (1,080 tons at 275 pounds per cubic yard) plus space for unloading trucks, loader mixing, and conveyance systems leading to the boilers.

Two (2) parallel train Biomass/RDF boiler systems will be installed (Refer to Figure 6-2). Each system will consist of a traveling grate stoker boiler complete with feed bins, feed rams, feed conveyors, auxiliary burners, super heater section, boiler section, economizer and combustion air heater. The boilers would be sized for 275,000 PPH of 600 psig 700° F steam production.

The boilers exhaust flue gas would pass through a state-of-the-art pollution control system as required by applicable environmental regulations. It is anticipated that this equipment will include a lime scrubber for SO_x and chlorine emission controls, an activated carbon injection for mercury emission control, and an industrial, reverse air baghouse for particulate control.

The produced steam will be split with an average of 225,994 PPH being supplied to Rock-Tenn with the balance driving a steam turbine generator producing an average of 7,258 KW/hour. Although not considered in this preliminary analysis, the boiler plant capacity may provide some portion of a district's heating and cooling for the surrounding area.

Condensate will be returned from Rock-Tenn to a storage tank. Supplemental condensate water will be made-up by a de-ionized water treatment facility. The mixture will be pumped to a 400,000 lb/hour de-aerator with the pre-heated, de-aerated boiler feed water (BFW) being pumped to the two (2) boilers.

The steam turbine generator will have an automatic 30 psig extraction for de-aerator operation with the balance of the steam being condensed. A cooling tower system will be installed to supply condenser cooling water.

The site layout (Figure 6-1) shows typical sizes for the major components and that they will fit in the available site. Final equipment selection and detail design will enable layout enhancements to minimize capital costs while improving operation.

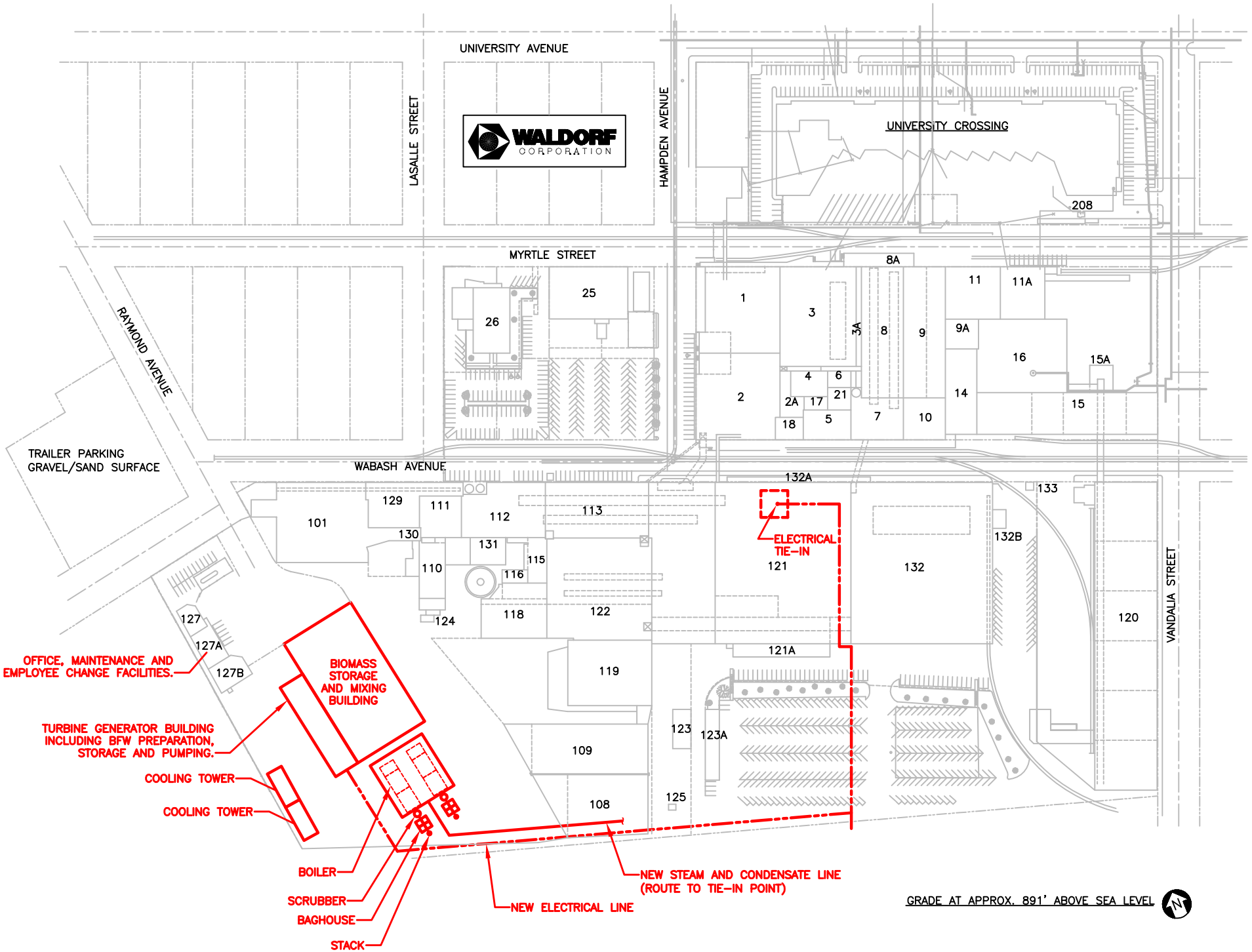
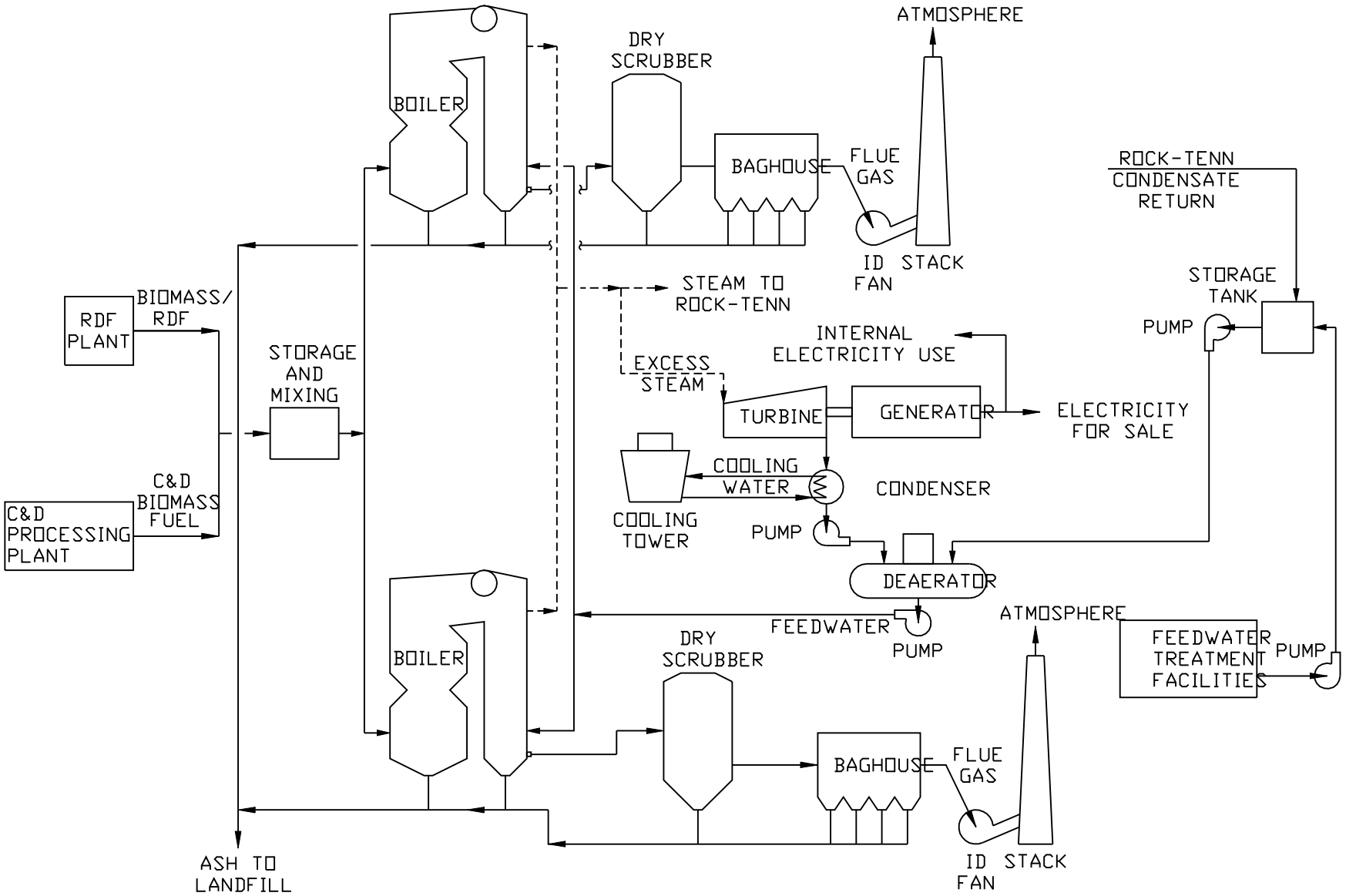


FIGURE 6-1: ROCK-TENN BIOMASS FACILITY SITE PLAN



ROCK - TENN

FIGURE 6-2

BIOMASS / RDF FIRED
STEAM / TURBINE GENERATOR PLANT

Foth & Van Dyke
engineers · architects · scientists

NOT TO SCALE

Date: APR. 2006 | By: CKV

I:\06r002\design\06R002-PFD.dgn
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6.1.1 Steam and Electrical Outputs

Table 6-1 provides the estimated RDF boiler system on stream efficiency (OSE).

Table 6-1 Dual Boiler System's On Stream Efficiency

Type of Outage	Hours/Year	Hours/Year/Boiler (%)
Planned common outage	120	1.37
Planned Outages Boiler A	480	5.48
Planned Outages Boiler B	480	5.48
Unplanned Outages Boiler A	451	5.15
Unplanned Outages Boiler B	451	5.15
Operating time Boiler A with B down	925	10.56
Operating time Boiler B with A down	925	10.56
Operating time Boilers A and B	6,784	77.44
Total hours per boiler	8,760	100

Based on the system's OSE (Table 6-1) and Rock-Tenn's steam usage (Refer to Table 3-1 B), the boiler system's ability to meet the steam demand is shown in Table 6-2.

Table 6-2 Dual Boiler System's Reliability in Meeting Rock-Tenn's Steam Demand (Assumes Planned outages are taken during low steam demand periods)

Comments	Two Boiler System	% of Hours Required
Boiler Capacity (PPH/ea)	275,000	
No steam available to Rock-Tenn	120	
0 - 225,000 PPH (average) to Rock-Tenn	4,672	99.68
Over 250,000 PPH to Rock-Tenn	2,663	94.96
Over 275,000 PPH to Rock-Tenn	997	94.96
Over 300,000 PPH to Rock-Tenn	113	94.96
Estimated total hours meeting demand	8,445	

In summary, the combined boiler feed would be 45 tons per hour producing a nominal 393,400 PPH of steam. In the event that one boiler is down, the running boiler would be fired at a

maximum capacity of 31.5 tons per hour feed. Staged scheduling of planned boiler outages will enable meeting Rock-Tenn's steam demand needs of 8,445 hours per year (out of a total possibility of 8,760 hors per year). Rock-Tenn will need to fire its existing back-up boilers for approximately 315 hours per year.

Table 6-3 identifies estimated annual Biomass/RDF fuel consumption, average saleable power after deducting internal power plant needs, and average steam sales to Rock-Tenn.

Table 6-3 Biomass/RDF Power Plant Production
(Assumes ramping the operating boiler up to 275,000 PPH when the other boiler is down)

Comments	Two Boiler System
Biomass/RDF Fuel Used (tons/hour)	45
Biomass/RDF Fuel Used (tons/hour) - one boiler down	31.5
Biomass/RDF Used Annually (tons/year)	363,555
Average Saleable Power (KW/hr)	9,631
Saleable Power (KW/Hr) 1 boiler	(950)
Saleable Power (KW hrs/yr)	63,579,204
Average Rock-Tenn Steam Sales (MM lbs./yr.	1,908.52

The actual Biomass/RDF power plant production will vary based upon operation and maintenance procedures, availability of bio-mass fuel, and Rock-Tenn's steam usage. There will be flexibility in the system to handle additional biomass fuel and produce additional electricity.

6.1.2 Steam and Electrical Revenue Potential

Table 3-3 Estimated Rock-Tenn Internal Steam Costs and Table 6-3 Biomass/RDF Power Plant Production provide the information to develop an estimate of the annual total steam revenue potential. Table 3-3 provides a value of $8.89 per mlb. of steam and Table 6-3 shows an annual Biomass/RDF production of 1,908.52 MM lbs./year. Multiplying these values provides a maximum annual dollar value of $16,966,742. This is an overly high estimate as there will be a need to account for some of the ongoing expenses for Rock-Tenn and there will likely be a negotiated sales price.

Rock-Tenn's current power is purchased from Xcel under Tier 2 pricing described in Rate Book MPUC No. 2. As described in Section 3.2, the facility will likely be viewed as an energy producer without a demand component.

Based upon off-setting a portion of Rock-Tenn's energy purchases at the same value that Rock-Tenn currently pays, the value of electric power sales is shown in Table 6-4.

Table 6-4 Electric Power Sales (Energy only)

	$/kWh	Hours/Year
Energy Rate per kWh - On Peak	0.045557	3,036
Energy Rate per kWh - Off Peak	0.035093	5,724
Average (Weighted)	0.038719564	8,760
Saleable Power (kWh/year) (Per Table 6-3)	63,579,204	
Gross Power Sales ($/year)	$2,461,755	
Saleable Power (kWh/month) (Average)	5,298,267	
Energy Charge Credit ($/kWh) (Per Rate Sheet)	0.007	
Energy Charge Credit ($/year)	$(445,021)	
Net Power Sales ($/yr)	$2,016,734	

The combined gross total potential annual energy revenues are therefore currently estimated at $18,983,476.

6.1.3 Capital Cost Estimate

The process flow diagram (Figure 6-2) was created and a mass and energy balance developed depicting the major components to burn bio-mass fuels producing sufficient steam to handle Rock-Tenn's normal steam load and fluctuations. Basic equipment was sized and budgetary inquiry specifications developed. Vendor estimates were received for the boiler, boiler feed water (BFW) treating facilities, de-aerator, baghouse, ID fan with drive motor, scrubber system, cooling towers and steam/turbine generator. Installation costs were developed based on past experience, published estimating standards, and vendor information.

The Association for Advancement of Cost Engineering, International (AACE) cost estimating classification was used to establish the accuracy range for each major estimate category based upon the level of definition, quality of the cost information and estimating methodology. Contingency was calculated by statistical analysis of the weighted sums of the accuracy of each line item. The selected contingency represents the 85 percent confidence level, which is consistent to the normal amount of contingency applied to a project of this type.

Table 6-5 provides a summary of estimated capital costs.

Table 6-5 Dual Boiler Capital Cost Estimate

Item	Cost (2006$)
General Conditions	$ 6,083,000
Site and Buildings	$ 7,371,000
Storage and Mixing Building	$ 3,335,000
Waste Removal/Disposal	$ 584,000
Boiler	$ 81,000,000
Boiler Feedwater Treatment	$ 458,000
De-aerator and BFW Pumping	$ 848,000
Baghouse	$ 1,767,000
Fan, Stack and Scrubber	$ 4,270,000
Cooling Tower	$ 2,061,000
Generator	$ 11,266,000
Contingency	$ 21,857,000
Total Project Cost	$140,900,000

The following descriptions provide a definition of the items included in each line item.

Capital Cost Estimate Basis:

The process flow diagram (Figure 6-2) was created and mass and energy balance developed depicting the major components to burn bio-mass fuel producing sufficient steam to handle Rock-Tenn's normal steam load and fluctuations. Basic equipment was sized and budgetary inquiry specifications were developed. Vendor correspondence regarding the specifications, cost estimates, design basis, and contingency costs are provided separately. Vendor estimates were received for the boiler, boiler feed water (BFW) treating facilities, de-aerator, baghouse, ID fan with drive motor, scrubber system, cooling towers and steam/turbine generator. Vendor equipment quotations account for over $60,000,000, or approximately one-half (1/2) of the base subtotal cost. Installation costs were developed based on past experience, published estimating standards, and vendor information. A ratio analysis was completed to assure that the installation costs were with normal estimating ranges of base process equipment costs.

General Conditions: $ 6,083,000

This includes permitting, architectural and engineering fees, construction management, field office expenses, miscellaneous construction equipment that will be retained for either maintenance or operations use, field construction support personnel, surveying, soil borings, construction quality control and temporary facilities.

Site & Buildings: **$ 7,371,000**

The estimate assumes modifying the existing on-site building to accommodate the plant office, maintenance, worker change/shower facilities and restrooms. Includes plant mobile equipment, equipment fueling facilities, underground utilities, communication systems, site preparation, earthwork, paving and surfacing, sewage and drainage, site improvements, landscaping, fencing, grounding grid, general area and building lighting, office equipment, maintenance shelving and equipment, lockers, storage and mixing building foundations, boiler foundations, turbine generator foundations, scrubber building, RDF boiler feed conveyors, baghouse foundations, ID fan foundations, stack foundations, steam pipe way and piping, power wiring to tie point points, cooling tower foundations and ash bin foundations.

Storage & Mixing Building: **$ 3,335,000**

Building construction and ancillaries necessary to store and mix (by loader) the RDF and biomass feed streams.

Waste Removal / Disposal: **$ 584,000**

Ash conveyance system from the boilers to the ash bins for truck loading; baghouse waste conveyance system for truck loading.

Boiler: **$ 81,000,000**

Fabricate, furnish and installing two (2) traveling grate stoker boilers, complete with super heater, boiler, economizer and combustion air heating modules, biomass fuel feed bins, feed rams, lower hoppers, feed conveyors, air swept spouts, auxiliary burners, soot blowers and all necessary ancillary equipment including fans, expansion joints, ductwork, natural gas flame safety systems and structural support steel. Costs include NO_x reduction through the use of low No_x burners, use of pre-heated combustion air, controlling excess combustion/oxygen (O_2) content and ammonia injection. Carbon injection facilities are included to further minimize emissions. Capital equipment costs were provided by Babcock and Wilcox Volund.

Boiler Feed Water Treatment: **$ 458,000**

Estimate includes a multi-train, de-ionized water treatment facility complete with tanks, pumps, filter beds, filters, vessels, controls and ancillaries including waste neutralization. Capital equipment costs were provided by Remco Engineering Water and Wastewater Treatment System.

De-aerator & BFW Pumping: **$ 848,000**

500,000 pounds/hour de-aerator, condensate pumps with drives, BFW pumps with drives, condensate storage tank. Capital equipment costs were provided by Permutit De-aerator Company.

Baghouse: **$ 1,767,000**

Fabricate, furnish and install two (2) multi-compartment, insulated, reverse air baghouses complete with hoppers, rotary air locks, expansions joints, controls and ancillaries. The baghouse use provides for particulate control and aids in SO_x and chlorine removal. Capital equipment costs were provided by CW Tech Sales representing CAMCORP.

Fan, Stack & Scrubber: **$ 4,270,000**

Costs for two (2) quench scrubbers with a common slurry preparation system including: scrubber towers, packed scrubber towers with integral sump tank, pumps and piping, water recycle systems, FRP exhaust ducting (stack), chemical feed pumps, control panel, and exhaust (ID) fans with 750 hp drive motors. The acid scrubber provides state-of-the-art control technology for SO_x and chlorine abatement. Capital equipment costs were provided by Advanced Air Technologies, Inc.

Cooling Tower: **$ 2, 061,000**

Prefabrication of materials, freight to jobsite, field assembly of a Plume Abated, multi-cell, ceramic cooling tower including fiberglass structure, fill, fill support lintels, drift eliminators, fan assemblies, speed reducers, fan drives, water distribution system and controls. Capital equipment costs were provided by SPX Cooling Technologies representing Marley cooling towers.

Generator **$ 11,266,000**

Forty (40) MW multi-stage condensing, single extraction steam turbine generator set complete with lubrication system, control system, vibration and temperature monitoring systems, excitation system, generator, condenser, breakers and controls, starting driver, alarms, shutdown devices, gantry service crane. Capital equipment costs were provided by Dresser-Rand and General Electric (GE).

Contingency: **$ 21,857,000**

The Association for Advancement of Cost Engineering, International (AACE) cost estimating classification was used to establish the accuracy range for each major estimate category based upon the level of definition, quality of the cost information and estimating methodology. The contingency was calculated by statistical analysis of the weighted sums of the accuracy of the each base estimate's individual line item. The selected

contingency represents the 85 percent confidence level, which is consistent with the normal amount of contingency to be applied to a project of this type.

Total Project Cost: **$140,900,000**

Project Cost Estimate Range:

Mean cost estimate (50 percent confidence level)	$124,300,000
Recommended control target cost (65 percent confidence level)	$132,600,000
Recommended budgeted cost (85 percent confidence level)	$140,900,000
Highest probable cost (95 percent confidence level)	$149,200,000

The above costs represent the engineer's best judgment as a design professional and are supplied for general guidance. Since engineer has no control over the cost of labor and materials or over competitive bidding and market conditions, the engineer does not guarantee that bids or actual construction costs will not vary from engineer's opinion of probable costs.

6.1.4 Operating Cost Estimate

Table 6-6 provides an estimate of the cost to operate the Rock-Tenn Biomass/RDF Facility. The costs were developed based on anticipated operating needs and the experience at similar facilities. The labor rates are similar to the rates used at the NRG Newport Facility for similar job classifications. Other operating costs are based on typical industry experience. The ash transport and disposal costs were developed in other sections of the report.

A provision for overhead, contingency, and profit is also provided. The overhead and supervision is based on 6 percent of direct expenses. A 10 percent contingency has been included. The Contract Operator estimate is based on an allowance of 40 percent of the labor costs. In this cost estimate, this ends up at just over 13 percent of the total annual costs without the Contract Operator cost line item.

6.2 Single Boiler Option

It is technically possible to install a single 400,000 PPH boiler that would fulfill Rock-Tenn's steam demands rather than the recommended two (2) boiler approach. Rock-Tenn desired to have this analysis as a comparison. The single boiler approach meets the steam demand for fewer hours per year and consumes less biomass fuel. It produces more power because it operates at a higher production rate when it is operating. The single boiler approach will also reduce capital cost by approximately $19,200,000. The applicable single boiler information is provided in Tables 6-7, 6-8, and 6-9. This approach does not match up to the steam demands of Rock-Tenn as well and over-all will not be as efficient and cost-effective. It is not considered further in this analysis.

Table 6-6 Rock-Tenn Biomass/RDF Facility Operating Costs

Item	Basis			Amount (2006 $)
Expenses:				
Direct:				
Labor (Wages & Salaries)	See below			$1,372,800
Overtime & Shift Coverage	18.5 %		Labor	$253,968
Benefits	Included	in	Labor rates	$0
Vehicles & Equipment	1/10 of 1 %	of	Total Investment	$140,900
Utilities:				
Natural Gas	7,382 MM BTU	yr	$7.085 / MM BTU	$52,300
Electric Demand	4,500 KW	@	$2.75 KW / mo.	$148,500
Electric Energy	(self produced)			$0
Water	200 GPM	@	$2.03 / 1000 gal	$213,394
Operating Supplies	2/100 of 1%	of	Total Investment	$28,180
Maintenance	2.5 %		Total Investment	$3,522,500
Insurance	2/10 of 1%	of	Total Investment	$281,800
Property Taxes	2/10 of 1%	of	Total Investment	$281,800
Other Expenses:				
Scrubber Reagent (Lime)	4,918 TPY	@	$120 / Ton	$590,160
Ash Transport	$0.099	@	Ton Mile	$515,000
Ash Disposal	118,200 Tons	@	$ 30.00 / Ton	$3,546,000
Subtotal Direct Expenses				**$10,947,302**
Indirect:				
Overhead & Supervison	6%	of	Direct Expenses	$656,840
Contingency	10%	of	Direct	$1,094,730
Contract Operator	40%	of	Labor & Overtime	$1,626,768
Subtotal Indirect Expenses				**$3,378,338**
Total Expenses				**$14,325,640**
Basis:				
Operating Labor				
Two (2)Boiler Operators	4 Shifts	@	$38.00 / hr	$632,320
One (1) Turbine Attendant	4 Shifts	@	$39.00 / hr	$324,480
One (1) Feed Attendant	4 Shifts	@	$25.00 / hr	$208,000
One (1) Helper	4 Shifts	@	$25.00 / hr	$208,000
Total Direct Operating labor				**$1,372,800**
Hours per Year				8,760 Hrs/yr
Overtime %	2,000 hrs / person	@	4 People	8,000 Hrs/yr
Coverage Hours / Yr				760 Hrs/yr
Holidays Hrs / Yr	6 Holidays @ 24 Hr	@	5 People	720
Total Overtime Hrs / Yr				**1,480**
Percent overtime				18.5 %

Table 6-7 Single Boiler System's Reliability in Meeting Rock-Tenn's Steam Demand

Comment	One Boiler System	% of Hours Required.
Boiler Capacity (PPH/ea)	400,000	
No steam available to Rock-Tenn	1,051	13.6
0 – 225,000 PPH (Avg) to Rock-Tenn		88.43
Over 250,000 PPH to Rock-Tenn		88.43
Over 275,000 PPH to Rock-Tenn		88.43
Over 300,000 PPH to Rock-Tenn	7,709	88.43
Estimated total hours meeting demand	7,709	

Table 6-8 Single Boiler Power Plant Production

Item	One Boiler System
Biomass/RDF Fuel Used (tons/hour)	45
Biomass/RDF Used Annually (tons/year)	346,905
Average Saleable Power (KW/hour)	9,631
Saleable Power (KW hours/year)	74,245,379
Average Power (KW hours/year)(8,760 hours/year)	8,476
Average Rock-Tenn Steam Sales (MM lbs/year	1,742.188

Table 6-9 Single Boiler Capital Cost Estimate

Item	Cost Estimate (2006$)
General Conditions	$ 6,083,000
Site and Buildings	$ 7,371,000
Storage and Mixing Building	$ 3,335,000
Waste Removal/Disposal	$ 584,000
Boiler	$ 65,855,000
Boiler Feedwater Treatment	$ 458,000
De-aerator and BFW Pumping	$ 848,000
Baghouse	$ 1,437,000
Fan, Stack and Scrubber	$ 3,472,000
Cooling Tower	$ 2,061,000
Generator	$ 11,266,000
Contingency	$ 18,930,000
Total Project Cost	$121,700,000