GRU
More than Energy

FINAL

BIOSOLIDS MANAGEMENT PLAN







Prepared by

CH2MHILL

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Acronyms and Abbreviations

^{o}C	degrees Celsius
AADF	annual average daily flow
AADL	annual average daily load
AD27	Aerobic Digestion, 27-day solids retention time (SRT)
AD60	Aerobic Digestion, 60-day SRT
AND	Conventional high rate anaerobic digestion
AAND15	Mesophelic Acid Hydrolysis Plug Flow Advanced Anaerobic Digestion
ASP	aerated static pile
ATAD	autothermal thermophilic aerobic digestion
AUP	Agricultural Use Plan
BC	Benefit Cost
BFP	Belt filter press
BFPDEW	Belt filter press dewatered biosolids
BMP	Biosolids Management Plan
BOD	biological oxygen demand
CENDEW	Centrifuge dewatered biosolids
CFM	coliform forming units
CFR	*Code of Federal Regulations*
COMP	Composting
CWA	Clean Water Act
DMR	daily monitoring reports
DNAS	Dedicated new agricultural site, owned by GRU
dry lb/MG	dry pounds per million gallons
dt	dry tons
EPA	U.S. Environmental Protection Agency
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FOR	Dedicated forest site
ft	feet
ft^3	cubic feet
g	grams
GBT	gravity belt thickener
GRU	Gainesville Regional Utilities

Hp	horsepower
IFAS	Institute of Food and Agricultural Sciences
ISCORS	Interagency Steering Committee on Radiation Standards
kg/ha	kilograms per hectare
KWRF	Kanapaha Water Reclamation Facility
LAS	land application site
LIMSTAB	Lime stabilization
lb/ac	pounds per acre
mg/kg	milligrams per kilogram
MGD	million gallons per day
MMADL	maximum month average daily load
MPN	most probable number
mrem/yr	millirem per year
MSWRF	Main Street Water Reclamation Facility
MUA	multi-attribute analysis
N	nitrogen
NORM	naturally occurring radioactive material
NMP	Nutrient Management Plan
NRC	Nuclear Regulatory Committee
O&M	operations and maintenance
P	phosphorus
PFRP	Process to Further Reduce Pathogens
POTW	publicly-owned treatment works
PSRP	Process to Significantly Reduce Pathogens
SOUR	specific oxygen uptake rate
SRT	solids retention time
SWE	surface water elevation
TH	Thickened liquid biosolids
TOX	Thermal oxidation
TPAD	temperature-phase anaerobic digestion
VSS	volatile suspended solids
WPR	Whistling Pines Ranch
WRF	Water Reclamation Facility

Executive Summary

Background

Gainesville Regional Utilities (GRU) serves the City of Gainesville and other portions of Alachua County, Florida, with electric, water, wastewater, natural gas, and telecommunications services. GRU currently owns and operates the Kanapaha Water Reclamation Facility (KWRF) and the Main Street Water Reclamation Facility (MSWRF), which produce aerobically-digested Class B biosolids. These biosolids are land-applied at Whistling Pines Ranch (WPR), an agricultural site located just west of the town of Archer in Alachua County. The biosolids supplement inorganic fertilizer that is used in growing a variety of forage and row crops.

The existing Class B land application program has been environmentally-sound and cost-effective for many years. However, due to projected capacity increases at the KWRF and MSWRF, newly proposed restrictive land application rules, and concerns about the long-term viability of the cooperative land application program at the WPR, GRU would like to explore alternative biosolids management alternatives for their facilities through year 2025.

Biosolids Management Program

Biosolids management programs include two basic components; treatment of the biosolids generated at water reclamation facilities and their disposal (i.e. end use). For each of the treatment alternatives; options to thicken or dewater the biosolids were taken into account.

A preliminary screening of biosolids treatment and disposal alternatives was generated and evaluated. The goal of this preliminary evaluation was to select a reasonable number of alternatives to further evaluate and develop budgetary construction, and operations and maintenance costs. The following is a summary of the results of the preliminary evaluation.

ES-1
Selected Alternatives from the Preliminary Screening of Biosolids Management Alternatives

End-Use Alternatives	Treatment Alternatives	Thickening/Dewatering Alternatives
Agricultural Land Application	Conventional Aerobic Digestion	Gravity Belt Thickening
Forest Land Application	Conventional Anaerobic Digestion	Belt Filter Press
Land Application at Public Contact Sites – Marketing and Distribution of Class A Biosolids	Advanced Anaerobic Digestion	
Thermal Oxidation	Composting	
	Alkaline Stabilization / Pasteurization	

A detailed listing of the specific alternatives evaluated is presented in Exhibit 6-2.

Detailed Evaluation and Ranking of Biosolids Management Alternatives

The selected alternatives from the preliminary screening were evaluated by developing conceptual designs, capital costs, O&M costs, and total present-worth costs. The objective was to associate each of the selected alternatives with a 20-year present-worth cost.

A detailed evaluation of each alternative, based upon non-monetary criteria, was also developed. The non-monetary evaluation considered aesthetics and public acceptance, product marketability, plant O&M, regulatory impacts, and constructability. The breakdown of the relative weights of the non-monetary analysis is presented in Exhibit 6-3.

The benefit scores from the non-monetary analysis were divided by the present worth costs to create a benefit/cost ratio; the greater the benefit/cost ratio, the higher the ranking.

A complete listing of the alternatives and their benefit/cost ranking is presented in Exhibit 6-4. Summarized below is list of the alternatives having the top 10 benefit/cost ratios.

ES-2
Benefit/Cost Ratios and Ranking of the Top Ten Alternatives

Alternative	Acronym	Weighted Benefit Score	PW Costs (million $)	Benefit-Cost Ratio	Rank [1]
1.3.a	AD27, TH, WPGRU	448	$ 25.13	17.8	1
1.3.b	AD60, TH, WPGRU	557	$ 31.41	17.7	2
1.1.a	AD27, TH, WP	443	$ 25.13	17.6	3
1.1.b	AD60, TH, WP	552	$ 31.41	17.6	3
1.2.b	AD60, TH, DNAS	529	$ 33.34	15.9	5
1.2.a	AD27, TH, DNAS	420	$ 27.18	15.5	6
6	AD27, BFPDEW, TOX	639	$ 43.41	14.7	7
2.3.b	AD60, BFPDEW, WPGRU	568	$ 41.00	13.8	8
2.1.b	AD60, BFPDEW, WP	563	$ 41.00	13.7	9
2.3.a	AD27, BFPDEW, WPGRU	459	$ 35.00	13.1	10

NOTE: (1) Rank based on cost/benefit ratio; PW Costs includes salvage value of land purchase greater than 50 acres.

ABBR: AD27 = Aerobic digestion, 27-day SRT; AD60 = Aerobic digestion, 60-day SRT; BFPDEW= Belt Filter Press Dewatered Biosolids, 16% solids content; DNAS= Dedicated New Agricultural Site, owned by GRU; PW= Present Worth Cost; TH = Thickened Liquid Biosolids, 5-6% solids content; TOX= Thermal Oxidation (Alternative Fuel for Deer Haven Power Plant); WP= Whistling Pines Ranch; WPGRU= Whistling Pines Ranch purchased by GRU

Alternative 1.3.a was the top rated option with a benefit/cost ratio of 17.8. In this alternative, the current practice of aerobic digestion is continued and a 27-day solids residence time (SRT) will be provided. The aerobically digested biosolids are then thickened and land applied on the WPR. In this alternative GRU negotiates the purchase of the WPR and can control the agronomic application rates of nitrogen and phosphorus.

The second-rated, Alternative 1.3.b, is identical to the top rated alternative with the exception of the solids residence time in the aerobic digester; Alternative 1.3.a provided for a 27-day SRT while Alternative 1.3.b provides for a 60-day SRT.

A key assumption for Alternatives 1.3.a and 1.3.b is that WPR biosolids application rates will be based on plant available nitrogen needs of the crops grown on the site without consideration for potential for future phosphorus loading limitations, currently being considered by the Florida Department of Environmental Protection (FDEP).

Alternatives 1.1.a and 1.1.b are tied for 3rd with benefit/cost scores of 17.6. These two alternatives are similar to the first two alternatives except that GRU continues their ongoing arrangement with the owner of the WPR instead of negotiating a purchase. Aerobic digestion is the preferred treatment alternative and solids are thickened to 5 to 6% solids.

The alternatives ranked 5th and 6th with benefit/cost scores of 15.9 and 15.5 are Alternatives 1.2.b and 1.2.a. The use of aerobic digestion treatment options with thickening of solids continues to be preferred but in these alternatives a new dedicated land application site is purchased by GRU. The reason that these two alternatives ranked lower than the GRU purchase of the WPR was that the new land application site was presumed to be further from GRU's treatment facilities making the hauling costs higher.

The seventh ranked alternative was aerobic digestion to a 27-day SRT, dewatering of biosolids to 16% concentration and thermal oxidation; with a benefit/cost ratio of 14.7. This alternative had a relatively high weighted benefit score due to its ability to handle all of the biosolids generated by GRU, maximize performance reliability under bad weather conditions, and maximize the use of renewable energy sources. This alternative would not be affected by the potential changes in biosolids regulations such as P loading limitations. The analysis presented in this report assumes that the use of dewatered biosolids would be compatible with the combustion process at the power generation facility and that the power generating system would neither charge or pay for the biosolids. At this time GRU is considering a number of alternatives for future power needs. The viability of this alternative can be better assessed once GRU's future power generation alternatives are further developed.

The alternatives rounding out the top ten were aerobic digestion treatment options that include dewatering of the biosolids with a belt filter press to 16% concentration and hauling to WPR. The differences between these alternatives are the degree of digestion 27-days vs. 60 days and whether the WPR is purchased by GRU. Because the hauling distance between GRU's treatment facilities and the WPR is relatively short (less than 15 miles) the additional capital cost of upgrading to a dewatered biosolids product is not as economical.

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1. Introduction

1.1 Background

Gainesville Regional Utilities (GRU) serves the City of Gainesville and other portions of Alachua County, Florida, with electric, water, wastewater, natural gas, and telecommunications services. GRU currently owns and operates the Kanapaha Water Reclamation Facility (KWRF) and the Main Street Water Reclamation Facility (MSWRF), which produce aerobically-digested Class B biosolids. These biosolids are land-applied at Whistling Pines Ranch (WPR), an agricultural site located just west of the town of Archer in Alachua County. The biosolids supplement inorganic fertilizer that is used in growing a variety of forage and row crops used in animal feed.

GRU is currently satisfied with the existing Class B land application program; this biosolids management program has been environmentally-sound and cost-effective for many years. However, due to projected capacity increases at the KWRF and MSWRF, newly proposed restrictive land application rules, and concerns about the long-term viability of the cooperative land application program at the WPR, GRU would like to explore alternative biosolids management options for their facilities through the year 2025.

1.2 Project Scope

A Biosolids Management Plan (BMP) was developed for managing the biosolids generated at the KWRF and MSWRF. The objective of this study was to evaluate various biosolids management alternatives through the year 2025, and identify the best alternative for GRU. To accomplish this objective, CH2M HILL performed the following activities:

1) Reviewed biosolids regulations
2) Reviewed existing facilities and loads
3) Developed biosolids management alternatives
4) Screened, ranked, and evaluated biosolids management alternatives
5) Developed a BMP for GRU
6) Developed a BMP Contingency Plan.

1.3 Evaluation Approach

GRU and CH2M HILL adopted a step-wise, interactive BMP development process that included the use of workshops to foster participation and input from all levels of GRU's organization. The interactive development process also included a multi-attribute analysis (MUA) for screening and evaluating the proposed biosolids management alternatives. A short summary of each step of the BMP development process is presented below:

1.3.1 Task 1 – Workshop No. 1: Project Kickoff

CH2M HILL held an initial project kickoff meeting with GRU, which included staff from the strategic planning, water and wastewater engineering, and plant operations departments.

During this introductory meeting, the team reviewed the objective and schedule for the project and identified the roles and responsibilities of project team members. In addition, GRU provided the following documents and data to be used in the BMP development process:

- *Sludge Treatment Facilities Plan Part I & II*, Gainesville Regional Utilities Strategic Planning Department; July 8, 1994
- Record plant data for both WRFs
- State of Florida Domestic Wastewater Facility Permits FL0112895 and FL0027251

1.3.2 Task 2 – Workshop No. 2: Framing the Issue

The purpose of Task 2 was to establish the items to be addressed by the BMP. The project team toured the KWRF, MSWRF, and WPR to develop a better understanding of the conditions of the existing unit processes and land application practices. In addition, CH2M HILL performed the following activities as part of Task 2:

- Reviewed existing plant and land application site (LAS) data to project biosolids production rates and to determine biosolids disposal needs through 2025.
- Identified existing capacity shortfalls, loading projections, performance requirements, process upgrades, site expansion, and issues with offsite disposal.
- Identified pending regulations that may affect either the current BMP or any of the proposed alternatives.

The results from the Task 2 activities were presented to GRU in Workshop No. 2. During this workshop, the project team was introduced to general, non-monetary, evaluation criteria for biosolids management operations (e.g., aesthetics, odor, constructability) to identify GRU's preferences. The evaluation criteria would become particularly important for screening and evaluating proposed biosolids management alternatives.

1.3.3 Task 3 – Workshop No. 3: Preliminary Screening of Alternatives

Based on the findings from Task 2, CH2M HILL compiled a comprehensive list of biosolids management alternatives for the project team to review and perform a preliminary screening based on general costs, constructability, and GRU preferences. The comprehensive list included advantages, disadvantages, and, for some, typical costs for potential biosolids onsite treatment processes and end-use alternatives. The objective from the preliminary screening was to select a reasonable number of alternatives that would be carried through conceptual design and budgetary cost estimating.

1.3.4 Task 4 – Workshop No. 4: Evaluation and Ranking of Screened Biosolids Alternatives

The objective of Task 4 was to evaluate the screened alternatives carried over from Workshop No. 3 by developing conceptual designs and budget-level cost estimates. The alternatives were evaluated through 2025. Process schematics, major equipment lists, and other preliminary design criteria were prepared for each option, as well as order-of-magnitude capital, operations and maintenance (O&M), and net present-worth costs. Options were compared on the basis of both capital cost and total present-worth cost.

At the conclusion of Task 4, adequate information had been gathered to make a comparative analysis of the screened alternatives, leading to the selection of a preferred alternative. The non-monetary criteria identified in Task 3 and the costs developed in Task 4 were input into the MUA model to rank the alternatives. The costs, selected criteria, and weightings were used to identify the preferred alternative, which was presented and discussed at Workshop No. 4.

1.3.5 Task 5 – Workshop No. 5: Development of Draft BMP Report

During Workshop No. 4, a consensus was reached on the ranking of the biosolids management alternatives. Although a preferred alternative was identified, the project team realized that the ultimate decision is largely contingent upon the final biosolids rule that will be issued by the Florida Department of Environmental Protection (FDEP) in late 2006 or early 2007. A working draft of the rule was released for public comment in May 2006. As a 20-year BMP cannot be determined at this time, GRU asked CH2M HILL to incorporate a decision flowchart to guide GRU staff on charting a biosolids management course based on various outcomes of future regulatory actions. However, the team did identify an interim (5-year) BMP. Task 5 also included the documentation of the BMP process and draft BMP preparation. The team subsequently met to discuss the report contents and organization.

1.3.6 Task 6 – Workshop No. 6: Development of Final BMP Report

The team met to discuss and adjudicate review comments on the draft BMP report. Review comments from GRU were incorporated into the final BMP report.

1.4 Report Organization

This BMP report evaluates the various biosolids management alternatives during the time period through 2025 and identifies the best alternative for GRU. **Section 1** of the report presents a detailed review of current and pending regulations that influence GRU's biosolids management operations. **Section 2** presents an overview of current and future federal and state regulations, as well as other issues. A review of the current production and projections of biosolids at the KWRF and MSWRF is presented in **Section 3**. **Section 4** summarizes a comprehensive list of biosolids treatment and end-use alternatives that were discussed by the project team during Workshop No. 3. The objective of Workshop No. 3 was to develop a shortened list of alternatives to carry through to the conceptual design and order-of-magnitude cost estimating phases. The selected biosolids management alternatives are presented in **Section 5**. The screening, ranking, and evaluation of the alternatives are presented in **Section 6**. **Section 7** presents the decision flowchart requested by GRU to decide what path to take based on future regulatory outcomes. **Appendix A** provides the preliminary list of potential biosolids management alternatives, **Appendix B** provides the minimum land requirement based on nitrogen loading rates, **Appendix C** provides the benefit-cost score, **Appendix D** is a copy of the GRU Biosolids Contingency Plan (draft memorandum), and **Appendix E** provides a cost summary of the different alternatives.

1.5 Acknowledgements

The development of this BMP has been a collaborative effort between GRU and CH2M HILL. Without the dedicated efforts of the entire GRU strategic planning, engineering, and O&M staff, the successful completion of the BMP would not have been possible.

Biosolids Regulations and Issues

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2. Biosolids Regulations and Issues

This section identifies and evaluates the potential impacts of biosolids regulations and issues on GRU's biosolids management program. The following review includes regulations and issues that are current or pending as of the report date. Prior to the final design and implementation of a preferred biosolids management alternative, an updated review of all pertinent regulations should be performed.

2.1 Biosolids Regulations

The objective of biosolids regulations is to ensure protection of the environment and public health. The current rules are meant to anticipate adverse effects of certain pollutants or contaminants that may be present in the biosolids. Biosolids may be regulated at all levels – federal, state, and local. The federal rules set the minimum standards but a state or local community may choose to adopt rules that are more stringent. The following are brief summaries of current regulations that affect the management of GRU's biosolids.

2.1.1 Federal Regulations

With the issuance of Title 40 of the *Code of Federal Regulations* (CFR), Part 503, on February 19, 1993, the U.S. Environmental Protection Agency (EPA) met its long-standing obligation under the Clean Water Act (CWA) to establish standards for the use and disposal of sewage sludge (i.e., biosolids). The EPA amended the Part 503 Rule in 1994 and 1999. Brief overviews of subparts A, B, C, D, and E are provided below.

Subpart A: General Provisions

Subpart A covers general provisions, such as regulatory scope, compliance periods, and exclusions. The Part 503 Rule establishes numerical, management, and operational standards for the use or disposal of biosolids that are (1) applied to land (including products that are sold or given away), (2) placed in or on surface disposal sites (e.g., landfills), or (3) incinerated. Compliance with the Part 503 Rule was required by February 19, 1994, if no facility construction was needed, and by February 19, 1995, if facility construction was necessary.

When biosolids are prepared for land application, placed in a surface disposal site, or incinerated, such preparation must meet the applicable requirements specified in the Part 503 Rule. The preparer can be the individual who generates biosolids during the treatment of domestic wastewater or the individual who derives a material from the biosolids. The latter would include, for example, an individual who blends biosolids with some other material or a private contractor who receives biosolids from a treatment works and then blends the biosolids with some other material (e.g., a bulking agent).

The recordkeeping and reporting requirements of the Part 503 Rule specify who must develop and retain information, what information must be developed, and the length of time such information must be kept. Section 405(f) of the CWA provides that permits issued to a publicly-owned treatment works (POTW) or any treatment works treating domestic sewage shall include conditions to implement the Part 503 Rule unless such are included in permits issued under other federal or approved state programs. However, it should be noted that the requirements in the Part 503 Rule must be met even in the **absence** of a permit, i.e., the Part 503 Rule is self-implementing. Thus, a responsible person must become aware of the Part 503 standards, comply with them, perform appropriate monitoring and recordkeeping and, if applicable, report information to the permitting authority even when a permit is not issued. These standards are also directly enforceable against any individual who uses or disposes of biosolids through any of the practices addressed in the final regulations. An enforcement action can be taken against an individual who does not meet those requirements, even in the absence of a permit.

Subpart B: Land Application

The land application of biosolids takes advantage of the soil conditioning and fertilizing properties of biosolids by spreading, injecting, or incorporating them on nutrient deficient lands. The EPA encourages this beneficial use of biosolids. The types of land that can benefit from this application can be categorized as *non-public contact* lands (areas not frequented by the public, such as agricultural lands, forests, and reclamation sites) or *public contact* lands (areas where people will become in contact with biosolids, such as golf courses or gardening). Based on these end uses, Subpart B provides the standards for land application of biosolids, including criteria on nutrients and pollutant loading; pathogen reduction; vector attraction reduction; distribution and marketing of biosolids; and requirements for agricultural operations. The flow chart in **Exhibit 2-1** illustrates the process for compliance with Subpart B.

In addition, Subpart B requires the monitoring of biosolids that are applied to land for nutrients, metals, pathogens, and vector attraction reduction. The required frequency of monitoring depends on the amount of biosolids used or disposed of per year. Brief overviews of various key topics from Subpart B are presented below.

Pollutant Limits for Land Application. The land application requirements specify maximum concentrations and annual and cumulative loadings for metals; the applicability of each is dependent on the biosolids quality and use. Pollutant limits in Subpart B, Tables 1 through 4, are summarized in **Exhibit 2-2**. The use of each table is explained in **Exhibit 2-1.**

Though biosolids may be in compliance with **Exhibit 2-2**, Subpart B precludes land application (1) where it is likely to adversely affect a threatened or endangered species or habitat; (2) to land that is flooded, frozen, or snow-covered so that biosolids enter a wetland or other waters of the U.S.; (3) within 10 meters of waters of the U.S.; and (4) at a biosolids application rate greater than the agronomic rate (nitrogen-based) of the site, unless otherwise specified by the permitting agency for a reclamation site.

If biosolids are sold or given away in a bag or other container, a label or information sheet may be required. The information must include the name and address of the preparer, application instructions, and loading rates that will not exceed the annual loading rates in **Exhibit 2-2.**

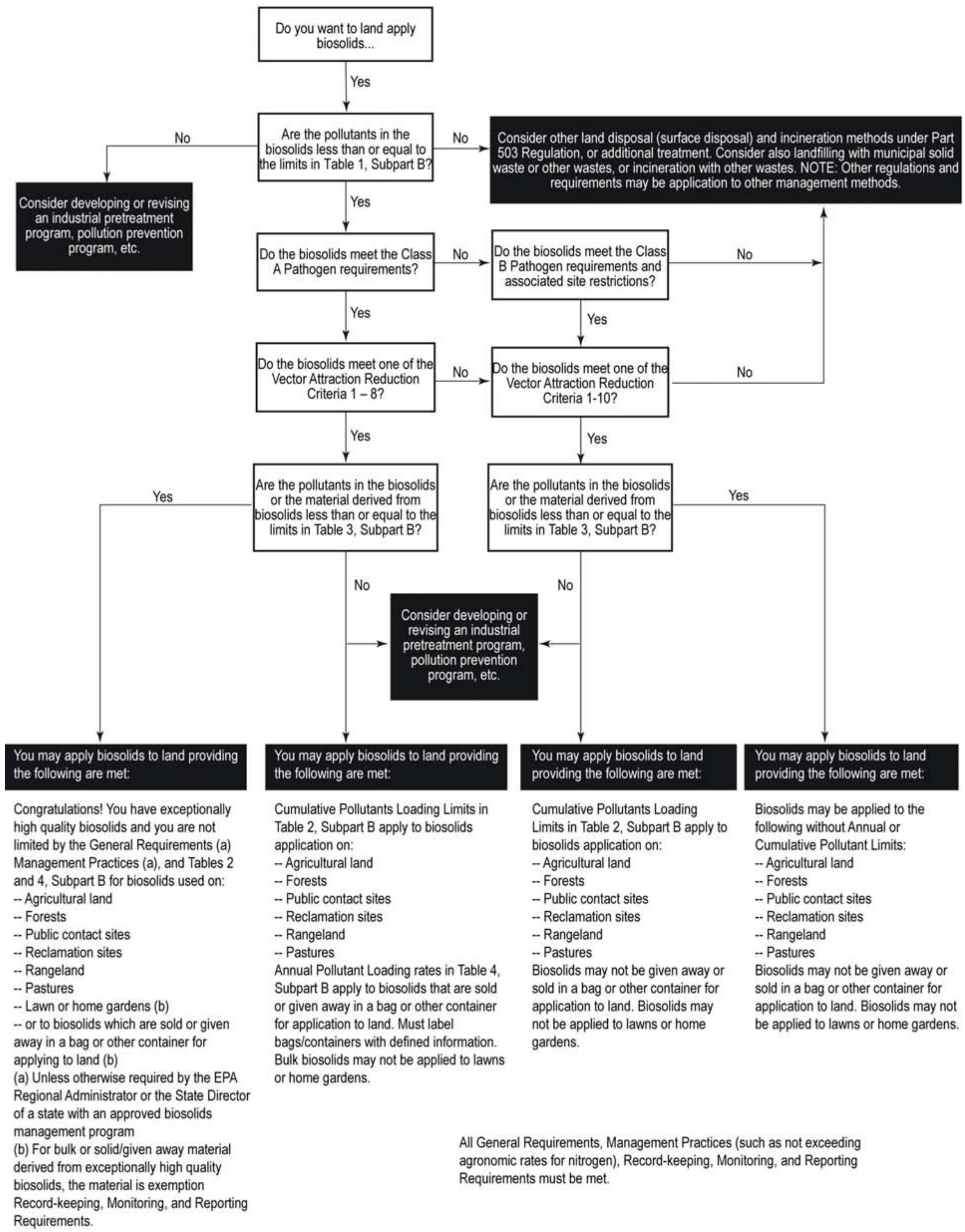


EXHIBIT 2-1
Flow Chart for Subpart B - Land Application
GRU Biosolids Master Plan

WB072006002GNV BMP_Exhibit2-1_FlowChart_rev1.ai

EXHIBIT 2-2
Summary Tables for 40 CFR Part 503 Land Application Subpart B
GRU Biosolids Management Plan

Pollutant	Subpart B TABLE 1 Pollutant Ceiling Concentrations (mg/kg)[1]	Subpart B TABLE 2 Cumulative Pollutant Loading Rates (kg/ha)[2,3]	Subpart B TABLE 3 Pollutant Concentrations (mg/kg)[3]	Subpart B TABLE 4 Annual Pollutant Loading Rates (kg/ha-year)[2,4]
Arsenic	75	41	41	2
Cadmium	85	39	39	1.9
Copper	4,300	1,500	1,500	75
Lead	840	300	300	15
Mercury	57	17	17	0.85
Molybdenum	75	NA	TBD	NA
Nickel	420	420	420	21
Selenium	100	100	36	5
Zinc	7,500	2,800	2,800	140

Table numbers are from Subpart B, Part 503 Regulation. All values are on a dry weight basis.
[1] Applies to all biosolids to be land-applied.
[2] Multiply kilograms per hectare (kg/ha) by 0.9 to convert to pounds per acre (lb/ac).
[3] Applies to bulk biosolids land-applied.
[4] Applies to biosolids sold or given away in bag or other container for land application.
mg/kg = milligrams per kilogram
TBD = to be determined; NA = not applicable

Pathogen and Vector Attraction Reduction for Land Application. The Part 503 Rule provides separate requirements for pathogen and vector attraction reduction. Pathogen requirements have two classifications: Class A and Class B, with Class A being the more stringent. These classifications indicate the density (number/mass) of pathogens. The pathogen reduction requirements can be meet by implementing certain specified technologies (as discussed in Subpart D) or by demonstrating that the quality of the biosolids meet the set pathogen criteria.

Biosolids that meet the Class A pathogen requirements, one of the vector attraction reduction requirements (criteria 1 through 8 in Subpart D), and the numerical criteria in Table 3, are referred to as “Exceptional Quality.” As such, these biosolids have minimal regulatory requirements and can be land-applied in public contact sites.

Biosolids that are Class B with respect to pathogen requirements are restricted to bulk application to non-public contact lands: agricultural land, forest, or reclamation sites. Additional site restrictions may apply, such as food crop, grazing, and public access restrictions. Moreover, one of the first 10 criteria specified under Subpart D (described later) for vector attraction reduction must be met in order to land-apply Class B biosolids.

Nutrient Requirements for Land Application. The Part 503 Rule requires that biosolids be land-applied at a rate that is equal to or less than the agronomic rate for nitrogen at the application site. The intent is to avoid excess nitrogen passing the root zone and contaminating the ground water. The current rule does not address other nutrients such as phosphorus.

Potential Impacts to GRU -- Land Application. GRU's biosolids are able to meet the current specified Part 503 Rule numerical limits for land application (Subpart B Tables 1-4). The limiting criteria will most likely be the pathogen and vector attraction reduction requirements or the nitrogen application rate.

Subpart C: Surface Disposal

The Part 503 Rule defines surface disposal as placing biosolids on an area of land or final disposal. Surface disposal sites include monofills, sludge-only landfills, surface impoundments, lagoons, waste piles, and dedicated disposal sites. Subpart C applies to any person who prepares biosolids that are placed on a surface disposal site, to the owner/operator of the site, and to the surface disposal site itself. This subpart does not apply to biosolids stored on an area of land for two years or less.

Should GRU site and permit a sludge-only landfill or monofill, the Part 503 Rule would apply, in addition to FDEP siting, permitting, and monitoring requirements. However, Subpart C does not apply to the co-disposal of biosolids with other municipal solid waste in municipal solid waste landfills. Co-disposal or use of biosolids at municipal solid waste landfills is regulated under 40 CFR Part 258. Biosolids disposed of in a municipal solid waste landfill must be non-hazardous and pass the Paint Filter Test. Other site-specific requirements may apply depending on the landfill accepting the material.

Pollutant Limits for Surface Disposal. Pollutant limits are specified for surface disposal units without a liner and leachate collection system for three metals: arsenic, 73 milligrams per kilogram (mg/kg); chromium, 600 mg/kg; and nickel, 420 mg/kg. GRU's biosolids meet these metal limits. If the pollutant concentrations exceed the specified limits, and the site does not have a liner or leachate collection system, site-specific pollutant limits may be requested at the time of permit application. The permitting authority must determine if site-specific pollutant limits are appropriate.

Management Practices for Surface Disposal. The following requirements apply to surface disposal of biosolids:

- A surface disposal site must not adversely affect a threatened or endangered species or its habitat, and it must not restrict the flow of a base flood.
- A surface disposal site must be designed to withstand certain seismic zone conditions.
- Runoff and leachate (for systems with a leachate collection system) must be collected and disposed of in accordance with the site permit.
- Methane gas must be controlled and monitored if the unit is covered.
- Food, feed, and fiber crops must not be grown and animals must not graze on active sites unless it is demonstrated that public health and the environment are protected. Public access to site must be restricted until three years after closure.
- A groundwater monitoring program must be developed to demonstrate that biosolids do not contaminate any aquifer.

Pathogen and Vector Attraction Reduction for Surface Disposal. Class A or Class B pathogen reduction requirements must be met for biosolids disposed of in a surface disposal unit unless a daily soil cover is placed. If daily cover is not used, the biosolids must be Class A or Class B, and must meet one of the alternative vector attraction reduction criteria specified in Subpart D of the Part 503 Rule.

Potential Impacts to GRU – Surface Disposal. Biosolids generators who plan to use surface disposal sites must ensure that the biosolids meet the pollutant concentration limits imposed for that site. In addition, nitrogen in the groundwater must be monitored. Some monofills receive raw solids that will not meet the Class A or B requirements. If a daily cover is placed, pathogen requirements do not have to be satisfied. While GRU's biosolids meet the specified pollutant limits, daily cover for the surface disposal site is recommended to minimize any pathogen and vector attraction concerns.

Subpart D: Pathogen and Vector Attraction Reduction

Prior to issuing the Part 503 Rule, the EPA used a technology-based approach to pathogen and vector attraction reduction by requiring that biosolids undergo either Process to Significantly Reduce Pathogens (PSRP) or Process to Further Reduce Pathogens (PFRP) prior to being land-applied. Although these processes are still recognized, additional requirements are specified to ensure process reliability.

As specified in Subpart B, either Class A or Class B pathogen reduction requirements must be met when biosolids are applied to the land or placed on a surface disposal site. These classifications indicate the density (number/mass) of pathogens. In addition, the regulations require reduction of vector attraction; that is, control of those characteristics of biosolids that attract disease-spreading agents (e.g., flies or rats) when applied to the land or placed on a surface disposal site. Subpart D of the regulations prescribes operational standards that designate the level of pathogen reduction for certain management methods, as shown in **Exhibit 2-3.**

EXHIBIT 2-3
40 CFR Part 503 Subpart D Pathogen Reduction Requirements
GRU Biosolids Management Plan

Management Method	Requirement
Land Application (any)	Class A or B
Surface Disposal	Class A or B
Lawn or Home Garden	Class A
Sold or Given Away in a Bag or Other Container	Class A

Class A Pathogen Reduction Options. All Class A pathogen reduction options must show that the biosolids have met either (1) the microbiological requirement for Class A, or (2) one of six alternatives listed below:

- Demonstrate <1,000 most probable number (MPN) fecal coliforms per gram total solids, or <3 MPN *Salmonella* per 4 grams of total solids

- Apply one of six alternatives:
  - Alternative 1 – Time and Temperature
  - Alternative 2 – Raise pH
  - Alternative 3 –Reduce enteric viruses and helminth ova (low pathogen biosolids)
  - Alternative 4 – Reduce enteric viruses and helminth ova (normal biosolids)
  - Alternative 5 – Process to Further Reduce Pathogens (PFRP)
  - Alternative 6 – PFRP equivalent treatment (approved by FDEP)

Class B Pathogen Reduction Options. The three options for Class B pathogen reduction are:

1. Demonstrate 2 million MPN or coliform forming units (CFUs) fecal coliforms per gram total solids
2. Apply a Process to Significantly Reduce Pathogens (PSRP)
3. Apply PSRP equivalent treatment

In addition, there are a number of site restrictions for land application of Class B biosolids.

Vector Attraction Reduction. Twelve criteria are specified in the Part 503 Regulation for vector attraction reduction. The application of vector attraction reduction criteria depends on the type of biosolids and how they are to be used. For example, for biosolids that are to be land-applied, biosolids must meet at least one of Criteria 1 through 10. For surface disposal, any one of Criteria 1 through 11 may be used. Criterion 12 applies only to septage.

- Criterion 1. Volatile solids must be reduced by a minimum of 38 percent.
- Criterion 2. For anaerobically digested biosolids that cannot meet Criterion 1, bench-scale testing for 40 additional days at 30 to 37 degrees Celsius (^{o}C) with 17 percent volatile solids reduction can be used.
- Criterion 3. Similar to Criterion 2 except that digestion takes place over 30 days at 20^{o}C to show a 15 percent reduction.
- Criterion 4. The specific oxygen uptake rate (SOUR) for biosolids treated in an aerobic process shall be equal to or less than 1.5 mg O_2 per hour (hr) per gram (g) of total dry solids.
- Criterion 5. For aerobic processes (e.g., composting), a minimum retention time of 14 days at 40^{o}C must be provided. An average temperature of 45^{o}C must be maintained.
- Criterion 6. Sufficient alkali must be added to raise the pH to 12 or higher for a period of 2 hours, with the biosolids remaining at a pH of 11.5 for an additional 22 hours without the use of additional alkali.
- Criterion 7. The total solids concentration of the portion of biosolids that does not contain unstabilized primary solids should be a minimum of 75 percent prior to blending with other materials.
- Criterion 8. The total solids concentration of the portion of biosolids that does contain unstabilized primary solids should be a minimum of 90 percent prior to blending with other materials.

- Criterion 9. Biosolids that are subsurface-injected must have no significant amount of biosolids on the surface within 1 hour after injection.
- Criterion 10. Surface-applied biosolids must be incorporated within 6 hours after application.
- Criterion 11. Biosolids placed on an active surface disposal site must be covered each operating day with soil or other material.
- Criterion 12. The pH of domestic septage must be raised to pH 12 by sufficient alkali addition for at least 30 minutes.

Potential Impacts to GRU – Pathogen and Vector Attraction Reduction. GRU currently produces Class B biosolids (Option 1) and uses Criterion 4 (SOUR ≤ 1.5 mg O_2/hr/g of dry solids) to demonstrate compliance with vector attraction reduction standards. When evaluating future biosolids management alternatives, GRU should consider the following advantages and disadvantages associated with producing Class A versus Class B material:

- More alternatives are available for end-use of Class A products.
- Regulatory monitoring and recordkeeping requirements are less stringent for Class A products than for Class B materials.
- Typically, Class A stabilization requires additional capital facilities, which may increase overall processing costs.
- Producing Class A products may alleviate growing public perceptions and concerns about health effects associated with pathogens.

Subpart E: Incineration

Subpart E covers the incineration of biosolids, which is the firing of biosolids at a high temperature in a closed environment. In general, Subpart E includes pollutant limits, operational standards, frequency of monitoring, recordkeeping, and reporting. The incineration process and the air pollution control devices remove some of the pollutants/emissions from biosolids. The incinerator stack disperses the remaining emissions. The levels of various heavy metals, including lead, arsenic, cadmium, chromium, nickel, beryllium, mercury, and total hydrocarbons, must meet the Part 503 Rule standards.

Non-hazardous incinerator ash generated during the firing of biosolids is covered by the Part 503 Rule when is used or disposed of. 40 CFR Part 258 is applicable if the ash is LAN filled and 40 CFR 257 if it is land-applied.

Potential Impacts to GRU – Auxiliary Fuel in Deerhaven Boilers. If GRU were to pursue thermal oxidation of biosolids as auxiliary fuel at Deerhaven, GRU would have to negotiate a permit with FDEP by demonstrating that the operation does not threaten or endanger animal or plant species, or that its critical habitat is affected. GRU may have to undergo performance testing prior to being permitted.

2.1.2 Pending Federal Regulations

The following regulations (or issues) concerning the management and disposal of biosolids are currently under review by either state or federal government officials.

Dioxins

The EPA proposed a rule to regulate dioxins on December 15, 1999, and was under a court-ordered deadline of December 15, 2001, to issue a final rule. Dioxins are a group of highly toxic persistent compounds, which are a byproduct of certain combustion and chemical manufacturing processes. After conducting separate risk assessments for these two sludge management practices, the agency concluded that dioxin risk to human health from these sources is small and that existing regulations are adequate to protect the environment. Based on the October 24, 2003 Federal Register, EPA decided not to regulate dioxins in land-applied sewage sludge.

Potential Impacts to GRU – Dioxins. Based on EPA's current stance on dioxins and its decision not to issue new dioxin regulations, there should be no impacts on GRU related to dioxins in biosolids.

Radioactivity

Over the last decade, issues and concerns regarding radioactivity in municipal wastewater and biosolids have been increasing. This growing concern can be largely attributed to the discovery of elevated radioactivity at several wastewater treatment plants in the U.S. While these incidents did not contribute to radiation exposure to the public or plant operators, significant cleanup projects resulted.

Radioactive material enters the collection system from a variety of sources, including man-made sources and natural sources. Man-made sources such as nuclear reactors are easier to identify and regulate. On the other hand, naturally occurring radioactive material (NORM) is ubiquitous in the environment; it is found in soil, building materials, fertilizer, air, and human wastes. Consequently, wastewater, as well as surface runoff, contains small amounts of NORM. All municipal solids, including biosolids, contain some NORM and are naturally radioactive to some extent. An analysis of biosolids is necessary to determine if they exhibit an elevated level of radioactivity. Guidance documents pertaining to the evaluation of radioactivity in industry, including municipal wastewater treatment, are focused primarily on the discharge of man-made radioactive material.

In 1995, the Interagency Steering Committee on Radiation Standards (ISCORS) was formed by the Nuclear Regulatory Committee (NRC) and EPA, along with other federal agencies to assist in resolving and coordinating regulatory issues associated with radiation standards. After almost 10 years of investigation, the overall conclusions of the ISCORS effort is that the levels of radioactive materials found in sewage sludge and ash samples are generally low. In addition, the associated radiation exposure to workers and the public is very low, and is not likely to be of concern (ISCORS Technical Report, 2004-04). However, the ISCORS recommends consulting with state radiation protection regulatory agency when the estimated annual dose using screening calculations exceeds 10 millirem per year (mrem/yr). Elevated levels of radioactivity in biosolids are generally very localized problems, which occur only in a small number of wastewater treatment plants downstream of radioactive dischargers.

There are some existing criteria for radionuclide soil concentrations, as well as acceptable soil levels for facilities undergoing decommissioning prior to being released from NRC license conditions. These soil criteria are provided in Appendix C of the *Characterization of Radioactivity Sources at Wastewater Treatment Facilities: Guidance Document for Pretreatment Coordinators and Biosolids Managers* (National Association of Clean Water Agencies [NACWA], 1999). If, for example, these soil criteria were used for determining application rates for land application, the soil criteria would most likely be conservative since the biosolids are typically incorporated into the soil, thereby diluting the concentration of radionuclides present in the biosolids. For other biosolids management options, such as landfilling/surface disposal or incineration, the potential impacts of elevated radionuclides in the biosolids would likely be less than those of land application.

Monitoring of radioactive materials discharging to the wastewater treatment plant is required to identify the potential for radiological incidents. Information provided by NRC should enable the municipality to identify facilities of concern. If it is determined that a significant amount of man-made radioactive material is discharged into the collection system, a survey and sampling program should be implemented to show what impact, if any, such discharges are having on the plant and biosolids quality. CH2M HILL recommends that a sampling program should be conducted in the following two phases:

- **Exposure monitoring.** Using survey instruments, radiation exposure rates within the treatment plant are determined. If these levels exceed background rates, a more specific testing protocol should be implemented. This type of monitoring does not indicate which radionuclides are present or specific concentrations.
- **Specific testing and limits.** If the exposure amount is above background rates, additional analyses should be conducted to determine specific radionuclides and concentrations.

Worker and public safety should be informed as soon as contamination is detected or suspected. If contamination is detected or suspected, biosolids should be sampled and tested for radionuclides. These analyses may be costly. Initial gamma scans exceed $100 per test, and Gross alpha and beta tests are approximately $50 per test. More specific testing, such as alpha spectroscopy, costs from $100 to $250 per sample. Sample collection procedures and sample transport to the laboratory should be coordinated with the qualified laboratory.

Next, the source(s) of contamination must be identified. NRC and/or FDEP should be able to provide some assistance to locate potential sources. However, the burden of dealing with elevated radioactivity levels will fall primarily to the municipality/wastewater treatment plant. Solutions to address elevated concentrations at the plant will continue to be determined on a case-by-case basis by the municipality, appropriate regulatory authority, and the discharger of the material. Given the potential liabilities and public sensitivities involved, any municipality that has discovered elevated levels should contact a qualified radiation consultant and seek competent legal advice.

Potential Impacts to GRU – Radioactivity. Radioactivity regulations and criteria for biosolids management practices do not currently exist. If regulations are developed in the future, monitoring and recordkeeping requirements may increase, as well as analytical costs to determine the extent of radioactivity, if any, and sources. GRU should attempt to stay involved in national committees that represent the wastewater treatment industry in order to protect their interests.

2.1.3 State of Florida Regulations

In addition to federal regulations, the State of Florida has issued its own set of rules for biosolids management and disposal. The rules can be found in various chapter of the Florida Administrative Code (FAC). FDEP is responsible for regulating and enforcing their state regulations, but has not been delegated responsibility by EPA for delegating the federal sludge regulation.

As does the EPA, Florida promotes the beneficial use of biosolids. Chapter 62-640 FAC, Domestic Wastewater Residuals, provides the minimum standards for the treatment of biosolids and septage for land application and distribution and marketing. Chapter 62-640 FAC also establishes land application criteria and defines the requirements for agricultural practices that use biosolids or septage. In general, Chapter 62-640 FAC adopts the pollutant, pathogen, and vector attraction reduction criteria from the Part 503 Rule as presented above under Subpart B and D. However, Florida rules include additional requirements. Brief overviews of the additional requirements that affect GRU operations are provided below:

Subpart B – Additional Requirements

The Part 503 Rule calculates nitrogen loading based on biosolids application vs. crop needs (uptake), available nitrogen from previous applications or leguminous crops, and volatilization losses. Florida includes additional sources of nitrogen (i.e., fertilizers, reclaimed water, and animal manure) in establishing application rates. The FDEP also requires the preparation and submittal of an Agricultural Use Plan (AUP), Form 62-640.210(2)(a). The AUP includes the nutrient contents of biosolids and all other nutrient contributions. For land application or reclamation using biosolids or biosolids-derived products, FDEP specifies biosolids monitoring, reporting, recordkeeping requirements, application rates, management practices, and stockpiling practices.

Subpart D – Additional Requirements

The FDEP incorporated an additional pathogen reduction category - Class AA. Class AA is unique to Florida and is basically Class A residual with low concentrations of heavy metals (defined by EPA as “Exceptional Quality”). Residuals distributed and marketed as Class AA must be analyzed in accordance to the pollutant concentrations as shown in **Exhibit 2-2.** Although the Part 503 Rule allows the distribution and marketing of Class A products, this is reserved exclusively to Class AA in Florida. Moreover, any facility that produces Class AA biosolids must submit a Monthly Biosolids Distribution and Marketing Report, Form 62-640.210(2)(c). Details on how to submit the report can be found in Chapter 62-640.850, FAC.

AUPs, permits, and any revisions to approved plans must be submitted by the generator and/or contractor to the FDEP for review and approval. Permit applications are also required for any new or modified biosolids storage or processing facility.

Florida rules for disposal of biosolids in landfills, monofills, surface impoundments, waste piles, or dedicated sites are covered under Chapter 62-701 FAC; incineration of biosolids must meet the requirements of Chapter 62-210 FAC; co-composting of residuals other than with yard waste must comply with Chapter 62-709 FAC.

2.1.4 Pending State of Florida Regulation

In May 2006, FDEP issued a draft Chapter 62-640 FAC Biosolids Rule for public comment. This draft rule includes significant changes to the existing rule and includes new requirements that could have a substantial impact on GRU's current and future biosolids management programs. The final rule is expected to be issued no sooner than the first or second quarter of 2007. A general overview of key provisions of the proposed rule and their potential impact on GRU follows. CH2M HILL recommends that GRU conduct a thorough review of the proposed rule and provide written comments to the FDEP to ensure that FDEP understands any potential negative impacts to GRU operations due to some aspects of the regulation.

62-640.200 Definitions

FDEP has deleted the requirement for submittal of AUPs. Instead, FDEP has replaced the AUP with a requirement to submit a more detailed Nutrient Management Plan (NMP). A NMP is a site-specific plan establishing the rate at which all biosolids, soil amendments, and sources of nutrients can be applied to the land so as to meet crop nutrient needs while minimizing the amount of pollutants and nutrients discharged to waters of the state. If promulgated, this requirement will place additional permitting and monitoring burdens on GRU and could potentially result in lower allowable biosolids loading rates.

62-640.300 General Requirements

Subsection 62-640.300(2) exempts Class AA biosolids from almost all requirements placed on Class B or Class A biosolids. Class AA biosolids do not require a spill response plan, site registration, NMPs, or adherence to land application site criteria. This requirement adds additional benefits to Class AA biosolids products such as compost or heat-dried biosolids, while adding permitting and monitoring costs for Class A and B land application programs. All existing and new land application sites will have to be registered and a NMP submitted within 30 days of a site being used.

This subsection also contains language which attempts to increase liability exposure of the wastewater treatment facility permittee in situations where a biosolids management facility or contract operator is processing or applying biosolids provided by the wastewater treatment facility. Although GRU currently shoulders much of the responsibility and liability for proper operation of WPR, this language will tend to increase GRU's liability exposure for things that the site owner may do that are outside the direct control of GRU. This would tend to increase the desirability for GRU to be able to exercise greater control over biosolids disposal operations at WPR and other sites.

62-640.400 Prohibitions

Article (7) of this subsection stipulates that treatment, management, transportation, use, land application, or disposal of all biosolids, including Class AA not cause a violation of the odor prohibition in Rule 62-296.320(2), FAC. This requirement is too general and vague and could lead to many complaints and lawsuits for biosolids management operations. This requirement, if it remains in final rule, could potentially negatively impact land application operations more so than options that have better control over odor emissions such as enclosed composting facilities and thermal drying facilities.

62-640.500 Nutrient Management Plan

This new subsection has the potential to have a significant impact on GRU's current and future land application operations. It is a comprehensive section that requires a NMP be prepared for every site where Class B and Class A biosolids are applied. The most significant requirement of the NMP is that application rates shall be based on the most limiting crop nutrient or standards adopted by the NRCS and the University of Florida's Institute of Food and Agricultural Sciences (IFAS) for determining rates and timing of land application of biosolids. The NMP must consider all nutrient sources for nitrogen (N) and phosphorus (P). This is a significant change since to date FDEP has required agronomic rates only be based on N requirements. This subsection is not clear what methods are suitable for calculating agronomic P loading rates. It allows an assumption of 50-percent availability for P but is ambiguous if the Florida P index methodology can be used by a certified planner to establish P loading rates. This sub-section needs additional clarification by FDEP so wastewater treatment facilities and biosolids management facilities can determine the impact to their operations. In verbal communications between the GRU and the FDEP, the FDEP indicated that the intent is to allow the Florida P index to be used. This index takes into account soil type, site conditions, and proximity and susceptibility of surface waters to receiving phosphorus from applied biosolids on a site-specific basis. There are no nearby surface waters likely to be impacted by the WPR site. If the Florida P index is allowed, this subsection would not likely significantly impact biosolids application at the WPR site. However, if the Florida P index method is not allowed and the 50-percent available P criterion remains in the final rule, then the land area requirements for GRU's planning period biosolids production would likely exceed the available application area at WPR. For example, using the current WPR crop mix and a P concentration of 5 percent in biosolids, GRU would need approximately 2,800 acres of land for the design year biosolids production. This exceeds the available application area of WPR by approximately 1,600 acres. This aspect of the proposed rule, if issued, would require GRU to obtain additional land application area or implement Class AA distribution and marketing programs.

62-640.600 Pathogen Reduction and Vector Attraction Reduction

Paragraph 62-640.600(1)(b) adds a requirement that a permittee demonstrate a 2 log reduction of fecal coliform in addition to meeting the fecal limit when using the fecal monitoring only option for Class B compliance. This requirement is somewhat ambiguous since it basically requires all wastewater treatment facilities to meet reduction even if incoming coliform concentrations to the process are well below Class B standards. Some Class B aerobic and anaerobic digestion processes may not be able to meet this standard even though they are meeting EPA standards. It is questionable whether or not facilities that do not meet the strict PSRP standards could meet this requirement. GRU should monitor their operations to determine if this requirement will have a major impact on current or planned operations and provide comments to FDEP that question the validity and need for this requirement in the final rule.

62-640.650 Monitoring, Record Keeping, Reporting, and Notification

FDEP has significantly increased the monitoring, record keeping, and reporting requirement for Class A and Class B land application programs. Although these requirements will not prevent the operation of these programs, they will increase operating and supervisory costs associated with Class A or Class B land application.

62-640.700 Criteria for Land Application of Class A and Class B Biosolids at Land Application Sites

FDEP has also proposed increased land application criteria requirements for Class A and Class B land application programs. Key requirements that have been added or increased include restrictions on maximum loading rates to sites, restrictions on the type of equipment that can be used to apply biosolids, requirement to track metals loading for all Class B sites regardless of metals concentrations in biosolids, and increased setback distances. These requirements will not prevent Class B land application, but will increase costs to permit new sites and will increase amount of land required for application sites.

2.2 Other Concerns

The following topics should be considered when evaluating biosolids management alternatives.

2.2.1 Comprehensive Nutrient Management Planning Trends

Biosolids are good sources of nutrients, particularly nitrogen and phosphorus. Since nitrogen and phosphorus are essential for healthy and vigorous plant growth, biosolids provide significant fertilizer value for agricultural, silvicultural, horticultural, and reclamation purposes. The management of nutrients is a critical component of any program to ensure that biosolids are used in an environmentally sound manner.

The term *agronomic* refers to the use of biosolids at a rate that provides adequate nutrients for crop growth, without causing environmental pollution. The nutrient content in biosolids, as well as animal manure, will not be in total balance with the nutrient needs of all crops. For example, if biosolids are applied at the rate that meets the plant needs for a particular nutrient or trace element, other nutrients/elements may not necessarily be present in the amounts needed by that crop. Chemical composition and characteristics of biosolids are dependent on many factors (e.g., liquid- and solids-handling treatment processes and bulking agents). Most biosolids have two to three times more phosphorus than nitrogen available for plant uptake. Therefore, if biosolids were applied to satisfy the plant nitrogen requirements, over-application of phosphorus could result. The same would be true for animal manure. For chicken and dairy manure, the ratio of phosphorus to nitrogen is approximately 4:1 and 2.5:1, respectively. Generally, the land area required for biosolids application, when limits are based on phosphorus, is two to four times that required when limits are based on nitrogen.

Excess phosphorus, unlike nitrogen, is seldom a concern in groundwater, primarily due to its tendency to adsorb to the soil matrix. Applying some additional phosphorus, beyond what is recommended based on soil fertility test, can be tolerated without resulting in environmental degradation or adverse impacts. However, continuous over-application can increase the soil P concentration beyond the soil absorption capacity and result in elevated P in groundwater. Increased P in the soil beyond its absorption capacity is likely to increase the P concentration in runoff. Increased P in runoff can be a problem if surface waters nearby are susceptible to P loading.

While the Part 503 Rule does not directly specify agronomic requirements for a particular crop, it does preclude the application of biosolids at a rate greater than the agronomic rate of the site, unless otherwise specified by the permitting agency for a reclamation site.

Most states regulate land application loading rates based on metals concentrations, pH, and crop nitrogen requirements. However, there is a current trend nationally towards implementation of total nutrient management planning concepts in determining loading rates for biosolids and other organic materials such as animal wastes. Some states are considering developing guidance and/or regulations that would place limits on phosphorus application to protect against potential water quality degradation to nearby surface waters. These regulatory efforts are based on long-standing concerns that nutrients are key contributors to excess algae blooms, as well as harmful bacteria such as *Pfiesteria.* In Florida, legislation has been passed to restrict the application of fertilizers and organic amendment based on phosphorus in three drainage basins located in South Florida. Legislation has been passed or introduced in Maryland and Virginia to implement nutrient management practices to consider both nitrogen and phosphorus. The Delaware Department of Natural Resources and Environmental Control has identified phosphorus as a key factor in non-point source pollution of surface waters and called for a nutrient control strategy to reduce nutrient losses to surface water by 2007. The Wisconsin Department of Natural Resources requires that biosolids application to certain lands adjacent to lakes be limited by crop phosphorus requirements. In addition, the State of Illinois limits biosolids application based on crop phosphorus requirements for specific soil characteristics and land areas. Even with these trends, EPA has not indicated any new push to revise the Part 503 Rule to specifically include total nutrient management planning. Most of the action on this front is expected to occur at the state level.

Until the recent issuance of the draft Biosolids Rule, FDEP had never considered imposing state-wide limits on nutrients. The current regulation only limits applications based on nitrogen loading rates, except for three designated drainage basins in South Florida. However, with the issuance of the draft Chapter 62-640 biosolids rule in May 2006, FDEP is now requiring that the total nutrient management planning approach be used to establish agronomic loading rates for biosolids. Specific requirements and language found in the draft rule that may impact GRU is discussed in more detail in the following sub-section.

Potential Impacts to GRU–Nutrient Management

The nutrient concentrations in biosolids are dependent on treatment processes utilized. Research by the University of Florida and other universities indicate that there is a wide variability in average phosphorus concentrations in biosolids. Other research is currently ongoing to further investigate variations in available phosphorus and potential water quality impacts of applied biosolids.

Depending on the concentrations of nutrients in the biosolids, as well as site characteristics, future nutrient management regulations could limit the application rate, thereby requiring more area for a land application program. Conversely, should biosolids treatment processes employed by GRU reduce concentrations of total nitrogen and phosphorus, the resulting biosolids product could potentially be applied at higher loading rates at sites where nutrients are restricted due to nutrient management requirements. More specific impacts of nutrient management planning and other requirements currently included in FDEP's draft Chapter 62-640, FAC Biosolids Rule is discussed in the following subsection.

2.2.2 Public Acceptance

Utilities across the U.S. continue to face pressures associated with increasing regulations, public awareness, and concerns about waste management, urbanization, odors, and competition for land. In many regions, counties and municipalities are either banning or further restricting biosolids application by implementing local ordinances. The public has become extremely sensitive, and in some cases, quite organized in opposing almost all types of waste management options with little or no differentiation between trash, biomedical waste, animal manure, or biosolids. To many in the general public, the material is still *sludge* and is usually not perceived as a beneficial-use product.

Successful biosolids management programs include more than operating an effective treatment process and meeting the pertinent regulations. The opportunity for success can be enhanced by a communications program to educate the community on the environmental benefits of various biosolids management approaches. However, such communication efforts are not simple. The complexity of identifying and engaging numerous stakeholders can be a serious obstacle. To overcome this and other obstacles, a targeted program is needed that is based on an understanding of the technical and regulatory processes, a well defined decision-making process, and the support of key stakeholders.

The basic actions required for a successful communications program include:

- **Identification of Stakeholders.** Who is likely to be concerned? Which groups or individuals must provide support for implementation? Who is too powerful to ignore? What are stakeholder expectations?
- **Development of a Communications Plan.** This plan must integrate the technical elements of the program with the major concerns of the key stakeholders. It determines how and where to target the vital component of public education and what modes of communication are required.
- **Development of Strategic Messages.** The public needs to understand the treatment processes, management practices, and safeguards that are in place to ensure program

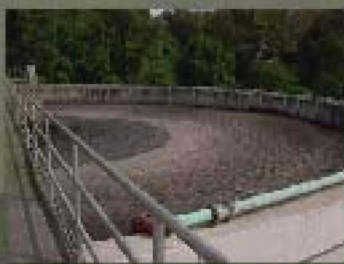
acceptance. Messages must be communicated in ways that the general public can understand.

- **Development of Outreach Materials.** Various media may be selected for outreach materials, such as brochures, fact sheets, telephone hotlines, Internet sites, etc.

Potential Impacts to GRU – Public Acceptance

As GRU investigates alternative technologies and end-use practices for its long-term program, the following appear to be the primary issues to be considered from the community's perspective:

- Potential for odors, both onsite and offsite, for specific technologies
- Biosolids quality, including any pollutants of public concern
- Relative volumes of material to be trucked off site depending on method of stabilization and processing employed (ash, pellets, compost, lime stabilized material, dewatered cake)
- Siting issues, including land application sites, as well as offsite processing and storage facilities
- Other sensitive, community-specific issues based on previous experience with GRU's or other waste management programs.





Review of Existing Facilities and Loads

WB072006002GNV

3. Review of Existing Facilities and Loads

GRU has successfully practiced the beneficial use of biosolids through land application to permitted sites for over 25 years. Biosolids are a byproduct of the wastewater treatment process. GRU owns and operates two WRFs, the KWRF and MSWRF, where biosolids are generated and treated for vector and pathogen reduction prior to land application (see Section 2). Under the current program, biosolids from both facilities are land applied on a single agricultural site. The following section describes the existing treatment and land application facilities.

3.1 Kanapaha Water Reclamation Facility (KWRF)

The KWRF is located at the intersection of SW 63rd Boulevard and SW 41st Place and operates under FDEP permit no. FL0112895. This is the larger of the two WRFs serving the City of Gainesville. Although KWRF is currently experiencing annual average daily flows (AADFs) of approximately 11 million gallons per day (MGD) and is rated as a 14.9-MGD AADF advanced wastewater treatment facility, it serves a fast-growing community and is expected to experience flows of up to 17 MGD AADF by 2025. Therefore, GRU is already evaluating the expansion of the KWRF to its build-out capacity of 17.5 MGD AADF.

The KWRF treatment process consists of a preliminary treatment with mechanical bar screens and vortex grit removal units, an extended aeration activated sludge process, secondary clarifiers, deep bed filters, and chlorine contact basins. The biosolids treatment process is depicted in **Exhibit 3-1.** The biosolids are stabilized by three aerobic digesters in series followed by gravity belt thickening. The KWRF achieves Class B pathogen reduction by monitoring indicator organisms, as detailed in 40 CFR Part 503, Subpart D, Option 1. The system complies with the vector attraction reduction criteria by providing enough treatment to reduce the SOUR to equal or less than 1.5 mg of oxygen per gram of biosolids, as per 40 CFR Part 503 Rule, Subpart D, Option 4. **Exhibit 3-2** summarizes the existing facilities at KWRF.

3.2 Main Street Water Reclamation Facility (MSWRF)

The MSWRF is located at the intersection of Main Street and SW 16 Avenue in southeast Gainesville, Florida. The plant is rated at its build-out capacity of 7.5 MGD AADF. Though the plant is approaching build-out capacity, the growth in the service area is flat and wastewater flows are not expected to increase significantly in the future.

The wastewater treatment process at MSWRF consists on preliminary treatment, with bar screens and grit removal units, an activated sludge process, secondary clarifiers, upflow filters, and chlorine contact basins. The wastewater residuals (biosolids) are aerobically stabilized to meet Class B requirements, thickened by gravity belt thickeners, and subsequently land applied to approved agricultural sites.

Exhibit 3-3 depicts a process flow diagram of the MSWRF biosolids treatment process. The stabilization process consists of two large aerobic digesters in series that qualify as a PSRP as detailed in 40 CFR Part 503, Subpart D, Option 2. Thus, the MSWRF achieves Class B pathogen reduction by meeting PSRP requirements.

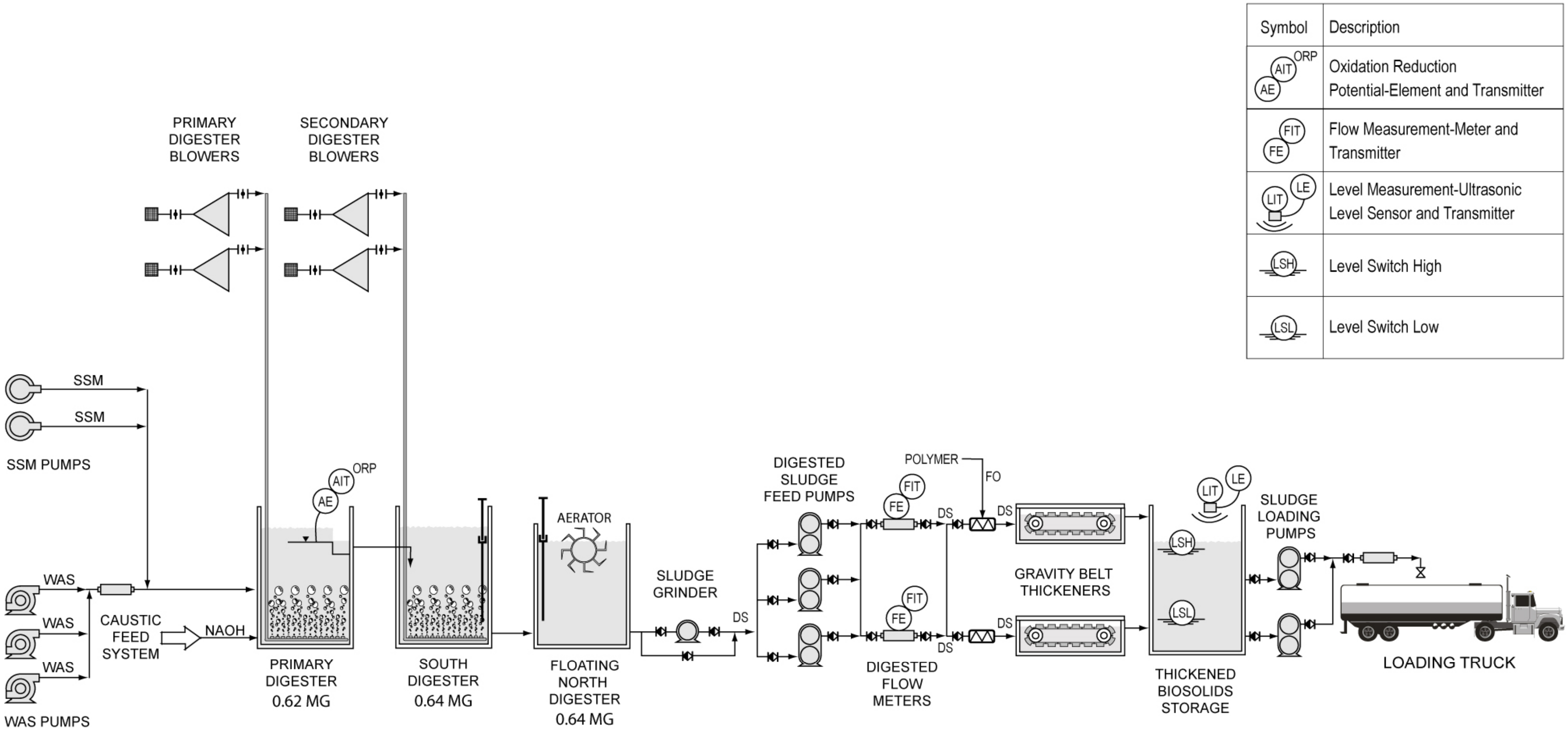


EXHIBIT 3-1
Existing Process Flow Diagram
GRU Kanapaha WRF
CH2MHILL

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EXHIBIT 3-2
Existing Biosolids Treatment Facilities at the KWRF
GRU Biosolids Management Plan

Item	Value
Aerobic Digestion (tanks in series)	
No. of Aerobic Digesters	3
Primary Digester	
Volume, MG	0.66
Diameter, ft	95
Surface Water Elevation (SWE), ft	11.75
Type of System	Coarse Bubble Diffusers
No. of Blowers / Blower Rated Capacity, Hp	2 / 125
South Digester	
Volume, MG	0.66
Diameter, ft	95
Surface Water Elevation (SWE), ft	11.75
Type of System	Coarse Bubble Diffusers
No. of Blowers / Blower Rated Capacity, Hp	2 / 100
North Digester	
Volume, MG	0.66
Diameter, ft	95
Surface Water Elevation (SWE), ft	11.75 (floating)
Type of System	Surface Aerator
No. of Surface Aerators / Rated Capacity, Hp	1 / 75
Sludge Gravity Thickener	
Diameter, ft	40
No. of Sludge Recycle Pumps / Capacity, gpm	2 / 100
No. of Sludge Transfer Pumps / Capacity, gpm	2 / 50
Digested Sludge Pump Station	
Sludge Grinder / Capacity, gpm	1 / 800
Sludge Pumps / Capacity, gpm	3 / 400
Gravity Belt Thickening	
No. or 2.0 m Thickeners	2
No. of Polymer Feed Pumps / Capacity, gph	3 / 4.5
No. of Filtrate Return Pumps / Capacity, gpm	2 / 650
Sludge Truck Loading	
No. of Sludge Pumps / Capacity, gpm	2 / 300

ft feet
gph gallons per hour
gpm gallons per minute
Hp horsepower
MG million gallons

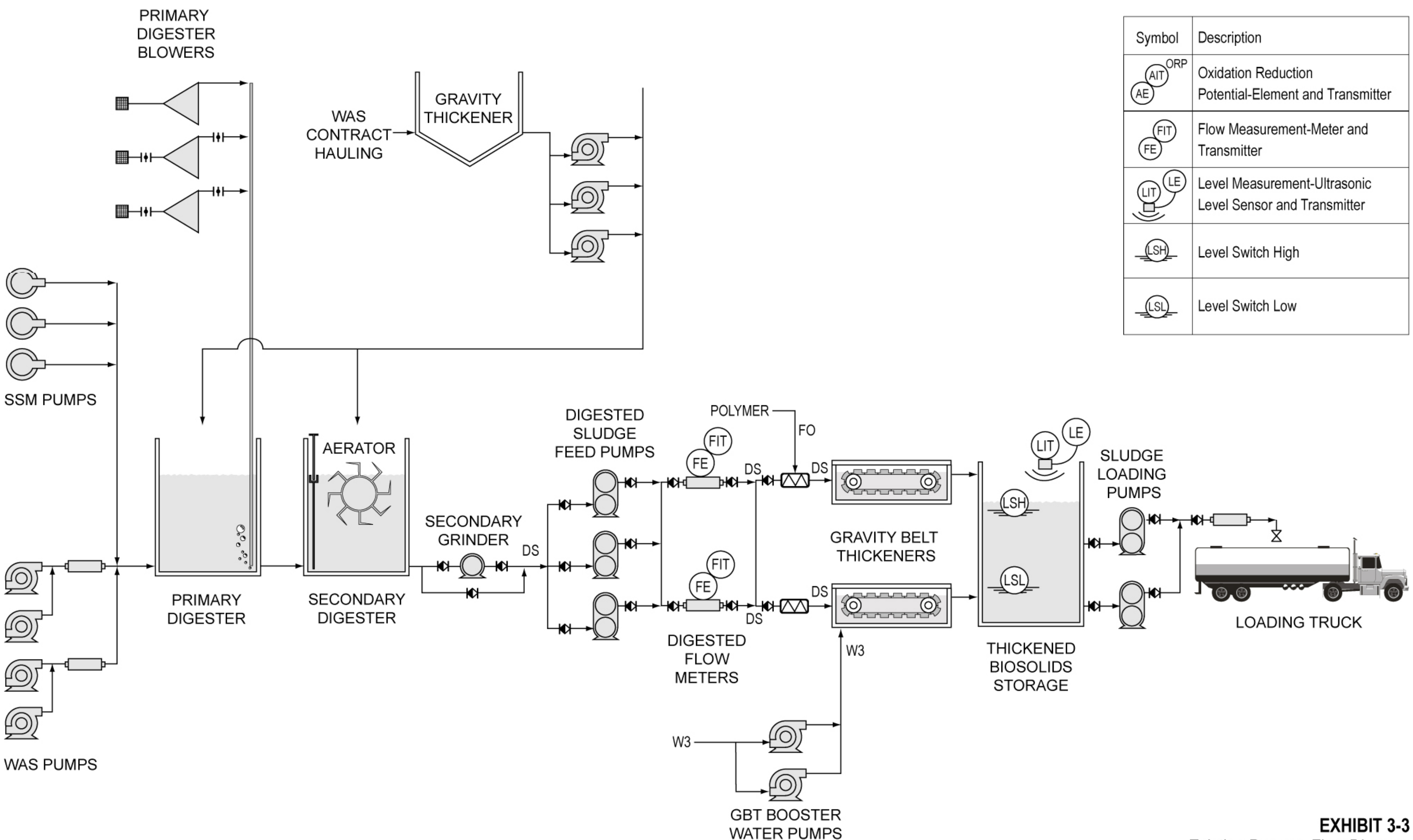

EXHIBIT 3-3
Existing Process Flow Diagram
GRU Main Street WRF

WB022008003GNV MSWRF_Exhibit3-3_Main_Street_Process_Flow_Diagram.ai

Moreover, the MSWRF achieves vector attraction reduction by meeting SOUR requirements, as specified in 40 CFR Part 503, Subpart D, Option 4; or, as backup, by injection of biosolids below the soil surface, as specified in 40 CFR Part 503, Subpart D, Option 9. A summary of the existing biosolids treatment facilities at the MSWRF is presented in **Exhibit 3-4**.

EXHIBIT 3-4
Existing Biosolids Treatment Facilities at MSWRF
GRU Biosolids Management Plan

Item	Value
Aerobic Digestion (tanks in series)	
No. of Aerobic Digesters	2
Digester No. 1	-
Volume, MG	1.29
Diameter, ft	112
Surface Water Elevation (SWE), ft	16.5
Type of System	Coarse Bubble Diffusers
No. of Blowers / Blower Rated Capacity, Hp	3 / 200
Digester No. 2	-
Volume, MG	1.29
Diameter, ft	112
Surface Water Elevation (SWE), ft	16.5
Type of System	Surface Aerator
Surface Aerator Rated Capacity, Hp	100
Sludge Gravity Thickener	-
Diameter, ft	40
No. of Sludge Transfer Pumps / Capacity, gpm	3 / 200
Digested Sludge Pump Station	
Sludge Grinder / Capacity, gpm	1 / 800
Sludge Pumps / Capacity, gpm	3 / 400
Gravity Belt Thickening	
Type of 2.0 m Thickeners	2
No. of Polymer Feed Pumps / Capacity, gph	3 / 4.5
No. of Filtrate Return Pumps / Capacity, gpm	2 / 650
Sludge Truck Loading	
No. of Sludge Pumps / Capacity, gpm	2 / 300

ft feet
gph gallons per hour
gpm gallons per minute
Hp horsepower
MG million gallons

3.3 Current Biosolids Loads at GRU Facilities

Record data was examined to determine the biosolids production rates for each WRF. The generation of biosolids was evaluated in terms of dry pounds per million gallons (dry lb/MG) of raw wastewater treated. It was assumed that the rate of production per MG of treated wastewater would remain constant throughout the next 20 years.

Daily monitoring reports (DMR) dating from 2003 to 2005 were evaluated to determine the Annual Average Daily Loads (AADL) and Maximum Month Average Daily Loads (MMADL), in dry lb/MG, for each facility. The loads were calculated by dividing the average biosolids production by the average plant flow for each month. Using a frequency distribution analysis, the plot shown in **Exhibit 3-5** was generated. Based on the *WEF Manual of Practice No.8, 4th Edition* (WEF, 1998), the AADL and MMADL were estimated by calculating the average and 92nd percentile of the time-period evaluated. The resulting AADL and MMADL are shown in **Exhibit 3-6.**

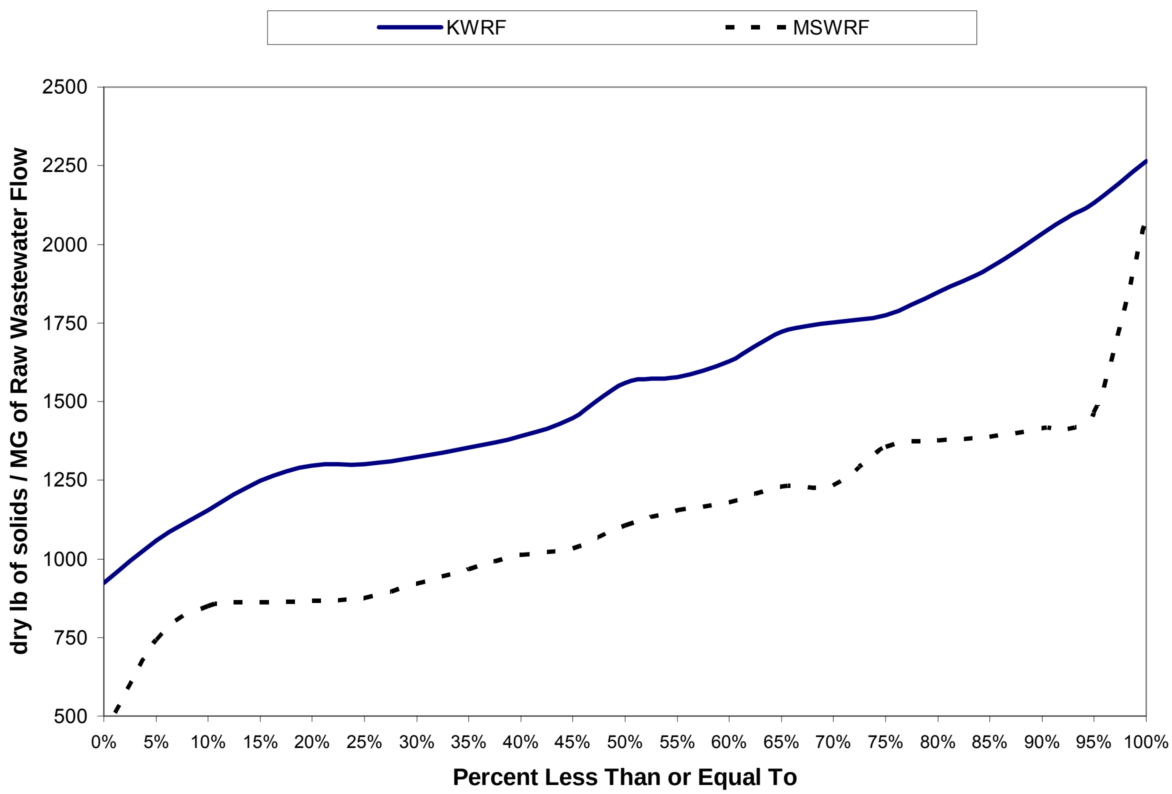

EXHIBIT 3-5
Solids Production Frequency Distribution for 2003 - 2005
GRU Biosolids Management Plan

EXHIBIT 3-6
Historical Biosolids Loading Rates for 2003-2005[1]
GRU Biosolids Management Plan

Facility	Annual Average Daily Load (AADL)[2] (lb/MG)	Maximum Month Average Daily Load (MMADL)[3](lb/MG)
KWRF	1,560	2,000
MSWRF	1,120	1,550

[1] Data from Plant Daily Operations Reports (DMRs)
[2] Average WAS Flow (gal) x % TSS in WAS x 8.34 lb/gal / Average Plant Flow (MGD)
[3] 92^{nd} percentile of biosolids production rates in 2003-2005

3.4 Land Application Program

Under GRU's present biosolids utilization/disposal program, biosolids from the two WRFs are land-applied on an agricultural site, WPR, located in western Alachua County. Biosolids are land-applied for beneficial use at WPR under a cooperative land application program between the owner of WPR and the GRU. Biosolids provide nutrients (such as nitrogen and phosphorus) and micronutrients including trace metals (i.e., boron, calcium, iron, copper, and zinc) that are useful for crop production. Biosolids act as a supplement to inorganic fertilizer reducing the need for inorganic fertilizer. Under the current cooperative land application program, GRU has a lease agreement with the owner of the agricultural land which allows the former to use the WPR for the application of biosolids. The current contract between the GRU and the owner of WPR expires in 2009; however, it can be renewed upon agreement by both concerned parties.

The WPR is located on Archer Road, approximately 2 miles west of the town of Archer, in Alachua County, Florida. The WPR site is divided into 10 fields with a total area of approximately 1,175 acres (see **Exhibits 3-7** and **3-8**). Under the terms of the current agreement between the GRU and owner of WPR, the fields F, I and Q are available for land application on a year-round basis while the fields E, G and H are available only from January 1 to March 31. The remaining fields (A, B, C, and D) can be available for land application as needed. Based on the 2004 cropping pattern, ryegrass, corn, native grass, corn and peas are grown at WPR. The center pivot irrigation system is used to provide supplemental water for crop production at WPR. Supplemental irrigation water is obtained from eight Floridan aquifer wells that are installed at the WPR.

Biosolids from the two GRU WRFs are transported to the WPR in a 6,000-gallon tanker. At the WPR the biosolids are stored in a 200,000-gallon tank until land application. Based on the 2006 production capacity of the two WRFs, the storage tank provides nearly 3.5 days of wet weather storage for the biosolids. Land application at WPR involves injecting biosolids into the soil using a tine cultivator injection system. The tine cultivator injection system allows liquid biosolids to flow directly behind each tine and be injected approximately 4 to 6 inches below the ground surface. During 2004, 3,772 dry ton (dt) of biosolids were applied at WPR at a rate of 4.71 tons/acre. The amount of nitrogen in the biosolids varies from 3.9 to 8.1 percent, while phosphorus varies from 3.5 to 4.5 percent.

EXHIBIT 3-7
Whistling Pines Fields and Corresponding Areas
GRU Biosolids Management Plan

Field Name	Area (acres)
A [1]	148
B [1]	110
C [1]	146
D [1]	146
E [2]	149
F [3]	42
G [2]	151
H [2]	148
I [3]	58
Q [3]	77

[1] Available from January to March
[2] Available as needed
[3] Available for entire year

Under the current agreement with the owner of WPR, GRU is responsible for the transporting biosolids from the WRFs to the WPR. Land application is the responsibility of WPR. While the farm provides all the labor and fuel needed for the land application process, the equipment needed for spreading or soil incorporation of biosolids is provided by GRU. The GRU has provided a 9,500-gallon tanker trailer with a mounted subsurface injection system and a tractor needed to pull the tanker trailer, currently being used for the surface spreading or injection of biosolids. Under the terms of the agreement, WPR coordinates each year's cropping schedule with GRU. As compensation for using WPR as a biosolids application site, GRU pays $35,000 annually to the owner of WPR. In addition, GRU also pays for the use of a spare WPR-owned tractor, at the rate of $30 per hour, in the event that the primary application tractor becomes inoperable.

While the current contract is valid until 2009, the owner of WPR can terminate the contract anytime at their discretion, with prior notice of one year. This leads to uncertainties in GRU's current biosolids utilization/disposal program. Furthermore, there are uncertainties in the long-term viability of the program as the owner of WPR may opt to sell or pass the property on to family members instead of continuing to lease the land for biosolids land application.

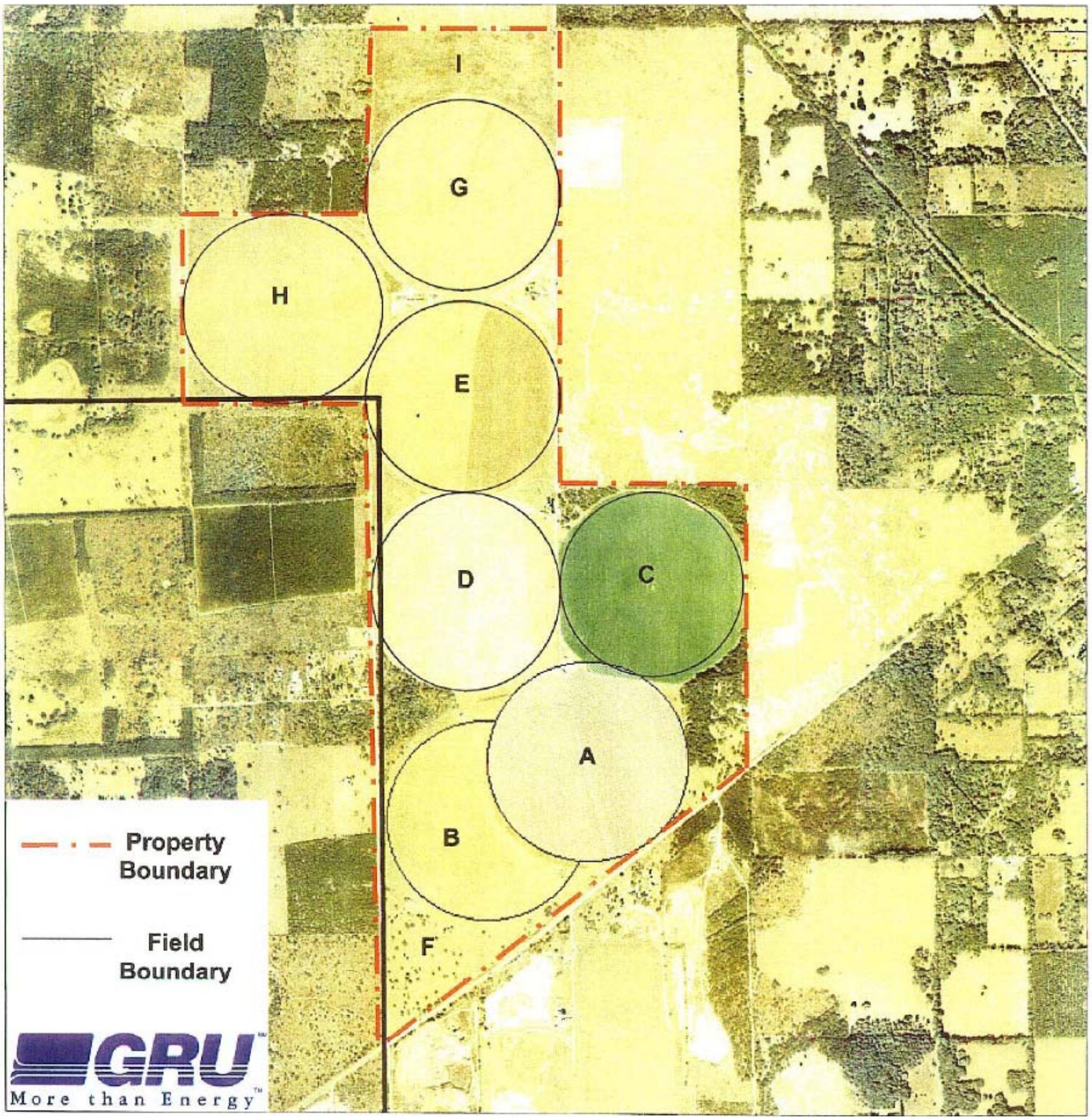

EXHIBIT 3-8
Aerial View of Existing Fields at Whistling Pines Ranch
GRU Biosolids Management Plan

Preliminary Selection of
Biosolids Management Alternatives

WB072006002GNV

4. Preliminary Selection of Biosolids Management Alternatives

In general, biosolids management programs include the two basic components of treatment and disposal (or "End Use"). When evaluating biosolids management alternatives, it is customary to begin with the end-use in mind. The end-use of biosolids determines the level of treatment required. For example, the existing means of disposal for GRU is land application of biosolids for beneficial use in agricultural land. Thus, the minimum treatment required for agricultural land application of biosolids is outlined in Subpart B of the Part 503 Rule (i.e., pathogen and vector attraction reduction). Alternatively, biosolids could be taken to a municipal landfill where an alternate treatment approach, such as volume reduction, would be applied.

The following section offers a summary of various end-use and treatment alternatives that are practiced throughout the U.S. and are accessible to GRU. The following is an effort to recapitulate the preliminary screening of biosolids management alternatives by the project team. A more extensive list of alternatives presented to the group for discussion is provided in **Appendix A.**

4.1 End-Use Alternatives

End-uses include an array of alternatives to utilize or dispose biosolids once they leave the treatment facility. End-uses include the beneficial reuse of biosolids through land application, landfill disposal, and thermal oxidation. The disposal of biosolids in landfill is currently a contingency option for short-term disposal of biosolids for GRU and was not considered as a viable long-term end-use alternative (see **Appendix D**). Some of the common end-uses biosolids practiced in the U.S. are described below.

4.1.1 Agricultural Land Application

Biosolids application on agricultural land is the most common and acceptable biosolids disposal option practiced in the U.S. Biosolids are a good source of macronutrients (i.e., nitrogen and phosphorus) as well as the micronutrients (i.e., boron, copper, and iron) needed from plant growth. However, there are certain restrictions for harvesting food for human and animal consumption. For instance, the application rate of biosolids needs to be equal to or less than the "agronomic rate"(nutrient uptake) as defined in the Part 503 Rule. EPA has also established limits on biosolids metal concentrations. Biosolids can be applied through surface application or subsurface injection. Surface application involves using applicator vehicles followed by disking or ploughing the field to mix the biosolid with the soil. Subsurface application is carried out by injecting liquid biosolids below the soil surface using injection shanks mounted on tractor-drawn tank wagons or self-propelled application vehicles. Subsurface methods are more popular due to greater public acceptance, reduced odor, and reduced ammonia volatilization. **Exhibit 4-1** discusses some of the common advantages and disadvantages of agricultural land application.

EXHIBIT 4-1
Advantages and Disadvantages of Agricultural Land Application
GRU Biosolids Management Plan

Advantages	Disadvantages
Valuable soil conditioner	Land intensive
Due to rural settings, it is not likely to become public nuisance	Highly dependent on weather, cropping practices, and good management practices
Simple to operate and understand	Onsite storage generally required
Typically less expensive than other alternatives	

4.1.2 Forest Land Application

Biosolids can also be applied to natural and planted forest plantation sites that are used for timber production. Biosolids application has been known to improve the productivity of forestlands. While it is not a common biosolid disposal option in some areas of the country, it has the potential to be a major disposal option in the near future since nearly two-thirds of all forestlands in the U.S. are commercial timberland. Forest application can be carried on a cleared site prior to planting, young plantations and established forests. Pre-plant application on a clear site includes application using a delivery truck followed by disking of the field. Application on a young plantation or established forest involves application of liquid or dewatered biosolids over the treetops. Such application warrants preparation of application trails. It also requires periodic maintenance of the application trails to keep them clear of vegetation which may obstruct application vehicle movement. Other advantages and disadvantages of application of biosolids on forested land are discussed in **Exhibit 4-2**.

EXHIBIT 4-2
Advantages and Disadvantages of Forest Land Application
GRU Biosolids Management Plan

Advantages	Disadvantages
Does not directly affects human food consumption	Regulatory guidance limited due to limited application
Due to extensive forest land minimum land requirement is generally not the critical factor	Access to these site may often be difficult for the applicator vehicles
Accelerates plant growth leading to quick economic returns, in cases of commercial forest plantations	Accelerated plant growth can result in changing the basic wood characteristics
Favorable public perception	Difficult to control public access to such large sites

4.1.3 Land Application at a Reclamation Site

Biosolids can be applied to sites that have been mined for coal, clay, gravel, or other minerals. Due to the destructive nature of mining operations, soils at such sites typically cannot adequately support vegetation due to lack of nutrients and organic matter, altered physical and chemical properties, reduced biological activities, and altered topography resulting in high erosion of top soil. However, application of biosolids to such sites is generally a one-time process. Therefore, long-term viability of such alternatives is dependent on availability of new sites over the course of time. As a one-time application, Part 503 allows for application of more than the agronomic rate for nitrogen, provided the application rate is approved by the permitting agency. **Exhibit 4-3** provides other advantages and disadvantages of biosolids application at a reclamation site.

EXHIBIT 4-3
Advantages and Disadvantages of Land Application at a Reclamation Site
GRU Biosolids Management Plan

Advantages	Disadvantages
Reclaims unusable land	Extensive work needed for site preparations
Potential to apply biosolids at high application rates	Irregular land patterns can create problems in application and re-vegetation
No land purchase needed	

4.1.4 Land Application at a Public Contact Site

Biosolids can be land-applied to sites that have a high potential of public contact. In Florida, biosolids must comply with Class A or AA standards to be applied to these sites. If the product is placed in a container and distributed and marketed to the public, it must meet Class AA standards. Such sites include golf courses, public parks, ball fields, highway medians, and cemeteries. Biosolids can be applied to such sites for land reclamation and as a substitute to inorganic fertilizer application. The advantages and disadvantages of application of biosolids at a public contact site are discussed in **Exhibit 4-4**.

EXHIBIT 4-4
Advantages and Disadvantages of Land Application at a Public Contact Site
GRU Biosolids Management Plan

Advantages	Disadvantages
Cheaper substitute of fertilizer for the end user	Strictly regulated due to opportunity for public contact
Improves fertility of soil by adding organic matter and promoting biological activity	High price tag for meeting the strict regulations
Suitable for operations where other disposal alternative are not viable	Requires higher level of treatment to significantly reduce the amount of biosolids present in the biosolids.
	In event of regulation violations, corrective operations can be very expensive

4.1.5 Landfill Disposal

In some areas of the country, biosolids disposal in a landfill is still a reliable, low-cost method of biosolids disposal. However, landfill disposal is not considered a beneficial reuse. The use of landfills for biosolid disposal in the U.S. is expected to be reduced from 17 to 10 percent from 1998 to 2010 (EPA, 1999). The advantages and disadvantages of biosolids disposal in a landfill are discussed in **Exhibit 4-5**.

EXHIBIT 4-5
Advantages and Disadvantages of Landfill Disposal
GRU Biosolids Management Plan

Advantages	Disadvantages
Not dependent on weather	High tipping fees
Reliable disposal method	Occupies landfill space

4.1.6 Thermal Oxidation

Thermal oxidation of biosolids involves burning the volatile organic materials in the biosolids in the presence of oxygen. High temperature and pressure breaks the biosolids and reduces it to ash, which is about 20 percent of the original volume. The process destroys nearly all the volatile solids and pathogens and degrades most toxic organic chemicals. However, metals are not degraded and become concentrated in the residual ash and particulate matter that is contained in the exhaust gases generated by the process. Part 503 of the biosolids rule for gas emission limiting the air pollution must be followed. Non-hazardous ash can be disposed of in a landfill or used in aggregate (e.g., concrete) production, as a fluxing agent in ore processing. Due to their higher volatile solids content, biosolids from primary wastewater treatment processes are more suitable for thermal oxidation than those that have undergone secondary treatment or above. Biosolids from secondary wastewater treatment processes are more difficult to burn because of their lower volatile solids content and the higher water content. Biosolids dewatering is required prior to thermal oxidation. The types of furnaces most commonly used are multiple-hearth and fluidized bed. Due to their more advanced technology, fluidized-bed furnaces have more uniform combustion of biosolids. The advantages and disadvantages of thermal oxidation or incineration of biosolids are discussed in **Exhibit 4-6**.

EXHIBIT 4-6
Advantages and Disadvantages of Thermal Oxidation
GRU Biosolids Management Plan

Advantages	Disadvantages
Maximum solids reduction	High Capital and O&M costs
Energy recovery	Air Pollution
Pathogens completely eliminated	Disposal of hazardous ash containing metal

O&M operations and maintenance

4.2 Biosolids Treatment Alternatives

The main objective for treatment of biosolids is to produce stable biosolids by reducing pathogens and vector attraction, and to reduce the overall volume through destruction of volatile suspended solids (VSS). Some of the biosolids treatment options to GRU are described below.

4.2.1 Aerobic Digestion

Conventional Aerobic Digestion

Aerobic digestion is similar to the activated-sludge process. Excess biomass from the activated-sludge tanks is wasted into digesters (tanks) that continue to maintain a high oxygen level without introducing new organic matter (raw sewage). Thus, substrate is rapidly depleted forcing microorganisms to starve and consume their own cell tissue. The cell tissue is oxidized to carbon dioxide, water, and ammonia. Ammonia is subsequently converted to nitrate, which consumes alkalinity and may decrease the effluent pH.

Factors that need to be considered in aerobic digestion are temperature, SRT, feed solids concentration, and oxygen requirements. Aerobic digesters are generally open tanks where liquid temperature is subject to ambient conditions (i.e., local weather). Lower temperatures slow the digestion process and increase SRT requirements. Though aerobic digestion is usually accomplished with air (i.e., blowers or mechanical mixers) some installations use high-purity oxygen. Moreover, as a rule of thumb, the feed solids concentration should be kept below two-percent solids to provide good mixing and oxygen transfer efficiency.

EXHIBIT 4-7
Advantages and Disadvantages of Conventional Aerobic Digestion
GRU Biosolids Management Plan

Advantages	Disadvantages
High VSS reduction	High energy cost
Low effluent BOD	Biosolids result in poor dewatering characteristics
Higher fertilizing properties	Process is susceptible to temperature, altitude, tank dimensions, and solids concentration
Simple operation with high reliability	
Low capital cost	Requires more tankage; high SRT
Odorless (compared to anaerobic digestion)	May experience foaming
	Less VSS destruction than anaerobic digestion

BOD biological oxygen demand
SRT solids retention time
VSS volatile suspended solids

Autothermal Thermophilic Aerobic Digestion (ATAD)

ATAD is a variation of conventional aerobic digestion. Excess biomass from the activated-sludge tanks is wasted into digesters (tanks) that continue to maintain a high oxygen level without introducing new substrate (organic matter). In ATAD, however, the wasted activated sludge from the activated-sludge process is thickened prior to being introduced into the digesters; hence, adequate mixing is important to avoid anaerobic conditions. The digesters are insulated to conserve the heat from the exothermic reaction from the oxidation of VSS. The heat generated, without supplemental heating, is usually enough to drive the process up to the thermophilic range (55 to 70 $^{\circ}$C), which in turn will increase the VSS destruction rate. **Exhibit 4-8** presents the advantages and disadvantages of ATAD.

EXHIBIT 4-8
Advantages and Disadvantages of ATAD
GRU Biosolids Management Plan

Advantages	Disadvantages
Higher VSS reduction than conventional aerobic digestion	Higher Capital and O&M costs than conventional aerobic digestion
May produce Class A pathogen reduction	Lack of nitrification
Lower retention times than conventional Aerobic digestion	Potential for foaming
Low effluent BOD	Biosolids result in poor dewatering characteristics
Higher fertilizing properties	Requires skilled operators
Simple operation with high reliability	Odorous Product

BOD biological oxygen demand
O&M operations and maintenance
VSS volatile suspended solids

4.2.2 Anaerobic Digestion

Conventional Anaerobic Digestion

Anaerobic digestion involves the decomposition of organic matter (and some inorganic) in the absence of oxygen. This digestion process consists on three stages: hydrolysis of organic matter, a chemical process enzyme driven; fermentation, also called acidogenesis (the conversion of organic matter into organic acids); and methanogenesis (the conversion of organic acids into methane and carbon dioxide). The latter two processes are biological. If properly designed, anaerobic digestion of municipal wastewater may produce sufficient methane gas to meet the energy requirements of the biosolids stabilization process. The extent of methane production is specific to environmental and/or design conditions. The specific gas production at a municipal plant can be estimated by assuming 13 to 18 cubic feet (ft^3) of gas per pound of VSS consumed.

Temperature plays an important role in anaerobic digestion. Temperature affects the rate of digestion, gas product, and SRT requirements. Earlier designs of anaerobic digestion system (also referred to as *low-rate*) did not include supplemental heating (or mixing), which resulted in a longer SRTs and larger tanks. Conversely, conventional anaerobic digestion systems are now generally designed to operate in the mesophilic range (30 to 38 ^{o}C). To reach this temperature, supplemental heating (and mixing) is required. These modified systems are known as *high-rate* anaerobic digestion. It is critical to maintain a constant temperature, since anaerobic microorganisms are sensitive to temperature variations. Anaerobic digesters (tanks) are covered, insulated, and include complex mixing systems. To reduce tankage and heating requirement, pre-thickening of the feed flow is typical, but usually not necessary for treatment of primary sludge. **Exhibit 4-9** presents the advantages and disadvantages of conventional anaerobic digestion.

EXHIBIT 4-9
Advantages and Disadvantages of Conventional Anaerobic Digestion
GRU Biosolids Management Plan

Advantages	Disadvantages
Low net energy requirements: Net operational cost may be low if enough methane is produced	High capital cost
High VSS reduction (40 to 60 percent)	Safety concerns with handling gas
Lower retention times than conventional aerobic digestion	Requires skilled operators
Low effluent BOD	The process can be easily upset and recovers slowly from upsets
High pathogen reduction	Odorous dewatering operations
Reduces total sludge mass	In combination with dewatering, anaerobic processes produces a high concentration of nitrogen in the filtrate

BOD biological oxygen demand
VSS volatile suspended solids

Thermophilic Anaerobic Digestion

Thermophilic anaerobic digestion is a variation of conventional high-rate anaerobic digestion; hence, the advantages and disadvantages presented under conventional anaerobic digestion are still applicable. This is simply an anaerobic digestion system designed to operate in the thermophilic temperature range (between 50 to 75 °C). Thermophilic digesters are more difficult to operate than mesophilic digesters because they are more sensitive to temperature changes. Because the temperature is higher, the heating cost will also be higher. The driver to for adopting a thermophilic process is usually to meet more stringent disposal constraints (i.e., Class A biosolids). By operating at a higher temperature, the biochemical reaction rates increase resulting in an increased solids reduction and methane gas production, which also results in a reduction of SRT and tankage requirements. Thermophilic digestion offers increased pathogen reduction and better sludge dewatering characteristics, as compared to mesophilic digestion. **Exhibit 4-10** presents the advantages and disadvantages of thermophilic anaerobic digestion.

EXHIBIT 4-10
Advantages and Disadvantages of Thermophilic Anaerobic Digestion
GRU Biosolids Management Plan

Advantages	Disadvantages
Higher production of energy as methane gas than mesophilic anaerobic digestion	Higher heating requirements than mesophilic anaerobic digestion
Capable of meeting Class A product	More complex operation than conventional anaerobic digestion.
Higher VSS reduction than mesophilic digestion	Higher capital cost than conventional anaerobic digestion
Lower retention times than conventional aerobic digestion	The process can be easily upset

EXHIBIT 4-10
Advantages and Disadvantages of Thermophilic Anaerobic Digestion
GRU Biosolids Management Plan

Advantages	Disadvantages
Lower effluent BOD than mesophilic anaerobic digestion	More odorous dewatering operations than conventional anaerobic digestion
Higher pathogen reduction than mesophilic anaerobic digestion	

BOD biological oxygen demand
VSS volatile suspended solids

Temperature-Phase Anaerobic Digestion (TPAD)

TPAD is a variation of conventional (high-rate) anaerobic digestion; hence, the advantages and disadvantages presented under conventional anaerobic digestion are still applicable. TPAD combines the thermophilic and mesophilic processes described above to benefits from both processes: the higher digestion rates of thermophilic digestion and the stabilization and odor mitigation properties of mesophilic digestion. The thermophilic stage provides greater hydrolysis and biological activity that result in greater VSS reduction and gas production. The mesophilic stage conditions the sludge for further handling (i.e. easier to dewater) and reduces the amount of odorous compounds. The main advantages of this system, however, are the ability to reduce coliform count and meet the Class A biosolids criteria under the 40 CFR Part 503 Rule. The TPAD process can be operated in either a mesophilic-thermophilic or a thermophilic-mesophilic arrangement. **Exhibit 4-11** presents the advantages and disadvantages of TPAD.

EXHIBIT 4-11
Advantages and Disadvantages of Temperature-Phase Anaerobic Digestion (TPAD)
GRU Biosolids Management Plan

Advantages	Disadvantages
Higher production of energy as methane gas than mesophilic anaerobic digestion	Higher heating requirements than mesophilic anaerobic digestion
Higher VSS reduction than mesophilic anaerobic digestion	Requires skilled operators
Lower retention times than mesophilic anaerobic digestion	Higher capital costs than mesophilic aerobic digestion
Higher pathogen reduction than mesophilic anaerobic digestion	The process can be easily upset by temperature changes
Higher stabilization of biosolids than thermophilic anaerobic digestion	In combination with dewatering, anaerobic processes produces a high concentration of nitrogen in the filtrate
Less odorous product than thermophilic anaerobic digestion	
Capable of meeting Class A product	

VSS volatile suspended solids

Acid/Gas-Phased Anaerobic Digestion

The following is another variation of anaerobic digestion; hence, the advantages and disadvantages presented under conventional anaerobic digestion are still applicable. The acid/gas-phased anaerobic system separates the hydrolysis/fermentation processes from methanogenesys (or gas production), to benefit the overall biosolids stabilization process. The first stage (i.e., acid formation) converts the substrate into low molecular weight volatile acids. This first stage can be operated in the thermophilic or mesophilic temperature range. During acid formation, the pH is kept around 5.5-6.5 limiting the methanogens. Then, the second stage provides ideal environmental conditions for methanogens, gas-producing microorganisms, typically operated in the mesophilic temperature range. The second stage is conducted at a neutral pH. **Exhibit 4-12** presents the advantages and disadvantages of acid/gas-phased anaerobic digestion.

EXHIBIT 4-12
Advantages and Disadvantages of Acid/Gas-Phased Anaerobic Digestion
GRU Biosolids Management Plan

Advantages	Disadvantages
Enhanced control of foaming	
Higher production of energy as methane gas than mesophilic anaerobic digestion	Higher heating requirements than mesophilic anaerobic digestion
Higher VSS reduction than mesophilic anaerobic digestion	Requires skilled operators
Lower retention times than mesophilic anaerobic digestion	Higher capital costs than mesophilic aerobic digestion
Higher pathogen reduction than mesophilic anaerobic digestion	The process can be easily upset
Higher stabilization of biosolids than thermophilic anaerobic digestion	In combination with dewatering, anaerobic processes produces a high concentration of nitrogen in the filtrate
Less odorous product than thermophilic anaerobic digestion	
Capable of meeting Class A product	

VSS volatile suspended solids

4.2.3 Alkaline Stabilization and Pasteurization

An alternative method for biosolids stabilization is by using alkaline materials to raise the pH to make the material unsuitable for microorganism. Quicklime (CaO) is typically used to drive this process. In general, adding quicklime to a dewatered biosolids can either act as a stabilization or pasteurization process depending on the amount added.

- Lime to biosolids ratio of 1.5:1 to produce Class A
- Lime to biosolids ratio of 0.3:1 to produce Class B

The lime to biosolids ratios listed above are general rules of thumbs used to determine the volume of lime required for each process. According to the Part 503 Rule, to meet Class B biosolids, sufficient lime should be added to raise the pH to 12 after two hours of contact (40

CFR 503.32[b][3]). To meet Class A standards, the temperature of the biosolids should be maintained at 70 °C for more than 30 minutes (40 CFR 503.32[a][7]). The required pH and temperature can be met by adjusting the lime to biosolids ratio and/or by adding supplemental heating.

Several proprietary advanced alkaline technologies may reduce the required lime to biosolids ratio. There are multiple benefits from reducing the percentage of lime in the final product. A lower lime to biosolids ratio will save money in lime (i.e., raw material) and will maximize the land application rate of the final product. The land application rate of lime-processed biosolids is limited by the existing soil pH and the calcium carbonate equivalency of the processed material. Thus, as the lime ratio increases, the maximum allowable application rate of lime stabilize/pasteurize biosolids will decrease. **Exhibit 4-13** presents the advantages and disadvantages of lime stabilization.

EXHIBIT 4-13
Advantages and Disadvantages of Lime Stabilization
GRU Biosolids Management Plan

Advantages	Disadvantages
Flexible, Class A or Class B achievable	Ability to apply and allowable application rates may be limited by soil condition and crop type
Reliable process	Safety concerns, creates dust
Multiple markets (for Class A, pasteurization), product has a value as a liming agent and low-grade fertilizer	High O&M costs
Relatively easy to operate	High chemical use (i.e. quicklime, and polymer)
Properly stabilized product is easy to handle	Dewatering and odor control required
	Some processes are proprietary

O&M is operations and maintenance

4.2.4 Composting

Composting converts dewatered biosolids to a humus-like product, relatively free of human and animal pathogens and which is beneficial to soil health and plant growth. Composting is considered beneficial reuse and is considered a marketable product. Different methods are used for making compost. These methods can be broadly categorized into two categories: open composting and in-vessel composting

Open Composting

Several methods of open-air composting are currently being used in the U.S., including the Windrow and Aerated Static Pile (ASP) processes. The Windrow process involves placing the composting mixture in rows and periodically turning it using a mechanical device. Oxygen is supplied during the process of disturbing the mixture and through natural ventilation. The ASP method is a relatively simple process that is less labor- and energy-intensive. When using the ASP method, dewatered biosolids are mixed with a bulking agent (i.e., wood chips or shredded tires) and formed into large piles. The quantity of bulking agent to biosolids varies from 2:1 to 3:1 by volume. The piles are typically left for 21 to 28 days for the process of primary composting. No mixing of the pile is needed in this process; however, air is introduced into the pile through a forced air or induced draft distribution system. After primary composting, the material is screened to separate out the bulking agent. The bulking agent is sent back to be reused for primary composting with the next batch of biosolids, while the remaining material is formed into a second pile and left for next 30 to 60 days for curing. The product of the curing process is the final compost product. Compost product will be stored at the facility for up to 30 days before being transported by an agent or a buyer.

In-Vessel Composting

In-vessel composting is similar to open composting, except that the process of composting occurs in a closed or semi-closed vessel such as a tank, concrete tunnel, or open-top concrete bay. Using a closed, controlled environment helps reduce the potential for odor releases that are normally a problem with open air composting process and also makes the process less weather dependent. However, higher capital and operating costs are needed to provide for buildings and machinery. Some of the advantages of disadvantages of using a composting process are presented in **Exhibit 4-14**.

EXHIBIT 4-14
Advantages and Disadvantages of Composting
GRU Biosolids Management Plan

Advantages	Disadvantages
No additional treatment processes needed	Produces odors; odor control systems are usually required along with air permits
Marketable product, Class A product	Prices may increase due to future end-product marketability, permitting issues, energy & labor price increases
	Requires bulking material (i.e., yard waste)
	Additional storage space may be required for seasonal usage peaks

4.2.5 Thickening and Dewatering Applications

Gravity Belt Thickener (GBT)

A gravity belt thickener (GBT) is a device that accomplishes solids-liquid separation by means of a fabric-mesh belt. Dilute wastewater sludge is fed continuously on to the belt; water percolates through the belt by gravity and thickened sludge is carried on top of the belt on to the discharge side of the GBT. The filtrate is collected by a sump and returned to the plant's headworks. However, without chemical addition for coagulation and flocculation, the open-mesh fabric would permit excessive solids loss. Thus, the sludge has to be conditioned with polymer prior to being fed into the GBT.

GBTs are limited to sludges having solids concentrations lower than two percent. The process can achieve product concentrations between 5.5 and 8.0 percent dry-solids. GBTs are not self-contained and must be installed inside a building, preferably with ventilation and odor control systems. The typical hydraulic loading rate is 150 gallons/minute/meter; Solid loading rates range between 200 to 600 kg/minute/meter; polymer dosages are approximately 6 to 14 lb per ton of dry solids. **Exhibit 4-15** presents the advantages and disadvantages of using the GBT.

EXHIBIT 4-15
Advantages and Disadvantages of Gravity Belt Thickener (GBT)
GRU Biosolids Management Plan

Advantages	Disadvantages
Reliable equipment and process	Large overall disposal volume of biosolids compared to dewatering operations
Low polymer dose	Final product easier to handle at land application site
Capable of high loading rates	
May use pumps to load trucks	

Belt Filter Press (BFP)

Similar to GBTs, BFPs dewater wastewater sludge by percolating through belts by gravity. However, on BFPs, as biosolids are fed onto the belt and dewater by gravity, a second belt applies force from above squeezing the biosolids from both sides. Water is filtered through the permeable belts and dewatered biosolids (between 16 to 20 percent solids) remaining within the belts is later discharged on to a hopper. BFPs apply a gradually increasing pressure on the sludge as it passes between two belts.

Good conditioning (i.e., polymer) is important to achieve acceptable cake dryness and a moderate level of operator attention is needed to maintain optimal performance. BFPs typically achieve 16 to 20 percent solids on WAS sludges and 22 to 30 percent solids on primary sludges. Typical hydraulic loading rates are 100 gallons/minute/meter; the solid loading rate is approximately 600 lb/hr/meter; the polymer dose is approximately 15 lb per ton of dry solids. **Exhibit 4-16** presents the advantages and disadvantages of using the BFP.

EXHIBIT 4-16
Advantages and Disadvantages of Belt Filter Press (BFP)
GRU Biosolids Management Plan

Advantages	Disadvantages
Higher percent solids than GBT	Odorous operation
Lower overall disposal volume of Biosolids than thickening operations	Lower loading rate than GBT
Easy to operate and maintain	Higher polymer dosage than GBT
Reliable equipment	Significant filtrate flow, with high ammonia, returned to the plant headwork.
Lower energy requirements than centrifuges	Belt conveyer are required to transport dewatered biosolids

EXHIBIT 4-16
Advantages and Disadvantages of Belt Filter Press (BFP)
GRU Biosolids Management Plan

Advantages	Disadvantages

GBT gravity belt thickener

Centrifuge

Centrifuges are devices frequently used for dewatering municipal wastewater sludges. Though there are various types of centrifuges, the solid-bowl conveyer centrifuge is generally used for dewatering wastewater sludge. This centrifuge consists on a rotating cylindrical-conical bowl (reactor) that separates solids form liquid by centripetal force. As this force is applied to dilute wastewater sludge, the difference in density between the solids and water makes each accelerate at a different rate and thus separate. A screw conveyer then pushes the solids to one end of the bowl while the water drains by gravity at the opposite end.

The resulting product from centrifuges is typically 15 to 36 percent solids. As with other dewatering equipment, polymer is required to achieve the upper range percent solids. Polymer dosages are approximately 20 lb per ton of dry solids. The initial cost, power, and polymer requirements for installing centrifuges are higher than to install either BFPs or GBTs. However, centrifuges require less space and odors are contained within the unit; hence, it requires a smaller building and odor control system. **Exhibit 4-17** presents the advantages and disadvantages of using centrifuges.

EXHIBIT 4-17
Advantages and Disadvantages of Centrifuges
GRU Biosolids Management Plan

Advantages	Disadvantages
Higher percent solids product than BFP	Not reliable; requires a stand-by unit for redundancy
Lower overall disposal volume of biosolids than BFP operations	High capital cost
Clean appearance	High power and polymer costs
Easy to control odor emissions	Moderately high suspended solids in the centrate
Easy to operate	

BFP belt filter press

4.3 Results from Preliminary Screening of Biosolids Management Alternatives

The project team held a workshop to perform a preliminary screening of pertinent biosolids management alternatives. During the workshop, CH2M HILL presented a list of potential biosolids end-use and treatment alternatives that included advantages, disadvantages, and, for some, order-of-magnitude costs (Appendix A). The workshop participants reached a consensus that a successful biosolids management program should have the following characteristics:

- Constructability
- Reliability
- Cost-effectiveness
- Flexibility
- Health, safety and environmental protection
- High quality product

The preliminary screening objective was to select a reasonable number of alternatives that would be carried through conceptual design and budgetary cost pricing. The selected alternatives are presented in **Exhibit 4-18.**

EXHIBIT 4-18
Selected Alternatives from the Preliminary Screening of Biosolids Management Alternatives
GRU Biosolids Management Plan

End-Use Alternatives	Treatment Alternatives	Thickening/Dewatering Alternatives
Agricultural Land Application	Conventional Aerobic Digestion	Gravity Belt Thickening
Forest Land Application	Conventional Anaerobic Digestion	Belt Filter Press
Land Application at Public Contact Sites – Marketing and Distribution of Class A Biosolids	Advanced Anaerobic Digestion	
Thermal Oxidation	Composting	
	Alkaline Stabilization / Pasteurization	








Biosolids Management Alternatives
Selected for Detailed Evaluation

5. Biosolids Management Alternatives Selected for Detailed Evaluation

The selected alternatives from the preliminary screening of biosolids management alternatives (**Section 4**) were evaluated by developing conceptual designs, capital costs, O&M costs, and total present-worth costs. The objective was to associate each of the selected alternatives with a 20-year present-worth cost. A detailed evaluation of each alternative, based upon non-monetary criteria, was also developed and is discussed later in this report. The preferred alternative will be selected based on cost ranking and non-monetary benefits.

The following section will present the general design criteria for the evaluation; the cost estimation methodology; and the conceptual designs and costs for the selected end-use and treatment alternatives. Each of the selected alternatives is accompanied by an acronym. The acronyms were developed as a way to identify and track the various options when presenting them in exhibits.

5.1 Conceptual Design Criteria

To compare the selected alternatives, all the conceptual designs were developed based on the plant buildout conditions presented in **Exhibit 5-1.** Record data from 2003 to 2005 were evaluated using a frequency distribution analysis (see **Section 3**) to determine the AADL and MMADL, in dry lb/MG, for each facility. These parameters provide the basis for sizing of the biosolids management facilities.

EXHIBIT 5-1
Conceptual Design Criteria
GRU Biosolids Management Plan

Design Criteria	KWRF	MSWRF
Annual Average Daily Flow (AADF), MGD	17.5	7.5
Water Temperature, °C	15	15
Waste Activated Sludge (WAS) Production[1]		
Annual Average Daily Load (AADL)[2], dry lb/MG	1,560	1,120
Max. Month Average Daily Load (MMADL)[3], dry lb/MG	2,000	1,550
Other WAS contributions, dry lb/day	-	4,000 [4]
WAS VSS/TSS Ratio	0.77	0.77
WAS Percent Solids	1.85	1.96

[1] Data from Plant Daily Operations Reports (DMRs)
[2] AADL values are based on monthly averages of WAS production for 2003-2005
[3] MMADL values are based on the 92nd percentile of WAS production for 2003-2005
[4] Projected sludge contribution from the University of Florida in 2025

To evaluate operation and maintenance requirements, the GRU Strategic Planning Department provided CH2M HILL with anticipated wastewater flows for the next 20 years based on customer forecasts. CH2M HILL used this information to generated biosolids yearly projections for the KWRF and the MSWRF through 2025.

5.2 Cost Estimating Methodology

The report used capital and O&M costs to calculate the total present-worth value for each alternative. The following section documents the assumptions used for cost development. The cost estimates herein presented are considered to be Class 5 estimates in the new Association of the Advancement of Cost Engineering International (AACEI) classification system 18R-97 or order-of-magnitude in the older ANSI Z94.2–1989 standard. Based on AACEI guidelines, these estimates are considered accurate to within plus 40 percent and minus 25 percent of the actual cost. This level of estimate is prepared from the following:

- Outline design criteria
- General assumptions of existing soils conditions and/or foundation requirements
- Rough sketches
- Approximate size and types of construction
- Rough utility requirements
- Process flow diagrams
- Parametric cost models
- Vendor quotes

5.2.1 Capital Costs

New Facilities

This report assumes that new facilities and major equipment would be installed in 2006. Thus, capital costs were incorporated in year 2006 dollars without regard for discounting or inflation. In addition, it was assumed that there would be no phasing of construction over the 20-year life of the analysis. All facilities required for build-out conditions would be designed and constructed immediately.

The capital costs were based primarily on major equipment quotes and facility layouts generated for each option. Building costs are based on cost per square foot (ft^2) data from previous GRU projects. Concrete costs for tankage and structures were based on current information from CH2M HILL construction cost estimators.

To complete the construction cost estimates, allowances were used to determine the approximate total construction costs. A summary of the allowances is presented in **Exhibit 5-2.** As was discussed with GRU staff, a construction contingency of 30 percent was applied to all cost estimates due to the conceptual nature of these evaluations. The construction contingency accounts for unidentified project components. In addition, standby power needs will require further analysis to determine the compatibility with the existing generators. Therefore, the cost of additional generators was not included in any of the options herein presented.

EXHIBIT 5-2
Capital Cost Assumptions
GRU Biosolids Management Plan

Item	Percentage of Capital Cost
General Conditions	3%
Site Work	7%
Electrical and I&C	19%
Overhead (construction)	10%
Profit (construction)	8%
MOB/Bonding	5%
Contingency	30%
Engineering / Administration	25%
Auxiliary Power	Not included

Transportation

Biosolids can be transported from a WRF to an application/disposal site using trucks, railroad, or pipeline. However, for short distances truck hauling is a flexible, economical and widely used method of hauling biosolids. Currently, liquid biosolids from both GRU WRFs are transported via trucks to the WPR land application site. Since the sites for all the current and proposed application/disposal options considered in this management plan are within Alachua County, transporting biosolids using trucks is considered to be the most cost-effective method. For all the current and proposed options discussed in this report, transportation of biosolids from the WRFs to the application/disposal site will be via trucks.

For each alternative, annual estimates of transportation costs were developed for the years 2006 to 2025. Transportation capital costs were based on the number of vehicles needed for hauling biosolids. The number of vehicles for each year was calculated based on the MMDL projections and the estimated transport cycle times. Useful life of the vehicles was also taken into consideration and the cost of any replacement vehicles needed before 2025 was added to the capital cost as needed. Cost of replacement vehicles was calculated based on its cost in 2006 with 4-percent annual escalation to the year the replacement vehicle is needed. For the treatment alternatives which produce liquid biosolids, the existing fleet of transportation owned by GRU was used until a replacement vehicle was needed, based on the useful life and the year of purchase of the vehicle. GRU currently uses a 6,000-gallon tanker and a Freightliner highway tractor to transport liquid biosolids to the WPR. For the dewatered biosolids alternatives, costs for new equipment were included in the startup year of 2006. Details of the transportation vehicles used for different alternatives are provided in **Exhibit 5-3**.

EXHIBIT 5-3
Details of Transportation Vehicles
GRU Biosolids Management Plan

Origination	Purchase year	Cost [1]	Useful Life (years)
Current GRU Vehicle			

EXHIBIT 5-3
Details of Transportation Vehicles
GRU Biosolids Management Plan

Origination	Purchase year	Cost [1]	Useful Life (years)
6,000-gallon tanker truck	1997	$65,000	20
Freightliner highway tractor	2002	$125,000	10
New Vehicle			
25-cu yd truck	2006	$105,000	20
Freightliner highway tractor	2006	$141,000	10

[1] Cost at the time of purchase
cu yd cubic yards

Land Application

Capital costs for the proposed end-use alternatives included the cost of application equipment or application vehicles, cost of storage facilities need (e.g., storage facility to provide for 14 days of wet weather storage for dewatered land application options), and cost of purchasing land, if applicable. The number of application vehicles was calculated for each year based on the MMADL projections. The cost of additional vehicle, if needed, and cost of replacement vehicle based on its useful life was also added to the total capital cost of an alternative. For alternatives where liquid biosolid was land-applied, application equipment currently owned by GRU was also taken into account in the capital cost estimations. The GRU currently has one liquid biosolids application vehicle, a Houle 9500, which has a carrying capacity of 9,500 gallons. General assumptions for computing the capital cost of the application equipment used are shown in **Exhibit 5-4**.

EXHIBIT 5-4
Details of Land Application Vehicles
GRU Biosolids Management Plan

Origination	Purchase Year	Capacity	Cost[1]	Useful Life (years)
Current GRU Vehicle				
9500 Houle applicator	2002	9,500 gallons	$350,000	15
New Vehicle				
Liquid applicator [1]	2006	6,000 gallons	$275,000	15
Side spreader [2]	2006	16 yd^3	$127,500	15
Side slinger [3]	2006	13 yd^3	$110,000	15
Front End Loader	2006	3 yd^3	$220,000	15

[1] For agricultural application of liquid biosolids
[2] For agricultural application of dewatered biosolids
[3] For forest application of dewatered biosolids
yd^3 cubic yards

Cost of Land

The cost of purchasing land for the alternative that required the purchase of land was computed based on the land costs provided by GRU (see **Exhibit 5-5**). For the alternatives that require land purchase, it was assumed that the necessary land would be acquired in 2006. Thus, land costs were incorporated in year 2006 dollars without regards for discounting or inflation. The land area needed for each alternative was calculated based on nitrogen loading requirements without consideration for potential future implementation of P loading requirements. (See **Appendix B**).

EXHIBIT 5-5
Land Cost Used in Cost Estimates
GRU Biosolids Management Plan

Area	Property size (acres)	Land cost ($/acre)
Archer/Newberry area	Less than 100	$15,000
	More than 100	$12,000
Parker Road area	Less than 100	$30,000
	More than 100	$20,000
Eastern Alachua County	Less than 100	$12,000
	More than 100	$8,000

5.2.2 O&M Costs

New Facilities

The O&M costs for new facilities were derived from estimates of electrical power, labor, chemicals, repair, and replacement, and miscellaneous costs for each treatment alternative. The costs were computed on a yearly basis based on projected flow data provided by GRU and presented in **Exhibit 5-6**. Subsequently, present-worth O&M costs for each alternative were calculated assuming a 7.5-percent discount rate over the 20-years planning period (2006-2025).

EXHIBIT 5-6
Projected Average Annual Daily Flows (AADF) for GRU WRFs
GRU Biosolids Management Plan

	Average Annual Daily Flow (MGD)	
Year	KWRF	MSWRF
2006	12.0	6.0
2007	12.3	6.0
2008	12.5	6.1
2009	12.8	6.1
2010	13.1	6.2
2011	13.3	6.2
2012	13.6	6.3
2013	13.9	6.3

EXHIBIT 5-6
Projected Average Annual Daily Flows (AADF) for GRU WRFs
GRU Biosolids Management Plan

	Average Annual Daily Flow (MGD)	
Year	**KWRF**	**MSWRF**
2014	14.1	6.4
2015	14.4	6.4
2016	14.6	6.5
2017	14.9	6.5
2018	15.1	6.6
2019	15.4	6.6
2020	15.6	6.7
2021	15.8	6.7
2022	16.1	6.7
2023	16.3	6.8
2024	16.5	6.8
2025	16.7	6.9

Data provided by GRU/Strategic Planning Department.
MGD million gallons per day

Electrical Power

Power costs were calculated based on the horsepower (HP) rating of the equipment. The analysis assumes that the equipment necessary to meet the average daily flow requirements is in service and that all digesters are continuously operated. Therefore, digesters are not shut down during low flows or summer months. The yearly costs per kilowatt-hour were provided by GRU and are presented in **Exhibit 5-7.**

EXHIBIT 5-7
Anticipated Electrical Power Costs
GRU Biosolids Management Plan

Year	Power, $/Kilowatt-hr
2006	0.075
2007	0.078
2008	0.080
2009	0.081
2010	0.083
2011	0.084
2012	0.075
2013	0.077
2014	0.078
2015	0.079
2016	0.080

EXHIBIT 5-7
Anticipated Electrical Power Costs
GRU Biosolids Management Plan

Year	Power, $/Kilowatt-hr
2017	0.081
2018	0.082
2019	0.083
2020	0.084
2021	0.086
2022	0.087
2023	0.088
2024	0.090
2025	0.092

Data provided by GRU/Strategic Planning Department

Labor

Unless otherwise specified in the detail description of a selected alternative, a labor rate of $28 per hour was assumed. This rate, provided by GRU, is based on the average 2006 pay-rate of a plant operator. A 3-percent yearly escalation was used to estimate labor rates through 2025. This labor cost was intended to represent an average cost of an operator and do not represent a particular level of operator. Moreover, this rate includes a 40-percent mark-up for fringe benefits and overhead costs.

Chemicals

Chemical usage was calculated based on AADL requirements. Historical records show that chemical costs have fluctuated throughout the last two decades. Factors affecting local prices include local market conditions (i.e. production vs. demand) and international oil prices. Thus, it is difficult to predict future chemical prices based on historical trends with a good level of confidence. For this reason, year 2006 prices were escalated by 3-percent to estimate chemical prices in subsequent years. A summary of chemical costs is provided in **Exhibit 5-8**.

EXHIBIT 5-8
Estimate Chemical Costs
GRU Biosolids Management Plan

Chemical Name	2006 Price
Polymer	$1.5/lb
Quicklime	$90.0/ton

Replacement and Repair

For each alternative, a value equal to 2-percent of the equipment cost was budgeted for miscellaneous repairs, with a 3-percent escalation per year to account for inflation. This is a general assumption based on CH2M HILL project experience.

Transportation and Land Application

The O&M cost for transportation and land application alternatives were calculated based on the methodology provided by EPA (1985). The O&M costs for biosolids transport and land application were based on the AADL. The O&M cost included fuel cost, labor cost, and vehicle maintenance cost. Fuel was priced as $ 2.60 per gallon in 2006 with and annual increase of 3 per year to estimate fuel costs for subsequent years. Fuel requirement for transportation cost was a function of the hauling distance and number of trips annually. Labor cost for transportation and land application was based on cost assumptions as described in the pertinent subsection. Annual labor requirement was calculated based on the round trip travel time and the annual number of trips. Average travel speed of the transportation vehicles used to calculate the round trip travel time for different alternatives is provided in **Exhibit 5-9**. Vehicle maintenance cost was calculated based on the mileage for the transportation vehicles with an annual escalation factor of 3 percent. Annual mileage of the trucks was calculated based on the average distances to the land application sites (see **Exhibit 5-9**). Based on recent project budget by CH2M HILL, the vehicle maintenance cost was estimated as 53 cents/mile for the 6,000 gallon tanker and 59 cents/mile for the 25-yd^3 flatbed truck.

EXHIBIT 5-9
Hauling Distances for Biosolids and Yard Waste
GRU Biosolids Management Plan

Origination	Destination	Hauling Distance (miles)	Average Travel Speed (mph)[1]
(1) Transportation of Biosolids			
Kanapaha WRF[2]	Whistling Pines Ranch	10	25
	New Agricultural site	20	25
	Forest Site	22	30
	Compost Processing Site	10	25
	Deer Haven	9	25
	Offsite Storage[3]	20	30
Main Street WRF	Whistling Pines Ranch	20	25
	New Agricultural site	30	25
	Forest Site	15	30
	Composting Processing Site	20	25
	Deer Haven	15	25
	Offsite Storage[3]	10	25
Offsite Storage	Land application site	20	35
(2) Transportation of Yard Waste			
Gainesville	Compost Processing Site	30	30

[1] Miles per hour

[2] Wastewater Reclamation Facility

[3] Lime pasteurization alternative

The O&M cost for land application at WPR is the responsibility of the property owner. GRU pays an annual compensation to the owner to use their land for application of biosolids. The annual compensation used for this analysis is discussed in detail in Section 5.3. Similarly for the dedicated new agricultural site it was assumed that GRU will lease the operations of the farm in an arrangement similar to the one they currently have with the owner of WPR. For alternatives with forestland application, the assumption was that GRU would be responsible for all the operations and management of the operations. A detailed cost of land application for such options was developed based on the procedure outlined by EPA (1985).

5.3 Proposed End-Use Alternatives

The following section evaluates the proposed biosolids end-uses selected from the preliminary screening discussed in **Section 4**. The alternatives short-listed in the preliminary screening task were evaluated to develop the present worth of capital cost, present worth of O&M cost, and total present-worth cost.

5.3.1 Land Application at Whistling Pines Ranch

As discussed previously in this report, biosolids from the MSWRF and KWRF are currently taken to WPR for land application. The current contract allows GRU to use WPR until 2009. While the contract between GRU and WPR can be renewed, there are uncertainties regarding the long-term viability of the contract since the WPR owner may opt to sell or pass the property on to family members instead of continuing to lease the land for biosolids land application. In addition, the potential for elevated NO_3 groundwater concentrations common to agricultural lands where inorganic fertilizers has been used over a long period could impact the use of WPR for biosolids application. The following options discuss the cost analysis of GRU continuing to use the WPR as a land application site.

GRU Under Contract with Whistling Pines Ranch (WPR)

In this alternative, GRU will continue to use WPR as a land application site (LAS) through 2025 and beyond. This would require that GRU renegotiate a contract with the WPR owner after 2009. Renegotiation of the contract may lead to an increase in the compensation to the WPR owner. However, for the purpose of this report, cost estimates were based on the GRU paying $35,000 annually to the WPR owner as compensation, with an annual increase of 3 percent to adjust for inflation. Due to potential impacts to groundwater, GRU should attempt to reduce or eliminate the application of inorganic nitrogen fertilizer at the WPR. As an incentive to the owner, it was assumed that GRU would pay an additional fee for any reduction in the yield caused by the reduction of inorganic fertilizer. For the purpose of this analysis, this fee was assumed to be 20 percent of the annual compensation paid by the GRU. For this option, transportation and land application vehicles currently owned and operated by GRU were used until they had to be replaced. The O&M cost was based on the assumptions discussed in the previous sections. The O&M cost for land application only consists of the annual compensation paid to the owner and was the same for all of the onsite treatment alternatives. Cost summaries for transportation (see **Exhibit 5-10**) and land application (see **Exhibit 5-11**) for this alternative were developed for each of the selected treatment alternatives. A detailed discussion on the selected treatment alternatives is provided in **Section 5.4**. For the purpose of simplification, costs presented for an alternative are the total cost for both the WRFs.

EXHIBIT 5-10
Summary of Transportation Costs (in millions of dollars) for Whistling Pines Ranch Land Application Site
GRU Biosolids Management Plan

Treatment Process[1]	Present-Worth Capital Cost	Present-Worth O&M Cost	Total Present-Worth Cost
Thickened			
Aerobic- 27 days SRT	0.631	3.240	3.871
Aerobic- 60 days SRT	0.631	3.062	3.693
Conventional Anaerobic	0.631	2.869	3.500
Advanced Anaerobic	0.631	2.062	2.693
Dewatered			
Aerobic- 27 days SRT	0.434	1.250	1.684
Aerobic- 60 days SRT	0.434	1.181	1.615
Conventional Anaerobic	0.434	1.119	1.553
Advanced Anaerobic	0.434	0.785	1.129

[1] For a detailed discussion on treatment alternatives see Section 5.4.

EXHIBIT 5-11
Summary of Land Application Costs (in millions of dollars) for Whistling Pines Ranch Land Application Site
GRU Biosolids Management Plan

Treatment Process[1]	Present-Worth Capital Cost	Present-Worth O&M Cost	Total Present-Worth Cost
Thickened			
Aerobic- 27 days SRT	1.231	0.537	1.768
Aerobic- 60 days SRT	1.231	0.537	1.768
Conventional Anaerobic	0.787	0.537	1.324
Advanced Anaerobic	0.736	0.537	1.273
Dewatered			
Aerobic- 27 days SRT	1.561	0.537	2.098
Aerobic- 60 days SRT	1.536	0.537	2.073
Conventional Anaerobic	1.394	0.537	1.931
Advanced Anaerobic	1.296	0.537	1.833

[1] For a detailed discussion on treatment alternatives see Section 5.4.

GRU to Purchase Whistling Pines Ranch (GRUWP)

Operationally this alternative is the same as the one discussed previously with the only difference being that GRU will purchase WPR. This alternative assumes that GRU will not be involved in the land application of biosolids (same as the existing contract with the owner of WPR). The O&M of the site will be leased to a different entity. As the owner of the land application site, GRU can exercise more control over the application of biosolids, inorganic nitrogen fertilizer, and other amendments. However, GRU would need additional capital to purchase the 1,175-acre site. For this alternative, the transportation cost (capital and O&M cost) and O&M cost for land application is the same as that of the previous alternative. However, the capital cost of each alternative will increase due to the additional cost incurred to buy the property. A cost summary for this alternative is shown in **Exhibit 5-12**.

EXHIBIT 5-12
Summary of Land Application Cost (in millions of dollars) for GRU to Buy Whistling Pines Ranch
GRU Biosolids Management Plan

Treatment Process[1]	Present-Worth Capital Cost [2]	Present-Worth O&M Cost	Total Present-Worth Cost
Thickened			
Aerobic- 27 days SRT	15.331	0.537	15.868
Aerobic- 60 days SRT	15.331	0.537	15.868
Conventional Anaerobic	14.887	0.537	15.424
Advanced Anaerobic	14.836	0.537	15.373
Dewatered			
Aerobic- 27 days SRT	15.661	0.537	16.198
Aerobic- 60 days SRT	15.636	0.537	16.173
Conventional Anaerobic	15.494	0.537	16.031
Advanced Anaerobic	15.396	0.537	15.933

[1] For a detailed discussion on treatment alternatives see Section 5.4.
[2] PW cost does not Include the salvage value of land purchase

5.3.2 Land Application at Dedicated New Agricultural Site (DNAS)

This alternative assumes that GRU will purchase new property for agricultural land application of biosolids. The location of the new site was assumed to be about 20 miles from KWRF and 30 miles from MSWRF (see **Exhibit 5-9**). For the purpose of this report it was assumed that the O&M of the farming operation at the new site will be leased to a separate entity, while GRU will continue to provide for the land application equipment and the transportation of biosolids to the site. This is the same approach currently used by GRU and WPR. Because GRU would own the new site, they can implement a land application program which has a primary goal of treating biosolids as compared to trying to balance biosolids treatment goals against the economic goals of the private farming enterprise. An initial annual fee of $50,000 would be paid to a lessee for the operation and management of the farm. It was assumed that this fee would increase by 3 percent each year. A summary of capital and O&M costs for transportation and land application for the DNAS option is provided in **Exhibits 5-13 and 5-14**.

For this analysis it was assumed that a single site of adequate size could be purchased. Due to limitations in available land area, in practice it may be necessary to purchase multiple non-continuous sites. This would increase the capital and O&M costs for transportation, storage and application equipments.

EXHIBIT 5-13
Summary of Transportation Cost (in millions of dollars) for New Dedicated Agricultural Site Alternative
GRU Biosolids Management Plan

Treatment Process[1]	**Present-Worth Capital Cost**	**Present-Worth O&M Cost**	**Total Present-Worth Cost**
Thickened			
Aerobic- 27 days SRT	0.631	5.179	5.809
Aerobic- 60 days SRT	0.631	4.896	5.527
Conventional Anaerobic	0.631	4.545	5.176
Advanced Anaerobic	0.631	3.336	3.967
Dewatered			
Aerobic- 27 days SRT	0.434	1.974	2.408
Aerobic- 60 days SRT	0.434	1.867	2.301
Conventional Anaerobic	0.434	1.752	2.186
Advanced Anaerobic	0.434	1.256	1.690

[1] For a detailed discussion on treatment alternatives see Section 5.4.

EXHIBIT 5-14
Summary of Land Application Costs for (in millions of dollars) New Dedicated Agricultural Site Alternative
GRU Biosolids Management Plan

Treatment Process[1]	**Present-Worth Capital Cost** [2]	**Present-Worth O&M Cost**	**Total Present-Worth Cost**
Thickened			
Aerobic- 27 days SRT	15.871	0.639	16.510
Aerobic- 60 days SRT	15.031	0.639	15.067
Conventional Anaerobic	13.507	0.639	14.146
Advanced Anaerobic	12.136	0.639	12.775
Dewatered			
Aerobic- 27 days SRT	14.041	0.639	14.680
Aerobic- 60 days SRT	13.416	0.639	14.055
Conventional Anaerobic	12.314	0.639	12.953
Advanced Anaerobic	11.016	0.639	11.655

[1] For a detailed discussion on treatment alternatives see Section 5.4.

EXHIBIT 5-14
Summary of Land Application Costs for (in millions of dollars) New Dedicated Agricultural Site Alternative
GRU Biosolids Management Plan

Treatment Process[1]	Present-Worth Capital Cost [2]	Present-Worth O&M Cost	Total Present-Worth Cost

[2] PW cost does not Include the salvage value of land purchase

5.3.3 Forest Application (FOR)

This alternative analyzed the cost of biosolids application at a forested site. For the purpose of this report it was assumed that the GRU will lease the forested site from a private entity. The location of the forested site is assumed to be in eastern Alachua County. The lease cost to be paid by GRU was assumed to be $ 3.00 per acre. GRU will also be responsible for providing the equipment, labor, and fuel needed for land application operation. Additional cost incurred by GRU for this alternative will be the cost of road grading and clearing of brushes and trees to keep the site accessible for application equipment. Based on the preliminary screening, this alternative was not evaluated for thickened biosolids from the conventional anaerobic and advanced anaerobic onsite WRF upgrades. A summary of capital and O&M costs for the forested land application option is provided in **Exhibits 5-15** and **5-16**.

EXHIBIT 5-15
Summary of Transportation Costs (in millions of dollars) for Forest Land Application Site Alternative (FOR)
GRU Biosolids Management Plan

Treatment Process[1]	Present-Worth Capital Cost	Present-Worth O&M Cost	Total Present-Worth Cost
Thickened			
Aerobic- 27 days SRT	0.631	4.339	4.970
Aerobic- 60 days SRT	0.631	4.102	4.733
Dewatered			
Aerobic- 27 days SRT	0.434	1.608	2.042
Aerobic- 60 days SRT	0.434	1.521	1.955
Conventional Anaerobic	0.434	1.384	1.818
Advanced Anaerobic	0.434	1.064	1.498

[1] For a detailed discussion on treatment alternatives see Section 5.4.

EXHIBIT 5-16
Summary of Land Application Costs (in millions of dollars) for Forest Land Application Site Alternative (FOR)
GRU Biosolids Management Plan

Treatment Process[1]	Present-Worth Capital Cost	Present-Worth O&M Cost	Total Present-Worth Cost
Thickened			
Aerobic- 27 days SRT	5.292	4.166	9.458
Aerobic- 60 days SRT	4.934	3.950	8.884
Dewatered			
Aerobic- 27 days SRT	4.476	2.277	6.753
Aerobic- 60 days SRT	4.287	2.247	6.534
Conventional Anaerobic	4.453	2.247	6.700
Advanced Anaerobic	3.982	1.754	5.736

[1] For a detailed discussion on treatment alternatives see Section 5.4.

5.3.4 Composting (COMP)

For this alternative, biosolids from the two WRFs will be taken to an offsite composting facility where biosolids will be processed into compost. As discussed in Section 4.2.4, different methodologies are available for processing compost. For the purpose of this analysis, the GRU's offsite composting facility was assumed to utilize the Aerated Static Pile (ASP) technology. The ASP technology was selected because it is relatively simple and less labor and energy-intensive than the other compost processing technologies. A conceptual design for the ASP composting facility was developed based on the biosolids production capacities of the two WRFs in the design year (2025). Based on an AADL production of the design year biosolids production rate 69.24 wet tons per day in 2025, a mass balance was used to compute the amount of bulking agent needed for mixing with biosolids. The conceptual design of the facility is based on operating five days per week. The mass balance was adjusted to achieve the desired bulking agent to biosolids ratio of 1.0 to 1.1 (gravimetric basis). Based on the mass balance, it was estimated that the ASP composting facility will produce approximately 47.3 wet tons/day of compost product at 55 percent solids content.

The minimum size of each building within the composting facility such as the primary composting building, curing building and final product storage building was calculated based on the mass balance and CH2M HILL's experience with similar projects. The composting facility will have the capacity to store the finished product for up to 30 days. Based on the sizes of the buildings within the facility, the size of the facility was estimated to be about 26 acres. A composting facility can potentially lead to nuisance due to odor, dust, insect development and attraction of birds and rodents (Haug, 1993). To avoid the nuisance the proposed facility will have a quarter mile vegetative buffer on each side. The size of the property, including the vegetative buffer area, was determined to be approximately 327 acres (see **Exhibit 5-17**).

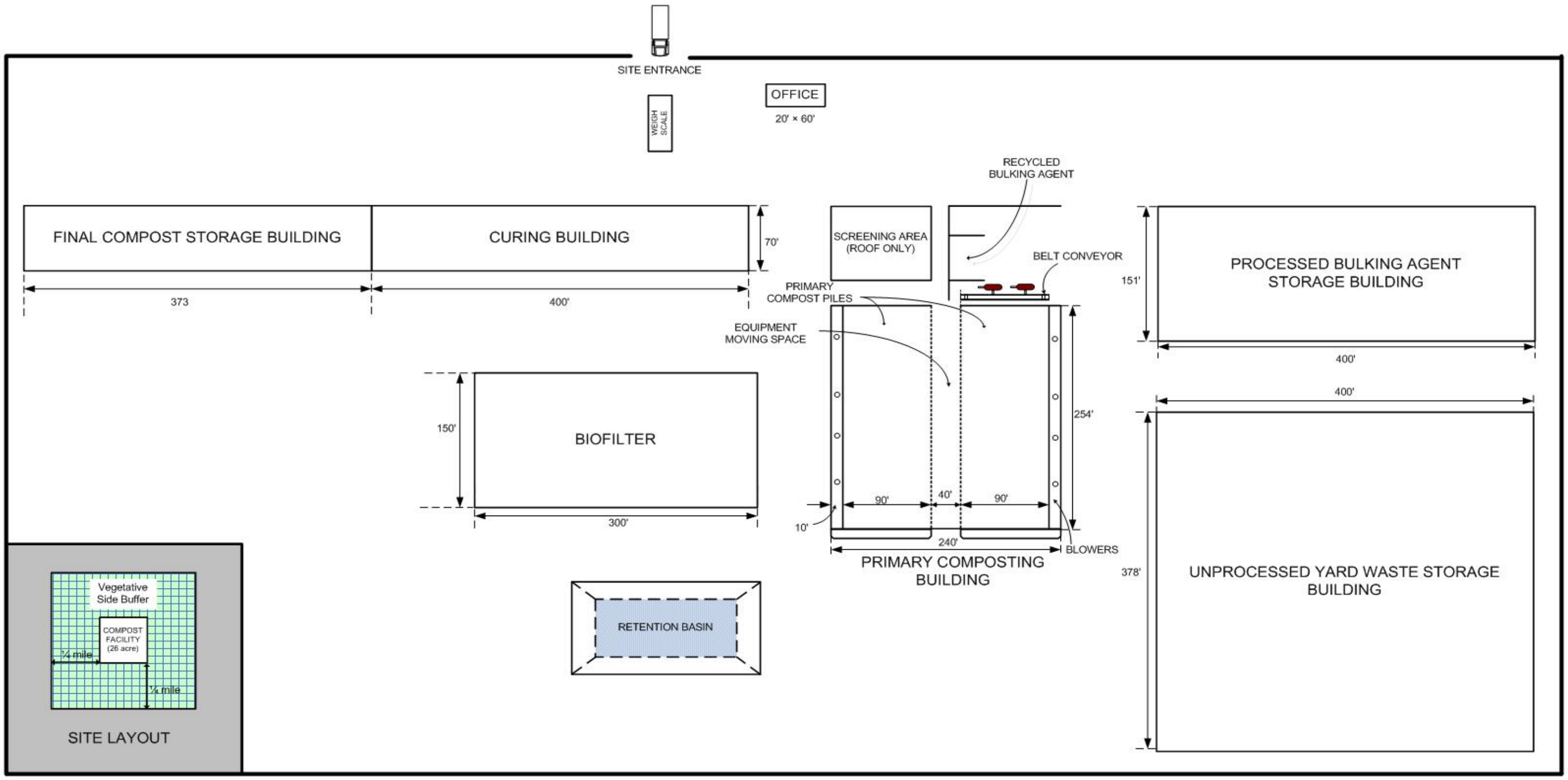

EXHIBIT 5-17
Conceptual Layout of the Aerated Static Pile (ASP) Composting Facility
GRU Biosolids Management Plan

The capital cost of the facility included the cost of equipment needed for the operation of the compost facility (see **Exhibit 5-18**) and the cost of purchasing the 327-acre property. The equipment requirement for the ASP facility was based on similar ASP compost facility recently designed by CH2M HILL.

EXHIBIT 5-18
Equipment Requirements and Initial Costs for the Aerated Static Pile (ASP) Composting Alternative(COMP)
GRU Biosolids Management Plan

Equipment	Current Unit Cost ($) [1]	Number of Units
Front-end loader	220,000	3.0
Roll out bucket	20,000	2.0
Batch Mixers	130,000	2.0
Screen	130,000	2.0
Tub Grinder	200,000	1.0
Portable steam cleaner	1,000	2.0
Stacking Conveyors	1,000	85.0 feet

[1] Based on cost in 2006.

For this alternative, GRU would be responsible for all the operational costs including the cost of transportation of biosolids from the two WRFs to the offsite facility and the cost of operation of the composting facility. The O&M cost for the operation of the composting facility included the cost of labor, fuel, power, operating supplies, and miscellaneous cost. The labor cost for the operation of the composting facility was divided into different labor categories. The labor categories included were motor equipment operator, sludge equipment operator, supervisor, and manager. The number of people needed for each labor category was estimated based on a similar composting facility recently designed by CH2M HILL (see **Exhibit 5-19**). The labor rate for each category was provided by GRU (**Exhibit 5-19**). A unit power cost based on $ per KW-hr was provided by GRU and was shown in **Exhibit 5-7**. The maintenance cost, fuel cost, and miscellaneous cost for the composting facility were based on the cost obtained from a similar facility recently designed by CH2M HILL.

EXHIBIT 5-19
Labor Categories for Composting Alternative
GRU Biosolids Management Plan

Labor Category	Number of People	Annual Wages (in dollars)
Motor Equipment Operator	4	$37,000
Sludge Equipment Operator	3	$44,000
Supervisor	1	$66,000
Manager	0.5 [1]	$77,800

[1] refers to half time appointment

A summary of the capital and O&M costs for transportation and the conceptual composting facility is shown in **Exhibit 5-20**.

EXHIBIT 5-20
Conceptual Cost Summary (in millions of dollars) for Compost Alternative
GRU Biosolids Management Plan

Item	Transportation	ASP Composting Facility[1, 2]
Capital Cost	1.300	27.247
Present-Worth of O&M Cost	6.861	6.375
Total Present-Worth Cost	8.161	33.621

[1] ASP = Aerated Static Pile

[2] PW cost does not Include the salvage value of land purchase

5.3.5 Lime Pasteurization (LIMSTAB)

This alternative included the lime pasteurization dewatered biosolids (16-percent) at a central processing facility and land application of the lime-pasteurized product at an agricultural site. For the purpose of this report, it was assumed that the central processing facility would be located at the KWRF. GRU will provide for the equipment and labor needed for the transportation of dewatered biosolids from the MSWRF to the lime pasteurization facility at the KWRF. The lime-pasteurized product from the KWRF will be transported to an offsite storage facility, which is a 9,900-ft^2 facility located 20 miles away from KWRF, from where it will be transported to the land application site. For the purpose of this report it was assumed that the lime-pasteurized product will be applied to a cooperative land application site leased by GRU. GRU will provide the equipment, labor, and fuel needed for the land application operations. A 16-yd^3 land application vehicle was used to calculate the number of vehicles needed application of the lime-pasteurized product. The costing methodology was similar to that used for the land application options.

Lime-pasteurized product cannot be applied to the same site every year because its prolonged application can cause an increase in the soil pH due to the high pH of the product. To ensure the long-term success of this alternative, GRU would have to search for new alternative sites that would be willing to accept the lime-pasteurized product. While there is a possibility that GRU could generate some revenue by selling the lime-pasteurized product, no such revenue was considered for the purpose of this analysis. A summary of transportation and land application costs for the lime pasteurization alternative is provided in **Exhibit 5-21**.

EXHIBIT 5-21
Summary of Transportation and Land Application Costs (in millions of dollars) for Land Application of Lime-Pasteurized Product
GRU Biosolids Management Plan

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Transportation	1.300	4.647	5.947
Land Application	14.972	8.286	23.258

5.3.6 Thermal Oxidation (TOX)

The viability of using thermal oxidation as an end use alternative is contingent on the future expansion of the Deerhaven Generating Facility. For this analysis, it was assumed that the Deerhaven Generating Facility will come online in 2013, which would start accepting biosolids as a fuel source. GRU would continue to use WPR as a land application site until 2012. Therefore, the land application cost computed for this alternative is similar to the costs discussed in Section 5.3.1. However, the transportation cost for the alternative included the cost of transporting biosolids to WPR until 2012 and to the Deerhaven Power Plant from 2013 to 2025. A summary of the land application cost until 2012 and the transportation cost until 2025 is shown in **Exhibit 5-22**.

EXHIBIT 5-22
Summary of Transportation and Land Application Costs (in millions of dollars) for Thermal Oxidation Alternative
GRU Biosolids Management Plan

	Capital Cost	Present Worth O&M Cost	Total Present Worth Cost
Transportation	0.867	0.934	1. 801
Land Application [1]	12.240	0.242	12.482

[1]Only until 2012 at Whistling Pines Ranch.

5.4 Biosolids Treatment Alternatives

The EPA protects the public health and the environment by reducing the potential for contact with pathogens from biosolids. The Part 503 Rule described in **Section 2** establishes the minimum treatment criteria for biosolids prior to land application. Land application, a beneficial use of biosolids, encompasses most of the end-use alternatives selected by the project team during preliminary screening (see Section 5.3). Therefore, with the exception of thermal oxidation, the primary design objectives for the treatment of biosolids at GRU facilities are to satisfy the Part 503 Rule criteria for pathogen reduction (either Class A or Class B standards), and vector attraction reduction (one of 12 options in the Part 503 Rule, Subpart D).

The option of replacing the existing GBTs with dewatering facilities was evaluated as part of the proposed capital expenditures. Although the existing GBTs at both GRU WRFs have sufficient capacity to handle plant build-out conditions, GRU wished to evaluate whether it is cost-effective to replace these facilities with BFPs to reduce transportation costs. Therefore, for applicable alternatives, treatment costs were developed “with thickening” or “with dewatering” options. Thickening and dewatering facilities were assumed to operate 5 days per week, 16 hours per day. The existing gravity belt thickeners were assumed to be in good condition and would continue to operate through 2025. On the other hand, adding BFPs will influence the capital, operational, transportation, and disposal costs for the pertinent alternative. The cost for installing dewatering facilities would have to be justified by long-term (20-year) transportation, land-use, and/or disposal savings.

The following sections present the conceptual designs, layouts, and costs for each of the selected biosolids treatment alternatives. For general information on each treatment alternative, please refer to Section 4.

5.4.1 Conventional Aerobic Digestion

Conventional aerobic digestion is the current method for biosolids stabilization employed at both GRU WRFs. Therefore, the following treatment alternative is an expansion of the existing system in order to meet plant buildout conditions. Although some upgrades and repairs may be necessary, the following assumes that the existing digesters and equipment is in good condition and that it would continue to operate through 2025.

In general, conventional aerobic digestion systems are intended for agricultural (non-public contact) land application and designed to meet Class B pathogen reduction and vector attraction reduction requirements. As detailed in **Section 2**, there are multiple ways to satisfy these requirements.

GRU currently meets the pathogen and vector attraction reduction requirements by monitoring and reporting fecal coliforms and SOUR, respectively. The advantage of monitoring fecal coliforms (Option 1), rather than adopting a PSRP (Option 2) or a PSRP Equivalent Treatment (Option 3) to meet Class B pathogen reduction, is that it reduces the require digestion volume. The most common practice for meeting pathogen reduction using aerobic digestion in Florida is to use the fecal coliform monitoring option rather than designing for a 60 day SRT. The disadvantages of the monitoring option are that it is sampling intensive, site specific, and susceptible to temperature changes, loading variations, and other operational intricacies. On any day, if either the pathogen (or the SOUR) reduction requirement is not satisfied, the land application of biosolids may have to be discontinued until these conditions are met.

The FDEP is considering modifying the fecal coliform monitoring option to require a 2-log reduction in fecal coliform from raw waste sludge in addition to the 2,000,000 MPN requirements. If implemented, this could eliminate the use of the fecal coliform monitoring option for systems using extended aeration (such as GRU) which yield relatively low fecal coliform in raw sludge. Due to this regulatory uncertainty, and for comparison purposes, GRU asked CH2M HILL to include the evaluation of 60-day SRT aerobic digestion systems for both plants as part of the scope of the project.

Two conventional aerobic digestion scenarios were evaluated: 1) an expansion to GRU's current mode of operation (AD27), and 2) an expansion to meet anticipated regulations (AD60). A summary of the general design criteria for the proposed conventional anaerobic digestion systems is presented in **Exhibit 5-23**.

EXHIBIT 5-23
General Design Criteria for Conventional Aerobic Digestion
GRU Biosolids Management Plan

Design Criteria	Value
Loading Rate	Based on MMADL
Min. VSS Destruction Rate, percent	38%
Oxygen Requirements, lb 0_2/Lb VSS destroyed	2.3
Oxygen Transfer Efficiency for Coarse Bubble Diffusers, lb 0_2/ ft tank depth	0.75

EXHIBIT 5-23
General Design Criteria for Conventional Aerobic Digestion
GRU Biosolids Management Plan

Design Criteria	Value
Oxygen Transfer Efficiency for Mechanical Surface Aerators, lb 0_2/ Hp	1.2
Equipment efficiency, percent	80

Aerobic Digestion with a 27-Day SRT (AD27)

The following evaluates the option of continuing the current mode of biosolids stabilization approach practiced at GRU facilities. GRU currently meets the pathogen and vector attraction reduction requirements by continuously monitoring pathogens (Class B) and the SOUR, respectively. On a daily basis, GRU has to show compliance by:

- Demonstrating that less than 2.0 million MPN or coliform forming units (CFUs) fecal coliforms per gram total solids (40 CFR Part 503.32[b][2]), and
- Demonstrating that the specific oxygen uptake rate (SOUR) is equal to or less than 1.5 mg O_2 per hour per gram of total dry solids (40 CFR Part 503.33[b][4]).

Based on typical conventional aerobic digestion performance data and record data (2003-2005) from GRU WRFs, it was determined that a design based 38-percent VSS reduction should be sufficient to meet the above pathogen and SOUR requirements. Therefore, CH2M HILL adopted a 27-day SRT for the design, which corresponds to the minimum SRT required to accomplish a 38-percent VSS reduction at 15 ^{o}C (WEF, 1995).

The following will describe the proposed expansions to the existing conventional aerobic digestion systems at the KWRF and MSWRF to meet a 27-day SRT during build-out conditions.

Kanapaha Water Reclamation Facility (AD27)

The process flow diagram for the proposed expansion to the existing conventional aerobic digestion system at the KWRF is presented in **Exhibit 5-24**. The proposed system would operate in parallel to the existing system, but operators will also have the option to run all the digesters in series. The only change to the existing system would be to add a third blower at the primary digester.

The intent of this design is to have the existing three digesters continue to serve the original Ludzak-Ettinger (MLE) facility (10 MGD AADF), while the new digesters would serve existing and future Carousel® basins (7.5 MGD AADF). The new digesters are designed to be deeper, as compared to the existing digesters, which will maximize the oxygen transfer efficiency. This, however, would also increase the horsepower requirements of the blowers. The design includes a new electrical building to house electrical equipment (e.g., motor controls, and control panels). To reduce the installation of multiple spare blowers, the blowers for the new system will serve either of the new digesters. A summary of the additional facilities required to implement AD27 at the KWRF is presented in **Exhibit 5-25**; **Exhibit 5-26** illustrates a possible location for the new facility within the plant.

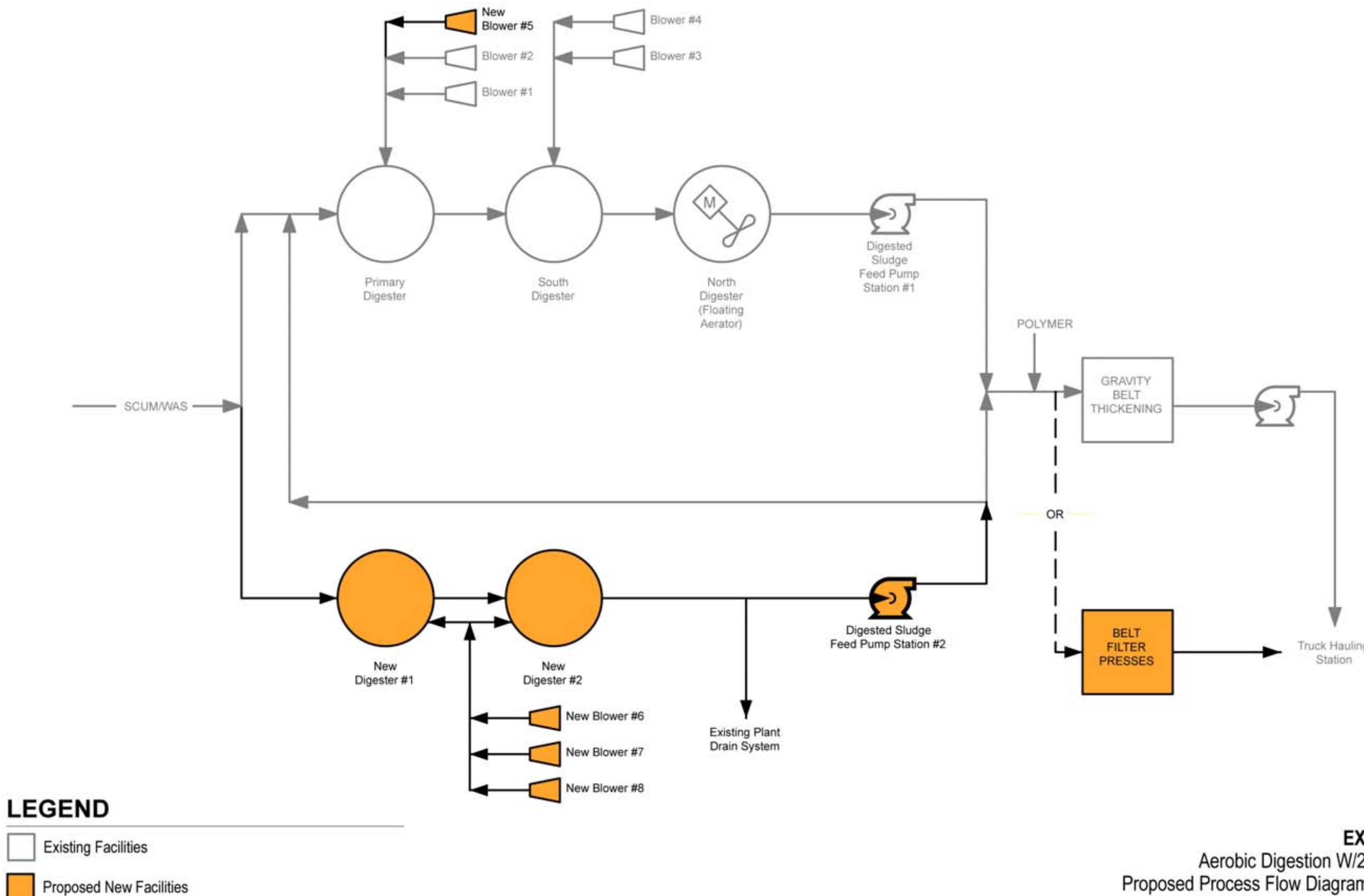

EXHIBIT 5-24
Aerobic Digestion W/27 Day SRT
Proposed Process Flow Diagram for KWRF
GRU Biosolids Management Plan
CH2MHILL

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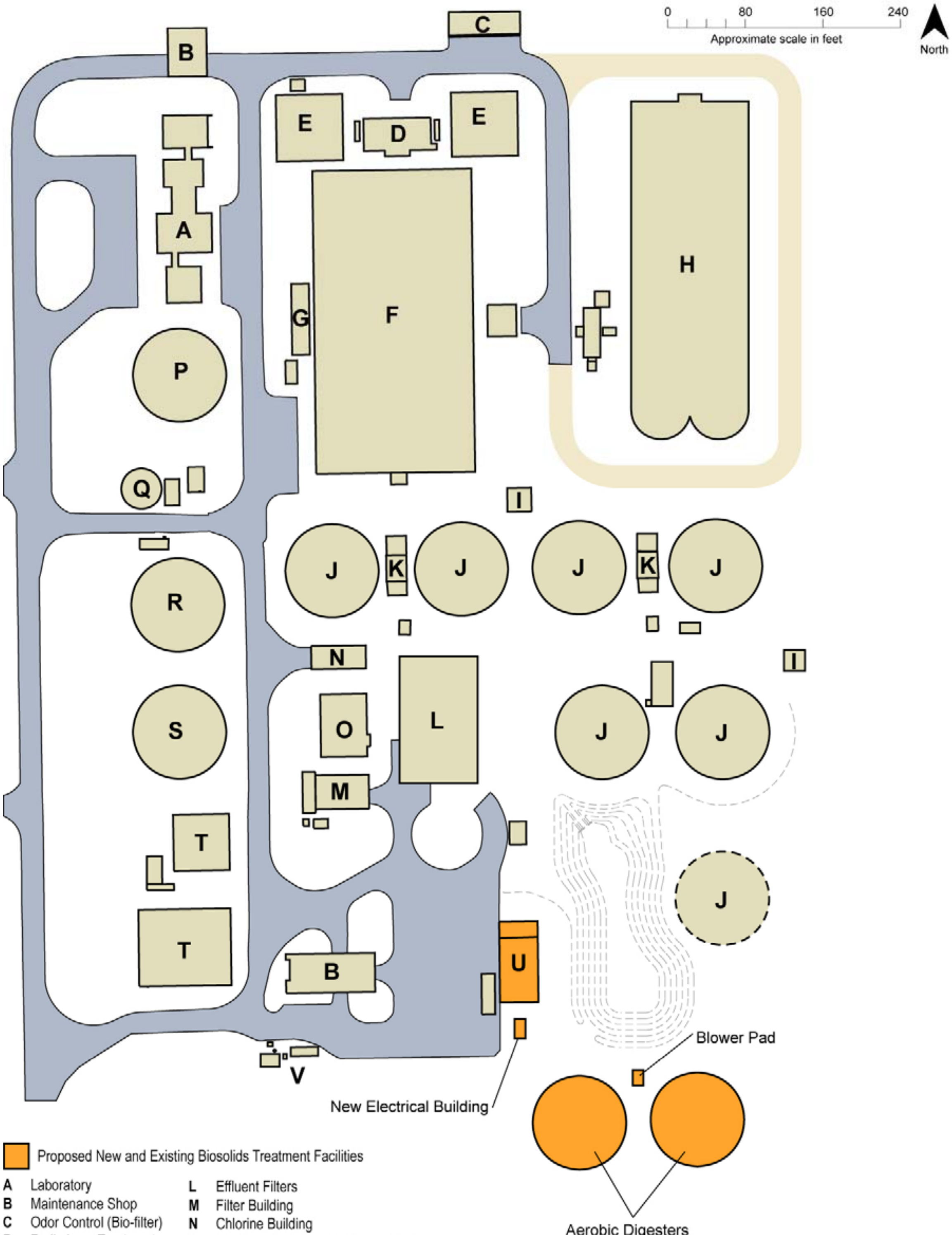
EXHIBIT 5-25
New Facilities Required for Implementation of Aerobic Digestion (AD27) at KWRF
GRU Biosolids Management Plan

Item	Value[1]
New Aerobic Digesters	
No. of Digesters	2
Volume per tank, MG	0.76
Diameter, ft	90
Side Water Depth (SWE), ft	16.5
Type of Aeration System	Coarse Bubble Diffusers
Total No. of Blowers / Capacity, SCFM each	4 / 5,000 (including 1 @ existing Primary Digester)
New Electrical Building	
Length, ft	20
Width, ft	12
Digested Sludge Pump Station	
No. Sludge Grinders	2
No. Sludge Pumps	3
Dewatering Option: Belt Filter Presses (BFP)	
No. of 2.2 meter BFPs	2
Hydraulic Loading Rate, gpm	200
Solids Loading Rate dry lb/hr	1,200
No. of Polymer Feed Pumps	3
No. of BFP Washdown Pumps	3
No. of conveyers for truck loading	3
Truck Loading Bin, yd^3	25

Note 1: Equipment sizing is based on MMADL.



Proposed New and Existing Biosolids Treatment Facilities

- **A** Laboratory
- **B** Maintenance Shop
- **C** Odor Control (Bio-filter)
- **D** Preliminary Treatment
- **E** Anoxic Basins
- **F** Original Oxidation Basins
- **G** Operations Building
- **H** New Oxidation Basins
- **I** Mixed Liquor Splitter Box
- **J** Secondary Clarifier
- **K** RAS/WAS Pump Station
- **L** Effluent Filters
- **M** Filter Building
- **N** Chlorine Building
- **O** Post Aeration/Filter Backwash Basins
- **P** Preliminary Digester
- **Q** Gravity Thickener
- **R** North Digester
- **S** South Digester
- **T** Chlorine Contact Basins
- **U** Gravity Belt Thickening Building
- **V** Reuse Water Pump Station

EXHIBIT 5-26
Conventional Aerobic Digestion W/27 Day SRT
Proposed Site Plan for KWRF
GRU Biosolids Management Plan

WB022008003GNV MSWRF_Exhibit5-26_24__Day_SRT_rev1.ai

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A summary of the capital, O&M, and total present value costs for the expansion of the current biosolids stabilization method with the costs for both thickening and dewatering facilities is presented in **Exhibit 5-27**.

EXHIBIT 5-27
Summary of Onsite Treatment Costs for Implementation of Aerobic Digestion (AD27) at KWRF
GRU Biosolids Management Plan

Item	w/ Thickening	w/ Dewatering
Capital Cost	$5,172,000	$10,529,000
Present-Worth O&M Cost	$8,020,000	$9,202,000
Total Present-Worth Cost	**$13,192,000**	**$19,731,000**

Main Street Water Reclamation Facility (AD27)

Additional tankage is not required at the MSWRF for this alternative. The existing facilities have adequate volume to provide a 27-day SRT, at 15 ^{0}C liquid temperature, during plant build-out conditions. However, the installation of coarse bubble diffusers in Digester No. 2 is recommended. By installing diffusers to the second digester, in lieu of the surface mechanical aerator, GRU will benefit from operational redundancy. The oxygen transfer efficiency of a diffuser system is superior to a mechanical aerator. **Exhibit 5-28** presents a summary of the proposed facilities for the MSWRF.

EXHIBIT 5-28
New Facilities Required for Implementation of Aerobic Digestion (AD27) at MSWRF
GRU Biosolids Management Plan

Item	Value [1]
New Diffuser System for Digester No. 2 [2]	
Type of System	Coarse Bubble Diffusers
No. of Blowers / Blower Rated Capacity, Hp	3 / 200
Dewatering Option: Belt Filter Presses (BFPs)	
No. of 2.2 meter BFPs	2
Hydraulic Loading Rate, gpm	200
Solids Loading Rate, dry lb/hr	1200
No. of Polymer Feed Pumps	3
No. of BFP Washdown Pumps	3
No. of conveyers for truck loading	3
Truck Loading Bin/ Capacity, yd^3	25

Note 1: Equipment sizing is based on MMADL.
Note 2: Same equipment as installed in Digester #1 (2006).

A summary of the capital, O&M, and total present value costs for the suggested modifications to the MSWRF with the costs for both thickening and dewatering facilities is presented in **Exhibit 5-29**.

EXHIBIT 5-29
Summary of Onsite Treatment Costs for Implementation of Aerobic Digestion (AD27) at MSWRF
GRU Biosolids Management Plan

Item	w/ Thickening	w/ Dewatering
Capital Cost	$ 1,228,000	$ 5,627,000
Present-Worth O&M Cost	$ 5,074,000	$ 5,861,000
Total Present-Worth Cost	**$ 6,302,000**	**$ 11,488,000**

Aerobic Digestion with a 60-Day SRT (AD60)

The second scenario for implementing conventional aerobic digestion systems at both GRU WRFs is to expand the system to provide a 60-day SRT (AD60) during build-out conditions. By doing this, GRU would guarantee compliance with future regulation and benefit from adopting a PSRP. Under this scenario, GRU would comply with federal regulations as follows:

- The combination of 60-day SRT and 15 °C liquid temperature satisfies the requirements for a PSRP listed in the Part 503 Rule solids (40 CFR Part 503.32[b][3]). By using a PSRP to produce a Class B product, GRU is not required by the Part 503 Rule to monitor pathogen. However, the FDEP may still require some monitoring.
- By extending aerobic digestion beyond 27 days, GRU is getting at least 38-percent VSS reduction, which meets the Category 1 requirements in Subpart D (see **Section 2**) for reducing vector attraction (40 CFR Part 503.33[b][1]). Thus, monitoring SOUR would no longer be necessary.

The proposed expansions to the existing biosolids treatment systems at the KWRF and MSWRF, to meet a 60-day SRT during build-out conditions, are presented below.

Kanapaha Water Reclamation Facility (AD60)

The process flow diagram for the proposed expansion to the conventional aerobic digestion system at the KWRF is presented in **Exhibit 5-30**. Similar to AD27, the proposed system would operate in parallel to the existing system, but operators would also have the option to run all the digesters in series. The intent of this design is to have the existing digesters continue to serve the original MLE plant, while the new digesters would serve the Carousels®.

The new digesters are designed to be deeper, as compared to the existing digesters, to maximize the oxygen transfer efficiency. This, however, would also increase the horsepower requirements of the blowers. To reduce the installation of multiple spare blowers, the blowers for the new digester will serve either digester. A summary of the additional facilities required to implement AD60 at KWRF is presented in **Exhibit 5-31**. In addition, **Exhibit 5-32** illustrates a possible location for the new facility within the plant.

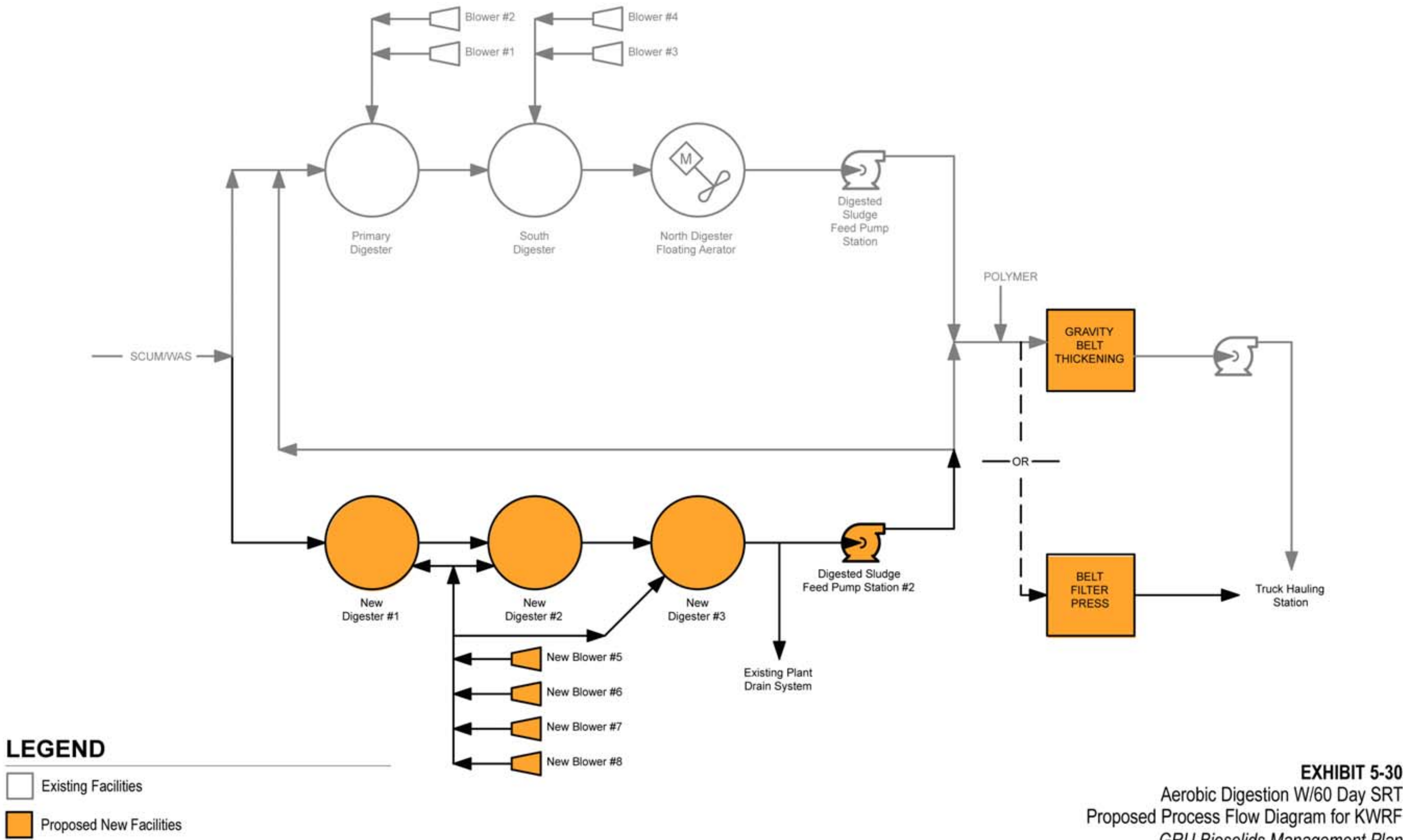

EXHIBIT 5-30
Aerobic Digestion W/60 Day SRT
Proposed Process Flow Diagram for KWRF
GRU Biosolids Management Plan

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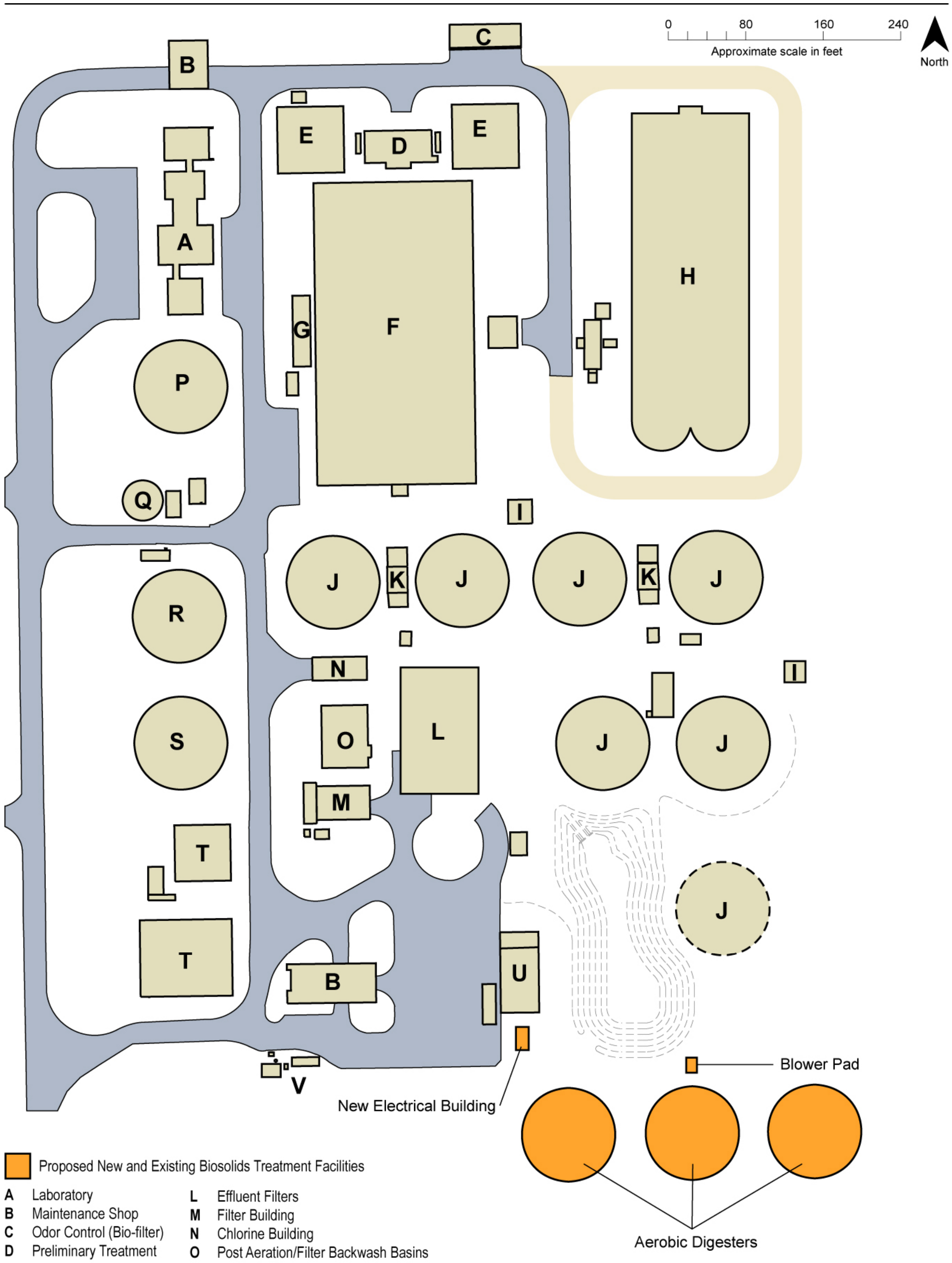
EXHIBIT 5-31
New Facilities Required for Implementation of Aerobic Digestion at (AD60) KWRF
GRU Biosolids Management Plan

Item	Value
Aerobic Digestion (new digesters in series, but in parallel to existing system)	
No. of Digesters	3
Volume per tank, MG	1.1
Diameter, ft	105
Side Water Depth (SWE), ft	16.5
Type of Aeration System	Coarse Bubble Diffusers
Total No. of Blowers / Blower Rated Capacity, SCFM	5 / 5,000
Digested Sludge Pump Station	
No. of Sludge Grinders	2
No. of Sludge Pumps	3
Dewatering Option: Belt Filter Presses (BFP)	
No. of 2.2 meter BFPs	2
Hydraulic Loading Rate, gpm	200
Solids Loading Rate, dry lb/hr	1,200
No. of Polymer Feed Pumps	3
No. of BFP Washdown Pumps	3
No. of conveyers for truck loading	3
Truck Loading Bin/ Capacity, yd^3	25

Notes: Equipment sizing is based on MMADL.



Proposed New and Existing Biosolids Treatment Facilities

A	Laboratory	**L**	Effluent Filters
B	Maintenance Shop	**M**	Filter Building
C	Odor Control (Bio-filter)	**N**	Chlorine Building
D	Preliminary Treatment	**O**	Post Aeration/Filter Backwash Basins
E	Anoxic Basins	**P**	Preliminary Digester
F	Original Oxidation Basins	**Q**	Gravity Thickener
G	Operations Building	**R**	North Digester
H	New Oxidation Basins	**S**	South Digester
I	Mixed Liquor Splitter Box	**T**	Chlorine Contact Basins
J	Secondary Clarifier	**U**	Gravity Belt Thickening Building
K	RAS/WAS Pump Station	**V**	Reuse Water Pump Station

EXHIBIT 5-32
Conventional Aerobic Digestion W/60 Day SRT
Proposed Site Plan for KWRF
GRU Biosolids Management Plan
CH2MHILL

WB022008003GNV MSWRF_Exhibit5-32_60_Day_SRT_rev1.ai

A summary of the capital, operations and maintenance, and total present value costs for the implementation of a 60-day SRT aerobic digestion system in KWRF is depicted in **Exhibit 5-33**.The costs with both thickening and with dewatering facilities are presented.

EXHIBIT 5-33
Summary of Onsite Treatment Costs for Implementation of Aerobic Digestion (AD60) at KWRF
GRU Biosolids Management Plan

Item	w/ Thickening	w/ Dewatering
Capital Cost	$ 8,376000	$ 13,788,000
Present-Worth O&M Cost	$ 8,620,000	$ 9,642,000
Total Present-Worth Cost	**$ 16,997,000**	**$ 23,430,000**

Main Street Water Reclamation Facility (AD60)

Additional tankage to implement AD60 is not required at the MSWRF. The existing digesters have adequate volume to provide a 60-day SRT, at 15 ºC liquid temperature, during plant build-out conditions. However, installing coarse bubble diffusers in Digester No. 2 is required in order to supply enough oxygen into the process to meet the required demand. The facility requirements for AD60 are the same as those mentioned above for AD27. Refer to **Exhibit 5-28** for a list of facilities required at the MSWRF.

A summary of the capital, O&M, and total present value costs for the upgrades at MSWRF are depicted in **Exhibit 5-34**. Note that although the capital costs are the same as that of AD27, a longer SRT will increase operation and maintenance costs. Both costs with thickening and with dewatering facilities are presented.

EXHIBIT 5-34
Summary of Onsite Treatment Costs for Implementation of Aerobic Digestion (AD60) at MSWRF
GRU Biosolids Management Plan

Item	w/ Thickening	w/ Dewatering
Capital Cost	$ 1,228,000	$5,627,000
Present-Worth O&M Cost	$ 7,720,000	$ 8,253,000
Total Present-Worth Cost	**$ 8,948,000**	**$ 13,880,000**

5.4.2 Conventional Anaerobic Digestion (AND)

The Part 503 Rule recognizes conventional anaerobic digestion as a PSRP as an option for achieving Class B pathogen reduction. This is a proven technology for the stabilization of waste-activated sludge and is usually the preferred choice for new, large wastewater treatment facilities. Benefits from anaerobic digestion include smaller volume requirements and the production of methane gas, which can be used to provide energy for the stabilization process.

Although anaerobic digestion can provide long-term power savings, the capital cost of retrofitting the existing aerobic digestion system is high and does not provide a higher level of treatment. To transition into anaerobic digestion, the existing aerobic digesters system would need to be replaced by new deeper covered digesters. The existing tanks (especially at KWRF) are too shallow to be converted into anaerobic digesters. Moreover, the proposed conventional anaerobic digesters require insulation, supplemental heating, mechanical mixers, and a gas handling system. The gasses produced during anaerobic digestion are collected just beneath the tank covers, processed, compressed, and used to power onsite equipment (e.g., boilers and mixers). For the purposes of this report, it was assumed that the energy that results from anaerobic digestion is enough to satisfy the heating requirements of the process. Though there maybe excess energy, City power was used to calculate the operational costs for running pumps, thickening or dewatering facilities, etc. However, the revenue from selling the excess energy ($0.40/MMBTU) was included in the analysis.

The proposed conventional aerobic systems were designed to operate with a minimum 15-day SRT and within the mesophilic temperature range (30 to 38°C). Under this scenario, GRU would comply with federal regulations as follows:

- According to the Part 503 Rule, sewage sludge that is treated in the absence of oxygen (anaerobic) for a mean cell residence time of 15 days at 35 to 55°C meet the Class B Alternative 2 requirements for pathogen reduction. Specifically, the proposed SRT and temperature conforms to a PSRP.
- By implementing a 15-day SRT anaerobic digestion system at 35°C, GRU is getting at least 38-percent VSS destruction, which meets the Category 1 requirements in Subpart D (see **Section 2**) for reducing vector attraction (40 CFR Part 503.33[b][1]).

A summary of general design criteria for the proposed advanced anaerobic digestion (AND) system is presented in **Exhibit 5-35**. In addition, a process flow diagram for the proposed systems is presented in **Exhibit 5-36**. Although tankage and equipment requirements at each facility will vary, the overall process schematic is the same for both GRU WRFs. The proposed advanced anaerobic digestion system would consists of a WAS storage tank, which could be an existing digester with a floating mechanical aerator for odor control; pre-thickening facilities to raise the solids concentration prior to anaerobic digestion; three digesters; sludge heating, sludge recirculation, and gas handling facilities; and either additional thickeners or dewatering (BFPs) facility with truck loading conveyer.

EXHIBIT 5-35
General Design Criteria for Conventional Anaerobic Digestion (AND)
GRU Biosolids Management Plan

Design Criteria	Value
Loading Rate	Based on MMADL
VSS Destruction Rate, percent	55
Gas Production, ft^3/lb VSS destroyed	13
Minimum SRT, days	15
Process Feed Suspended Solids, percent	5
Side Water Depth (SWE), ft	25
Min. Height / diameter Ration	0.5
Mixing Requirements, Hp/1,000 ft^3 tankage	1.0
Gas energy value, BTU/ ft^3	600
Gas to energy transfer efficiency, percent	80

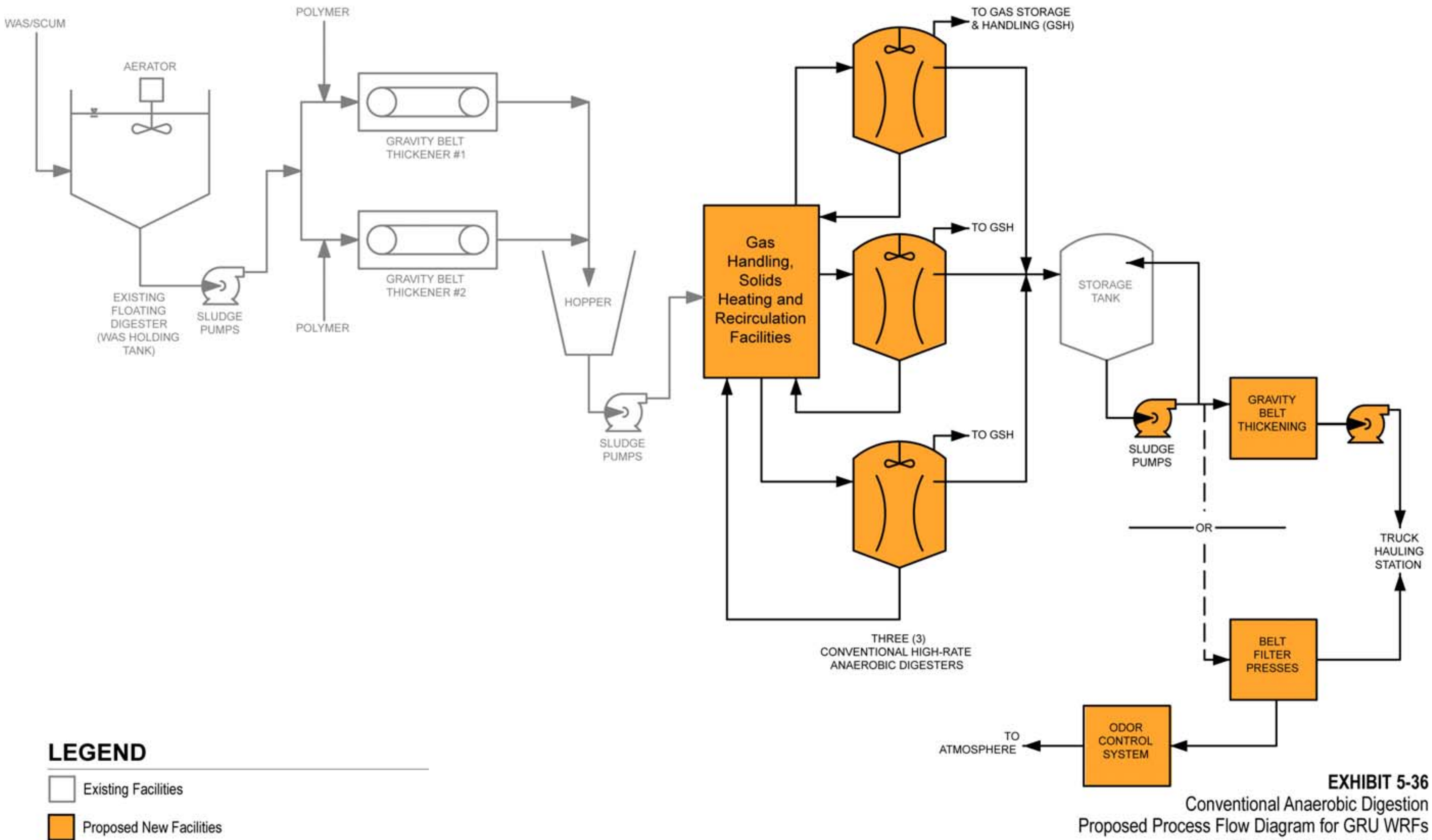


EXHIBIT 5-36
Conventional Anaerobic Digestion
Proposed Process Flow Diagram for GRU WRFs
GRU Biosolids Management Plan

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The proposed facilities and equipment to be installed at the KWRF and the MSWRF, to meet AND during build-out conditions are presented below.

Kanapaha Water Reclamation Facility (AND)

A summary of the equipment and facilities required to implement AND at KWRF is presented in **Exhibit 5-37**. In addition, **Exhibit 5-38** illustrates a possible location for the proposed facilities.

EXHIBIT 5-37
New Facilities Required for Implementation of Conventional Anaerobic Digestion (AND) at KWRF
GRU Biosolids Management Plan

Item	Value [1]
WAS Storage Tank (North Digester)	
Volume, Million Gallons (MG)	0.66
Diameter, ft	95
Side Water Depth (SWE), ft	11.75 (floating)
Type of Aeration System	Surface Aerator
No. of Surface Aerators / Rated Capacity, Hp	1 / 75
Pre-Digestion Gravity Belt Thickening (GBT) [2]	
No. of 2.0 meter GBTs	2
Hydraulic Loading Rate, gpm	600
Solids Loading Rate, dry lb/hr	2,000
No. of Polymer Feed Pumps	2
No. of Sludge Pumps for Truck Loading	2
No. of Filtrate Return Pumps	2
Thickened Sludge Storage Bin, yd^3	15
Feed Pump Station	
No. of Sludge Grinders	2
No. of Sludge Transfer Pumps	3
Conventional Anaerobic Digesters (w/ covers)	
No. of Digesters	3
Volume, MG	0.6
Diameter, ft	63
Side Water Depth (SWE), ft	25
Type of Mixing System	Mechanical Mixer
Digested Sludge Storage Tank (South Digester)	
Volume, MG	0.66
Diameter, ft	95

EXHIBIT 5-37
New Facilities Required for Implementation of Conventional Anaerobic Digestion (AND) at KWRF
GRU Biosolids Management Plan

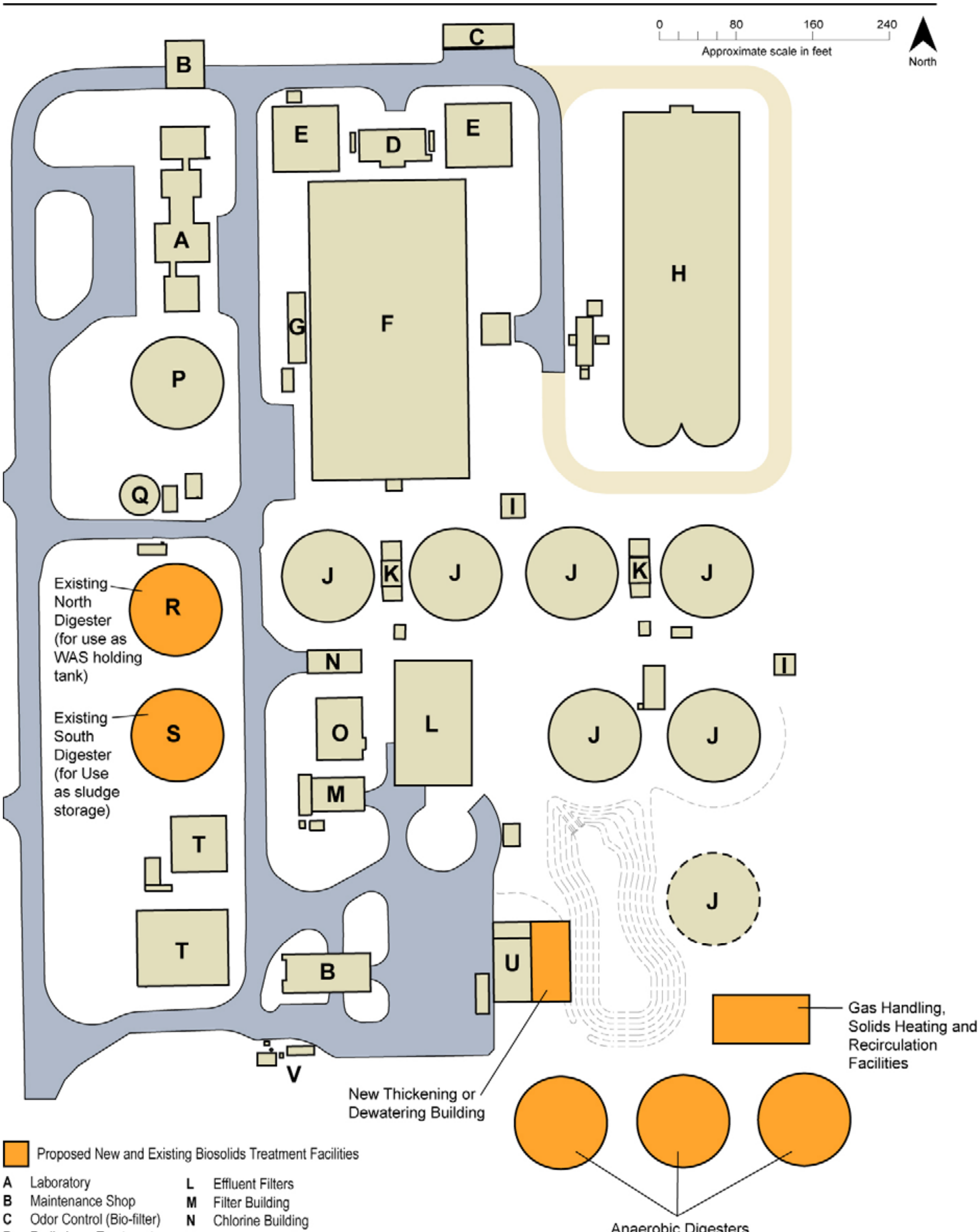
Item	Value [1]
Side Water Depth (SWE), ft	11.75
Type of Mixing System	Recirculation Flow
<u>Heating & Recirculation System</u>	
No. of Boilers	2
No. of Heat Exchangers / Capacity ea, MMBTU/hr	3 / 1.5
No. of Sludge Recycle Pumps / Capacity, gpm	6
<u>Gas Storage and Handling Equipment</u>	Note 3
<u>Dewatering Option: Belt Filter Presses (BFP)</u>	
No. of 2.2 meter BFPs	2
Hydraulic Loading Rate, gpm	200
Solids Loading Rate, dry lb/hr	1200
No. of Polymer Feed Pumps	3
No. of BFP Washdown Pumps	3
No. of conveyers for truck loading	3
Odor Control System	Note 4
Truck Loading Bin/ Capacity, yd^3	15

Note 1: Equipment sizing is based on MMADL.

Note 2: The existing GBTs can be dedicated to either pretreatment or final thickening.

Note 3: Gas Storage and handling equipment includes gas piping, filters, and storage tanks. The cost for generators was not included. GRU owns various generators that can be relocated to the WRFs.

Note 4: Anaerobic digested sludge is known to be more odorous than aerobic sludge; thus require odor control.



Proposed New and Existing Biosolids Treatment Facilities

A	Laboratory	L	Effluent Filters
B	Maintenance Shop	M	Filter Building
C	Odor Control (Bio-filter)	N	Chlorine Building
D	Preliminary Treatment	O	Post Aeration/Filter Backwash Basins
E	Anoxic Basins	P	Preliminary Digester
F	Original Oxidation Basins	Q	Gravity Thickener
G	Operations Building	R	North Digester
H	New Oxidation Basins	S	South Digester
I	Mixed Liquor Splitter Box	T	Chlorine Contact Basins
J	Secondary Clarifier	U	Gravity Belt Thickening Building
K	RAS/WAS Pump Station	V	Reuse Water Pump Station

EXHIBIT 5-38
Conventional Anaerobic Digestion
Proposed Site Plan for KWRF
GRU Biosolids Management Plan

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A summary of the capital, O&M, and total present value costs for implementing a conventional anaerobic digestion system at KWRF is depicted in **Exhibit 5-39**. The costs with both thickening and dewatering facilities are presented.

EXHIBIT 5-39
Summary of Onsite Treatment Costs for Implementation of Conventional Anaerobic Digestion (AND) at KWRF
GRU Biosolids Management Plan

Item	w/ Thickening	w/ Dewatering
Capital Cost	$ 20,584,000	$ 24,836,000
Present-Worth O&M Cost	$ 6,297,000	$ 7,512,000
Total Present-Worth Cost	**$ 26,881,000**	**$ 32,348,000**

Main Street Water Reclamation Facility (AND)

A summary of the equipment and facilities required to implement AND at the MSWRF is presented in **Exhibit 5-40**. However, since the MSWRF is space-limited, a possible location for the proposed facilities is not presented. In order to install a conventional anaerobic digestion system, the existing digesters and other facilities will have to be demolished. Provisions will need to be made to continue operation of the MSWRF during construction. Such provisions were not included in the evaluation.

Though a conceptual design and budgetary cost were developed, the installation of a conventional anaerobic digestion system at the MSWRF is not necessary. From a regulatory perspective, the MSWRF already has adequate capacity to meet Class B pathogen reduction and Category 1 vector attraction reduction. The only benefits of adopting an anaerobic digestion process at MSWRF are long-term power savings (i.e., methane production) and enhanced VSS destruction.

EXHIBIT 5-40
New Facilities Required for Implementation of Conventional Anaerobic Digestion (AND) at MSWRF
GRU Biosolids Management Plan

Item	Value [1]
WAS Storage Tank	
Volume, gal	50,000
Diameter, ft	30
Side Water Depth (SWE), ft	10 (floating)
Type of System	Surface Aerator
No. of Surface Aerators	1
Pre-Digestion Gravity Belt Thickening (GBT) [2]	
No. of 2.0 meter GBTs	2
Hydraulic Loading Rate, gpm	600

EXHIBIT 5-40
New Facilities Required for Implementation of Conventional Anaerobic Digestion (AND) at MSWRF
GRU Biosolids Management Plan

Item	Value [1]
Solids Loading Rate, dry lb/hr	1,000
No. of Thickener Feed Pumps	2
No. of Polymer Feed Pumps	2
No. of Filtrate Return Pumps	2
Thickened Sludge Storage Bin/Sump, yd^3	15
Digester Feed Pump Station	
No. of Sludge Grinder	2
No. of Sludge Transfer Pumps	3
Conventional Anaerobic Digesters (w/ covers)	
No. of Digesters	3
Volume per tank, MG	0.3
Diameter, ft	45
Side Water Depth (SWE), ft	25
Type of Mixing System	Mechanical Mixer
Digested Sludge Storage Tank (w/ cover)	
Volume, MG	50,000
Diameter, ft	30
Side Water Depth (SWE), ft	10
Type of Mixing System	Recalculating Flow
Heating & Recirculation System	
No. of Boilers	2
No. of Heat Exchangers / Capacity ea, MMBTU/hr	3 / 0.5
No. of Sludge Recycle Pumps / Capacity, gpm	6
Gas Storage and Handling Equipment	Note 3
Dewatering Option: Belt Filter Presses (BFP)	
No. of 2.2 meter BFPs	2
Hydraulic Loading Rate, gpm	200
Solids Loading Rate, dry lb/hr	1,200
No. of Polymer Feed Pumps	3
No. of BFP Washdown Pumps	3
No. of conveyers for truck loading	3

EXHIBIT 5-40
New Facilities Required for Implementation of Conventional Anaerobic Digestion (AND) at MSWRF
GRU Biosolids Management Plan

Item	Value [1]
Odor Control System	Note 4
Truck Loading Bin/ Capacity, yd^3	15

Notes: Equipment sizing is based on MMADL.

Note 1: Equipment sizing is based on MMADL.

Note 2: The existing GBTs can be dedicated to either pretreatment or final thickening.

Note 3: Gas Storage and handling equipment includes gas piping, filters, and storage tanks. The cost for generators was not included. GRU owns various generators that can be relocated to the WRFs.

Note 4: Anaerobic digested sludge is known to be more odorous than aerobic sludge; thus require odor control.

A summary of the capital, O&M, and total present value costs for this alternative is depicted in **Exhibit 5-41**. The costs with both thickening and dewatering facilities are presented.

EXHIBIT 5-41
Summary of Onsite Treatment Costs for Implementation of Conventional Anaerobic Digestion (AND) at MSWRF[1]
GRU Biosolids Management Plan

Item	w/ Thickening	w/ Dewatering
Capital Cost	$ 18,737,000	$ 21,654,000
Present-Worth O&M Cost	$ 4,615,000	$ 5,484,000
Total Present-Worth Cost	**$ 23,352,000**	**$ 27,138,000**

[1] The MSWRF costs presented herein do not account for demolition of existing facilities or provisions for operating the plant during construction.

5.4.3 Advanced Anaerobic Digestion (AAND)

Advanced anaerobic digestion (AAND) systems include a number of variations from the conventional anaerobic digestion process (see **Section 4**). A Mesophilic Acid Hydrolysis Plug Flow Phase System was selected for this evaluation. The proposed system separates the hydrolysis/fermentation process from methanogenesys. Plug flow acid-phased reactors are known as the patented Enzymatic Hydrolysis (EH) Process. The EH Process consists of six continuously stirred reactors in series providing a total retention time in the order of 2 days at MMADL; five tanks operating in series can handle 100 percent of the loading rate. Operated at 42°C, the EH stage converts the influent substrate into volatile acids. The selection of the 42°C temperature is based on extensive study of pathogen die-off kinetics, VSS destruction, and heat requirements to eliminate the need for subsequent heating throughout the process. The second stage, operated at 35°C and a minimum 13-day SRT, provides the ideal environmental conditions for gas-producing microorganisms. This process was selected, based on CH2M HILL experience, for its reliability for meeting Class A requirements. It should be noted that this process is not approved by the EPA as a PFRP.

Therefore, validation testing and pre-approval by the EPA Pathogen Equivalency committee would be required before the system can be classified equivalent to a PFRP. Under this scenario, GRU would comply with federal regulations as follows:

- As per Alternative 6 (see **Section 2**) of the options to meet Class A pathogen reduction, the Part 503 Rule allows any treatment process to be determined equivalent to a PFRP (40 CFR Part 503.32[a][8]). Alternative 6 enables the treatment facility to validate a treatment process by undertaking a validation procedure. After successful validation, minor monitoring/sampling is required.
- By implementing AAND, GRU is getting at least 38 percent, which meets the Category 1 requirements in Subpart D (see **Section 2**) for reducing vector attraction (40 CFR Part 503.33[b][(1]).

A summary of general design criteria for AAND is presented in **Exhibit 5-42**. The process flow diagram for the proposed advanced anaerobic digestion systems is presented in **Exhibit 5-43**. Although tankage and equipment requirements at each facility are different, the process flow diagram is applicable to both WRFs. In brief, the proposed AAND process consists of a WAS storage tank, which may be an existing digester with a floating mechanical aerator for odor control; pre-thickening facilities (GBTs) to raise the percent solids prior to digestion; six acid-hydrolysis tanks that operate at 42°C; four methane digesters that operate at 35°C; sludge heating, sludge recirculation, and gas handling equipment; and, either additional GBTs or dewatering (BFPs) facilities with truck loading conveyers.

EXHIBIT 5-42
General Design Criteria for Implementation of Advanced Anaerobic Digestion (AAND)
GRU Biosolids Management Plan

Design Criteria	Value
Loading Rate	Based on MMADL
VSS Destruction Rate, percent	65%
Gas Production, ft^3/lb VSS destroyed	16
Acid Hydrolysis SRT, days	2
Methane Digestion SRT, days	13
Process Feed Suspended Solids, percent	5%
Side Water Depth (SWE), ft	25
Mixing Requirements, Hp/1,000 ft^3 tankage	1.0
Gas energy value, BTU/ ft^3	600
Equipment power usage efficiency, percent	80
Gas to energy transfer efficiency, percent	80

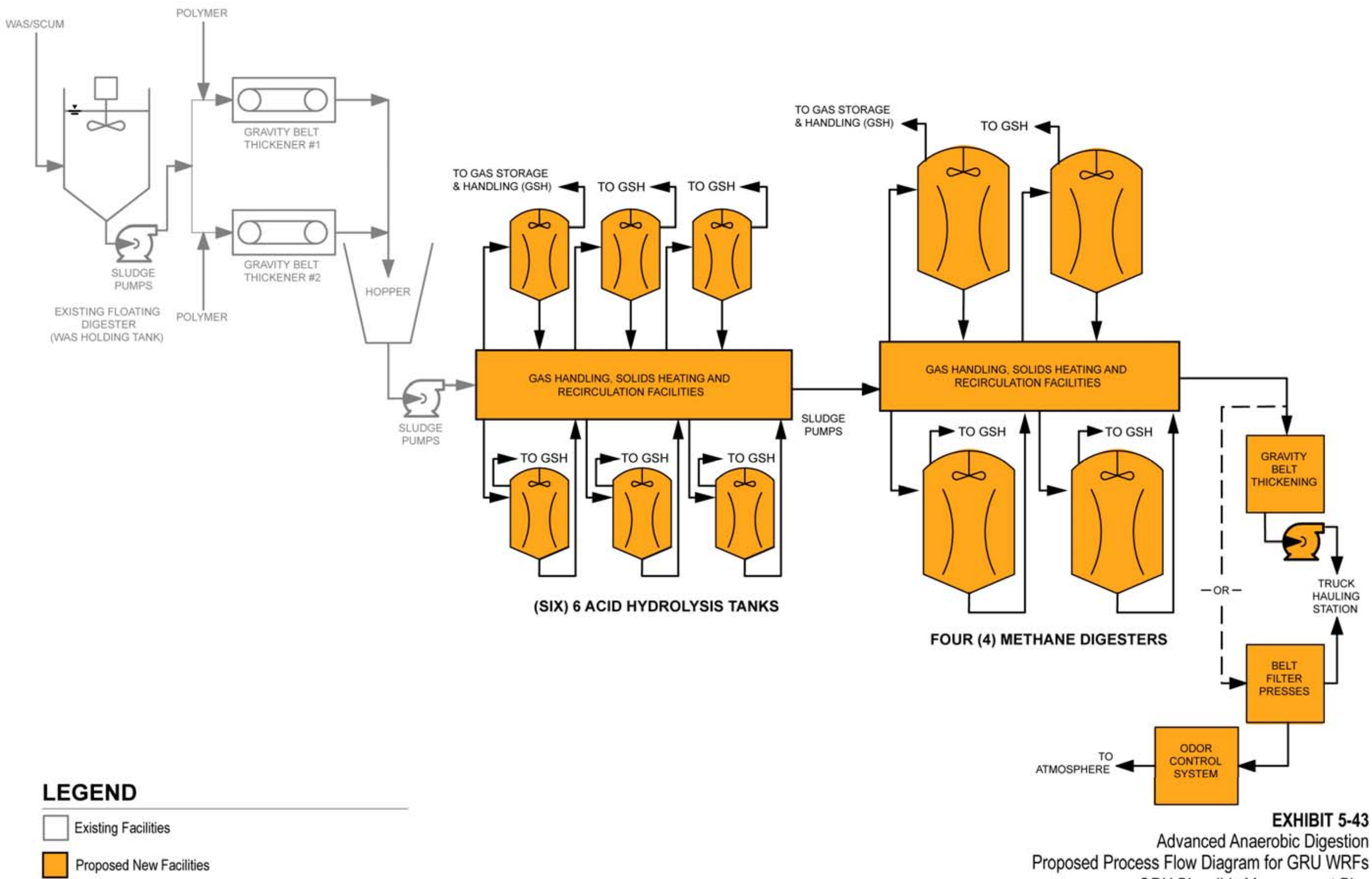

EXHIBIT 5-43
Advanced Anaerobic Digestion
Proposed Process Flow Diagram for GRU WRFs
GRU Biosolids Management Plan
CH2MHILL

WB072006002GNV BMP_Exhibit5-43_Advanced_Anaerobic_Digestion_Flow_Diagram.ai

The proposed facilities and equipment to be installed at the KWRF and the MSWRF to meet AAND during build-out conditions are presented below.

Kanapaha Water Reclamation Facility (AAND)

A summary of the equipment and facilities required to implement AAND at the KWRF is presented in **Exhibit 5-44**. In addition, **Exhibit 5-45** illustrates a possible location for the proposed system.

EXHIBIT 5-44
New Facilities Required for Implementation of Advanced Anaerobic Digestion (AAND) at KWRF
GRU Biosolids Management Plan

Item	Value [1]
WAS Storage Tank (North Digester)	
Volume, MG	0.66
Diameter, ft	95
Side Water Depth (SWE), ft	11.75 (floating)
Type of System	Surface Aerator
No. of Surface Aerators / Rated Capacity, Hp	1 / 75
Pre-Digestion Gravity Belt Thickening (GBT) [2]	
No. of 2.0 m Thickeners	2
Hydraulic Loading Rate, gpm	600
Solids Loading Rate, dry lb/hr	1,000
No. of Thickener Feed Pumps	2
No. of Polymer Feed Pumps	2
No. of Filtrate Return Pumps	2
Thickened Sludge Storage Bin/Sump, yd^3	15
Digestion Feed Pump Station	
Sludge Grinder / Capacity, gpm	2
No. of Sludge Transfer Pumps / Capacity, gpm	3
Advanced Anaerobic Digesters (w/ covers)	
Acid Hydrolysis (42 Degree C)	
No. of Digesters	6
Volume, gal	29,000
Diameter, ft	14
Side Water Depth (SWE), ft	25
Type of Mixing System	Mechanical Mixer

EXHIBIT 5-44
New Facilities Required for Implementation of Advanced Anaerobic Digestion (AAND) at KWRF
GRU Biosolids Management Plan

Item	Value [1]
Methane Digestion (35 ºC)	
No. of Digesters	4
Volume, gal	300,000
Diameter, ft	46
Side Water Depth (SWE), ft	25
Type of Mixing System	Mechanical Mixer
Heating & Recirculation System	
No. of Boilers	3
No. of Heat Exchangers / Capacity, MMBTU/hr	4 / 1.5
No. of Heat Exchangers / Capacity, MMBTU/hr	2 / 2.0
No. of Sludge Recycle Pumps	12
Gas Storage and Handling Equipment	Note 3
Dewatering Option: Belt Filter Presses (BFP)	
No. of 2.2 meter BFPs	2
Hydraulic Loading Rate, gpm	200
Solids Loading Rate, dry lb/hr	1,200
No. of Polymer Feed Pumps	3
No. of BFP Washdown Pumps	3
No. of conveyers for truck loading	3
Odor Control System	Note 4
Truck Loading Bin, yd^3	15

Note 1: Equipment sizing is based on MMADL.

Note 2: The existing GBTs can be dedicated to either pretreatment or final thickening.

Note 3: Gas Storage and handling equipment includes gas piping, filters, and storage tanks. The cost for generators was not included. GRU owns various generators that can be relocated to the WRFs.

Note 4: Anaerobic digested sludge is known to be more odorous than aerobic sludge; thus require odor control.

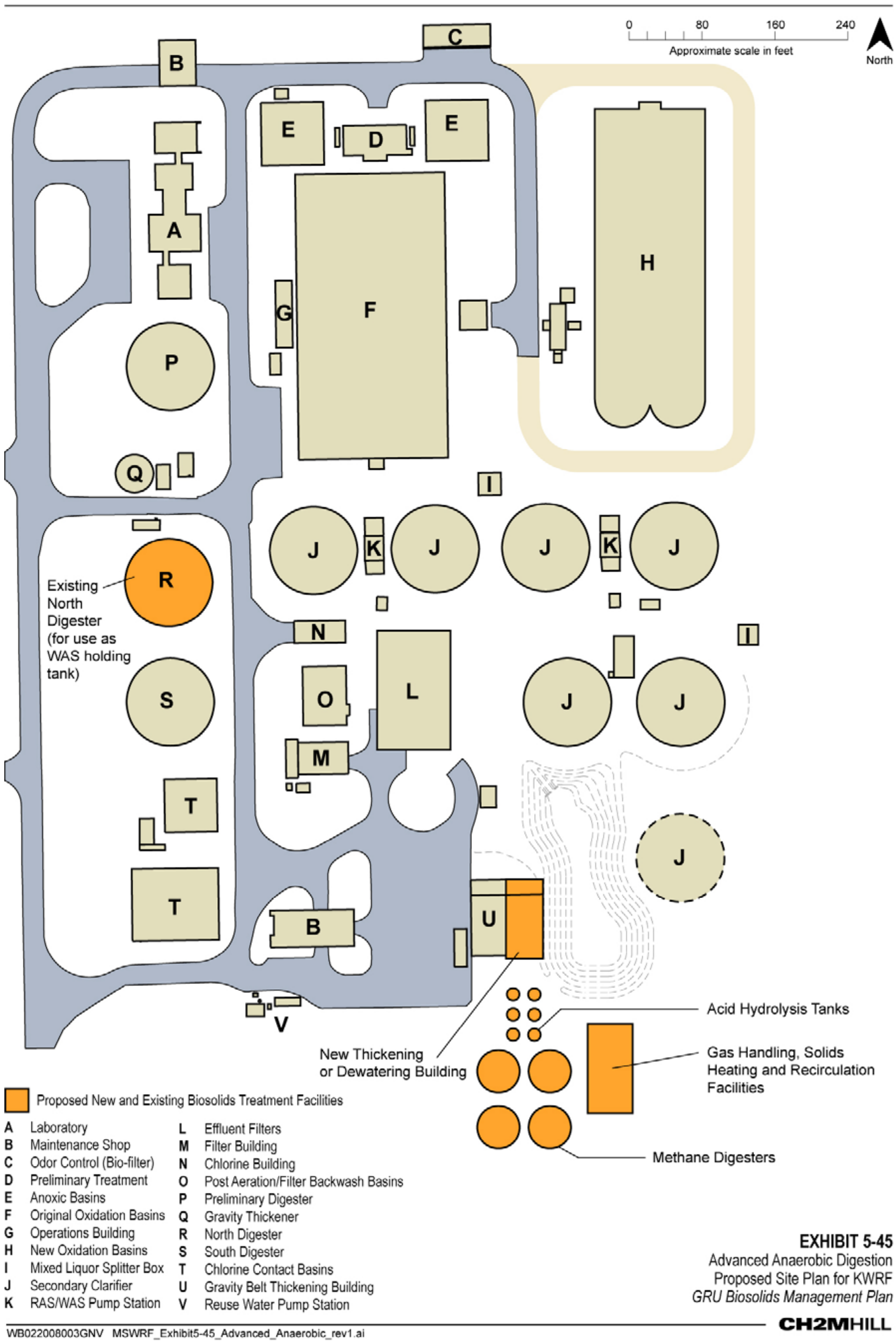

EXHIBIT 5-45
Advanced Anaerobic Digestion
Proposed Site Plan for KWRF
GRU Biosolids Management Plan

A summary of the capital, O&M, and total present-worth costs for this alternative are depicted in **Exhibit 5-46**. The costs for both thickening and dewatering facilities are presented.

EXHIBIT 5-46
Summary of Onsite Treatment Costs for Implementation of Advanced Anaerobic Digestion (AAND) at KWRF
GRU Biosolids Management Plan

Item	w/ Thickening	w/ Dewatering
Capital Cost	$ 21,919,000	$ 25,716,000
Present-Worth O&M Cost	$ 6,930,000	$ 7,454,000
Total Present-Worth Cost	**$ 28,849,000**	**$ 33,170,000**

Main Street Water Reclamation Facility (AAND)

A summary of the equipment and facilities required to implement AAND at the MSWRF is presented in **Exhibit 5-47**. By adopting an AAND process, the MSWRF would benefit from long-term power saving (i.e., methane production), enhanced VSS destruction, and the production of Class A product. However, since the MSWRF is space-limited, a site plan for the proposed facilities is not presented. In order to install an AAND system, the existing digesters and/or other facilities will have to be demolished. Moreover, provisions will need to be made to continue operation of the MSWRF during construction. Such provisions were not included in the evaluation.

EXHIBIT 5-47
New Facilities Required for Implementation of Advanced Anaerobic Digestion (AAND) at MSWRF
GRU Biosolids Management Plan

Item	Value[1]
WAS Storage Tank (North Digester)	-
Volume, gal	50,000
Diameter, ft	20
Side Water Depth (SWE), ft	25 (floating)
Type of System	Surface Aerator
No. of Surface Aerators / Rated Capacity, Hp	1 / 100
Pre-Digestion Gravity Belt Thickening (GBT) [2]	
No. of 2.0 m Thickeners	2
Hydraulic Loading Rate, gpm	600
Solids Loading Rate, dry lb/hr	1,000
No. of Thickener Feed Pumps	2
No. of Polymer Feed Pumps	2
No. of Filtrate Return Pumps	2
Thickened Sludge Storage Bin/Sump, yd^3	15
Digestion Feed Pump Station	
Sludge Grinder / Capacity, gpm	2

EXHIBIT 5-47
New Facilities Required for Implementation of Advanced Anaerobic Digestion (AAND) at MSWRF
GRU Biosolids Management Plan

Item	Value[1]
No. of Sludge Transfer Pumps / Capacity, gpm	3
Advanced Anaerobic Digesters (w/ covers)	
Acid Hydrolysis (42 Degree C)	
No. of Digesters	6
Volume, gal	18,000
Diameter, ft	11
Side Water Depth (SWE), ft	25
Type of Mixing System	Mechanical Mixer
Methane Digestion (35 Degree C)	
No. of Digesters	4
Volume, gal	200,000
Diameter, ft	37
Side Water Depth (SWE), ft	25
Type of Mixing System	Mechanical Mixer
Heating & Recirculation System	
No. of Boilers	2
No. of Heat Exchangers / Capacity, MMBTU/hr	2 / 1.5
No. of Sludge Recycle Pumps	12
Gas Storage and Handling Equipment	Note 3
Dewatering Option: Belt Filter Presses (BFP)	
No. of 2.2 meter BFPs	2
Hydraulic Loading Rate, gpm	200
Solids Loading Rate, dry lb/hr	1,200
No. of Polymer Feed Pumps	3
No. of BFP Washdown Pumps	3
No. of conveyers for truck loading	3
Type of Odor Control System	Note 4
Truck Loading Bin, yd^3	15

Note 1: Equipment sizing is based on MMADL.

Note 2: The existing GBTs can be dedicated to either pretreatment or final thickening.

Note 3: Gas Storage and handling equipment includes gas piping, filters, and storage tanks. The cost for generators was not included. GRU owns various generators that can be relocated to the WRFs.

Note 4: Anaerobic digested sludge is known to be more odorous than aerobic sludge; thus require odor control.

A summary of the capital, O&M, and total present-worth costs for this alternative is depicted in **Exhibit 5-48**. The costs for both thickening and dewatering facilities are presented.

EXHIBIT 5-48
Summary of Onsite Treatment Costs for implementation of Advanced Anaerobic Digestion (AAND15) at MSWRF[1]
GRU Biosolids Management Plan

Item	w/ Thickening	w/ Dewatering
Capital Cost	$18,879,000	$22,524,000
Present-Worth O&M Cost	$5,241,000	$5,471,000
Total Present-Worth Cost	**$24,120,000**	**$27,995,000**

[1] MSWRF costs presented herein do not account for demolition of existing facilities or provisions for operating the plant during construction.

5.4.4 Composting (Comp)

Composting is the second alternative considered to produce Class A biosolids and enable GRU to market their product for public-access applications. As discussed in **Section 4**, composting is a biosolids stabilization method that destroys pathogens while producing a humus-like product that is beneficial to plant growth and can be used for soil conditioning in public access sites. Section 5.3.4 presents and explains the details of the offsite facility that is required under this alternate. The objective in this section is to explain how composting complies with the Part 503 Rule and to present the onsite facility requirement for both plants. Under this scenario, GRU would comply with federal regulations as follows:

- As per Alternative 5 (see **Section 2**) of the options to meet Class A pathogen reduction, the static aerated pile composting method operated at 55°C or greater for more than 3 days qualifies as a PFRP (40 CFR Part 503.32[a][7]).
- As per Category 2 (see **Section 2**) of the options to meet vector attraction reduction, the static aerated pile composting method operated at 40°C or greater for more than 5 days qualifies as a PSRP (40 CFR Part 503.32[b][3]).

The proposed composting facility will meet both of the criteria by operating at an average temperature of 55°C and a minimum curing time of 5 days. When composting, it is beneficial to use biosolids with at least 20-percent solids. Therefore, to implement a composting process, the operation of the existing thickening facilities would need to be discontinued and replaced by dewatering facilities by use of centrifuges (with a conveyer system to load trucks). For the KWRF, the costs of new buildings were included. Conversely, for the MSWRF, since it is space-limited, the existing thickening buildings were modified. The new facilities will include odor control, a new electrical room, conveyer belts, a bridge crane, and hoppers to temporarily store biosolids and load trucks. In addition, it is assumed that the existing aerobic digestion systems will continue to operate to control odors and for preliminary biosolids stabilization. The proposed facilities and equipment to be installed at the KWRF and the MSWRF under this alternative are presented below.

Kanapaha Water Reclamation Facility (COMP)

A summary of the equipment and facilities required to implement this alternative is presented in **Exhibit 5-49**. The new building would replace the existing GBT facilities. This alternative assumes that the existing aerobic digesters at KWRF will continue to operate through 2025.

EXHIBIT 5-49
New Facilities Required for Implementation of Composting (Comp) at KWRF
GRU Biosolids Management Plan

Item	Value [1]
Dewatering with Centrifuges	
No. of Sludge Feed Pumps	3
No. of Centrifuges	3 (2 online, 1 stand-by)
Hydraulic Loading Rate, gpm	180
Solids Loading Rate, dry lb/hr	1,800
No. of Polymer Feed Pumps	4
Maintenance Bridge Crane	1
No. of conveyers for truck loading	5
Truck Loading Bin Capacity, yd^3	25
New Centrifuge Building	
Length, ft	70
Width , ft	52

[1] Equipment sizing is based on 2025 MMADL, assuming that the existing 2006 facilities continue to operate (15 VSS reduction).

Main Street Water Reclamation Facility (COMP)

A summary of the equipment and facilities required to implement this alternative is presented in **Exhibit 5-50**.

EXHIBIT 5-50
New Facilities Required for Implementation of Composting (Comp) at MSWRF
GRU Biosolids Management Plan

Item	Value [1]
Dewatering with Centrifuges	
No. of Sludge Feed Pumps	3
No. of Centrifuges	2 (1 online, 1 stand-by)
Hydraulic Loading Rate, gpm	180
Solids Loading Rate, dry lb/hr	1,800
No. of Polymer Feed Pumps	3
Bridge Crane	1
No. of conveyers for truck loading	4
Truck Loading Bin Capacity, yd^3	25

[1] Equipment sizing is based on MMADL.

A summary of the onsite capital, O&M, and total present-worth costs for this alternative is presented in **Exhibit 5-51**.

EXHIBIT 5-51
Summary of Onsite Treatment Costs for Implementation of Composting (COMP) at GRU WRFs
GRU Biosolids Management Plan

Item	KWRF	MSWRF
Capital Cost	$ 9,381,000	$ 5,558,000
Present-Worth O&M Cost	$ 6,214,000	$ 5,781,000
Total Present-Worth Cost	**$ 15,595,000**	**11,339,000**

5.4.5 Lime Stabilization (LIMSTAB)

The EnVessel Pasteurization™ process, a proprietary advanced alkaline system, was selected for this evaluation. EnVessel Pasteurization™ uses a combination of quicklime, supplemental heat, and an insulated enclosed reactor vessel to produce Class A biosolids and reduce vector attraction. If GRU adopts this alternative, only the North Digester (with a 75-hp surface aerator) would be operated as a WAS holding facility. The remaining digester would no longer be necessary. Under this scenario, GRU would comply with federal and state regulations as follows:

- As per Alternative 5 (see **Section 2**) of the options to meet Class A pathogen reduction, pasteurization methods operated at 70°C or greater for more than 30 minutes qualify as a PFRP (40 CFR Part 503.32[a][7]).
- As per Category 6 (see **Section 2**) of the options to meet vector attraction reduction, sufficient lime must be added to raise the pH to 12 or higher for a period of 2 hours, with the biosolids remaining at a pH of 11.5 for an additional 22 hours without the use of additional lime.

The proposed lime pasteurization process meets the above criteria. The process flow diagram is presented in **Exhibit 5-52.** The system consists of one EnVessel Pasteurization™ system located at the KWRF with adequate capacity to handle the MMDL, during build-out conditions, from both plants. Due to space limitations at the MSWRF and for operational convenience, the biosolids from the MSWRF would be dewatered onsite and transported to the KWRF. New dewatering facilities using BFPs would be necessary at both GRU WRFs. The new dewatering facilities would include odor control, temporary storage of biosolids, and a belt conveyer system to load trucks.

Dewatered biosolids (at approximately 16-percent solids) from both facilities will be combined at the KWRF by a system of screw and belt conveyers prior to EnVessel Pasteurization™. The EnVessel Pasteurization™ system will first preheat the biosolids by use of a ThermoBlender™ - a mixing, electrical-heating devise that is submerged into the material. Lime from a lime storage silo is added at the ThermoBlender™ to heat the contents to 70°C in a lime to biosolids ratio of approximately 0.3:1. The combined solids are then placed into an insulted vessel that stores the contents for at least 30-minutes. The pasteurization vessel includes temperature sensors that demonstrate compliance with the Part 503 Rule.

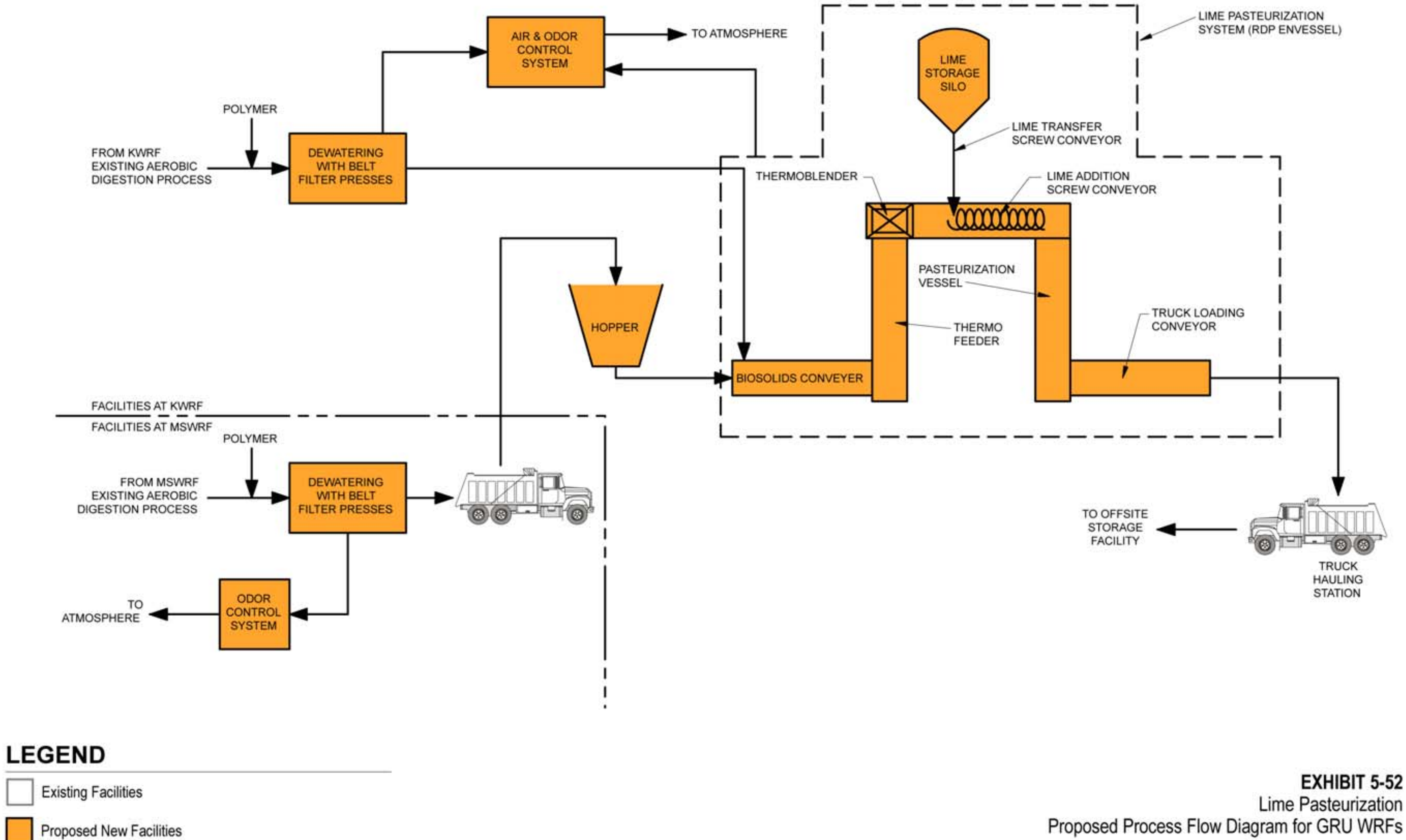

EXHIBIT 5-52
Lime Pasteurization
Proposed Process Flow Diagram for GRU WRFs
GRU Biosolids Management Plan

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Odor control is important when considering a lime pasteurization process since the elevated pH and temperature result in a release of gaseous ammonia. Lime dust is also inherent to the process. Thus, the proposed system includes an allowance for a dust and odor control system.

After processing by the EnVessel Pasteurization™ system, the product is loaded into trucks and stored offsite, where it is stored for at least 24 hours (at a pH of about 12). The offsite facility is an open wall building sized for two weeks of storage based on a combined AADL.

Kanapaha Water Reclamation Facility (LIMSTAB)

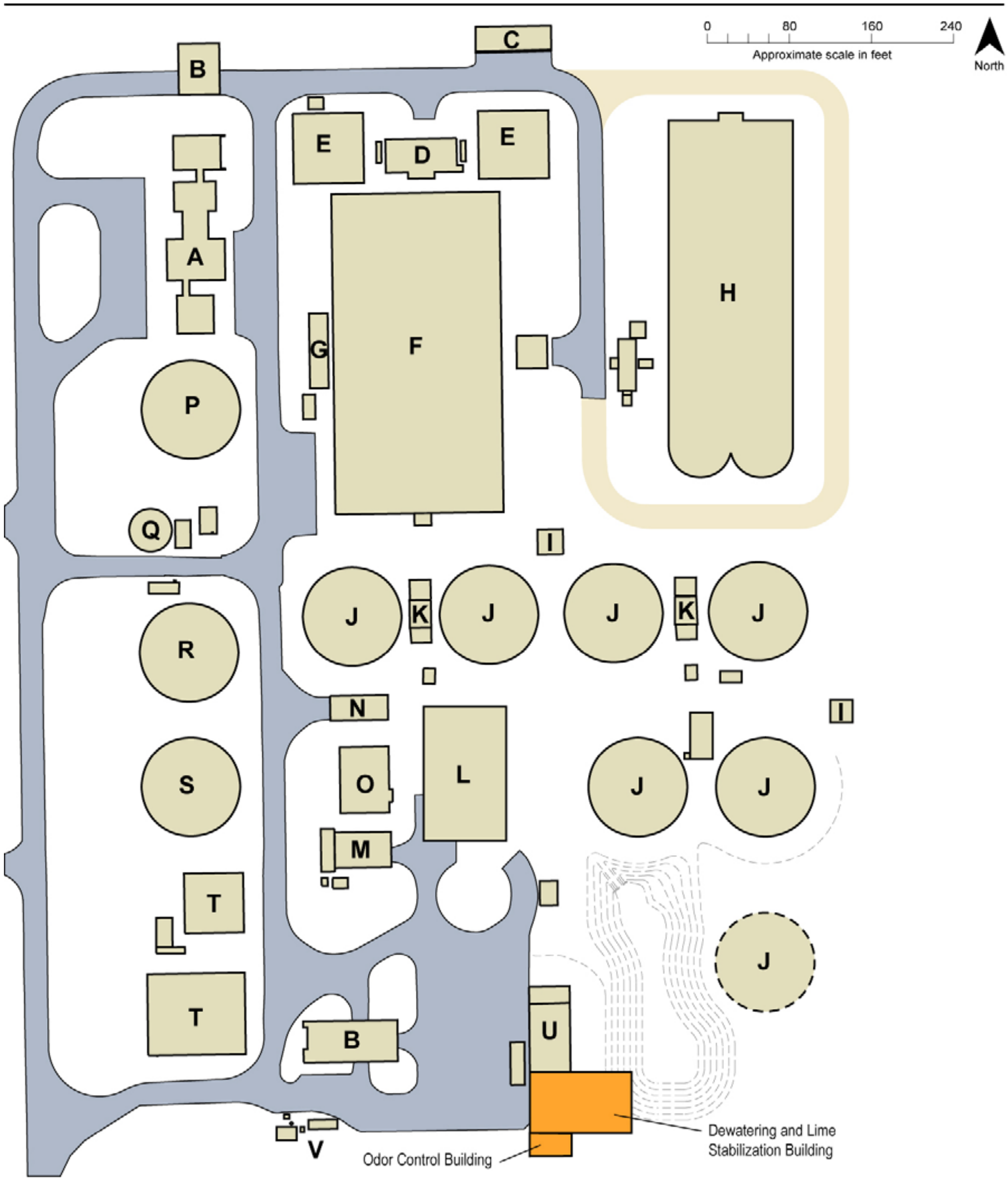
A summary of the equipment and facilities required to implement this alternative is presented in **Exhibit 5-53**. In addition, **Exhibit 5-54** illustrates a possible location for the proposed facilities.

EXHIBIT 5-53
New Facilities Required for Implementation of Lime Pasteurization (LIMSTAB) at KWRF
GRU Biosolids Management Plan

Item	Value
MSWRF Receiving Bin/Sump Volume, yd^3	15
Dewatering with Belt Filter Presses (BFP)	
No. of 2.2 meter BFPs / Capacity, lb/hr	3
Hydraulic Loading Rate, gpm	200
Solids Loading Rate, dry lb/hr	1,200
No. of Feed Pumps / Capacity, gpm	4
No. of Polymer Feed Pumps	4
No. of BFP Washdown Pumps	4
No. of conveyers for truck loading	4
Cake Storage & Mixing Bin/Sump, yd^3	30
Lime Pasteurization Process	
Belt Conveyers	2
Thermo Feeder	1
Heat System Power Control Center	1
Lime Addition & Mixing Screw Conveyers	2
Pasteurization Vessel	1
Lime Storage Silo	1
New Building	
Length, ft	110
Width , ft	87
Odor Control System	Note 2

Note 1: Equipment sizing is based on MMADL.

Note 2: The excess ammonia gas and lime dust produced by the pasteurization process require odor and air pollution control.



Proposed New and Existing Biosolids Treatment Facilities

A	Laboratory	L	Effluent Filters
B	Maintenance Shop	M	Filter Building
C	Odor Control (Bio-filter)	N	Chlorine Building
D	Preliminary Treatment	O	Post Aeration/Filter Backwash Basins
E	Anoxic Basins	P	Preliminary Digester
F	Original Oxidation Basins	Q	Gravity Thickener
G	Operations Building	R	North Digester
H	New Oxidation Basins	S	South Digester
I	Mixed Liquor Splitter Box	T	Chlorine Contact Basins
J	Secondary Clarifier	U	Gravity Belt Thickening Building
K	RAS/WAS Pump Station	V	Reuse Water Pump Station

EXHIBIT 5-54
Lime Pasteurization
Proposed Site Plan for KWRF
GRU Biosolids Management Plan

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Main Street Water Reclamation Facility (LIMSTAB)

A summary of the equipment and facilities required to implement this alternative at the MSWRF is presented in **Exhibit 5-55**. Since the MSWRF is space-limited, the dewatering facilities would replace the GBTs. Provisions will need to be made to continue operation of the MSWRF during construction. Such provisions were not included in the evaluation.

EXHIBIT 5-55
New Facilities Required for Implementation of Lime Pasteurization (LIMSTAB) at MSWRF
GRU Biosolids Management Plan

Item	Value
Dewatering with Belt Filter Presses (BFP)	
No. of 2.2 meter BFPs	2
Hydraulic Loading Rate, gpm	200
Solids Loading Rate, dry lb/hr	1,200
No. of Polymer Feed Pumps	3
No. of BFP Washdown Pumps	3
No. of conveyers for truck loading	3
No. of conveyers for truck loading	3
Truck Loading Bin Volume, yd^3	15

A summary of the capital, operations and maintenance, and total present worth costs for the treatment aspect of this alternative is depicted in **Exhibit 5-56**. While calculating operations costs, it was assumed that the existing aerobic digestion facilities would continue to operate for minor VSS destruction, odors control, equalization, and temporary storage.

EXHIBIT 5-56
Summary of Onsite Treatment Costs for Implementation of Lime Pasteurization (LIMSTAB) at GRU WRFs
GRU Biosolids Management Plan

Item	KWRF [1]	MSWRF
Capital Cost	$21,461,000	$4,840,000
Present-Worth of O&M Cost	$ 8,969,000	$ 5,227,000
Total Present-Worth Cost	**$30,431,000**	**$10,067,000**

1 In addition to the facilities depicted in Exhibit 5-55, the KWRF cost includes the cost for the offsite 9,900 ft2 storage facility.

5.4.6 Thermal Oxidation (TOX)

Depending on the configuration of the future generating facilities at the Deerhaven Generating Station, there may be the ability to biosolids as a supplemental energy source. Although the fuel heating value from the biosolids is relatively small compared to the coal and/or fuel requirements, thermal oxidation would dispose of biosolids while contributing to the generation of electrical power. Thus, this may be a win-win situation for GRU and the community.

Thermal oxidation of biosolids involves burning the organic materials in the biosolids in presence of oxygen. The primary concerns from co-firing of biosolids include: impact of water content of biosolids on the combustion process, air emissions and ash disposal. Air emissions from the combustion will have to meet the current air permit emission for Deerhaven. Moreover, although not expected, thermally-oxidized biosolids may result in ash with elevated concentrations of heavy metals. The Part 503 Rule regulates the disposal of non-hazardous incinerator ash generated during the firing of biosolids. Ash deemed as hazardous would have to be taken to a hazardous waste landfill.

The proposed facilities and equipment to be installed at the KWRF and the MSWRF for this alternative are presented below. Although biosolids are combustible, they will ignite only if sufficient water has been removed. Thus, the onsite facility requirements for this alternative included dewatering using centrifuges. The centrifuged biosolids from both GRU WRFs would be transported to the Deerhaven Power Plant where a truck receiving station and storage silos would be installed. The process flow diagram for this alternative is presented in **Exhibit 5-57.**

For this analysis, no tipping fees were included for Deerhaven Generating Facility to accept the biosolids, i.e., it is assumed that the costs and benefits to the power generating system would be equal and no charges would be paid to either system from the other.

Kanapaha Water Reclamation Facility (TOX)

A summary of the equipment and facilities required to implement this alternative at the KWRF is presented in **Exhibit 5-58**. In addition, **Exhibit 5-59** illustrates a possible location for the proposed equipment.

Based on a preliminary schedule provided by GRU, it was assumed that the new Deerhaven Power Plant expansion will become operational in 2013. It was assumed that until 2012, GRU would continue aerobic digestion and applying the Class B product at the Whistling Pines Farm (WP). After this date, only the North Digester would be operated as a WAS holding facility. Minor system improvements are necessary to meet (assuming AD27) the projected flows through 2012. GRU would need to install an additional aerobic digester to at the KWRF.

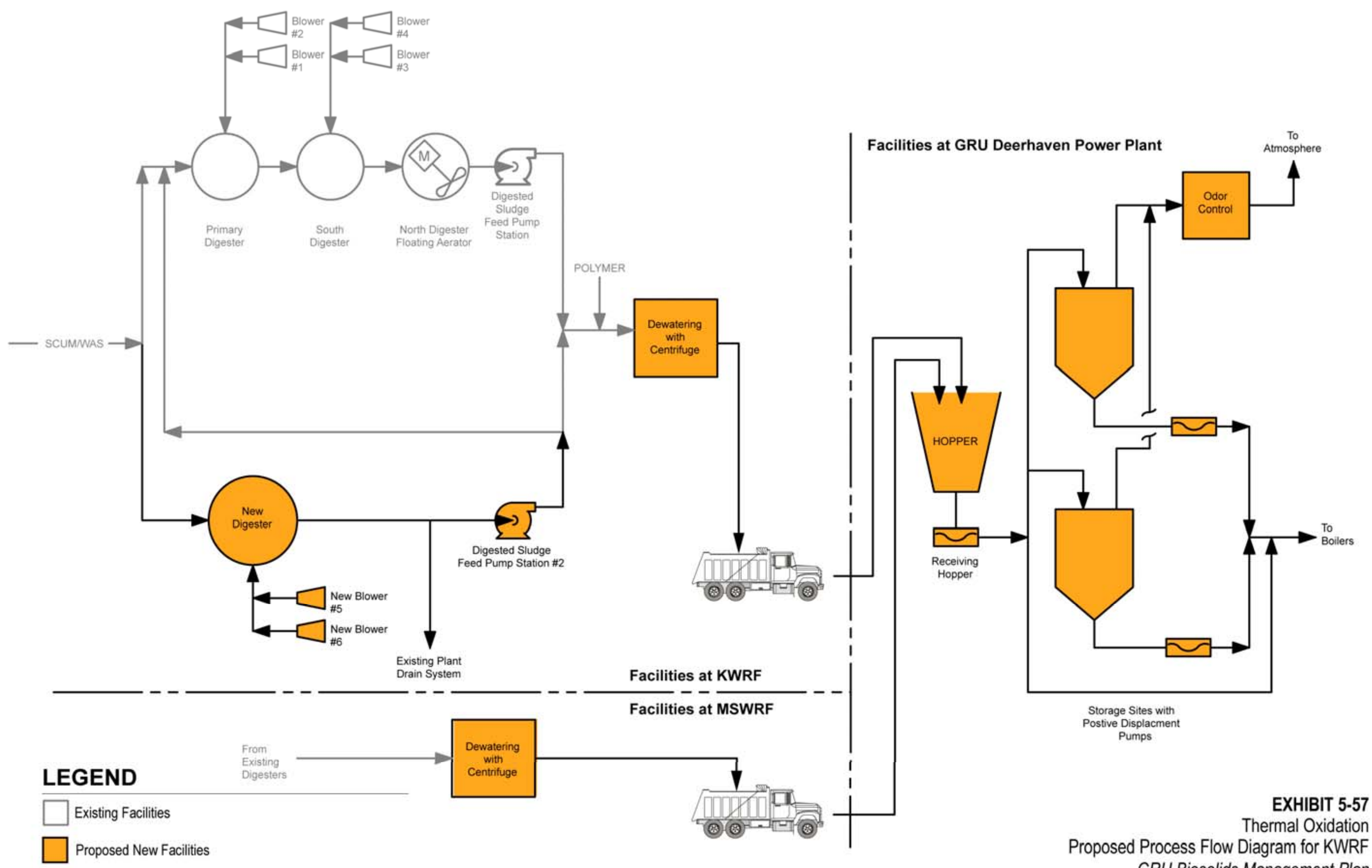

EXHIBIT 5-57
Thermal Oxidation
Proposed Process Flow Diagram for KWRF
GRU Biosolids Management Plan
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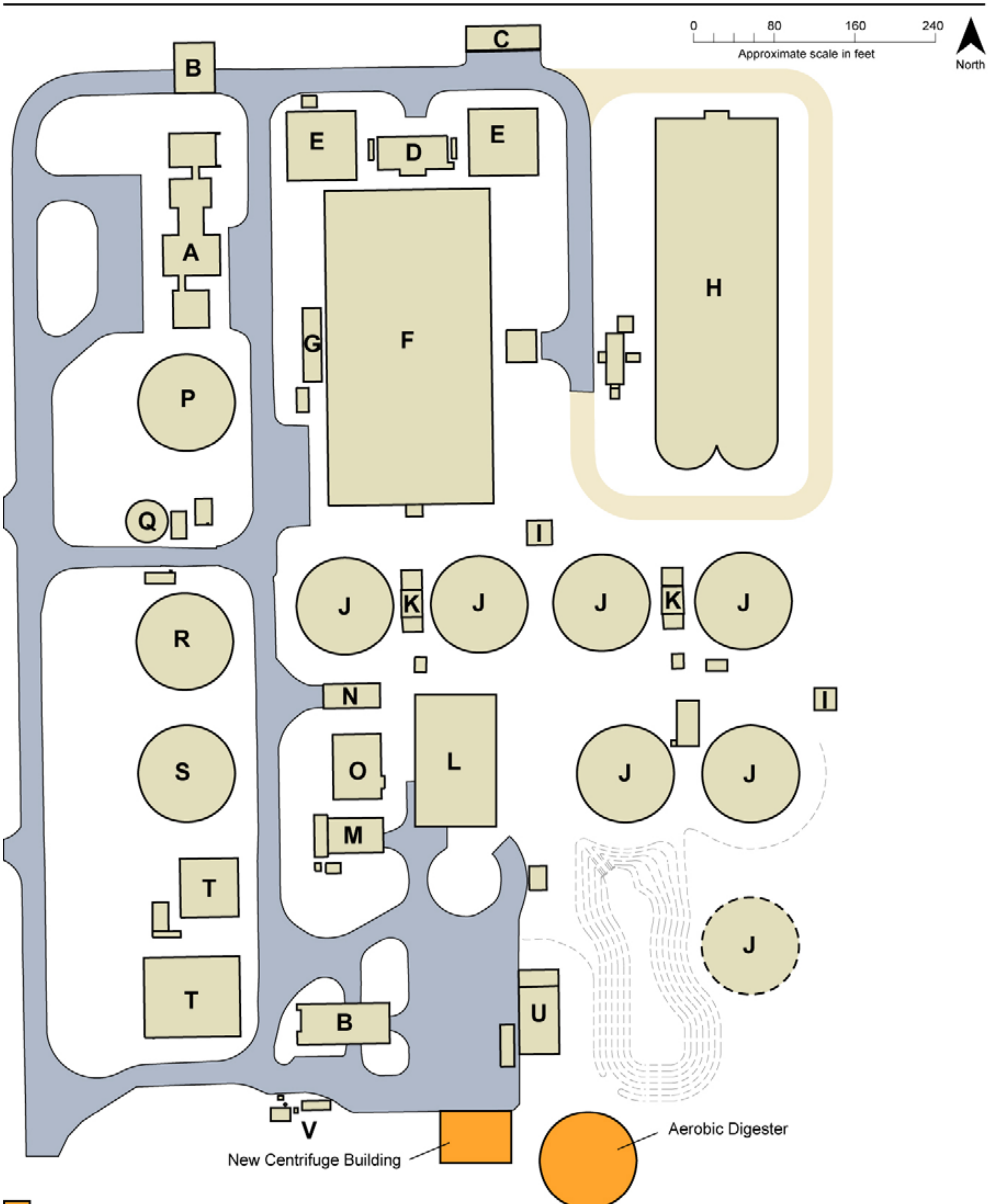
EXHIBIT 5-58
New Facilities Required for Implementation of Thermal Oxidation (TOX) at KWRF
GRU Biosolids Management Plan

Design Criteria	Value
Aerobic Digestion	
No. of Digesters	1
Volume, MG	0.75
Diameter, ft	90
Side Water Depth (SWD), ft	16.5
Type of Aeration System	Coarse Bubble Diffusers
No. of Blowers / Blower Rated Capacity, SCFM	3 / 5,000 SCFM
Digested Sludge Pump Station	
No. of Sludge Grinder	1
No. of Sludge Pumps	2
Dewatering with Centrifuges	
No. of Sludge Feed Pumps	3
No. of Centrifuges	2
Hydraulic Loading Rate, gpm	200
Solids Loading Rate, dry lb/hr	1,800
No. of Polymer Feed Pumps	3
Bridge Crane	1
No. of conveyers for truck loading	4
Truck Loading Bin Capacity, yd^3	25
New Centrifuge Building	
Length, ft	70
Width , ft	52



Proposed New and Existing Biosolids Treatment Facilities

A	Laboratory	**L**	Effluent Filters
B	Maintenance Shop	**M**	Filter Building
C	Odor Control (Bio-filter)	**N**	Chlorine Building
D	Preliminary Treatment	**O**	Post Aeration/Filter Backwash Basins
E	Anoxic Basins	**P**	Preliminary Digester
F	Original Oxidation Basins	**Q**	Gravity Thickener
G	Operations Building	**R**	North Digester
H	New Oxidation Basins	**S**	South Digester
I	Mixed Liquor Splitter Box	**T**	Chlorine Contact Basins
J	Secondary Clarifier	**U**	Gravity Belt Thickening Building
K	RAS/WAS Pump Station	**V**	Reuse Water Pump Station

EXHIBIT 5-59
Thermal Oxidation
Proposed Site Plan for KWRF
GRU Biosolids Management Plan

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Main Street Water Reclamation Facility (TOX)

The MSWRF has adequate treatment capacity until 2013. A summary of the dewatering facilities required to implement this alternative is presented in **Exhibit 5-60**. The new dewatering facilities would replace the existing GBTs.

EXHIBIT 5-60
New Facilities Required for Implementation of Thermal Oxidation (TOX) at MSWRF
GRU Biosolids Management Plan

Design Criteria	Value
Dewatering with Centrifuges	
No. of Sludge Feed Pumps	3
No. of Centrifuges	2
Hydraulic Loading Rate, gpm	200
Solids Loading Rate, dry lb/hr	1,800
No. of Polymer Feed Pumps	3
Bridge Crane	1
No. of conveyers for truck loading	4
Truck Loading Bin Capacity, yd^3	25

Deerhaven Power Plant (TOX)

A summary of the equipment and facilities required to implement this alternative at the Deerhaven Power Plant are listed in **Exhibit 5-61**. Biosolids receiving, storage and pumping (furnace feed) facilities would be required at Deerhaven.

EXHIBIT 5-61
New Facilities Required for Implementation of Thermal Oxidation (TOX) at Deerhaven
GRU Biosolids Management Plan

Design Criteria	Value
Covered Truck Receiving Area, ft^2	800
New Electrical Building, ft^2	800
Truck Receiving and Storage Equipment	
Sludge Pumps	4
Silos	2
Odor Control System	1

A summary of the capital, O&M, and total present-worth costs for the treatment aspect of this alternative is depicted in **Exhibit 5-62**. While calculating operations costs, it was assumed that one aerobic digestion (i.e., floating system) at each WRF would continue to operate for odors control, equalization, and temporary storage.

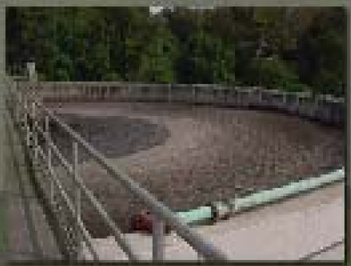
As described earlier, these costs do not include fees charges by (or paid by) the power generating system for accepting biosolids. The feasibility of this alternative can be better assessed based on the power generating alternatives that are developed.

EXHIBIT 5-62
Summary of Onsite Treatment Costs for Implementation of Thermal Oxidation (TOX) at GRU Facilities
GRU Biosolids Management Plan

Item	KWRF [1]	MSWRF
Capital Cost	$ 22,968,000	$ 5,558,,000
Present-Worth O&M Cost	$ 5,860,000	$ 5,781,000
Total Present-Worth Cost	**$ 28,828,000**	**$ 11,339,000**

[1] In addition to the facilities depicted in Exhibit 5-58, the KWRF costs includes the capital ($8.8 M) and O&M cost for the biosolids receiving and storage facilities at Deerhaven, which include a covered receiving area, an electrical building, sludge pumps, and storage silos.

Evaluation and Ranking of Biosolids Management Alternatives



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6. Evaluation and Ranking of Biosolids Management Alternatives

6.1 Preliminary Screening

CH2M HILL and GRU staff met for a series of five workshops from October 2005 to February 2006 to evaluate and rank the different alternatives for their ability to support the long-term viability (through year 2025) of GRU's biosolids management program. **Exhibit 6-1** presents a summary of the five workshops and the primary focus of each workshop.

EXHIBIT 6-1
Summary of Biosolids Management Planning Workshops
GRU Biosolids Management Plan

Workshop No.	Date	Primary Focus
1	October 10, 2005	Project Kickoff & Team Chartering
2	November 16, 2005	Framing the Issues
3	December 2, 2005	Evaluation Criteria Selection & Preliminary Screening of Alternatives
4	January 13, 2006	Preliminary Alternative Evaluations (Alternatives 1, 2, 4, & 5)
5	February 17, 2006	Preliminary Alternative Evaluations (Alternatives 3, 6, & 7) & Ranking of Alternatives

The current system operations, future disposal requirements and regulatory framework were discussed in Workshops Nos. 1 and 2. The project team conducted a preliminary screening of a multitude of potential treatment and end-use alternatives during Workshop No. 3. The alternatives considered during the preliminary screening process were discussed previously in **Section 4**. After preliminary screening, the project team developed a short list of biosolids treatment and end use options that were considered to have the most potential for meeting GRU's long-term objectives and then identified a final list of 33 different combinations of these biosolids treatment and end use alternatives for more detailed evaluation and cost analysis. The entire list of alternatives that were considered for detailed evaluation is summarized in **Exhibit 6-2**.

The costs of different alternatives presented in Section 5 did not include the salvage value of any capital improvement items such as machinery, equipment or land. Costs of most the items such as machinery, equipment will depreciate over time and will be only a small fraction of the actual cost during construction. Salvage value of such items will have minimal impact of the present worth (PW) value of an alternative. However, cost of land is likely to increase in the next 20 years. Since some of the alternatives required purchase of large land areas, and therefore the PW value of these alternatives can be considerably impacted by the salvage value of land. To incorporate the impact of large land purchase on the PW value of an alternative, salvage value of land greater than 50 acres was included the in the PW cost presented in Section 6. While the cost of land may increase over the time period of this project, to be conservative in calculating the benefit/cost (BC) ratio the salvage value of land was not escalated during the term of the project (i.e., through 2025).

EXHIBIT 6-2
List of Biosolids Management Alternatives Selected for Detailed Evaluation
GRU Biosolids Management Plan

Alternative No.	Alternative Acronym	Description	
		On-site Treatment Alternative	**Offsite Treatment / End Use Alternative**
1.1.a	AD27, TH, WP	Aerobic digestion, 27-day SRT; Thickened Liquid Biosolids, 5-6%	Agricultural land application at Whistling Pines
1.1.b	AD60, TH, WP	Aerobic digestion, 60-day SRT; Thickened Liquid Biosolids, 5-6%	Agricultural land application at Whistling Pines
1.2.a	AD27, TH, DNAS	Aerobic digestion, 27-day SRT; Thickened Liquid Biosolids, 5-6%	Agricultural land application at Dedicated New Agricultural Site, owned by GRU
1.2.b	AD60, TH, DNAS	Aerobic digestion, 60-day SRT; Thickened Liquid Biosolids, 5-6%	Agricultural land application at Dedicated New Agricultural Site, owned by GRU
1.3.a	AD27, TH, WPGRU	Aerobic digestion, 27-day SRT; Thickened Liquid Biosolids, 5-6%	Agricultural land application at Whistling Pines purchased by GRU
1.3.b	AD60, TH, WPGRU	Aerobic digestion, 60-day SRT; Thickened Liquid Biosolids, 5-6%	Agricultural land application at Whistling Pines purchased by GRU
1.4.a	AD27, TH, FOR	Aerobic digestion, 27-day SRT; Thickened Liquid Biosolids, 5-6%	Forest land application at dedicated site under contract
1.4.b	AD60, TH, FOR	Aerobic digestion, 60-day SRT; Thickened Liquid Biosolids, 5-6%	Forest land application at dedicated site under contract
2.1.a	AD27, BFPDEW, WP	Aerobic digestion, 27-day SRT; Belt Filter Press Dewatered Biosolids, 16%	Agricultural land application at Whistling Pines
2.1.b	AD60, BFPDEW, WP	Aerobic digestion, 60-day SRT; Belt Filter Press Dewatered Biosolids, 16%	Agricultural land application at Whistling Pines
2.2.a	AD27, BFPDEW, DNAS	Aerobic digestion, 27-day SRT; Belt Filter Press Dewatered Biosolids, 16%	Agricultural land application at Dedicated New Agricultural Site, owned by GRU
2.2.b	AD60, BFPDEW, DNAS	Aerobic digestion, 60-day SRT; Belt Filter Press Dewatered Biosolids, 16%	Agricultural land application at Dedicated New Agricultural Site, owned by GRU
2.3.a	AD27, BFPDEW, WPGRU	Aerobic digestion, 27-day SRT; Belt Filter Press Dewatered Biosolids, 16%	Agricultural land application at Whistling Pines purchased by GRU
2.3.b	AD60, BFPDEW, WPGRU	Aerobic digestion, 60-day SRT; Belt Filter Press Dewatered Biosolids, 16%	Agricultural land application at Whistling Pines purchased by GRU

EXHIBIT 6-2
List of Biosolids Management Alternatives Selected for Detailed Evaluation
GRU Biosolids Management Plan

Alternative No.	Alternative Acronym	Description	
		On-site Treatment Alternative	**Offsite Treatment / End Use Alternative**
2.4.a	AD27, BFPDEW, FOR	Aerobic digestion, 27-day SRT; Belt Filter Press Dewatered Biosolids, 16%	Forest land application at dedicated site under contract
2.4.b	AD60, BFPDEW, FOR	Aerobic digestion, 60-day SRT; Belt Filter Press Dewatered Biosolids, 16%	Forest land application at dedicated site under contract
3	CENDEW, COMP	Aerobic digestion, 27-day SRT; Centrifuge Dewatered Biosolids, 20%	Processing compost at an offsite facility
4.1.a	AND, TH, WP	Conventional high rate anaerobic digestion; Thickened Liquid Biosolids, 5-6%	Agricultural land application at Whistling Pines
4.1.b	AND,TH, DNAS	Conventional high rate anaerobic digestion; Thickened Liquid Biosolids, 5-6%	Agricultural land application at Dedicated New Agricultural Site, owned by GRU
4.1.c	AND, TH, WPGRU	Conventional high rate anaerobic digestion; Thickened Liquid Biosolids, 5-6%	Agricultural land application at Whistling Pines purchased by GRU
4.2.a	AND, BFPDEW, WP	Conventional high rate anaerobic digestion; Belt Filter Press Dewatered Biosolids, 16%	Agricultural land application at Whistling Pines
4.2.b	AND, BFPDEW, DNAS	Conventional high rate anaerobic digestion; Belt Filter Press Dewatered Biosolids, 16%	Agricultural land application at Dedicated New Agricultural Site, owned by GRU
4.2.c	AND, BFPDEW, WPGRU	Conventional high rate anaerobic digestion; Belt Filter Press Dewatered Biosolids, 16%	Agricultural land application at Whistling Pines purchased by GRU
4.2.d	AND, BFPDEW, FOR	Conventional high rate anaerobic digestion; Belt Filter Press Dewatered Biosolids, 16%	Forest land application at dedicated site under contract
5.1.a	AAND, TH, WP	Mesophilic Acid Hydrolysis Plug Flow Advanced Anaerobic Digestion; Thickened Liquid Biosolids, 5-6%	Agricultural land application at Whistling Pines
5.1.b	AAND, TH, DNAS	Mesophilic Acid Hydrolysis Plug Flow Advanced Anaerobic Digestion; Thickened Liquid Biosolids, 5-6%	Agricultural land application at Dedicated New Agricultural Site, owned by GRU
5.1.c	AAND, TH, WPGRU	Mesophilic Acid Hydrolysis Plug Flow Advanced Anaerobic Digestion; Thickened Liquid Biosolids, 5-6%	Agricultural land application at Whistling Pines purchased by GRU
5.2.a	AAND, BFPDEW, WP	Mesophilic Acid Hydrolysis Plug Flow Advanced Anaerobic Digestion; Belt Filter Press Dewatered Biosolids, 16%	Agricultural land application at Whistling Pines

EXHIBIT 6-2
List of Biosolids Management Alternatives Selected for Detailed Evaluation
GRU Biosolids Management Plan

Alternative No.	Alternative Acronym	Description	
		On-site Treatment Alternative	**Offsite Treatment / End Use Alternative**
5.2.b	AAND, BFPDEW, DNAS	Mesophilic Acid Hydrolysis Plug Flow Advanced Anaerobic Digestion; Belt Filter Press Dewatered Biosolids, 16%	Agricultural land application at Dedicated New Agricultural Site, owned by GRU
5.2.c	AAND, BFPDEW, WPGRU	Mesophilic Acid Hydrolysis Plug Flow Advanced Anaerobic Digestion; Belt Filter Press Dewatered Biosolids, 16%	Agricultural land application at Whistling Pines purchased by GRU
5.2.d	AAND, BFPDEW, FOR	Mesophilic Acid Hydrolysis Plug Flow Advanced Anaerobic Digestion; Belt Filter Press Dewatered Biosolids, 16%	Forest land application at dedicated site under contract
6	BDFDEW, TOX	Aerobic digestion, 27-day SRT; Belt Filter Press Dewatered Biosolids, 16%	Thermal Oxidation (Alternative Fuel for Deer Haven Power Plant)
7	BFPDEW, LIMSTAB	Aerobic digestion, 27-day SRT; Belt Filter Press Dewatered Biosolids, 16%; Lime Stabilization	Application of Lime Stabilized Product

NOTE: AD27 = Aerobic digestion, 27-day SRT; AD60 = Aerobic digestion, 60-day SRT; AND = Conventional high rate anaerobic digestion;

AAND = Mesophilic Acid Hydrolysis Plug Flow Advanced Anaerobic Digestion; TH = Thickened Liquid Biosolids, 5-6%; BFPDEW= Belt Filter Press Dewatered Biosolids, 16% CENDEW= Centrifuge Dewatered Biosolids, 20%; WP= Whistling Pines Ranch; DNAS= Dedicated New Agricultural Site, owned by GRU; WPGRU= Whistling Pines Ranch purchased by GRU; FOR= Dedicated Forest Site; COMP= Composting Facility; TOX= Thermal Oxidation (Alternative Fuel for Deer Haven Power Plant); LIMSTAB= Lime Stabilization

Therefore, it was assumed that in 2025, the salvage value of the land is the same as the price paid by GRU in 2006, effectively canceling out the initial capital expenditure for the land. The costs for biosolids treatment, transportation, and land application/processing for each alternative showing the PW value both including and excluding the salvage value are summarized in Appendix E.

In addition to evaluating order-of-magnitude costs for each alternative, during Workshop 3, the project team discussed how a non-monetary criteria evaluation process could be used to help identify the most appropriate option or group of options by comparing the benefits and cost of each alternative. The project team developed a non-monetary evaluation process to assist in the evaluation of alternatives. The result of this benefit/cost analysis is also presented in this section.

6.2 Non-Monetary Criteria and Benefit/Cost Ratio Analyses

For the non-monetary evaluation of the biosolids management alternatives, the following five major screening categories were identified by the project teams of GRU and CH2M HILL:

1) Aesthetics and Public Acceptance
2) Product Marketability
3) Plant O&M
4) Regulatory Impacts
5) Constructability

Environmental stewardship was discussed as a criteria, but was not included in the evaluation because all alternatives had to be environmentally sound to be seriously considered. Each of the five categories was then subdivided into additional sub-criteria. For example, the category *Aesthetics and Public Acceptance* was subdivided into the subcategories *Odor Potential*, *Traffic Impacts*, *Potential for Public Opposition*, *Visual Impacts/Buffer Area, Use of Renewable Energy Sources* and *Bi-product utilization*. In all, the project team from GRU selected a total of 22 sub-criteria to include in the analysis. Next, the GRU project team weighted each major category by its perceived order of importance by using a total weighting factor of 100 points for the five categories. *Constructability* received the lowest weight (14) among the major categories while the other four categories have almost similar weights. After determining the weight of each major category, each sub-criterion within each major category was then weighted by its perceived order of importance within a category, using a total weighting factor of 100 points for the category.

The final weight of each major category criterion and the relative weights of the 22 sub-criteria are shown in **Exhibit 6-3**. As shown in **Exhibit 6-3**, the highest weight (16.5) amongst the 22 sub-criteria was given to *20-year viability*, emphasizing the importance of the long-term viability of the selected alternative. The long-term viability was based on an alternative's compliance with anticipated future regulatory requirements and how it was affected by outside political and/or social influences. The sub-criteria within *Product Marketability* and sub-criterion *Potential for Public Opposition* had the second and third highest weights among the 22 sub-criteria.

EXHIBIT 6-3
Relative Weights of the Non-Monetary Analysis Criteria
GRU Biosolids Management Plan

Item	Category	Weighting %	Category and Sub-Criteria Weight Scores
1	**Aesthetics and Public Acceptance**		**22.0**
1.1	Odor Potential	25	5.5
1.2	Traffic Impacts - Off-Site Impacts	15	3.3
1.3	Potential for Public Opposition	30	6.6
1.4	Visual Impacts/Buffer Area	10	2.2
1.5	Use of Renewable Energy Sources	10	2.2
1.6	Bi-product utilization	10	2.2
2	**Product Marketability**		**21.0**
2.1	Sensitivity to changing markets	33.33	7.0
2.2	Business partner reliability/flexibility	33.33	7.0
2.3	End Use diversity/flexibility	33.33	7.0
3	**Plant Operations & Maintenance**		**21.0**
3.1	Performance Reliability due to Weather Impacts	20	4.2
3.2	Technical Risk	20	4.2
3.3	Process Complexity	20	4.2
3.4	Operational Flexibility	20	4.2
3.5	Process & Mechanical Reliability	20	4.2
4	**Regulatory Impacts**		**22.0**
4.1	20-yr Viability	75	16.5
4.2	5-yr Viability	25	5.5
5	**Constructability**		**14.0**
5.1	Site Impacts	15	2.1
5.2	Construction Time	10	1.4
5.3	Ability to Permit	45	6.3
5.4	Use of Proprietary Technologies	10	1.4
5.5	Offsite Land Area Required	10	1.4
5.6	Onsite Land Area Required	10	1.4

In the final step of the evaluation process, CH2M HILL's project team defined objective scoring scales for each sub-criterion and assigned preliminary raw scores using a 1-to-10 scale for each sub-criterion. GRU's project team then reviewed CH2M HILL's scoring rationale and raw scores and developed a revised raw scoring analysis. After developing the raw scores, the weighting factors for each sub-criterion were multiplied by the raw scores to calculate the total weighted benefit score for each alternative.

The benefit scores were then compared to the net present worth of each alternative to determine the benefit/cost (BC) ratio and then the alternatives were ranked based on the BC ratio. The PW costs presented in Section 5 do not salvage values for any of the capital improvement items such as machinery, vehicles or land. Since the salvage value of large areas of land purchased for an alternative will likely impact the PW value of the alternative, salvage value of included land purchase greater than 50 acre was included in the PW cost of an alternative. Revised PW costs, which included the salvage value of land, are presented in Section 6. The BC ratio for each alternative was calculated based on the revised PW cost which includes salvage value of land purchases (see Exhibit 6.4). Subsequently, the alternatives were ranked based on their BC ratio (see Exhibits 6.4 and 6.5).

Weighted benefit scores, present worth costs, and BC ratios are presented in **Exhibit 6-4**. In addition, **Exhibit 6-5** shows all 33 alternatives ranked from the highest to lowest BC ratio. **Appendix C** presents a Benefit-Cost Summary that includes more detailed information on the monetary and non-monetary criteria scoring analysis and BC ratio results.

As shown in **Exhibits 6-4** and **6-5**, Alternatives 1.1a, 1.1.b, 1.3.a and 1.3.b, which involve the upgrading of existing biosolids digestion facilities and the continued use of WPR for land application, all provide similar BC ratios and would rank as suitable alternatives for GRU's Biosolids Management Program based solely on the BC ratio analysis. Alternatives 1.3.a and 1.3.b, which involve GRU purchase of the WPR have slightly higher BC ratios than 1.1.a and 1.1.b primarily due to slightly higher weighted benefit scores. Benefit scores are slightly higher for the WPR purchase alternatives since GRU would have total control over the land application process at the site and know that they can count on the site for their long-term biosolids management needs. Alternatives 1.1.a and 1.1.b do not provide these advantages. Alternative 1.3.a would be more preferred over 1.3.b due to the lower capital cost of Alternative 1.3.a.

The alternatives involving the continued use of the WPR for biosolids land application assume that WPR biosolids application rates would continue to be based on plant available nitrogen needs of the crops grown on the site without consideration for potential future P loading limitations currently being considered by the FDEP. This is the current practice used on the WPR. However, if FDEP does implement future P loading limitations that reduce the amount of biosolids that can be applied to the WPR site, GRU would need to find additional land application areas or implement another biosolids management alternative for the biosolids production that cannot be applied to the WPR. Alternatives 1.2.a and 1.2.b have the next highest BC ratios as the WPR options, thus making them viable options to deal with any P loading limitations that may be implanted by FDEP. These alternatives would have similar unit implementation costs as Alternative 1.3.a, since GRU would have to locate and purchase additional land or enter into long-term leases.

Alternative 6, thermal oxidation of biosolids, was the seventh ranked alternative with a BC ratio of 14.7. This alternative had a relatively high WBS due to its ability to handle all of the biosolids generated by GRU, maximize performance reliability under bad weather conditions, and maximize the use of renewable energy sources. This alternative would not be affected by the potential changes in biosolids regulations such as P loading limitations. The analysis presented in this report assumes that the use of dewatered biosolids would be compatible with the combustion process at the power generation facility and that the power generating system would neither charge or pay for the biosolids. At this time GRU is considering a number of alternatives for future power needs. The viability of this alternative can be better assessed once GRU's future power generation alternatives are further developed.

EXHIBIT 6-4
Weighted Benefit Scores, Present Worth Costs, Benefit/Cost Ratios and Ranking of Alternatives
GRU Biosolids Management Plan

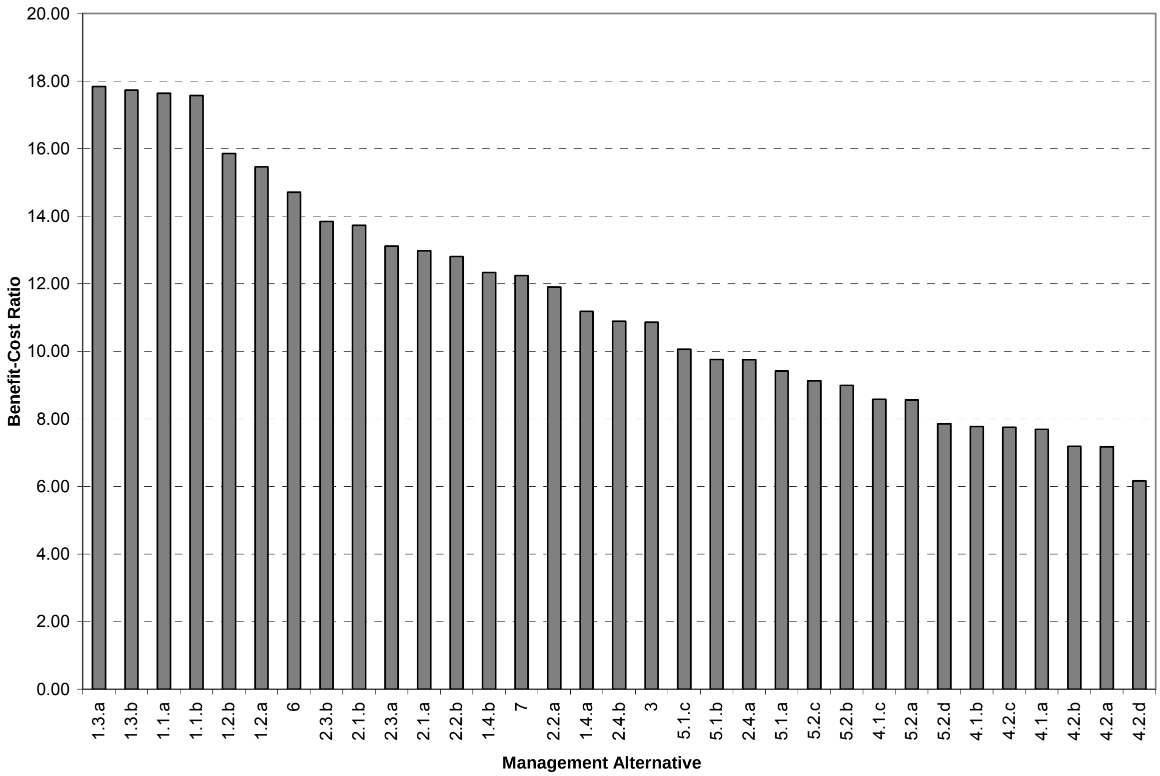
Alternative	Acronym	Weighted Benefit Score	PW Costs (million $) [1]	Benefit-Cost Ratio	Rank [2]
1.1.a	AD27, TH, WP	443	$ 25.13	17.6	3
1.1.b	AD60, TH, WP	552	$ 31.41	17.6	3
1.2.a	AD27, TH, DNAS	420	$ 27.18	15.5	6
1.2.b	AD60, TH, DNAS	529	$ 33.34	15.9	5
1.3.a	AD27, TH, WPGRU	448	$ 25.13	17.8	1
1.3.b	AD60, TH, WPGRU	557	$ 31.41	17.7	2
1.4.a	AD27, TH, FOR	379	$ 33.92	11.2	16
1.4.b	AD60, TH, FOR	488	$ 39.56	12.3	13
2.1.a	AD27, BFPDEW, WP	454	$ 35.00	13.0	11
2.1.b	AD60, BFPDEW, WP	563	$ 41.00	13.7	9
2.2.a	AD27, BFPDEW, DNAS	426	$ 35.83	11.9	15
2.2.b	AD60, BFPDEW, DNAS	535	$ 41.79	12.8	12
2.3.a	AD27, BFPDEW, WPGRU	459	$ 35.00	13.1	10
2.3.b	AD60, BFPDEW, WPGRU	568	$ 41.00	13.8	8
2.4.a	AD27, BFPDEW, FOR	390	$ 40.02	9.8	21
2.4.b	AD60, BFPDEW, FOR	499	$ 45.80	10.9	17
3	CENDEW, COMP	704	$ 64.79	10.9	18
4.1.a	AND, TH, WP	423	$ 55.06	7.7	30
4.1.b	AND,TH, DNAS	442	$ 56.84	7.8	28
4.1.c	AND, TH, WPGRU	472	$ 55.06	8.6	25
4.2.a	AND, BFPDEW, WP	452	$ 62.97	7.2	32
4.2.b	AND, BFPDEW, DNAS	458	$ 63.71	7.2	31
4.2.c	AND, BFPDEW, WPGRU	488	$ 62.97	7.8	29
4.2.d	AND, BFPDEW, FOR	419	$ 68.01	6.2	33
5.1.a	AAND, TH, WP	536	$ 56.94	9.4	22
5.1.b	AAND, TH, DNAS	569	$ 58.31	9.8	20
5.1.c	AAND, TH, WPGRU	573	$ 56.94	10.1	19
5.2.a	AAND, BFPDEW, WP	550	$ 64.22	8.6	26
5.2.b	AAND, BFPDEW, DNAS	583	$ 64.79	9.0	24
5.2.c	AAND, BFPDEW, WPGRU	586	$ 64.22	9.1	23
5.2.d	AAND, BFPDEW, FOR	537	$ 68.40	7.9	27
6	BDFDEW, TOX	639	$ 43.41	14.7	7
7	BFPDEW, LIMSTAB	622	$ 50.84	12.2	14

NOTE:
[1] Present Worth Cost includes the salvage value for the cost of land purchase greater than 50 acres;
[2] Rank based on the cost benefit ratio;

ABBREVIATIONS:

PW= Present Worth Cost;
AD27 = Aerobic digestion, 27-day SRT;
AD60 = Aerobic digestion, 60-day SRT;
AND = Conventional high rate anaerobic digestion;
AAND = Mesophilic Acid Hydrolysis Plug Flow Advanced Anaerobic Digestion;
TH = Thickened Liquid Biosolids, 5-6% solids content;
BFPDEW= Belt Filter Press Dewatered Biosolids, 16% solids content
CENDEW= Centrifuge Dewatered Biosolids, 20% solids content;
WP= Whistling Pines Ranch;
DNAS= Dedicated New Agricultural Site, owned by GRU;
WPGRU= Whistling Pines Ranch purchased by GRU;
FOR= Dedicated Forest Site;
COMP= Composting Facility;
TOX= Thermal Oxidation (Alternative Fuel for Deer Haven Power Plant);
LIMSTAB= Lime Stabilization

EXHIBIT 6-5
Ranking of Benefit-Cost Ratios for Biosolids Management Alternatives
GRU Biosolids Management Plan



After Alternative 6, the next 5 highest alternatives consist of application of aerobically-digested, dewatered biosolids to land application sites (WPR, WPRGRU, and DNAS). Based upon the BC ratios and cost analyses for these alternatives, it is apparent that implementation of a dewatered biosolids land application alternative, regardless of treatment technology used, is not cost-effective for the hauling distances being considered in this analysis. This conclusion is even valid for the alternatives based on implementing a widespread forestry land application program (1.4.a, 1.4.b, 2.4.a, 2.4.b, 4.2.d, 5.2.d).

The lone Class A alkaline stabilization alternative (7) was the 14th highest ranked alternative with a BC of 12.2. This score placed it in the general scoring range of some of the dewatered land application alternatives (2.2.a and 2.2.b). It received high WBS's for end use diversity, sensitivity to changing markets, and 20- and 5-year viabilities. However, its total present worth of $50.84 million lowers the overall BC ratio and puts it at a disadvantage to other lower cost alternatives. Alternative 7 could potentially be a viable Class A option if implementation of new regulations lowers the cost-effectiveness of Class B land application. However, the ability to apply this material is limited by soil pH conditions. Therefore, the risks and limitations resulting from the high pH of the material are a significant draw back. In addition, some of the potential benefits of this option could be degraded based on language found in the draft FDEP Biosolids Rule. FDEP has proposed that Class A alkaline biosolids can never be considered as Class AA biosolids even though the material may meet all FDEP and EPA limits for an exceptional quality material. This would mean that Class A alkaline materials would be essentially treated the same as Class B biosolids. Many of the current advantages of producing a Class A alkaline product would be lost if the proposed language is not deleted from the final rule.

Another Class A alternative, composting (Alternative 3), provides a BC ratio that is the 18th highest ratio and is slightly less than the Alternative 7 ranking. Composting receives high marks for sensitivity to changing markets, end use diversity, 20- and 5-year viability, and bi-product utilization. These high ratings help to offset the high capital and present worth cost of this alternative. Compost product would be likely to meet FDEP's Class AA designation which would mean there would be less monitoring and control of the final product as compared to Class B or Class A alkaline biosolids. Composting might be considered if GRU desires to implement a treatment and end use alternative that provides a Class A or AA product to augment land application operations at the WPR or as a replacement to land application.

Except for Alternative 2.4.a, the remaining 15 lowest ranked alternatives consist of various combinations of thickened and dewatered land application alternatives using anaerobic digestion (Alternative 4) and advanced anaerobic digestion (Alternative 5). All of the alternatives have BC ratios less than 10.1. One of the primary reasons for the low BC ratios is the high capital and O&M costs required to construct the digestion facilities. Of these alternatives, Alternative 5.1.c or 5.1.b could potentially be a suitable alternative if GRU wished to implement an alternative that would be able to provide a Class A biosolids material and were looking to maximize solids destruction and biogas production for onsite power production. However, 5.1.b and 5.1.c have capital costs of approximately $53.57 million dollars and $56.27 million dollars, respectively. These alternatives are at least $31 million higher than the highest ranked alternative's (1.3.a) capital cost. The high present worth costs of either anaerobic or advanced anaerobic digestion makes it extremely difficult to justify the implementation of these technologies.

6.3 Risk Based Evaluation of Alternatives

In addition to the BC analysis discussed in Section 6.2, the GRU requested an analysis of alternatives based on their abilities to accommodate potential risks. At this time biosolids regulations in Florida are in a state of flux. Uncertainties in what changes may occur in biosolids regulations, public opinion, market conditions and other factors must be considered when selecting alternatives. Otherwise, an alternative could be selected and implemented which may become unsuitable at a later date due to such changes, and result in a significant stranded cost.

Particular risk factors considered include:

1. Implementation of more restrictive phosphorus application limitations
2. More restrictive biosolids treatment requirements (elimination of Class B, or requirement for minimum time and temperature for Class B).
3. Public acceptance and marketability of lime based products.
4. Loss of disposal site/product marketability
5. Ability to transition without significant stranded cost

6.3.1 Consideration of Alternatives

The first step in a risk-based analysis is to consider the available alternatives and eliminate those alternatives that pose a high probability of not succeeding based on the risk factors. The following are the alternatives eliminated due to issues associated with the risk factors:

1. All of the belt filter press dewatering (BFPDEW) options were eliminated because all of these alternatives scored lower BC ratios than analogous alternatives using thickening (TH).
2. All of the conventional anaerobic digestion (AND20) alternatives were eliminated because conventional anaerobic digestion does not meet Class A treatment requirements. If GRU were to elect to make the investment to switch to anaerobic digestion, it should invest in advanced anaerobic digestion (AAND 15) since it would meet Class A requirements and costs approximately the same as conventional anaerobic digestion.
3. Purchase of a dedicated new agricultural site (DNAS) was eliminated as it would provide a similar risk profile as purchasing the WPR. Assuming that a reasonable purchase agreement can be made, the WPR would likely be preferable to other potential sites due to the established practice at the site, and the existing storage and unloading facilities at the site. In addition, a large contiguous property is preferable from an operating standpoint than multiple sites.
4. The intent of the aerobic digestion with 60-day SRT (AD60) alternative was to address the potential for future minimum time and temperature requirements (i.e. 60-day SRT at 15 degree Celsius). However, the aerobic digestion 27-day SRT alternative (AD27) can be converted to a 60-day SRT (AD60) by adding additional tanks with minimal stranded cost. Also, AD60 would not meet Class A treatment requirements. Therefore, AD60 was eliminated as an immediate alternative in favor of AD27.
5. Lime stabilization was eliminated due to risks associated with product marketability, and limitations on the amount that can be applied due to the high pH of this product.

Exhibit 6-6 summarizes the remaining alternatives, along with a qualitative evaluation of their tolerance to various risk factors.

EXHIBIT 6-6
Qualitative Risk Comparison of Biosolids Alternatives
GRU Biosolids Management Plan

Alternative	NPW [1]	Phosphorus limitations	Class	Marketability / site availability	Stranded Cost	Flexibility
1.1.a AD27 WPR	$25.1 M	Moderate	B	Poor	Good	Poor
1.2.a / 1.3.a AD27 WPGRU/DNAS	$27.2–$25.1 M	Moderate	B	Good	Good	Good
1.4.a AD27 FOR	$33.9 M	Good	B	Poor	Moderate	Poor
3. CEN DEW	$64.8 M	Moderate	A	Uncertain	Poor	Moderate
5.1.b/5.1.c AAND 15 WPR/DNAS	$58.3-56.9 M	Uncertain	A	Good	Poor	Good
6. AD 27 BDFDEW CFB	$43.4 M	Good	N/A	Good	Uncertain	Uncertain

[1] all NPV (Net Present Worth) costs are given in millions of dollars (M), includes the salvage value of land purchase.

6.3.2 Risk Based Evaluation Comparison

Although continuation of the current application at the WPR site would appear to be the most cost-effective alternative at this time, it carries significant long-term risk, in that GRU would depend on a contractual agreement with a single property owner. Furthermore, if the landowner were to not renew or to terminate the contract on relatively short notice, GRU would have little flexibility in implementing other alternatives. Therefore, this alternative was deemed as being unsustainable as a long-term alternative due to the risks it involves.

Forest application would appear to be the next most cost effective alternative since additional land application area would not have to be purchased (Option assumes that log-term leases could be negotiated). However, GRU has reported that, based on discussion with forest landowners, there is limited land available for forest application of Class B biosolids in Alachua County. There are also concerns about public acceptance issues related to forest application. Thirdly, Class A products from other areas are widely used for forest fertilization and would likely compete with GRU’s Class B biosolids. Finally, proposed regulatory changes may eliminate the use of spray application of liquid Class B products which may effectively eliminate this as an alternative. Therefore, this alternative carries very high risk in terms of marketability/site availability.

Continuation of aerobic digestion with purchase of the WPR site or of a new dedicated site appears to provide the best balance of cost and risk, and provide flexibility to change plans with minimal stranded costs. These alternatives also provide some of the highest BC ratios of any alternative evaluated. Continuation of the existing aerobic digestion process at this time minimizes potential stranded costs which could be associated with future change in treatment process. The primary risk associated with this alternative is that future regulations may require more stringent phosphorus application limitation which would increase the land area required beyond that available at the WPR. If this were to occur, GRU could still utilize the WPR site as part of its application program. Finally, because GRU would purchase the application site, this would be a recoverable assets should GRU later decide to curtail or eliminate land application operations.

Conversion to advanced anaerobic digestion (Alternatives 5.1.b and 5.1.c) can be implemented if and when it is needed to meet Class A requirements. However, investments in this conversion at this time would be a significant expense and could represent a significant stranded cost should conditions change.

Composting (Alternative 3) would meet Class A requirements and presumably have minimal risks associated with phosphorus limitation. However, this process depends on the ability to market this product. There are concerns that there could become a glut of Class A material on the market which may make it difficult and more costly for GRU to dispose of composted material. In addition, composting would also require a significant capital expenditure.

Alternative 6, thermal oxidation, may be a viable alternative, and will need to be evaluated more thoroughly once GRU’s future power generation plans are further developed.

Recommended Plan and Implementation Issues

7. Recommended Plan and Implementation Issues

7.1 Overview

This section presents the recommended biosolids management plan for GRU and provides a decision flowchart intended to be a guide for GRU in evaluating the most appropriate pathway to address regulatory changes and contingencies as they arise. Based upon the present-worth cost, BC ratio, and risk analyses presented in earlier sections and discussions with the GRU project team, GRU has elected to implement Alternative 1.3. a which entails the upgrading of aerobic digestion facilities at the KWRF and the MSWRF to provide a minimum 27-day SRT and the continued application of thickened Class B biosolids at the WPR with purchase of the site.

Estimated facility costs presented in this section are order-of-magnitude costs and were prepared primarily as a tool to compare and evaluate multiple alternatives. The budget-level cost estimates were developed by applying unit cost data from industry-accepted estimating guides, vendor quotes, and CH2M HILL's own cost database for similar projects. Estimated costs include labor, materials, contractor's markup, overhead, profit, bond, mobilization, insurance, taxes, engineering, and a contingency.

Estimated project construction costs are based on preliminary schematic designs summarized in **Section 5**. Because detailed designs and complete plans and specifications have not yet been prepared, the estimate is based on a scope of work that is not completely defined at this time. These cost estimates are considered to be Class 5 cost estimates as defined by the American Association of the Advancement of Cost Engineering International (AACEI) with an assigned level of accuracy of +40 to -25 percent. These estimates will be refined during the design phase of each facility and after the preparation of detailed drawings and specifications. The actual cost of construction for each facility will depend on the final scope of work desired by the GRU, current economic conditions, and other pertinent factors.

7.2 Facility Improvements for Recommended Plan

7.2.1 Kanapaha Water Reclamation Facility

A summary of the additional facilities required to implement AD27 TH at the KWRF is presented in **Exhibit 5-25**. In order to meet the MMADL through 2025, two additional digesters are required at KWRF. Additional equipment includes four new blowers, a new electrical building, sludge grinders, and transfer pumps.

7.2.2 Main Street Water Reclamation Facility

Additional digestion capacity is not required at the MSWRF for this alternative. The existing facilities have adequate volume to provide a 27-day SRT, at 15°C liquid temperature, during plant build-out conditions. However, the installation of coarse bubble diffusers in Digester No. 2 is recommended. **Exhibit 5-28** presents a summary of the proposed facilities for the MSWRF.

7.2.3 Whistling Pines Ranch

The key issues that need to be addressed for the long-term viability of the using WPR as a land application site are: (1) renegotiating the current term of contract with WPR or purchasing WPR and (2) reducing the use of inorganic fertilizer. The current term of the contract ends in 2009 and will need to be renegotiated if the GRU does not purchase the site. Moreover, the contract would need to provide some safeguard from WPR breaking the contract with one year's notice. Recent groundwater testing has shown increased levels of NO_3. For the long term availability of WPR for biosolids application, it is critical that groundwater NO_3, does not exceed regulatory requirements. GRU needs to implement plans to reduce or eliminate the use of inorganic fertilizer at WPR. This could include providing incentives such as paying an additional fee for any decline in the yield caused by the reduction of inorganic fertilizer.

7.2.4 Selected Plan Implementation Capital Costs

Exhibit 7-1 shows the capital cost for implementation of the recommended alternative 1.3.a

EXHIBIT 7-1
Capital Cost Breakdown for the Recommended Alternative (1.3.a)
GRU Biosolids Management Plan

Facility	Capital Cost (millions of Dollars)
Kanapaha Water Reclamation Facility	5.17
Main Street Water Reclamation Facility	1.23
Whistling Pines Ranch (Transportation & Land Application)	1.86
Whistling Pines Ranch (Land Acquisition Cost)	**14.10**
Total Alternative Cost	**22.36**

7.3 Implementation Issues and Contingency Planning

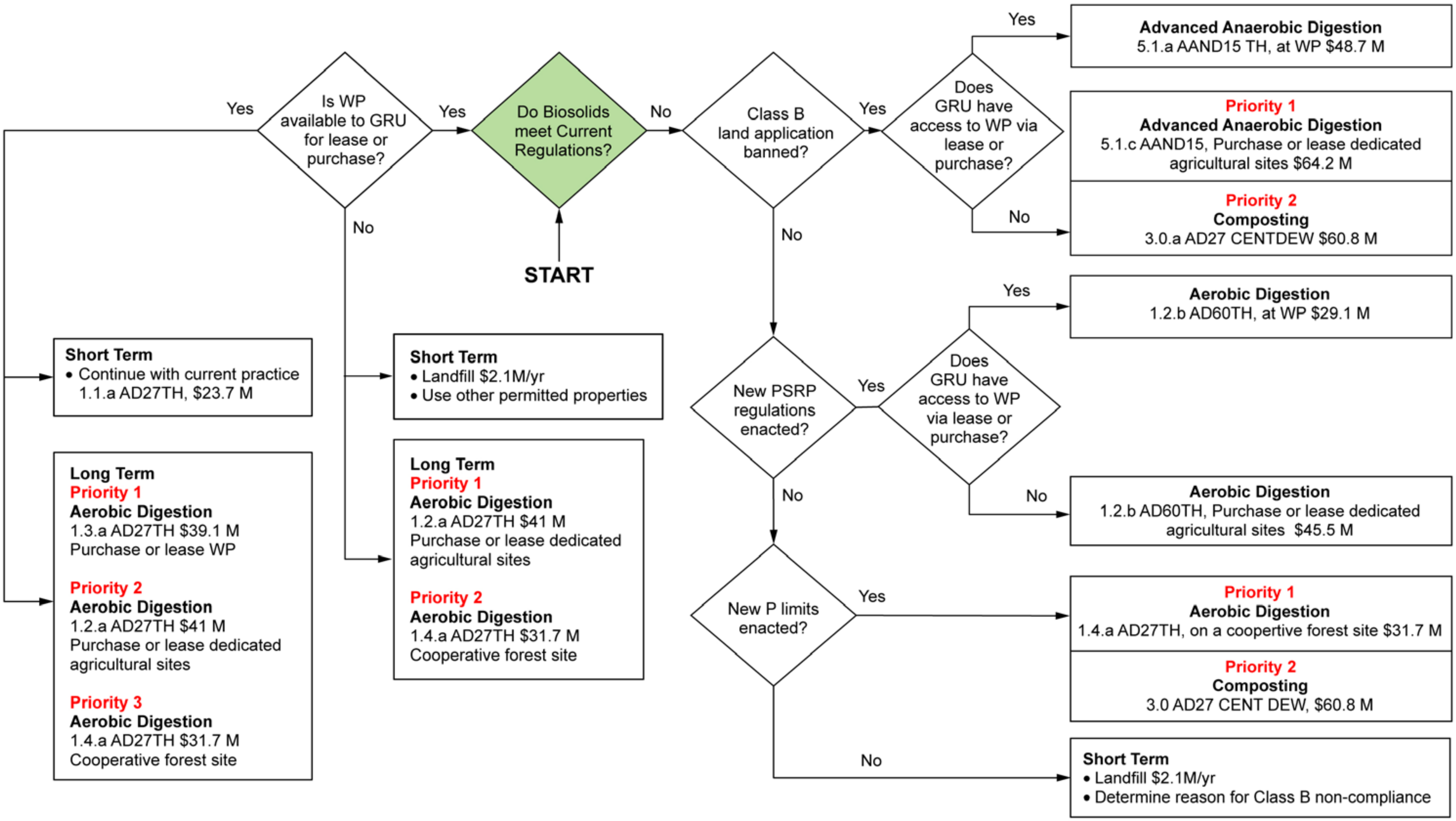
Implementation of the selected alternative is contingent upon a number of factors, many of which are related to the requirements of the final biosolids rule to be promulgated by FDEP and the long-term availability of WPR for Class B biosolids land application. Key issues in the draft Chapter 62-640, FAC Biosolids Rule that could negatively impact the implementation of the selected plan were previously discussed in **Section 2**. These regulatory issues and other factors which could affect the implementation of the selected plan include the following:

- Potential requirement to base biosolids loading rates on phosphorus as well as nitrogen crop nutrient requirements
- Potential requirement to provide 2 log reduction in fecal coliform concentration, as well as meeting fecal coliform concentration limits for Class B biosolids
- Loss of WPR for biosolids application
- Implementation of local ban on Class B land application

To address these potential impacts, GRU and CH2M HILL developed a biosolids management decision flowchart to assist GRU in determining the best plan of action to address issues as they arise. A general decision flowchart is provided in **Exhibit 7-2** to assist GRU in determining the appropriate course of action to address the identified contingency conditions. The decision flowchart provides both short-term and long-term options for GRU to implement to address any potential loss of the WPR for biosolids application. The long-term options have been prioritized so GRU can select an option that meets the needs of any particular situation that may arise. For instance, if GRU did not purchase the WPR and the WPR land owner decides not to renew the current lease, GRU could landfill biosolids on a short-term basis and/or use other sites that have been permitted. For other long-term alternative operations, GRU could pursue Alternatives 1.2.a or 1.4.a to continue Class B biosolids land application on new purchased or leased agricultural sites or on forest sites. The approximate total present-worth costs for other alternatives are included with each option.

Of all of the potential issues which could negatively impact the program, the proposed regulation that would require land application rates to be based on either nitrogen or phosphorus could have the largest impact on GRU's biosolids management program. If this requirement were to be promulgated in the final biosolid rule, biosolids application rates at WPR would probably have to be reduced to meet P crop requirements. For instance assuming that 50 percent of the total P in GRU's biosolids is available and using the current mix of crops grown, GRU would need approximately 2,700 to 3,000 acres for the design year biosolids production of 4,774 dry tons per year. However, there are only 1,175 useable acres on the WPR site. To address this situation, the decision flowchart shows that GRU could implement Alternatives 1.4.a or 3.0 composting to provide long-term management of their biosolids. In addition to these options, GRU could also opt to continue land application of biosolids on the WPR site at reduced loading rates and develop an alternative land application program or composting program for the remaining biosolids. Additional cost analyses would be required to determine which alternatives provide the most cost-effective solution for GRU.

The decision flowchart is intended to be a guide for GRU in evaluating the most appropriate pathway to address contingencies as they arise. However, this decision flowchart should be reviewed each year and modified if new treatment or disposal options are identified or new issues arise that require a contingency plan.



WP = Whistling Pines Ranch

EXHIBIT 7-2
Biosolids Management Decision Flow Chart
GRU Biosolids Management Plan

CH2MHILL

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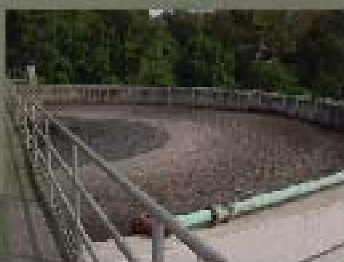





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8. References

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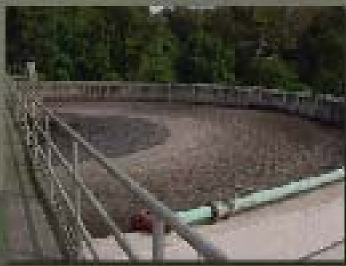

Appendices

APPENDIX A

Preliminary List of Potential Biosolids Management Alternatives

GRU Biosolids Management Plan
Workshop No. 3
Preliminary List of Potential Biosolids Management Alternatives

General Types of Management Activities Considered:

Class B

Aerobic Digestion and Hauling Liquid or Dewatered to LAS

Contract Operations

Anaerobic Digestion and Hauling Liquid or Dewatered to LAS

Landfill Disposal

Class A

Advanced Anaerobic Digestion and Hauling Liquid or Dewatered to LAS

Auto-Thermaphillic Aerobic Digestion (ATAD)

Alkaline Stabilization Thermal Drying

Composting

Detailed List of Biosolids Management Activities

1) (Status Quo) Continued land application of aerobically-digested; Class B biosolids at Whistling Pines Ranch LAS under the existing cooperative agreement.

    a) Truck tanker hauling of liquid biosolids, increased onsite wet weather storage

    b) Pipeline transport of liquid biosolids to site w/increased onsite wet weather storage

    c) Dewatered cake transport and application w/onsite wet weather storage

2) Purchase the Roger Williams site and land-apply liquid or dewatered Class B biosolids. **(Same sub-alternatives as Alt. 1.)**

3) Land-apply liquid or dewatered Class B biosolids to new farmland, grazing lands, or forest lands owned by others. **(Assume pipeline transport not an option.)**

4) Purchase new dedicated site and land-apply liquid or dewatered Class B biosolids for agricultural production. **(Assume pipeline transport not an option.)**

5) Purchase and develop new dedicated bioenergy plantation site and land-apply liquid or dewatered Class B biosolids to high-yield grass or tree species. Assume irrigated site for maximum yields. **(Assume pipeline transport not an option.)**

    a) Tree biomass (pine, eastern cottonwood, eucalyptus, tulip poplar)

    b) Grass biomass (giant reed, energy cane, switchgrass)

6) Disposal of biosolids via contract operations

7) Conversion to ATAD at both WRFs; land-application of a Class A liquid ATAD biosolids to new cooperative agricultural or forest sites. **(Assume truck hauling only, no pipeline transport or dewatered cake hauling.)**

8) Alkaline stabilization (lime, fly ash, cement kiln dust) with use as a landfill cover, agricultural lime amendment, or distribution and marketing of the alkaline product.

    a) Aerobic digestion @ both WRFs; use RDP quicklime + heat process for analysis; new site for processing facility

    b) Aerobic digestion @ both WRFs; use Deerhaven fly ash in N-Viro type process at regional site located at Deerhaven.

9) Production of a thermally-dried Class A product with associated distribution and marketing program.

    a) Aerobic digestion at both WRFs, new direct rotary drier facility located at Deerhaven.

10) Composting/co-composting of 100% of biosolids production with associated distribution and marketing programs.

    a) Continue aerobic digestion; dewater & haul of cake biosolids to new composting site; wood & yard waste used as bulking agent.

    b) Conversion to conventional anaerobic digestion; dewater & haul of cake biosolids to new composting site; wood & yard waste used as bulking agent.

11) Introduction of liquid Class B biosolids in closed landfill to increase biodegradation and methane yield of closed landfill. **(Probably not stand-alone option.)**

12) Use of Deerhaven waste heat or ash for additional biosolids treatment or disposal.

    a) Alt. 9 assumes waste heat used at primary energy source for thermal drying facility.

    b) Alt. 8b includes use of Deerhaven ash to produce alkaline product

13) Conversion to conventional anaerobic digestion at KWRF and/or MSWRF with utilization of methane gas for onsite energy production and digested biosolids for land application (agricultural, forest land, bioenergy plantation, etc).

14) Advanced anaerobic digestion (TPAD) at KWRF and MSWRF or only KWRF to reduce the quantity of biosolids to reduce solids quantities and achieve Class A pathogen levels; application to Whistling Pines Ranch.

    a) Truck tanker hauling of liquid biosolids, increased on-site wet weather storage.

    b) Pipeline transport of liquid biosolids to site w/increased onsite wet weather storage.

    c) Dewatered cake transport & application w/onsite wet weather storage.

15) Advanced anaerobic digestion (TPAD) at KWRF and MSWRF or only KWRF to reduce the quantity of biosolids to reduce solids quantities and achieve Class A pathogen levels; application to new cooperative agriculture or forested sites.

    a) Assume dewatered truck transport only due to distance to sites.

16) Landfill disposal of aerobically-digested, dewatered biosolids.

17) Combination alternatives desired?

APPENDIX B

Minimum Land Requirement Based on Nitrogen Loading Rates

EXHIBIT B

Minimum Land Requirement Based on Nitrogen Loading Rates

GRU Biosolids Management Plan

Type of Site [1]	Cropping Pattern	Annual Loading Rate (dry ton/acre/year)		Aerobic 27 Total Application Area		Aerobic 60 Total Application Area		Con. Anaerobic Total Application Area [2]		Adv. Anaerobic Total Application Area [3]	
		Liquid	Dewatered	Liquid (acres)	Dewatered (acres)	Liquid (acres)	Dewatered (acres)	Liquid (acres)	Dewatered (acres)	Liquid (acres)	Dewatered (acres)
Whistling Pines Ranch	Multi-crop similar to current cropping pattern	4.98	5.93	959	805	907	761	834	700	745	625
New Dedicated Site	Bermuda grass hay & annual ryegrass grazing	4.92	5.74	970	832	918	787	844	723	754	646
Forest Application	Slash Pine Plantation, 5-year application frequency	2.20	2.50	8,681	7,639	8,208	7,223	7,547	6,641	6,741	5,932

[1] Refers to the type of Land Application Site.

[2] Refers to the Conventional Anaerobic digestion process.

[3] Refers to the Advanced Anaerobic digestion process.

APPENDIX C

Benefit-Cost Score

		Present Worth Cost			1.0: AESTHETICS AND PUBLIC ACCEPTANCE`							2.0: PRODUCT MARKETABILITY			3.0: PLANT OPERATIONS AND MAINTENANCE					4.0 REGULATORY IMPACTS		5.0: CONSTRUCTABILITY								
Alternative	Description	PW of Capital Costs [1]	PW of Annual O&M Costs	Total PW [1]	1.1 Odor Potential	1.2 Traffic Impacts - Off-Site Impacts	1.3 Potential for Public Opposition	1.4 Visual & Noise Impacts/Buffer Area	1.5 Beneficial Reuse	1.6 Use of Renewable Energy Sources	1.7 Bi-product utilization	2.1 Sensitivity to changing markets	2.2 Business partner reliability/flexibility	2.3 End Use diversity/flexibility	3.1 Performance Reliability due to Weather Impacts	3.2 Technical Risk	3.3 Process Complexity	3.4 Operational Flexibility	3.5 Process & Mechanical Reliability	4.1 20-yr Viability	4.2 5-yr Viability	5.1 Effects on Other Existing Plant Processes	5.2 Construction Time	5.3 Ability to Phase	5.4 Ability to Permit	5.5 Use of Proprietary Technologies	5.6 Off-site Land Area Required	5.7 On-site Land Area Required	Total Weighted Score	Benefit:Cost Ratio
	Weight				5.5	3.3	6.6	2.2	0.0	2.2	2.2	7.0	7.0	7.0	4.2	4.2	4.2	4.2	4.2	16.5	5.5	2.1	1.4	0.0	6.3	1.4	1.4	1.4	100.0	
1.1.a	AD27, TH, WP	$8.26	$16.87	$25.13	38.5	3.3	46.2	8.8	0.0	2.2	2.2	7.0	35.0	7.0	4.2	42.0	42.0	4.2	21.0	16.5	27.5	21.0	14.0	0.0	63.0	14.0	14.0	9.8	443	17.6
1.1.b	AD60, TH, WP	$11.47	$19.94	$31.41	55.0	3.3	46.2	8.8	0.0	2.2	2.2	7.0	35.0	7.0	4.2	42.0	42.0	4.2	21.0	82.5	55.0	21.0	14.0	0.0	63.0	14.0	14.0	8.4	552	17.6
1.2.a	AD27, TH, DNAS	$8.26	$18.91	$27.18	38.5	3.3	26.4	8.8	0.0	2.2	2.2	7.0	70.0	7.0	4.2	42.0	42.0	16.8	21.0	16.5	27.5	21.0	7.0	0.0	31.5	14.0	1.4	9.8	420	15.5
1.2.b	AD60, TH, DNAS	$11.47	$21.88	$33.34	55.0	3.3	26.4	8.8	0.0	2.2	2.2	7.0	70.0	7.0	4.2	42.0	42.0	16.8	21.0	82.5	55.0	21.0	7.0	0.0	31.5	14.0	1.4	8.4	529	15.9
1.3.a	AD27, TH, WPGRU	$8.26	$16.87	$25.13	38.5	3.3	46.2	8.8	0.0	2.2	2.2	7.0	70.0	7.0	4.2	42.0	42.0	16.8	21.0	16.5	27.5	21.0	14.0	0.0	31.5	14.0	2.8	9.8	448	17.8
1.3.b	AD60, TH, WPGRU	$11.47	$19.94	$31.41	55.0	3.3	46.2	8.8	0.0	2.2	2.2	7.0	70.0	7.0	4.2	42.0	42.0	16.8	21.0	82.5	55.0	21.0	14.0	0.0	31.5	14.0	2.8	8.4	557	17.7
1.4.a	AD27, TH, FOR	$12.32	$21.60	$33.92	38.5	3.3	26.4	8.8	0.0	2.2	2.2	7.0	35.0	7.0	4.2	42.0	42.0	4.2	21.0	16.5	27.5	21.0	14.0	0.0	31.5	14.0	1.4	9.8	379	11.2
1.4.b	AD60, TH, FOR	$15.17	$24.39	$39.56	55.0	3.3	26.4	8.8	0.0	2.2	2.2	7.0	35.0	7.0	4.2	42.0	42.0	4.2	21.0	82.5	55.0	21.0	14.0	0.0	31.5	14.0	1.4	8.4	488	12.3
2.1.a	AD27, BFPDEW, WP	$18.15	$16.85	$35.00	38.5	33.0	46.2	8.8	0.0	2.2	2.2	7.0	35.0	7.0	4.2	42.0	33.6	4.2	16.8	16.5	27.5	14.7	14.0	0.0	63.0	14.0	14.0	9.8	454	13.0
2.1.b	AD60, BFPDEW, WP	$21.39	$19.61	$41.00	55.0	33.0	46.2	8.8	0.0	2.2	2.2	7.0	35.0	7.0	4.2	42.0	33.6	4.2	16.8	82.5	55.0	14.7	14.0	0.0	63.0	14.0	14.0	8.4	563	13.7
2.2.a	AD27, BFPDEW, DNAS	$18.15	$17.68	$35.83	38.5	33.0	26.4	4.4	0.0	2.2	2.2	7.0	70.0	7.0	4.2	42.0	33.6	16.8	16.8	16.5	27.5	14.7	7.0	0.0	31.5	14.0	1.4	9.8	426	11.9
2.2.b	AD60, BFPDEW, DNAS	$21.39	$20.40	$41.79	55.0	33.0	26.4	4.4	0.0	2.2	2.2	7.0	70.0	7.0	4.2	42.0	33.6	16.8	16.8	82.5	55.0	14.7	7.0	0.0	31.5	14.0	1.4	8.4	535	12.8
2.3.a	AD27, BFPDEW, WPGRU	$18.15	$16.85	$35.00	38.5	33.0	46.2	8.8	0.0	2.2	2.2	7.0	70.0	7.0	4.2	42.0	33.6	16.8	16.8	16.5	27.5	14.7	14.0	0.0	31.5	14.0	2.8	9.8	459	13.1
2.3.b	AD60, BFPDEW, WPGRI	$21.39	$19.61	$41.00	55.0	33.0	46.2	8.8	0.0	2.2	2.2	7.0	70.0	7.0	4.2	42.0	33.6	16.8	16.8	82.5	55.0	14.7	14.0	0.0	31.5	14.0	2.8	8.4	568	13.8
2.4.a	AD27, BFPDEW, FOR	$21.07	$18.95	$40.02	38.5	33.0	26.4	8.8	0.0	2.2	2.2	7.0	35.0	7.0	4.2	42.0	33.6	4.2	16.8	16.5	27.5	14.7	14.0	0.0	31.5	14.0	1.4	9.8	390	9.8
2.4.b	AD60, BFPDEW, FOR	$24.14	$21.66	$45.80	55.0	33.0	26.4	8.8	0.0	2.2	2.2	7.0	35.0	7.0	4.2	42.0	33.6	4.2	16.8	82.5	55.0	14.7	14.0	0.0	31.5	14.0	1.4	8.4	499	10.9
3	AD27, CENDEW, COMP	$39.56	$25.23	$64.79	22.0	3.3	66.0	2.2	0.0	2.2	22.0	70.0	35.0	70.0	21.0	29.4	21.0	33.6	4.2	165.0	55.0	12.6	7.0	0.0	31.5	14.0	5.6	11.2	704	10.9
4.1.a	AND, TH, WP	$40.74	$14.32	$55.06	22.0	3.3	46.2	6.6	0.0	8.8	2.2	7.0	35.0	7.0	4.2	29.4	21.0	4.2	8.4	82.5	55.0	12.6	14.0	0.0	31.5	1.4	14.0	7.0	423	7.7
4.1.b	AND,TH, DNAS	$40.74	$16.10	$56.84	22.0	3.3	26.4	4.4	0.0	8.8	2.2	7.0	70.0	7.0	4.2	29.4	21.0	16.8	8.4	82.5	55.0	12.6	7.0	0.0	31.5	14.0	1.4	7.0	442	7.8
4.1.c	AND, TH, WPGRU	$40.74	$14.32	$55.06	22.0	3.3	46.2	6.6	0.0	8.8	2.2	7.0	70.0	7.0	4.2	29.4	21.0	16.8	8.4	82.5	55.0	12.6	14.0	0.0	31.5	14.0	2.8	7.0	472	8.6

		Present Worth Cost			1.0: AESTHETICS AND PUBLIC ACCEPTANCE`							2.0: PRODUCT MARKETABILITY			3.0: PLANT OPERATIONS AND MAINTENANCE					4.0 REGULATORY IMPACTS		5.0: CONSTRUCTABILITY								
Alternative	Description	PW of Capital Costs [1]	PW of Annual O&M Costs	Total PW [1]	1.1 Odor Potential	1.2 Traffic Impacts - Off-Site Impacts	1.3 Potential for Public Opposition	1.4 Visual & Noise Impacts/Buffer Area	1.5 Beneficial Reuse	1.6 Use of Renewable Energy Sources	1.7 Bi-product utilization	2.1 Sensitivity to changing markets	2.2 Business partner reliability/flexibility	2.3 End Use diversity/flexibility	3.1 Performance Reliability due to Weather Impacts	3.2 Technical Risk	3.3 Process Complexity	3.4 Operational Flexibility	3.5 Process & Mechanical Reliability	4.1 20-yr Viability	4.2 5-yr Viability	5.1 Effects on Other Existing Plant Processes	5.2 Construction Time	5.3 Ability to Phase	5.4 Ability to Permit	5.5 Use of Proprietary Technologies	5.6 Off-site Land Area Required	5.7 On-site Land Area Required	Total Weighted Score	Benefit:Cost Ratio
	Weight				5.5	3.3	6.6	2.2	0.0	2.2	2.2	7.0	7.0	7.0	4.2	4.2	4.2	4.2	4.2	16.5	5.5	2.1	1.4	0.0	6.3	1.4	1.4	1.4	100.0	
4.2.a	AND, BFPDEW, WP	$48.32	$14.65	$62.97	16.5	33.0	46.2	6.6	0.0	8.8	2.2	7.0	35.0	7.0	4.2	29.4	16.8	4.2	8.4	82.5	55.0	8.4	14.0	0.0	31.5	14.0	14.0	7.0	452	7.2
4.2.b	AND, BFPDEW, DNAS	$48.32	$15.39	$63.71	16.5	33.0	26.4	4.4	0.0	8.8	2.2	7.0	70.0	7.0	4.2	29.4	16.8	16.8	8.4	82.5	55.0	8.4	7.0	0.0	31.5	14.0	1.4	7.0	458	7.2
4.2.c	AND, BFPDEW, WPGRU	$48.32	$14.65	$62.97	16.5	33.0	46.2	6.6	0.0	8.8	2.2	7.0	70.0	7.0	4.2	29.4	16.8	16.8	8.4	82.5	55.0	8.4	14.0	0.0	31.5	14.0	2.8	7.0	488	7.8
4.2.d	AND, BFPDEW, FOR	$51.38	$16.63	$68.01	16.5	33.0	26.4	6.6	0.0	8.8	2.2	7.0	35.0	7.0	4.2	29.4	16.8	4.2	8.4	82.5	55.0	8.4	14.0	0.0	31.5	14.0	1.4	7.0	419	6.2
5.1.a	AAND, TH, WP	$42.17	$14.77	$56.94	22.0	13.2	46.2	6.6	0.0	15.4	2.2	49.0	35.0	49.0	4.2	4.2	12.6	8.4	4.2	165.0	55.0	8.4	7.0	0.0	6.3	1.4	14.0	7.0	536	9.4
5.1.b	AAND, TH, DNAS	$42.17	$16.15	$58.31	22.0	13.2	46.2	4.4	0.0	15.4	2.2	49.0	70.0	49.0	4.2	4.2	12.6	21.0	4.2	165.0	55.0	8.4	7.0	0.0	6.3	1.4	1.4	7.0	569	9.8
5.1.c	AAND, TH, WPGRU	$42.17	$14.77	$56.94	22.0	13.2	46.2	6.6	0.0	15.4	2.2	49.0	70.0	49.0	4.2	4.2	12.6	21.0	4.2	165.0	55.0	8.4	7.0	0.0	6.3	1.4	2.8	7.0	573	10.1
5.2.a	AAND, BFPDEW, WP	$49.97	$14.25	$64.22	22.0	33.0	46.2	6.6	0.0	15.4	2.2	49.0	35.0	49.0	4.2	4.2	8.4	8.4	4.2	165.0	55.0	6.3	7.0	0.0	6.3	1.4	14.0	7.0	550	8.6
5.2.b	AAND, BFPDEW, DNAS	$49.97	$14.82	$64.79	22.0	33.0	46.2	4.4	0.0	15.4	2.2	49.0	70.0	49.0	4.2	4.2	8.4	21.0	4.2	165.0	55.0	6.3	7.0	0.0	6.3	1.4	1.4	7.0	583	9.0
5.2.c	AAND, BFPDEW, WPGRU	$49.97	$14.25	$64.22	22.0	33.0	46.2	6.6	0.0	15.4	2.2	49.0	70.0	49.0	4.2	4.2	8.4	21.0	4.2	165.0	55.0	6.3	7.0	0.0	6.3	1.4	2.8	7.0	586	9.1
5.2.d	AAND, BFPDEW, FOR	$52.66	$15.74	$68.40	22.0	33.0	46.2	6.6	0.0	15.4	2.2	49.0	35.0	49.0	4.2	4.2	8.4	8.4	4.2	165.0	55.0	6.3	7.0	0.0	6.3	1.4	1.4	7.0	537	7.9
6	AD27, BDFDEW, TOX	$30.59	$12.82	$43.41	38.5	33.0	46.2	8.8	0.0	22.0	11.0	28.0	70.0	28.0	42.0	29.4	29.4	16.8	16.8	82.5	55.0	14.7	14.0	0.0	18.9	14.0	9.8	9.8	639	14.7
7	AD27, BFPDEW, LIMSTAB	$28.56	$22.28	$50.84	22.0	13.2	46.2	2.2	0.0	2.2	2.2	49.0	35.0	49.0	21.0	29.4	21.0	25.2	8.4	165.0	55.0	12.6	8.4	0.0	31.5	9.8	5.6	8.4	622	12.2

ABBREVIATIONS:

AD27 = Aerobic digestion, 27-day SRT
AD60 = Aerobic digestion, 60-day SRT
AND = Conventional high rate anaerobic digestion
AAND15 = Mesophilic Acid Hydrolysis Plug Flow Advanced Anaerobic Digestion
TH = Thickened Liquid Biosolids, 5-6%
BFPDEW= Belt Filter Press Dewatered Biosolids, 16%
CENDEW= Centrifuge Dewatered Biosolids, 20%
WP= Whistling Pines Ranch

DNAS= Dedicated New Agricultural Site, owned by GRU
WPGRU= Whistling Pines Ranch purchased by GRU
FOR= Dedicated Forest Site
COMP= Composting Facility
TOX = Thermal Oxidation
LIMSTAB= Lime Stabilization

NOTE: [1] Present Worth Cost includes the salvage value of land purchase greater than 50 acres

APPENDIX D

GRU Biosolids Contingency Plan

GRU Biosolids Contingency Plan: Disposal of Biosolids in Landfill

TO: Gainesville Regional Utilities

DATE: April 26, 2006

PROJECT NUMBER: 335569.ST.EA

Purpose

As part of the Biosolids Master Plan project, GRU and CH2M HILL staff met on March 31, 2006. During this meeting, CH2M HILL was asked to review the "disposal of biosolids in landfill" option outlined in the existing Biosolids Contingency Plan and confirm if this option is still viable. Moreover, CH2M HILL was asked to calculate the total cost of implementing this disposal method for one-year.

Executive Summary

Results from this analysis show that the "disposal of biosolids in landfill" option, as outlined in the Biosolids Contingency Plan, is still viable to GRU. Based on year 2011 biosolids production rates, the approximate cost for implementing this disposal method for one-year is **$2.1 million dollars**.

Discussion

The intent of this exercise was to identify a tangible option for short-term emergency disposal of biosolids and calculate the approximate cost to implement this option. If necessary, GRU could enact this disposal method in a timeframe of 2 or 3 weeks. The disposal of biosolids in a landfill, however, is not the only alternative for GRU. The Biosolids Contingency Plan outlines other emergency operation alternatives that, if applicable, may be more cost-effective.

Currently, GRU hauls biosolids to the Whistling Pines Ranch and stores the material in a 200,000-gallon tank prior to land application. If this option becomes unavailable, GRU would have to implement an alternate means of disposal. GRU's 2004 Biosolids Contingency Plan describes the general strategy for disposal of biosolids in a landfill:

> "Haul noncompliant biosolids into landfill for disposal. Biosolids must be dewatered and pass paint filter test before they will be accepted into any landfill…" In addition, biosolids must pass a TCLP test before they are accepted into any landfill.
>
> "Each landfill has certain procedures for GRU to complete in order for them accept biosolids. The most feasible landfill for an emergency situation is Trail Ridge Landfill which only requires certain forms to be completed which can be found in Appendix G."

To confirm if the landfill disposal alternative is still viable, CH2M HILL contacted the Trail Ridge Landfill and Aspen Rental to confirm landfill availability and equipment rental prices respectively. The following people were contacted:

Linda Hair Trail Ridge Landfill 5110 US Hwy 301 S Baldwin, FL 32234 (904) 289-9106	Kirk Johnson Aspen Rental 2004 Victoria Street Freeport, TX 78542 (505) 570-5968

The landfill tipping-fee continues to be $40 per wet ton. The mobile belt filter presses (2.2 meter) are $11,000/month for one-year rental and $18,500 for mobilization and demobilization of the equipment. A quote from Aspen Rentals that also offers transportation services is attached to this memorandum.

Having confirmed that the landfill and rental equipment were available, the cost for one-year of "Disposal of Biosolids in Landfill" was developed. To do this, the following assumptions were made:

1) Since landfill disposal is a contingency plan that may be implemented at any time in the unforeseen future, the costs were generated based on 2011 biosolids production. It is suggested that GRU update these calculations often (e.g. 5-years) to check for changes. The cost for chemicals, trucking, and equipment rental were escalated by three-percent per year to compensate for inflation; the landfill tipping-fee remained constant.

2) The costs were generated as additional costs to the current plant operation costs; the cost for labor and operation of existing onsite facilities is not included.

3) KWRF and MSWRF will continue to operate their digesters (and belt thickeners) to maximize VSS destruction and minimize odor complaints. Therefore, covering the digesters in cold weather is still required. Although discontinuing aeration would save money to GRU on power cost; the transportation costs, polymer costs, and landfill tipping-fees from the resulting additional biosolids outweighs the electrical savings from discontinuing aeration.

4) Volatile solids destruction was based on the theoretical performance of aerobic digestion as a function of liquid temperature (20° C) and hydraulic retention time (HRT).

5) Thickened biosolids (5-percent suspended solids) generated at the Main Street Water Reclamation facility (MSWRF) will be transported with GRU trailers (6,000 gallons) to the Kanapaha Water Reclamation facility (KWRF). GRU personnel will pump the MSWRF biosolids into the existing open pit at KWRF.

6) Two, 2.2-meter belt filter presses (BFPs), with two conveyers, will be installed at the KWRF. Each belt filter press was assumed capable of dewatering thickened sludge (5%) to 15-percent solids, at a rate of 1,200 lb/hr. Both BFPs will simultaneously operate to fill one trailer at a time.

7) Calculations were based on one-year of continuous operation working five days per week and twelve hours per day (12 h, 5d/wk). At a rate of 1,200 lb/hr per press, two units will meet the operational requirements for annual average biosolids production. During maximum month biosolids production, the BFPs may have to run for longer periods or operated on weekends.

8) Aspen Rentals offers to account for system redundancy by keeping spare parts readily available. However, Aspen Rentals claims they can deliver a replacement press within a few days.

9) The following cost estimate assumes that GRU will hire the transport company associated with Aspen Rentals to haul biosolids to the Trail Ridge Landfill. Thus, $85/hr per truck was assumed. This includes the driver, truck, trailer, and gasoline. In addition, one extra trailer ($2, 000/month) is required so that one trailer is always being loaded while other loads are transported. Calculations suggest that a minimum of two trucks (with trailer) and an extra trailer will be required.

10) Calculations are based on 25 cubic yards (or 45,000 lb) per trailer and five trips to the landfill per day (5-day week).

11) Biosolids will be hauled from KWRF to the Trail Ridge Landfill located approximately 65 miles away from KWRF. The estimated roundtrip time is 4.0 hours. The Trail Ridge tipping-fee is $40 per wet ton; the tipping fee was assumed to remain constant.

12) Costs for onsite operation and maintenance of the belt filter presses were not included. It is assumed that GRU operators that are currently overseeing the thickening process at KWRF can incorporate the operation of the BFPs into their schedule. Aspen Rentals will provide maintenance and parts to the BFPs.

13) Power costs were calculated based on the horsepower rating of the equipment. The anticipated yearly power costs were provided by GRU.

14) Polymer was assumed to cost $1.50/lb in 2006; the cost was escalated by 3-percent per year to account for inflation. Polymer was assumed to be dosed at 15 pounds per dry ton of biosolids.

Based on these assumptions, the approximate cost to implement the “disposal of biosolids in landfill” option is $2.1 million dollar. Detailed results for the biosolids projections and costs evaluations generated in this study are presented in Exhibit A and Exhibit B attached to this memorandum.

Enclosures

Exhibit A: GRU Biosolids Projections Summary

Exhibit B: Annualized Cost for “Disposal of Biosolids in Landfill”

Quote from Aspen Rentals

Exhibit A: GRU Combined Biosolids Projections Summary
(Assuming Maximum Aerobic Digestion)

Thickened Sludge Concentration	**5.0%**	based on plant data
Dewatered Cake Concentration	**15%**	Assumed w/ Belt Filter Press

	Max Month Average Daily Load (MMADL)					**Annual Average Daily Load (AADL)**				
Year	MMADL* dry lb/d	Liquid @ 5% SS**** gal/day	Cake @ 5 % SS 12hr,5d/wk gpm	Cake @ 5 % SS 2,400 lb/hr ** hr	Cake @ 15 % 12hr,5d/wk CY/day	AADL* dry lb/d	Liquid @ 5% SS gal/day	Cake @ 15 % SS 12hr,5d/wk CY/day	# of Trucks to Landfill 25 CY/Truck	Tipping-fee/day*** @ Landfill $40/wet-ton
2006	26,005	60,546	118	15.2	137.3	19,425	45,227	103	4.1	$2,467
2007	26,628	61,995	121	15.5	140.6	19,890	46,308	105	4.2	$2,526
2008	27,223	63,381	123	15.9	143.7	20,335	47,344	107	4.3	$2,582
2009	27,839	64,815	126	16.2	147.0	20,796	48,418	110	4.4	$2,641
2010	28,439	66,213	129	16.6	150.1	21,247	49,467	112	4.5	$2,698
2011	**29,043**	**67,619**	**131**	**16.9**	**153.3**	**21,700**	**50,522**	**115**	**4.6**	**$2,756**

* Combined Biosolids Production (i.e KWRF + MSWRF) assuming maximum VSS destruction based on HRT for existing tankage (i.e. 2006) as per Figure 14-31 Matcalf & Eddy 4th Edition (20C)
** Operating time based on two 2.2 meter Belt Filter Presses operating at 1,200 lb/hr each
*** Tipping-fee based on AADL
**** SS = Suspended Solids

Exhibit B: Annualized Cost for "Disposal of Biosolids in Landfill"

Dewatering Polymer Dose	15	lb/dry ton
Total HP Used	78	hp

Year	KWRF + MSRF (dry lb) AADL	Electric Costs (12 hr, 5d/wk)	Polymer Cost	Trucking Costs (5 day/week) (5 trips per day)	BFP Rental (2 BFP & 1 Extra Trailer)	Tipping Fee ($40/wt constant)	Total Annual Cost
2006	19,425	$13,610	$79,766	$515,840	$306,500	$900,353	$1,816,068
2007	19,890	$14,156	$84,122	$531,315	$315,695	$921,866	$1,867,154
2008	20,335	$14,438	$88,585	$547,255	$325,166	$942,502	$1,917,946
2009	20,796	$14,736	$93,312	$563,672	$334,921	$963,879	$1,970,520
2010	21,247	$15,049	$98,194	$580,582	$344,968	$984,761	$2,023,555
2011	**21,700**	**$15,259**	**$103,296**	**$598,000**	**$355,318**	**$1,005,763**	**$2,077,636**

BELT FILTER PRESS EQUIPMENT			
ITEM	Quantity	HP each	**Total HP**
Belt Filter Press (2.2 m)	2	15	30
Washdown Pumps	2	5	10
BFP Feed Pumps	2	10	20
BFP Polymer System	2	1.5	3
Sludge Transfer Pumps	2	7.5	15
		Total HP	78

GRU TRUCKING COST: MSWRF TO KWRF					
	trips/day	miles/trip (or hr)	Cost/Mile (or hr)	cost/day	cost/yr
12 CY DUMP TRUCKS	9	20	$0.7	$126	$32,760
Drivers	2	8	$28	$448	$116,480
					$149,240
Drivers	1	8	$28	$224	$58,240
25 CY DUMP TRUCKS	5	20	$0.6	$60	$15,600
				Preferred Alternative =	**$73,840**

HIRED TRUCKING SERVICES					
	no of trips/day	$/hr	hr/trip	$/day	cost/year, 5d/wk
Truck & Trailer	5	85	4	$1,700	**$442,000**

RENTAL EQUIPMENT - FROM ASPEN RENTAL QUOTE			
	no of units	cost/unit/month	total cost/yr
BFP (w/ conveyers)	2	$11,000	$264,000
Extra Trailers	1	$2,000	$24,000
Mobilization/Demobilization	LS	$18,500	$18,500
			$306,500

1464 Lakeside Dr. W
Canyon Lake, Texas
505-776-5891
aspen-rentals.com

ASPEN RENTALS

Fax Quote

To:	Gerardo Castaneda	**From:**	Kirk Johnson
Fax:	352-692-4027	**Pages:**	1
Phone:	352-335-5877	**Date:**	4/19/2006
Re:	GRU - Plan BCL	**CC:**	

☐ **Urgent** ☐ **For Review** ☐ **Please Comment** ☐ **Please Reply** ☐ **Please Recycle**

Aspen Rentals was requested by Mr. Gerardo Castaneda of CH2M Hill to provide a proposal to provide mobile dewatering equipment and transportation in the event of an interruption in the current land application capabilities at GRU.

Aspen Rentals has the capability to provide mobile, two meter belt presses from our fleet at short notice. Our trucking and transport company (Pinon Services) can provide sludge transport as needed.

Aspen Rentals provides the highest quality beltpress equipment (Ashbrook beltpresses) designed to comply with all industrial plant safety standards throughout the U.S. and Canada. Our Ashbrook presses are of the highest quality in the US. The trailers are equipped with VFD controls, polymer tanks or polyblend systems, heated and air conditioned control rooms and cake discharge augers. We

would also provide overnight parts for our equipment along with normal maintenance to ensure the equipment reliability. Our assembly and maintenance facility is located in Freeport, Texas.

It is our understanding the sludge would be an aerobically digested sludge at 5% feed solids. Based on similar sludges we have seen in Florida, you could expect a gpm of approximately 50 gpm per meter of belt. All sludges are different and this number is for estimation purposes.

Rental pricing and mobilization is as follows:

1. **2.2 meter press rent - $12,000 per press, per month for six months. One press running extended hours would do approximately 90-110gpm, however, two presses would fill an end dump approximately every 2 hours and would add a margin of safety for the plant. This price includes stacking conveyor.**
2. **2.2 meter press rent - $11,000 per press, per month for twelve months (conveyor included).**
3. **Transport (end dumps) going to two possible landfills would operate at $85.00 per hour with extra trailers being loaded while the loads are transported. Empty trailers are $2000.00 per month rental. I would estimate two to three tractors and two extra trailers would allow for continuous operation if needed. The trips to the landfill would vary depending on distance. I would estimate a five hour trip for the 100 mile trip and a four hour trip for the closer landfill.**
4. **Mobilization and demobilization transport would be $5,250 per press, each way. The 40 ft. stacking conveyor would be a $4,000 mob / demob each way.**

Aspen is also able to provide operators or training for the beltpresses if needed.

Thank you for giving us the opportunity to provide you with a quote.

Thank you,

Kirk Johnson

- Note: This quote is valid for 30 days and the beltpressess are subject to availability.

APPENDIX E

Cost Summary of Different Alternatives

APPENDIX E
Cost Summary of Different Alternatives
GRU Biosolids Management Plan

		Biosolids Treatment Process				Transportation				Land Application / Processing						Summary Total for the Alternative				
Alternative	Description	PW of Capital Costs	PW of Annual O&M Costs	Annual O&M Cost [1] (2015)	Total PW	PW of Capital Costs	PW of Annual O&M Costs	Annual O&M Cost [1] (2015)	Total PW	Description	PW of Land Cost	PW of Equipment and Construction Cost	PW of Annual O&M Costs	Annual O&M Cost [1] (2015)	Total PW	PW of Capital Costs [2]	PW of Annual O&M Costs	Annual O&M Cost [1] (2015)	Total PW [2]	Total PW, including salvage value of land [3]
1.1.a	AD27, TH,	6.40	13.10	1.20	19.50	0.63	3.24	0.34	3.87	WP, 959 ac	-	1.23	0.54	0.05	1.77	8.26	16.87	1.59	25.13	25.13
1.1.b	AD60, TH	9.61	16.34	1.49	25.95	0.63	3.06	0.32	3.69	WP, 907 ac	-	1.23	0.54	0.05	1.77	11.47	19.94	1.86	31.41	31.41
1.2.a	AD27, TH,	6.40	13.10	1.20	19.50	0.63	5.18	0.54	5.81	DNAS, 1,220 ac [6]	14.64	1.23	0.64	0.07	16.51	22.90	18.91	1.80	41.82	27.18
1.2.b	AD60, TH	9.61	16.34	1.49	25.95	0.63	4.90	0.51	5.53	DNAS, 1,150 ac [6]	13.80	1.23	0.64	0.07	15.67	25.27	21.88	2.06	47.14	33.34
1.3.a	AD27, TH,	6.40	13.10	1.20	19.50	0.63	3.24	0.34	3.87	WPGRU, 1,175 ac	14.10	1.23	0.54	0.05	15.87	22.36	16.87	1.59	39.29	25.13
1.3.b	AD60, TH	9.61	16.34	1.49	25.95	0.63	3.06	0.32	3.69	WPGRU, 1,175 ac	14.10	1.23	0.54	0.05	15.87	25.57	19.94	1.86	45.51	31.41
1.4.a	AD27, TH,	6.40	13.10	1.20	19.50	0.63	4.34	0.45	4.97	FOR, 8,681 ac	-	5.29	4.17	0.39	9.46	12.32	21.60	2.04	33.92	33.92
1.4.b	AD60, TH	9.61	16.34	1.49	25.95	0.63	4.10	0.43	4.73	FOR, 8,208 ac	-	4.93	3.95	0.39	8.88	15.17	24.39	2.30	39.56	39.56
2.1.a	AD27, BFPDEW	16.16	15.06	1.39	31.22	0.43	1.25	0.13	1.68	WP, 805 ac	-	1.56	0.54	0.05	2.10	18.15	16.85	1.57	35.00	35.00
2.1.b	AD60, BFPDEW	19.42	17.90	1.64	37.31	0.43	1.18	0.12	1.62	WP, 761 ac	-	1.54	0.54	0.05	2.07	21.39	19.61	1.82	41.00	41.00
2.2.a	AD27, BFPDEW	16.16	15.06	1.39	31.22	0.43	1.97	0.20	2.41	DNAS, 1,040 ac [6]	12.48	1.56	0.64	0.07	14.68	30.63	17.68	1.66	48.31	35.83
2.2.b	AD60, BFPDEW	19.42	17.90	1.64	37.31	0.43	1.87	0.19	2.30	DNAS, 985 ac [6]	11.88	1.54	0.64	0.07	14.06	33.27	20.40	1.90	53.67	41.79
2.3.a	AD27, BFPDEW	16.16	15.06	1.39	31.22	0.43	1.25	0.13	1.68	WPGRU, 1,175 ac	14.10	1.56	0.54	0.05	16.20	32.25	16.85	1.57	49.10	35.00
2.3.b	AD60, BFPDEW	19.42	17.90	1.64	37.31	0.43	1.18	0.12	1.62	WPGRU, 1,175 ac	14.10	1.54	0.54	0.05	16.17	35.49	19.61	1.82	55.10	41.00
2.4.a	AD27, BFPDEW	16.16	15.06	1.39	31.22	0.43	1.61	0.17	2.04	FOR, 7,639 ac	-	4.48	2.28	0.23	6.75	21.07	18.95	1.79	40.02	40.02
2.4.b	AD60, BFPDEW	19.42	17.90	1.64	37.31	0.43	1.52	0.16	1.96	FOR, 7,223 ac	-	4.29	2.25	0.23	6.53	24.14	21.66	2.03	45.80	45.80
3	AD27, CENDEW, COMP [4]	14.94	12.00	1.11	26.94	1.30	6.86	0.68	8.16	COMP, 327 ac	3.92	23.32	6.38	0.65	33.62	43.49	25.23	2.44	68.72	64.79
4.1.a	AND20, TH	39.32	10.91	1.02	50.23	0.63	2.87	0.30	3.50	WP, 834 ac	-	0.79	0.54	0.05	1.32	40.74	14.32	1.37	55.06	55.06
4.1.b	AND20,TH	39.32	10.91	1.02	50.23	0.63	4.55	0.47	5.18	DNAS, 1,055 ac [6]	12.72	0.79	0.64	0.07	14.15	53.46	16.10	1.56	69.56	56.84
4.1.c	AND20, TH	39.32	10.91	1.02	50.23	0.63	2.87	0.30	3.50	WPGRU, 1,175 ac	14.10	0.79	0.54	0.05	15.42	54.84	14.32	1.37	69.16	55.06
4.2.a	AND20, BFPDEW	46.49	13.00	1.21	59.49	0.43	1.12	0.11	1.55	WP, 700 ac	-	1.39	0.54	0.05	1.93	48.32	14.65	1.38	62.97	62.97
4.2.b	AND20, BFPDEW	46.49	13.00	1.21	59.49	0.43	1.75	0.18	2.19	DNAS, 905 ac [6]	10.92	1.39	0.64	0.07	12.95	59.24	15.39	1.46	74.63	63.71
4.2.c	AND20, BFPDEW	46.49	13.00	1.21	59.49	0.43	1.12	0.11	1.55	WPGRU, 1,175 ac	14.10	1.39	0.54	0.05	16.03	62.42	14.65	1.38	77.07	62.97
4.2.d	AND20, BFPDEW	46.49	13.00	1.21	59.49	0.43	1.38	0.14	1.82	FOR, 6,641 ac	-	4.45	2.25	0.23	6.70	51.38	16.63	1.58	68.01	68.01

APPENDIX E
Cost Summary of Different Alternatives
GRU Biosolids Management Plan

		Biosolids Treatment Process				Transportation				Land Application / Processing						Summary Total for the Alternative				
Alternative	Description	PW of Capital Costs	PW of Annual O&M Costs	Annual O&M Cost [1] (2015)	Total PW	PW of Capital Costs	PW of Annual O&M Costs	Annual O&M Cost [1] (2015)	Total PW	Description	PW of Land Cost	PW of Equipment and Construction Cost	PW of Annual O&M Costs	Annual O&M Cost [1] (2015)	Total PW	PW of Capital Costs [2]	PW of Annual O&M Costs	Annual O&M Cost [1] (2015)	Total PW [2]	Total PW, including salvage value of land [3]
5.1.a	AAND15, TH	40.80	12.17	1.14	52.97	0.63	2.06	0.21	2.69	WP, 745 ac	-	0.74	0.54	0.05	1.27	42.17	14.77	1.41	56.94	56.94
5.1.b	AAND15, TH	40.80	12.17	1.14	52.97	0.63	3.34	0.35	3.97	DNAS, 945 ac [6]	11.40	0.74	0.64	0.07	12.78	53.57	16.15	1.55	69.71	58.31
5.1.c	AAND15, TH	40.80	12.17	1.14	52.97	0.63	2.06	0.21	2.69	WPGRU, 1.175 ac	14.10	0.74	0.54	0.05	15.37	56.27	14.77	1.41	71.04	56.94
5.2.a	AAND15, BFPDEW	48.24	12.93	1.14	61.17	0.43	0.79	0.08	1.22	WP, 625 ac	-	1.30	0.54	0.05	1.83	49.97	14.25	1.28	64.22	64.22
5.2.b	AAND15, BFPDEW	48.24	12.93	1.21	61.17	0.43	1.26	0.13	1.69	DNAS, 810 ac [6]	9.72	1.30	0.64	0.07	11.66	59.69	14.82	1.40	74.51	64.79
5.2.c	AAND15, BFPDEW	48.24	12.93	1.21	61.17	0.43	0.79	0.08	1.22	WPGRU, 1.175 ac	14.10	1.30	0.54	0.05	15.93	64.07	14.25	1.35	78.32	64.22
5.2.d	AAND15, BFPDEW	48.24	12.93	1.21	61.17	0.43	1.06	0.11	1.50	FOR, 5,932 ac	-	3.98	1.75	0.22	5.74	52.66	15.74	1.54	68.40	68.40
6	AD27, BDFDEW, TOX	17.49	11.64	1.07	29.13	0.87	0.93	0.09	1.80	TOX	-	12.24	0.24	0.05	12.48	30.59	12.82	1.21	43.41	43.41
7	AD27, BFPDEW, LIMSTAB [5]	12.29	9.35	1.32	21.63	1.30	4.65	0.48	5.95	LIMSTAB	-	14.97	8.29	0.27	23.26	28.56	22.28	2.06	50.84	50.84

Abbreviations:
AD27 = Aerobic digestion, 27-day SRT
AD60 = Aerobic digestion, 60-day SRT
AND = Conventional high rate anaerobic digestion
AAND15 = Mesophilic Acid Hydrolosis Plug Flow Advanced Anaerobic Digestion
TH = Thickened Liquid Biosolids, 5-6%
BFPDEW= Belt Filter Press Dewatered Biosolids, 16%
CENDEW= Centrifuge Dewatered Biosolids, 20%
WP= Whistling Pines Ranch
DNAS= Dedicated New Agricultural Site, owned by GRU
WPGRU= Whistling Pines Ranch purchased by GRU
FOR= Dedicated Forest Site
COMP= Composting Facility
TOX = Thermal Oxidation
LIMSTAB= Lime Stabilization

NOTE: All costs are shown in Millions of Dollars
Capital Cost includes 25% Engineering and Administration Cost
PW stands for Present Worth

[1] Annual O&M Cost is shown for the mid point year (2015) during the period of evaluation (2006-2025)
[2] The Present Worth Cost does not includes the salvage value of land
[3] The Present Worth Cost includes the salvage value of land greater than 50 acres, used for Benefit Cost Analysis
[4] Transportation Cost includes the transportation of Yard Waste to the Composting Facility
[5] Transportation Cost includes the cost of transportation of lime stabilized product from processing facility to offsite storage facility and then to the land application site
[6] Includes 25 percent extra land added to the minimum land requirement