City and County of San Francisco
2030 Sewer System Master Plan

TASK 600
TECHNICAL MEMORANDUM NO. 608
SOLIDS SITING AND COST ANALYSIS

FINAL DRAFT
August 2009

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CITY AND COUNTY OF SAN FRANCISCO
SEWER SYSTEM MASTER PLAN

TASK 600

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SOLIDS SITING AND COST ANALYSIS

Please note this memo was created in February of 2007 and was not updated. It was determined by the SFPUC and the consultants that it was important to capture the information at the time of development so the reviewers could see the progression of information and decisions made at the time of the memo development. Please also note that the word 'alternative' was used instead of 'configurations' for the memos reflecting the existing wording at the time it was written. In the Summary Report, the term was updated to 'configuration' so as not to confuse the CEQA review process. The configurations mentioned herein may have changed or been eliminated and are not considered full CEQA alternatives.

1.0 INTRODUCTION

A draft technical memorandum (TM) titled *Sewer System Master Plan Project Alternatives* San Francisco Public Utilities Commission (SFPUC) by the SFPUC on January 3, 2007 summarized the four treatment and disposal alternatives for the SFPUC Sewer System Master Plan (SSMP). Alternatives 1, 2 and 4 call for a Bayside Biosolids Center (BBC) to treat the solids in the Bayside system. Alternative 3 calls for an Oceanside Biosolids Center (OBC) to treat the solids from Bayside wastewater flows. The purpose of this TM is to briefly describe and compare the three pre-established site alternatives and identify the key design and operating criteria for the BBC/OBC, the footprint requirements for these Biosolids Centers, and the capital costs.

1.1 Summary of Requirements for BCC/OBC

The BBC/OBC will perform thickening, digestion, dewatering, and digester gas management of primary and secondary sludges from Southeast Plant (SEP), North Point Facility (NPF), or replacement Bayside wastewater plants/facilities. Unthickened solids will arrive at the BBC/OBC under all alternatives via pipeline flow. Space will also be allocated at the BBC/OBC for advanced biosolids processing (e.g., thermal or other types of processing) for likely future requirements. Design criteria used to size the BBC/OBC are summarized in the document titled *Unit Sizing Criteria Assumptions,* revised on September 5, 2006. Table 1-1 provides a summary of the BBC site criteria based on a 2007 Brown and Caldwell design.

The BBC/OBC will require approximately 8.6 acres for the facilities if all processes are located at the same site. If the processes are broken up into Thickening/Digestion/Gas Management at one site, and Dewatering/Advanced Processing at a second site, the footprint requirements will be 5.5 acres and 4.2 acres, respectively. These sizes are the minimum sizes necessary for facilities and do not consider space for visual or other mitigation. In summary, the facility footprint will be within a range of 7 to 10 acres. These are the minimum sizes necessary for facilities and do not consider requirements for site or facility screening or mitigation in terms of buffer needs, perimeter landscaping, berms, etc.

Furthermore, the minimum footprints include the handling of trucked brown grease, but do not include the processing of food waste or other solid/organic wastes. There could be advantages to a joint processing facility for wastewater solids and food/organic waste. Anaerobic digestion of both waste materials produces valuable biogas. Combining biogas production from digestion of both waste materials would allow a much larger electric power production or cogeneration facility to be implemented, resulting in greater renewable energy production and other benefits. An additional 5 acres each will be required for drying and for food waste processing. In total the combined facility will need approximately 18-20 acres to house the BBC, future advanced biosolids treatment facility, and food/organic waste processing facilities.

1.2 Bayside Solids Projections

Table 1 identifies the projections for raw solids quantities as well as digested solids quantities for the design year 2030. Also shown in the table is the sludge flow rate through the anaerobic digestion system for the average condition and various peaking conditions, assuming the thickened solids are at 6 percent. These quantities and flow rates are critical in terms of sizing the facilities. There is a 10 percent contingency included in the raw sludge quantities, as identified in the table, which is consistent with planning criteria developed for this work.

Brown grease quantities from the City and County of San Francisco (City) are estimated to be a few percent of the total wastewater solids quantities for Bayside. These grease quantities are, to some extent or even to a large extent, already received at the City's wastewater treatment plants via the sewer collection system and are, therefore, to some or a large extent included in the future wastewater solids projections of Table 1. Therefore, the brown grease estimates are not added onto the wastewater solids estimates. The 10 percent contingency is another reason to avoid adding brown grease quantities to the amounts in Table 1.

2.0 OVERVIEW OF VIABLE SITE OPTIONS

Site evaluations for Bayside solids processing have been underway since the mid-1990s, when it was determined that the anaerobic digestion facilities at the SEP needed replacement. A number of Bayside sites were considered for the new BBC including:

- Norcal site
- Griffith Pump Station
- Hunters Point Shipyard (Parcel E or 2E)

- Tuntex properties
- Circosta Lot
- Central Shops
- Selby Wedge
- The south side of the Southeast Plant
- Islais Creek Site (Caltrans, Parcels A & B, and Flynn Pump Station)
- Pier 92/94 Backlands

Table 1 Bayside Wastewater Solids Projections, Year 2030
2030 Sewer System Master Plan
City and County of San Francisco

Description	Peaking Factor	Total Raw Solids[1] (k lbs/d)	Digested Solids[2] (k lbs/d)	Sludge Flowrate through Digestion[3] (k gal/d)
Average annual	1.0	274	156	548
Peak month	1.31	358	205	715
Peak 2-week	1.35	369	211	737
Peak day	2.18	597	341	1,193

Notes:
(1) 10 percent contingency factor was added as a safety factor
(2) Volatile solids assumed to be 78 percent of total solids, and 55 percent volatile solids reduction.
(3) c at 6 percent solids feed to digestion.
Note: Trucked brown grease quantities are included in the projections in this table – see text.

After a conceptual review, several sites were eliminated from further consideration. The Norcal and Griffith Pump Station site areas were significantly less than the required footprint. Hunters Point Shipyard (Parcel E or 2E) and Tuntex properties are both located near residential areas and are heavily contaminated causing future cleanup, worker safety and public acceptance concerns. A majority of the Tuntex site is located in the City of Brisbane, requiring negotiations with both the City of Brisbane and the County of San Mateo for construction and operation of BBC. The Hunters Point Shipyard, Tuntex and Candlestick Point sites would require expensive pipe tunnels construction and substantial long-term pumping costs. The Candlestick Point site is located in a state recreation area, which would make public acceptance a major concern.

Another consideration in the BBC site selection was proximity to the primary and secondary treatment processes at SEP. The further the sludge is pumped from the source (SEP), the higher will be design and pumping costs. Sites in the proximity of the SEP were therefore given a more in-depth evaluation. Several properties adjacent to the SEP were considered, but quickly ruled out. The heavily trafficked railroad tracks and I-280 Freeway near the Selby Wedge site made it an unsafe location for operators and difficult for future construction and operation. The Circosta lot is considered heavily polluted and would probably require long-term cleanup and add a future monitoring expense. The Central Shops area is only 5.3 acres and while it cannot house all of the BBC facilities; it is considered a viable option for a portion of the facilities. However, this would increase costs since the existing facility would need to be relocated or replaced. After substantial review, three 15-acre minimum, site options were selected for further evaluation to house both the BBC and drying facilities. The site descriptions below focus primarily on siting BBC facilities; however the site alternatives for drying facilities are included in the comparison tables (Tables 2 and 3) that follow the site descriptions. Figure 1 provides a spatial representation of the three sites discussed below with respect to SEP.

2.1 Site Option 1: Southeast Plant

The south side of SEP houses the existing solids handling facility for Bayside. The SEP site is approximately two full city blocks and is bounded by Phelps Street to the southeast, Jerrold Avenue to the northeast, Quint Street to the northwest and the southwest property line, which roughly follows an imaginary extension line of La Salle Street (see Figure 2). The aging facility is scheduled to be replaced within the first ten years of the implementation of the SSMP. The site is only 8.3 acres and will require the use of another site (e.g., Caltrans and Parcel A&B) for the placement of a future advanced biosolids treatment facility.

The soil at the SEP is considered the best of all the southeastern bayside sites for construction and there is the potential to rebuild the digesters within the existing ones and utilize the existing pile structures underground. The terrain is relatively flat and the building height limit in this area is 65 foot. There is reasonable truck access with many access roads to the plant and there are no site acquisition costs as the BBC facilities will fit within the existing south side SEP property. There is contamination within the site including heavy metals and volatile organic compounds (VOC) however, this site alternative has the lowest associated cleanup costs.

A major concern with this site is primarily one of public acceptance as SEP has a history of odor, noise, and light complaints. Residences are located within 30 feet of the plant property, directly across Phelps Street, and prevailing wind blows southeast toward these nearby residences. In addition, the site requires a visual mitigation program; the existing digesters are located around the perimeter of the property and are not sufficiently screened from the surrounding neighborhood. However, proposed BBC facility layout for this site will mitigate many of these issues.

Table 2	**Bayside Biosolids Center Site Alternatives Summary Table 2030 Sewer System Master Plan City and County of San Francisco**		
Alternative	**Southeast Plant (Existing solids site and Caltrans)**	**Islais Creek Site (Caltrans, Parcels A & B, and Flynn Pump Station)**	**Pier 94 (Pier 92/94 Backlands)**
Zoning(1)	M-2/P/R 65-foot building height limit	M-2 65 to 80-foot building height limit	M-2 40-foot building height limit
Site Acquisition and Availability(1)	Currently owned by the City and County of San Francisco.	Portions owned by the State of California (Caltrans) and private owners. Railroad right-of-way intersects through site. The privately owned parcels increase acquisition time. In addition, existing warehouses and commercial/industrial uses will need to be relocated.	Owned by the Port of San Francisco and possibly part of the Public Land Trust - will require parcel exchange.
Acquisition Timeline	Site available now. Caltrans would take two years to acquire.	Minimum two years after EIR for eminent domain.	Several years. Requires approval from the State Lands Commission and possibly the CA legislature. Protracted litigation possible.
Constructability, Construction Sequencing(1,3)	Phased construction sequence	Demolish/Relocate buildings, cleanup site, need vapor barrier, possible radiation Historic building on Caltrans site	No buildings, cleanup waste dump site
Geotechnical Conditions(1,2,3)	Best soils site for solids handling	Marsh fill High groundwater Underlying bay mud and sand Liquefaction zone	30 feet of landfill Underlying bay mud and sand Liquefaction zone Piles necessary to 45 foot min. depth
Hazardous Site Conditions(2)	Some site contamination exists Heavy Metals, VOCs, BTEX, carbon disulfide, TPH-g, TPH-d, TPH-motor oil & grease	Some contamination exists on Caltrans site Heavy Metals, VOCs, SVOCs, PCE, TPH as motor oil and gasoline - mainly near soil surface VOCs in groundwater 2 active Underground Storage Tanks Asbestos containing material and lead based paint in building material.	Significant contamination exists due to stockpiling of concrete, soils, and debris Heavy Metals, PAHs, Petroleum Hydrocarbons (diesel), Methane, 2 Closed Hazardous Sites (HAZNET, Cortese, LUST, CA-FID UST) 2 Active Underground Storage Tanks (UST)
Elevation(3)	Some < 5 feet	< 5 feet	> 5 feet
Vehicle Access(1,2,3)	Good truck access. Many access roads Close to 101 and 280 Freeways.	Good truck and rail access One access road Close to 280 and 101 Freeways	Good truck and rail access, potential for barging One access road Farther from SEP and 280 Freeway
Acreage(1)	15 acres (8.3 acres at SEP)	18.7 acres	20 acres (proposed by Port of SF)
Multiple Use Opportunities(3)	No extra room for Class A solids Some room for Public Programs	No extra Room for Class A solids Room for advanced treatment	Room for Class A solids Room for advanced treatment Room for recycled water users
Proximity to Residences(2)	At the fence line	More than 1500 feet	More than 1000 feet

Table 2	Bayside Biosolids Center Site Alternatives Summary Table 2030 Sewer System Master Plan City and County of San Francisco		
Alternative	**Southeast Plant (Existing solids site and Caltrans)**	**Islais Creek Site (Caltrans, Parcels A & B, and Flynn Pump Station)**	**Pier 94 (Pier 92/94 Backlands)**
Proximity to Redevelopment[3]	New 3rd St light rail areas Future biking trail nearby	New 3rd St light rail areas Future biking trail nearby	Future uses probably industrial Future biking trail nearby
Ability to Mitigate[2,3]	Prevailing wind blows toward nearby residences Visible from nearby residences Exist. mitigation needs to be improved	Prevailing wind blows toward private buildings and Islais Creek Should be screened and landscaped	Prevailing wind blows toward Bay and Industrial Area Visible from distant residential area Should be screened and landscaped
Public Acceptance	History of odors at existing site may make implementation difficult.	May require environmental monitoring, mitigation, or buffering.	Will need public support for land trust exchange - need to show how exchange is beneficial to the State.

Notes:
(1) Information compiled from San Francisco Long-Term Biosolids Management Plan. Draft, June 7, 2007.
(2) Information compiled from teleconference decision 11/1/07.
(3) Information compiled from San Francisco Sewer System Master Plan, Chapter 8. Email from Melissa Moehle, October 18, 2007.

2.2 Site Option 2: Islais Creek Site

For Site option 2, Caltrans site, Parcels A & B, and Bruce Flynn Pump Station (BFPS) would be combined (including surface streets) to form approximately 18.5 acres. This is collectively referred to as the Islais Creek site and is located across Evans Avenue from the north side of the SEP. This combined area is bound by Evans Avenue to the southwest, Quint Street on the southeast and Islais Creek to the north (see Figure 3). The terrain is relatively flat and currently houses a number of warehouses, commercial, and industrial uses, and a historical building (located on the Caltrans parcel). The BFPS is already owned by the City, the Caltrans Parcel is owned by the state, and Parcels A and B are privately held.

The positive attributes for this site alternative are: close proximity to the existing SEP, truck and freeway access, and absence of adjacent residences. This site is located near the 101 and 280 Freeways and has a railway passing through one portion allowing both truck and rail access. . This site is farthest from any nearby residences and the prevailing winds blow offshore toward Islais Creek.

Issues of concern would be the costs involved with converting existing marshland to stable, uncontaminated ground for placement of BBC, proximity to Islais Creek, and the associated potential for future flooding. Groundwater in this area is high so liquefaction is also a concern. In addition, this site is contaminated with heavy metals, motor oils and gasoline, active underground storage tanks, and asbestos and lead paint building materials in the existing structures. Caltrans is interested in selling their Parcels to the City; however possible historical building on the premises would need to be incorporated into the site plan.

Table 3 Bayside Biosolids Center Site Alternatives Cost Table
2030 Sewer System Master Plan
City and County of San Francisco

	CLASS A DIGESTION			DRYING		
	SEP	Islais Creek (Cal Trans)	Pier 94 back lands	SEP (Cal Trans)	Islais Creek (Parcels A & B)	Pier 94 back lands
Site Acquisition Time (years)[(1)]	0	2	2	0	0	0
Area of Acquisition (ac) [(2)]	8.3	6.6	10	6.6	9.3	10
Area of Acquisition (sq ft)	361,500	287,500	435,600	287,500	405,100	435,600
Area for Remediation (ac) [(3)]	8.3	7.4	10	7.4	12.1	10
Area for Remediation (sq ft)	361,548	322,344	435,600	322,344	527,076	435,600
Site Acquisition Unit Costs ($/sq. ft) [(4,5)]	$0	$85	$50	$85	$200	$50
Monthly Leasing Costs ($/sq. ft)	NA	NA	$0.20	NA	NA	$0.20
Site Hauling & Tipping Unit Costs ($/sq ft) [(6,7)]	$13	$54	$54	$54	$54	$54
Site Acquisition Costs	$0	$24,437,500	$21,780,000	$24,437,500	$81,020,000	$21,780,000
Site Hauling and Tipping Costs	$4,752,819	$17,432,298	$23,557,159	$17,432,298	$28,504,162	$23,557,159
Process pipe interconnect, SEP to BBC [(8.9)]	$0	$21,200,000	$20,800,000	$21,200,000	$0	$0
BBC Construction Costs [(10)]	$564,000,000	$658,000,000	$658,000,000	$33,500,000	$33,500,000	$33,500,000
TOTALS	$568,752,819	$721,069,798	$724,137,159	$96,569,798	$143,024,162	$78,837,159

Notes:
(1) Assumes a two year delay to acquire land at Islais Creek or Pier 94 prior to Phase 1 construction (Class A Digestion).
(2) In some instances the area for remediation is greater than the area for acquisition because SF will not need to buy surface streets. For the Islais Creek option the area includes the Flynn Pump Station, which will be used for a possible future food waste facility.
(3) For the Islais Creek option the area includes the Flynn Pump Station, which will be used for a future food waste facility.
(4) Site Acquisition Unit Cost calculated using $85/sq ft for Caltrans land, $200/sq ft for Parcels A & B land, $20/sq ft for Pier 94 Backlands, teleconference decision 11/1/07.
(5) Site Acquisition Unit Cost for SEP and Flynn Pump Station are $0 because SF already owns both parcels.
(6) Site clean-up for SEP site assumes 6 ft depth of Class II soil to be hauled to landfill in Stockton. Site clean-up for all other sites assumes 6 ft depth of Class I soil to be hauled to landfill in Kettleman City and 6 ft depth of Class II soil to be hauled to landfill in Stockton.
(7) Class I hauling/tipping is approx. $41/sq ft, Class II hauling/tipping is approx. $13/sq ft.
(8) Gallery costs to connect SEP and Islais Creek site escalated to Dec. 2007 dollars from CH2M Hill - 2001 Pre-Design Cost Estimate.
(9) 96" Process pipe interconnect costs between SEP and Pier 94 site. M&E estimate 11/12/07.
(10) BBC Construction costs for Class A Digestions at Islais Creek and Pier 94 include an additional 2 years escalation to account for site acquisition lag time. 2007 dollars from B&C construction cost estimate.

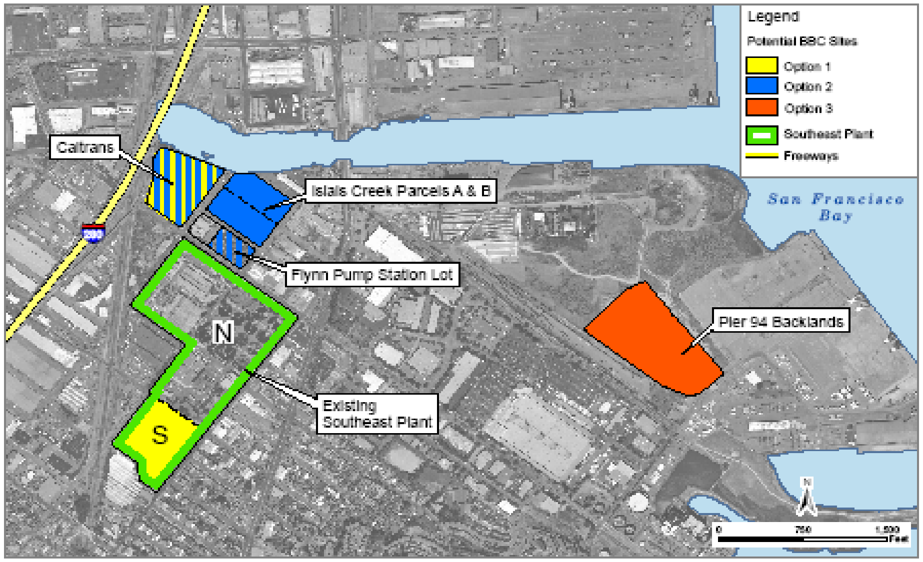

Figure 1 Location of Viable Sites for Bayside Solids Processing

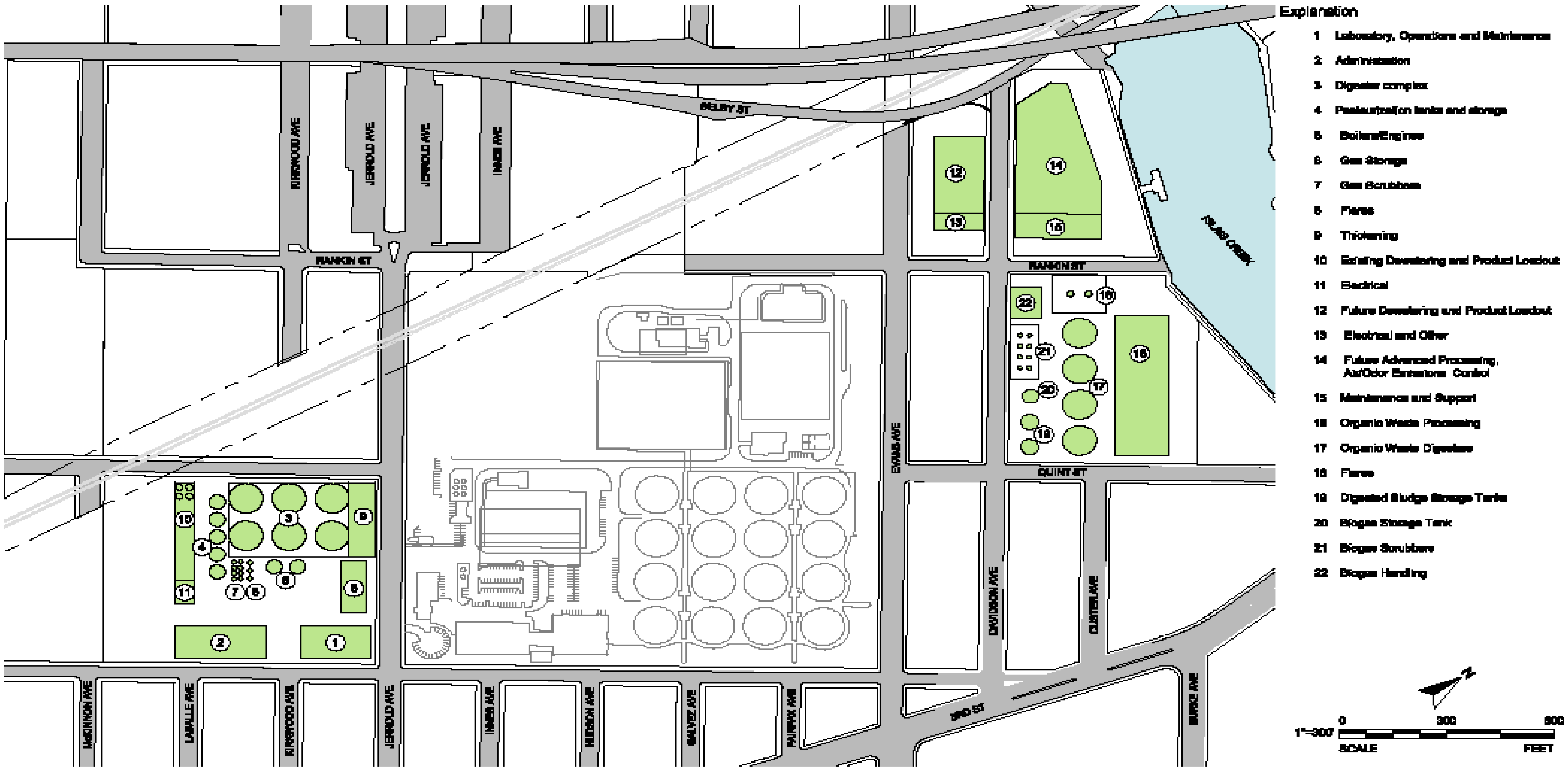

Figure 2 Location of Site Option 1: Southeast Plant

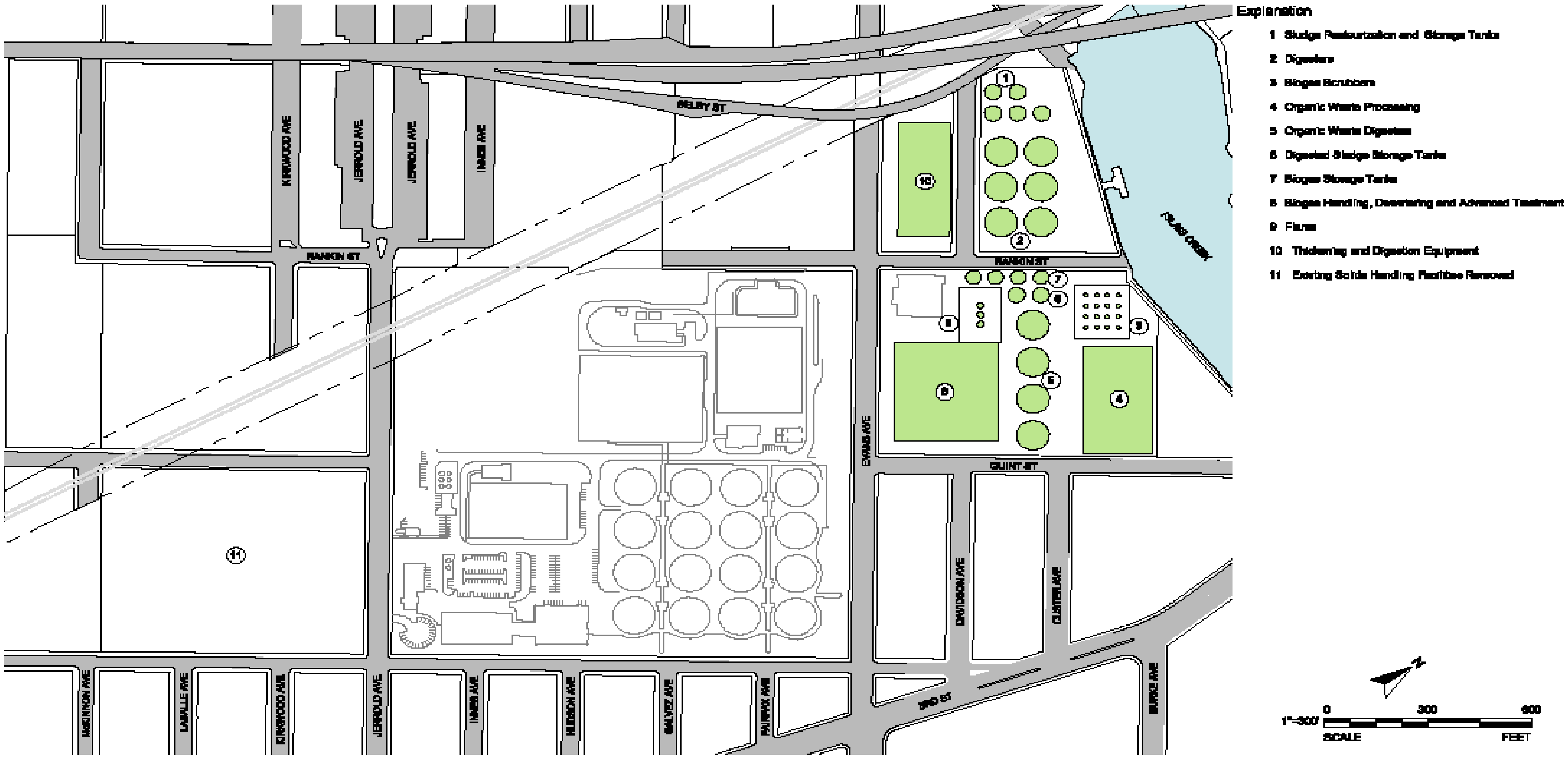

Figure 3 Location of Site Option 2: Islais Creek Site

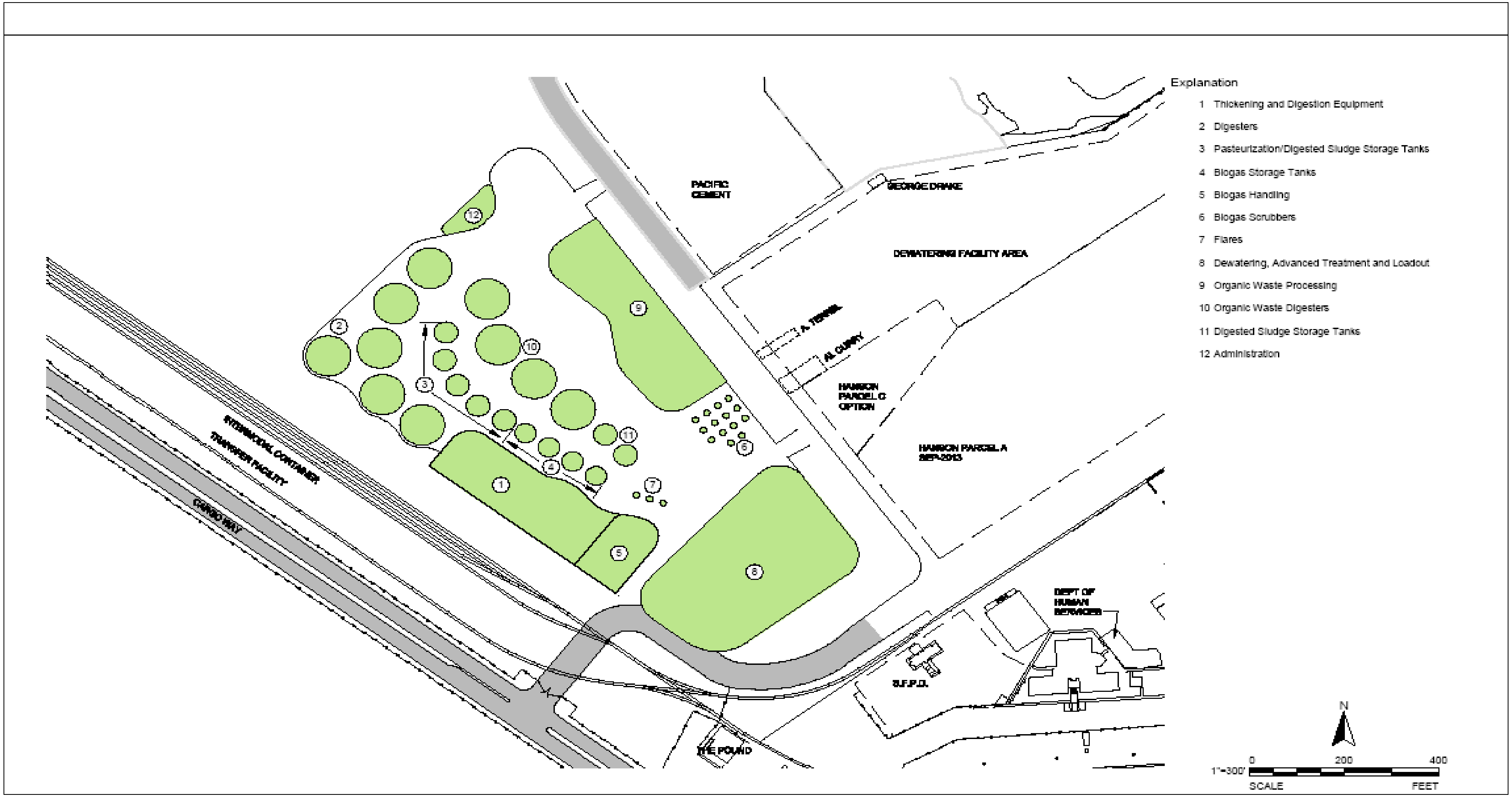

Figure 4 Location of Site Option 3: Pier 94

The City leases unused portion of the BFPS site to a private business, but the rest of the properties would need to be obtained through eminent domain proceedings and commercial and industrial users would need to be relocated.

2.3 Site Option 3: Pier 94

The Pier 94 Backlands site is located closer to the Bay and is only 1800 feet from SEP. The site is approximately 20 acres and bordered by Cargo Way to the southwest, Amador Street to the north, and a parking lot and San Francisco Bay to the east (see Figure 4). The Backlands site is away from residences, has no preexisting buildings to demolish, and is zoned as heavy industrial. The prominent structures and features surrounding the site are concrete silos, bridge cranes, shipping piers, cargo ships, shipping containers, hills of aggregate, loading conveyors, trucks, train tracks, railcars, warehouses and expanses of asphalt and concrete paving. The back lands site is primarily flat and industrial in appearance and has been historically used as a waste dumpsite, housing stockpiles of demolished concrete and other debris.

This heavy industrial zone has good truck and rail access with only moderate traffic between the site and the 101 and 280 Freeways. There is also an added opportunity for barge use. With no existing buildings, this site has only minimal demolition costs (underground storage tanks). In addition, the prevailing winds in at this site blow toward the Bay limiting the need for extensive odor mitigation.

However, there are a number of concerns with this site. The backlands are situated on approximately 30 feet of artificial fill and significant contamination exists due to waste stockpiling, both of which would require elaborate and expensive site preparation. While the property is more than 1,000 feet from any residential properties, it is also the farthest from the plant requiring additional sludge pipelines and process monitoring. A major concern for this site alternative is that the lands are part of a public trust. The Public Trust Doctrine only allows for development that facilitates commerce, like the Port of Oakland's convention center, or that requires waterfront access to operate. It is unlikely that the State Lands Commission, which oversees the administration of land trust, would approve the construction of a biosolids facility. One option for overcoming the land trust restrictions is to initiate a parcel exchange. Under the California State Public Resource Code, the City of San Francisco can substitute a non-trust parcel of land for the Pier 94 site so long as the lands are of equal value. This process is highly involved including site appraisals, environmental reviews, and often times, legislative action to lift restrictions on trust lands. A more detailed description of the Public Trust Doctrine and several case studies are presented in Appendix A. Furthermore, the Port is more interested in leasing the land than selling so the construction of BBC would require both approval from the Port of San Francisco and payment of an annual rental fee.

3.0 DESIGN CRITERIA FOR BBC/OBC

Table 4 provides the design and operating criteria for the BBC/OBC. As indicated, these are the sizes and capacities required to process all solids originating from plants/facilities on the Bayside of the City. No solids are assumed to be brought to this facility from Oceanside Plant (OSP).

As described in Section 2, for Alternative 1, 2, and 4, BBC is assumed to be located at one of these viable sites:

- Existing solids processing site at the SEP
- Caltrans Site plus Parcels A, B, C, and D
- Pier 92/94 Backlands

For Alternative 3, OBC is assumed to be located immediately adjacent to the current OSP. The following sections briefly describe each portion of the BBC/OBC. The processing system for solids is assumed to be the same for all BBC/OBC site options and liquid treatment-based alternatives.

3.1 Thickening and Digester Feeding

The primary, secondary, scum, and any related solids from the Bayside treatment plants/facilities would arrive at the BCC/OBC via pipelines in an unthickened slurry of about 0.5 to 1.5 percent solids. The primary and waste activated sludge flowstreams would be directed to the unthickened storage tanks for combined primary and activated sludge (CPAS). Two CPAS tanks are planned, each with a capacity of 50,000 gallons, and would be covered/contained for odor control. From these tanks, the combined and mixed sludge is pumped to one of six 4-meter-wide Gravity Belt Thickeners, to be thickened to 6 percent solids, average. The thickened sludge would be stored in the thickened storage tanks (TPAS), which are the digester feed tanks.

Scum would be directed to a separate system for scum thickening and perhaps screening, and the thickened scum would then be directed to the TPAS tanks, for blending, and digester feeding.

Trucked brown grease would be brought to the BBC/OBC and discharged to one of the trucked waste storage tanks for testing and checking prior to being fed to the TPAS tanks. These grease wastes are then mixed with the sludge and scum flows within the two TPAS tanks (each 80,000 gallons capacity).

The combined thickened solids would have several hours of average retention time within the TPAS tanks. This system would allow some degree of flow equalization for digester feeding to provide more constant gas production within the digestion system, thus allowing a higher percentage of the gas to be beneficially used. The TPAS tanks would be covered and contained for odor control, and the foul air/gas would be vented and treated.

Table 4 Design and Operating Criteria for BBC/OBC
2030 Sewer System Master Plan
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Parameter	Value or Related Information
Thickening System	
Unthickened Storage Tanks (CPAS)	
Number	2
Capacity of each, gallons	50,000
Mixing System type	Pump Mix
Odor Control	FA Contain/Treat
Gravity Belt Co-thickening	
GBT Feed pumps, No.	6
Number of GBT units	6
GBT size, width, meters	4-meter
Polymer feed expected, lb/ton	4 to 8
Co-thick. Solids content, %	6 %
Solids capture, %	95 %
Odor control	GBT enclosures + 15 AC/hr + FA treat
Thickened Solids Storage/pumping	
Number of Tanks (TPAS)	**2**
Capacity of each, gallons	80,000
Mixing System type	Pump Mix
Odor Control	FA Contain/treat
Digester Feed Pumps, No.	4
Anaerobic Digestion	
Digesters	
Number	6
Capacity each, gallons	2,500,000
Inside diameter, ft	90
Side Water Depth, ft	53
Cover type	Submerged fixed cover
Bottom configuration	4-waffle-bottom
Operating Mode	Class A TPAD
Digester mixing, type	Draft tube, mechanical mixers
Digester heating type	Spiral hot water/sludge HEX
Sludge cooling/heat recovery system	HEX to Water to HEX
Transfer system between digestion stages	Standpipes and pump transfer
Pasteurization Tanks/Digesters	
Number	4
Capacity each, gallons	600,000
Inside diameter, ft	48
Side water Depth, ft	45
Cover type	Fixed
Bottom configuration	Cone-shaped
Operating mode	Thermophilic, variable liquid level
Mixing system	Pump Mix
Heating system	Spiral HEX
Digested Solids Storage	
Number of tanks	1
Capacity, gallons	600,000
Size/configuration	Same as Pasteur. Tanks above
Mixing system	Pump Mix

Table 4 Design and Operating Criteria for BBC/OBC
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Parameter	Value or Related Information
Heating system	Same as Pasteur. Tanks above
Digestion Oper/Performance Criteria	
Vol Solids Load, ave, 5 tanks on-line	0.13 lb VS/ft³/day
Vol Solids Load to 1st stage thermo, Ave, 2 tanks on-line	0.32 lb VS/ft³/day
Volatile solids reduction	55 to 60 %
Solids Retention Time, days	
At Ave flow, 5 tanks on-line	17
At Peak 15-day, 5 tanks on-line	16
Thermophilic Temp, °C (°F)	~55 (131)
Mesophilic Temp, °C (°F)	~38 (100)
Digester Gas Management	
Gas Production	
Heating value, BTU/ft³ gas	580
Current, std ft³/day	1,100,000
Des Ave at 60 % VSR, std ft³/day	2,100,000
Des Pk 15-day, 60% VSR, std ft³/day	2,800,000
Gas pressure range from digestion	12 to 20 inches wc
Energy values:	
Current, Ave production	27 MM Btu/hr
Des Ave at 60 % VSR	51 MM Btu/hr
Des Pk 15-day at 60 % VSR	68 MM Btu/hr
Gas Storage (constant pressure)	
Number of storage tanks	2
Max volume, each, cubic feet	50,000
Diameter/height, ft	45/45
Gas Moisture Reduction	
Gas cooling (condenser), °F	40
Gas coolers, number, type	4, glycol
Gas Purification (H_2S removal)	
Type of system	Iron sponge
No. of units, diameter (ft) of each	8, 14
Gas Purification (Siloxane removal)	
Type of system	Carbon Adsorption
No. of units, diameter (ft) of each	4, 12
Gas Compressors, number	4
Horsepower, each	200
Boilers, number	3
Capacity, MM Btu/hr	~14
Flares, number	3
Capacity, std ft³/min, each	1200
Type	Enclosed, Low-NOx
Cogeneration Engines, number	3
Capacity, existing, mega-watt	2
Capacity, future units, mega-watt	1 to 2

3.2 Anaerobic Digestion

The digestion process defined here for costing purposes is a Class A anaerobic digestion process using thermophilic digestion and batch or flow-through pasteurization tanks to meet US Environmental Protection Agency (EPA) Class A pathogen control requirements for time and temperature. A final stage of mesophilic digestion is planned on the end of the digestion process to provide a dewatered cake product having low odor level. This process, a modification of the thermophilic/mesophilic or temperature phased anaerobic digestion (TPAD) process, provides greater destruction of volatile solids and therefore, provides a more stable product.

The first stage of digestion is anticipated to include 2 digesters in parallel using thermophilic digestion at slightly above 55°C. Two digesters would provide sufficient solids retention time for a stable first-stage system, even under peak flow rates. There would be an option of using 3 digesters as a first-stage system if warranted, and a third digester would have capability of operating as first-stage thermophilic in case either of the other 2 digesters was out of service.

Following this first-stage thermophilic digestion, the flow would be directed to 3 or 4 of the pasteurization tanks, also operated as thermophilic digesters at slightly above 55°C. These tanks could be operated as true batch tanks to meet the 24 hour/55°C time/temperature requirement of EPA’s part 503 rules, or, if EPA allowed a flow-through arrangement for Class A, the tanks could be operated as 3 or 4-stage thermophilic digestion in series. The Solids Residence Time (SRT) in each of the pasteurization tanks is only about 1 day on average, and ½ day under peak load.

After flowing through the pasteurization tanks, the flow would be directed to the remaining digester tanks (either 3 or 4 digesters in parallel) for final-stage mesophilic digestion at about 38°C. Temperature of the sludge would be reduced from thermo to meso temperature via heat exchangers, and the resulting warm water would be directed to the raw sludge to help heat it up and reduce heating requirements for the first-stage thermophilic system (heat recovery system).

Following mesophilic digestion, the digested sludge (biosolids) would be directed to the digested sludge storage tank for storage/holding prior to mechanical dewatering.

The digestion process would be designed to insure that the 15-day minimum SRT would be met under all peak 2-week loading conditions. All tanks described above are “digesters”, and have digester gas withdrawal, and are mixed and heated, with the possible exception of the final digested sludge storage tank, which may not be heated.

3.3 Digester Gas Management

A large majority of the digester gas will be produced within the thermophilic digesters, and the thermophilic gas will contain much more moisture content than mesophilic gas.

Therefore, a key design issue will be gas condensation and moisture removal. Moisture will be removed by cooling the gas to about 40°F, then, through compression, the gas will be heated by several 10s of degrees F. Gas storage in two constant-pressure tanks is planned. However, this gas storage provides only 1 hour or less of storage time at average production, and is primarily used to equalize gas flow rates and pressures.

The gas will probably need to be purified for hydrogen sulfide removal due to air permit restrictions on sulfur oxide emissions from combustion of the gas. Iron chloride can be added to the digesters to limit sulfide production and H_2S content in the gas. If this is insufficient to meet hydrogen sulfide limitations, the iron sponge process would be used to reduce hydrogen sulfide content down to the range of about 10 to 25 parts per million (ppm). In addition, for combustion within engines, siloxane removal will probably be required. At this time, we assume that a carbon adsorption system would be used for siloxane removal.

Under normal conditions, the cleaned gas would be sent to the cogeneration engines. About 2 to 3 mega-watts of electric power could be generated in the early years of the facilities, and perhaps 4 mega-watts or more in the future depending on various factors. The waste heat from the engines would be captured and used to heat the digesters to thermophilic temperatures. Waste heat recovery from the engines can also be used for other heating purposes at the plant.

Backup boilers would also be provided and would be used if the engines were not running. These would provide heating for digesters and other critical heating needs in the facilities. Flares must be provided for emergency combustion of the gas in case the engines and boilers are not able to accommodate the gas production quantities, or if the engines/boilers are not operating. Three large, enclosed, low-NOx flares are estimated to be required.

3.4 Dewatering and Cake Loadout

Digested sludge (biosolids) would be withdrawn from the digested sludge storage tank, and pumped with individual feed pumps to each dewatering machine. High-solids centrifuges are assumed to be used for dewatering, to achieve the maximum moisture removal, and the driest cake solids content. Estimates of cake solids content are in the range of 25 to 30 percent solids. Six centrifuges are anticipated, each with about 300 gallons per minute capacity. This system provides 100 percent redundancy in capacity for the dewatering system.

Cake conveyance could include some screw conveyors, but with the need to convey cake to the top of loadout hoppers/silos within a small footprint, the use of cake pumping equipment is anticipated at this time. The system for cake holding capacity is defined based on 3 days (maximum) of holding time at average conditions in the future. Two truck loadout bays are anticipated for reliability, and 5 cake silo/hopper loadout systems are assumed.

If dewatered cake will be further processed at the BBC/OBC (see below), then cake pumping equipment would allow the dewatered cake to be directed to these facilities as well as to the truck loadout system.

3.5 Advanced Biosolids Processing

In the future, it is anticipated that advanced biosolids processing will be required at the BBC/OBC. The specific type of processing is undetermined, but could include a wide variety of options including thermal drying or thermal conversion processes, or other product manufacturing systems. There are new systems under development at this time, and the next 5 to 10 years will provide more information about the most advantageous processes and arrangements that could be utilized. Making a decision at this time on the specific process required does not seem helpful, since conditions are very likely to change within the next 10 years as technology improves. Also, public perception about biosolids use and disposal may change over time, which could impact the type of facilities needed. Therefore, the San Francisco SSMP at this time, is reserving space or footprint at the BBC for this future advanced processing system. An area/footprint of 2.0 acres is used in this analysis. This is based on footprint needs for potential processes such as thermal drying and thermal conversion for a facility of the size required for BBC/OBC. For costing purposes, a heat drying system is assumed to be implemented. A system with 30 dry tons per day of digested biosolids cake capacity is assumed, which would be about one-third of the future City-wide biosolids production quantities, or about 42 percent of the Bayside biosolids quantities.

3.6 Additional Likely Solids Processing

Some additional processes are likely to be needed at the BBC/OBC, and these are discussed briefly here:

- Scum processing/thickening may be required. However, such processing might be conducted within SEP if the BBC is located immediately adjacent to the SEP.
- Screening of sludge/scum to remove debris (plastics, hair, woody/fibrous materials) is also likely to be required to enhance the characteristics of the final product which can be used not only in bulk agriculture, but also more refined products for commercial use. Wherever sludge/scum screening is conducted, the handling and load out of screenings materials must be anticipated - this is an odorous process and the waste screenings are quite odorous.

3.6.1 <u>Chemical Process Systems</u>

Besides odor control chemicals, there are two major chemical systems used for the anticipated solids processing facilities at the BBC/OBC:

- Polymer handling and feeding is required for both thickening (GBTs) and dewatering (centrifuges). The polymer system involves various tanks and handling systems for liquid and dry polymer systems, as well as polymer mixing tanks and polymer feed tanks/pumps.

- Ferric chloride feed system. Historically, this chemical has been required for struvite control in the centrifuge dewatering system, but is also helpful in controlling hydrogen sulfide content of digester gas. Therefore, feeding to both digesters and direct to the centrifuges is required for the project.

3.6.2 Odor Control – Foul Air Management

Odor control for the BBC/OBC will involve a variety of control measures and approaches, which will include chemical feeding of ferric chloride as well as details of tank mixing, hydraulic design, and configuration of the entire system. However, the most significant cost impact for odor control is the foul air containment, ventilation, and treatment system required. The basic approach is that the “strong” foul airstreams at the BBC/OBC would receive 2-stage treatment, and the less-strong foul airstreams would receive single stage treatment.

The strong airstreams are anticipated to include the following: unthickened and thickened raw solids storage tanks, brown grease storage tanks, GBT enclosures/area, scum concentrator, sludge screening, some polymer facilities, centrifuge and centrate line vents, cake conveyors, and cake hoppers/silos. The total airflow from these sources is anticipated to be about 70,000 cfm.

Foul air treatment for strong sources is assumed to involve a 2-stage system composed of chemical scrubbing followed by dry media adsorption. This would probably mean a chemical scrubbing system using NaOCl and NaOH, followed by activated carbon. This is the system detailed at this time. However, an alternate system of using manufactured biofiltration systems, followed by dry media adsorption should be pursued further as the project develops due to advances in such systems in recent years.

The less-strong foul airstreams are the following: various loadout areas and truck bays, sludge screening room, GBT room, and centrifuge room. These areas total an estimated 300,000 cubic feet per minute (cfm) – a large flow rate because of the need for 15 air changes/hour in these large, occupied spaces and rooms. For these less-strong airstreams, single-stage treatment via dry media adsorption is assumed – probably activated carbon, but other media may also be available for consideration.

A separate treatment system is needed for the pressure-relief valves (PRVs) at the tops of the digesters and pasteurization tanks. Assuming these are vented at a rate of 500 cfm per PRV, the total system would require 5,500 cfm for the 11 digester tanks having PRVs. An activated carbon system is assumed to be used for treatment. This system operates continuously, and whenever gas is released by a PRV, the gas would be largely captured by the intake and ventilated to the treatment system.

3.6.3 <u>Related Needs for BBC/OBC</u>

Besides the above process functions and odor control needs, there are many related needs for this facility. These include the following:

- Electrical supply and distribution systems – very significant for solids processing
- HVAC is a major element because the building spaces for these processes and support facilities are large.
- Maintenance areas/facilities are required for these solids processes
- Instrumentation and control functions required for solids processing, as well as some close-by laboratory support.
- Staff support facilities such as break room and restrooms
- An administrative center is also likely to be required if the BBC is located at a separate site away from the liquid processing plant for Bayside
- Safety spaces and requirements for digester gas handling facilities
- Maintenance access, security, parking, roadways, and related needs

4.0 FOOTPRINT ESTIMATE FOR BBC/OBC

Appendix B includes calculations to determine the footprint needs for BBC/OBC, whether all together at one site, or whether separated into two sites - one for thickening, digestion, gas management, and the other site for dewatering and advanced processing. This table includes site footprint only for processing and related needs, and does not include area/footprint for landscaping, aesthetic/visual or other mitigation requirements. The results are as follows:

- Minimum of 8.6 acres for the facilities described in this memo, if all solids processing is conducted at one site.
- If thickening, digestion, and digester gas management is located at one site, and then dewatering and advanced processing is located at another site, the minimum sizes are about 5.5 and 4.2 acres, respectively.

4.1 Summary of Costs

Construction cost estimates and annual costs of consumables are presented here for the Bayside Biosolids Center and Oceanside Biosolids Center.

4.2 Construction Cost Estimates

Table 5 identifies the construction cost estimates for the BBC and the OBC. These cost estimates were completed in January 2007. All elements discussed in the prior section are included, and costs are based on the master planning level of detail. The estimates were prepared using quantity take-offs, vendor quotes, and equipment pricing furnished by the design team or by the estimator. The estimate includes direct and indirect labor costs associated with all construction, all equipment identified, subcontractor costs, overhead and profit, architectural mitigation contingency, contingencies for other unknowns, and financing, bonding and related costs. A detailed description of the cost estimating procedure for these costs can be found in the *SFPUC Wastewater Treatment Plants Master Plan Conceptual Design Estimates - Basis of Estimate of Probable Construction Cost* submitted by Brown and Caldwell on January 8, 2007.

Table 5 Summary of Construction Costs for BBC and OBC
2030 Sewer System Master Plan
City and County of San Francisco

	BBC (2006 dollars)	**OBC (2006 dollars)**
Site Work, Yard Piping	10,500,000	10,400,000
Electrical, Instrumentation	132,000,000	132,000,000
Gravity Belt Thickeners, Storage Tanks	22,500,000	19,700,000
6 Digesters, Gas Handling	166,000,000	158,000,000
Pasteurization Tanks, Solids Storage	56,800,000	52,100,000
Dewatering and Scum/Grease Handling	43,000,000	41,400,000
Chemical Systems	6,780,000	6,070,000
Odor Control	38,900,000	37,700,000
Architectural Mitigation	87,400,000	83,900,000
Sub-total (no advanced treatment)	564,000,000	541,000,000
Advanced Treatment	33,500,000	32,000,000
Total Solids Treatment Construction Costs	597,000,000	573,000,000

In Table 5, the construction cost estimates for the BBC do not include site-specific features associated with each of the viable sites identified previously. Such site-specific features could include hazardous materials cleanup at the sites and other site mitigation features beyond the contingency amounts included in the estimate. The total BBC construction cost is higher than the OBC cost because all piles have been assumed for all BBC construction.

REFERENCES

REFERENCES

San Francisco Long-Term Biosolids Management Plan. Draft June 7, 2007

Future Site Table 21st. Emailed by Melissa Moehle, October 18, 2007.

San Francisco Sewer System Master Plan, Chapter 8. Emailed by Melissa Moehle, October 18, 2007

PMB 13 - Footprint Requirements BBC-OBC by Brown and Caldwell. February 18, 2007

Architectural Mitigation for SSWP Alternatives Technical Memorandum collated by Melissa Moehle and Manisha Shetye, SFPUC WWE. September 17, 2007.

Unit Sizing Criteria Assumptions by Brown and Caldwell. Revised September 5, 2006.

California State Lands Commission. 2001. *Public Trust Policy.* California State Lands Commission, Policy Statement.

California State Lands Commission. 2001. *The Public Trust Doctrine.* California State Lands Commission, Policy Statement.

Treasure Island Public Trust Exchange Act of 2004. California Statutes 2004, Chapter 543.

Lelchuk, Ilene. 2005. First shipyard parcel launched. San Francisco Chronicle, 13 January, San Francisco.

Hunters Point Shipyard Public Trust Exchange Act of 2003. California Statutes 2003, Chapter 435.

California Earth Corps v. State Lands Commission. (Third Appellate District of California, Sacramento, filed 4/21/05.)

California Earth Corps v. State Lands Commission. (Third Appellate District of California, Sacramento, filed 9/6/07).

Port of San Francisco. January 31, 2007. *Seawall Lot 337 at Mission Bay*: *Planning Overview and Orientation*. San Francisco: Port of San Francisco.

APPENDIX A - PUBLIC TRUST DOCTRINE AND CASE STUDIES

APPENDIX A - PUBLIC TRUST DOCTRINE AND CASE STUDIES

Public trusts were established over a hundred years ago in the United States for the purposes of protecting tidal lands. These lands provide the public with unique commercial and fishing opportunities and facilitate navigation. However, the state legislature has the authority to broaden or restrict uses of trust lands when granting lands to local governments. As a result, some trusts only allow uses such as recreational open space and others are much broader, allowing for facilities like retail stores and parking lots. Such developments are deemed to increase the public's enjoyment of and access to tidelands. Public trust lands can also be used for commercial enterprises that require access to waterways to operate, including bridges and nuclear power plants. Structures not related to the purpose of the trust can be built upon trust lands so long as they are incidental to achieving the goal of the trust or if the structures enhance the public's enjoyment of the land.

Parcel Exchange:

Under certain circumstances, the California State Lands Commission authorizes local governments to free lands from the public trust by substituting non-trust parcels of equal value. Section 6307 of the public resources code defines the conditions under which an exchange can take place: land parcels must be of equal value and the exchange itself must contribute to the overall benefit of the trust. The purpose of the exchange must be to improve navigation or waterways, aid in reclamation or flood control, enhance the physical configuration of the shoreline or trust land ownership, enhance public access to or along the water, enhance waterfront and nearshore development or redevelopment for public trust purposes, preserve, enhance, or create wetlands, riparian or littoral habitat, or open space, or resolve boundary or title disputes. The lands taken out of trust must also have been altered such that they are no longer tidal or submerged lands and they are no longer contributing to the benefit of the land trust. Below are three case studies illustrating situations in which this process has been used successfully:

San Francisco:

Treasure Island

In 1997, the Treasure Island Naval Station was closed under the Base Realignment and Closure Commission of 1993. In response, the California legislature established the Treasure Island Development Authority to oversee the transfer of lands from the Navy to the city and to administer the trust that the land is under. To facilitate San Francisco's redevelopment plans, in 2004 the state legislature passed the Treasure Island Public Trust

Exchange Act, which authorizes the exchange of lands between Yerba Beuna Island and the Treasure Island public trust. Yerba Buena Island was deemed to better serve the public trust due to its populations of unique wildlife, available facilities, and its sweeping views of the bay. This land will be exchanged with lands on Treasure Island that have been land-locked and can no longer be used for recreation or navigation. These lands will be redeveloped into low-income housing, a marina district, hotels, and facilitate an open space program and adaptive reuse of historic structures.

Bayview Hunters Point

An exchange of trust lands became needed in Bayview Hunters Point after the 1994 amendments to the National Defense Authorization Act were passed and the city anticipated gaining ownership over the shipyards. The city created a plan to redevelop the Hunters Point shipyards, but the plan hit some snags due environmental hazards (the site was declared a Superfund site in 1989) and the status of some parcels as public trust lands. To resolve this issue, the California legislature passed Assembly Bill 763 in 2003 which allows the exchange of public trust lands so that the redevelopment plan can be more fully realized. The bill authorizes the exchange of trust lands that have been cutoff from the waterfront or arranged in a grid pattern leaving them useless to the trust. However, the bill only authorizes these lands to be used for purposes that will ultimately uphold the broad public goals of the redevelopment plan and cannot be used for private residences. In exchange, lands adjacent to the waterfront and some interior lands will enter the trust. Exchanges will take place as parcels are remediated by the Navy in accordance with EPA regulations.

Long Beach:

Beginning in the 1920's the city of Long Beach reclaimed and paved over large swaths of tidelands in an effort to spur economic development of the waterfront. However, many of these parcels remained vacant until the city's redevelopment plan in the mid-1990's initiated new construction. The city proceeded with development and proposed adding a pedestrian walkway, cinema, day spa, and retail stores to a section known as the Queens bay parcel. Community groups and private citizens noted that the Queens bay parcel was under public trust and brought the issue to the State Lands Commission during a commission meeting to approve the Long Beach development. To avoid litigation, the commission proposed an exchange of lands such that an open space, 10-acre parcel along the Los Angeles River worth about $3.9 million would be swapped for the 3 acres of waterfront land worth only $2.9 million.

The Earth Corps, an environmental group, challenged the decision in court arguing that the Queens bay parcel was still useful under the trust and thus could not be traded. The court ruled against the Earth Corps, noting that the exchange could occur so long as the exchange would result in additional benefits as outlined in section 6307. Upon appeal the court reversed it's ruling and found that the State Lands Commission violated section 6307 because at the time, the code did not allow exchanges for the purpose of improving access. Additionally, the development would not physically reconfigure the shoreline for the public benefit. The court argued that building up did not geographically change the area and did not warrant an exchange. During the court case, the California State legislature expanded section 6307 to allow parcel exchanges for the purposes of development, enhancing open space, rearranging the layout of tidelands, and resolving boundary or title disputes. The court ruled in favor of the Earth Corps based upon existing law at the time, but the Earth Corps later withdrew its case due to the amendment of section 6307. According to the latest court ruling, as of September 9, 2007, the Commission can re-approve or disapprove the exchange of land and the development of the waterfront as it deems appropriate.

Terminating a trust:

One option the city could explore is abolishing the land trust governing the Pier 94 backlands without substituting a different parcel. However, in our extensive research we have only encountered one such example of this action. In 1987, the California legislature terminated the public trust on some seawall lots owned by the Port of San Francisco. This land, in the South Beach/Rincon Point area, had been separated from the coast and was not useful for the public trust. Once removed from the trust, the land was used for housing developments. Currently the Port of San Francisco is researching how to enact similar legislation so that it might lift restrictions on another seawall lot (Seawall Lot 337).

APPENDIX B - MINIMUM FOOTPRINT/AREA NEEDS FOR BBC/OBC

APPENDIX B - MINIMUM FOOTPRINT/AREA NEEDS FOR BBC/OBC

Updated 2/18/2007
Minimum Footprint/Area Needs for BBC/OBC
(all in square feet, except last line item in table)

These are "minimum" areas and encompass only process requirements – more area than identified here is desirable. These areas and footprints do not include requirements for site or facility screening, buffer, interior mitigation, or related perimeter aesthetic or architectural control measures. Process buildings are assumed to be 3 levels total (at about 18 to 20 ft minimum per level) encompassing either: (1) basement plus 2 levels above grade, or (2) no basement and 3 levels above grade. Some building spaces need tall rooms (30+ feet high) for bridge cranes, such as dewatering, and probably thickening. Boiler and cogen rooms also typically need to be quite tall to accommodate equipment.

Solids Processing Element	Assume All Solids Processing Together at one Site	Thickening, Digestion, and Gas Mgt Only	Dewat and Advanced Process. Only
Items 1 through 15 are floorspace in square feet			
1. **Thickening:** Assume up to six 4-meter GBT units eventually, plus CPAS blend tanks to feed GBTs, assoc pumping, conveyance and support equipment (based from 2001 layout	22,000	22,000	0
2. **Class A Digestion**: Assume TPAD Class A, and Pasteur. Tanks. All pumping, heating, cooling, feed system (blend tanks), piping, valving, and support for this equipment. Also, spacing for localized maintenance and access. Based on other large-plant digestion facilities and Class A digestion facilities (i.e., Annacis Island in particular).	100,000	100,000	0
3. **Dewatering:** Assume 6 machines ultimately, with space for some local maintenance – need tall room with bridge crane, and space to remove scroll, etc. Assume cake pumping on floor below.	20,000	0	20,000
4. **Polymer and Chemicals:** Besides polymer, assume ferric chloride, NaOCl and caustic. Based on 2001 solids bldg layout and other large-plant poly/chemical storage areas.	15,000	12,000	12,000
5. **Extra DS Storage for Remote:** If dewatering is separated from digestion, small DS storage area at dewatering area.	0	0	3,000

Solids Processing Element	Assume All Solids Processing Together at one Site	Thickening, Digestion, and Gas Mgt Only	Dewat and Advanced Process. Only
Items 1 through 15 are floorspace in square feet			
6. **Gas Cleaning and Boilers:** Gas compression and gas cooling equipment, plus two hot water boilers. Assume iron sponge vessels and siloxane carbon vessels are not included here (assumed to be outside tanks). Based on 2001 layout, plus other large-scale gas cleaning/boiler areas.	12,000	12,000	0
7. **Cogeneration Engine System:** Assume 3 engines for plant of this size, plus support systems. Need tall room. Assume any fuel cell system would not be within building.	5,000	5,000	0
8. **Electrical Rooms:** Based on 2001 solids processing layout at Caltrans site, and similar facilities. Several rooms throughout bldg, this is total floor-area needed.	12,000	9,000	6,000
9. **Maintenance space:** On-site maintenance for equipment in these facilities. Based on 2001 solids building and similar facilities.	6,000	4,000	4,000
10. **Control Room-Admin:** Based on 2001 layout and similar facilities.	6,000	4,000	8,000
11. **HVAC areas:** Fans for all building rooms and facilities, both Four Air and non-FA areas. Based on 2001 solids bldg layout and similar facilities.	10,000	7,000	7,000
12. **Odor Control:** FA treatment with some limited scrubbers for high-strength FA, then GAC for 400,000 cfm (total).	30,000	25,000	10,000
13. **Lunch-Break Room, Rstrms, Lab Spt:** Based on 2001 solids bldg and similar facilities.	4,000	3,000	3,000
14. **Miscellaneous:** Possibility of scum processing/screening and sludge screening with screenings haulout, and trucked grease processing. Also, elevators, hatches, and other items/elements not included. Estimate using 15 percent contingency.	36,000	30,000	10,000
15. **Subtotals:** Building floor space for these process and related functions (items 1 thru 14)	278,000	233,000	83,000
Building Footprint in square feet (16 through 19):			
16. **Footprint from item 15 subtotals:** Assume Three levels within buildings, so divide item 15 by 3.	93,000	78,000	28,000

Solids Processing Element	Assume All Solids Processing Together at one Site	Thickening, Digestion, and Gas Mgt Only	Dewat and Advanced Process. Only
Items 1 through 15 are floorspace in square feet			
17. Advanced Processing: Assume footprint is 2.0 acres for advanced processing	87,000	0	87,000
18. Truck Loadout: Loadout for dewatered cake and advanced product in same loadout facility. Assume product silos above 1 or 2-bay system.	8,000	0	8,000
19. Total Bldg Footprint (items 16 thru 18)	**188,000**	**78,000**	**123,000**
Outside Tank Area Needs (20 through 28):			
20. Digestion tanks: 6 at 95' diameter	**43,000**	**43,000**	**0**
21. Pasteur & DS Storage: 5 tanks in area of 60 x 300'	**18,000**	**18,000**	
22. Gas Storage: 2 tanks in area of 60' x 120'	**7,000**	**7,000**	**0**
23. Iron Sponge tanks: Area of 40' x 80'	**3,000**	**3,000**	**0**
24. Flares: 3 in area of 50' x 100'	**5,000**	**5,000**	**0**
25. Carbon Siloxane tanks: area 20' x 80'	**2,000**	**2,000**	**0**
26. Trucked Wastes Tanks: area 60' x 80'	**5,000**	**5,000**	**0**
27. Tankage Contingency: add 15 percent, and add 5,000 sq ft for Dewat/Adv area	**12,000**	**12,000**	**5,000**
28. Total Outside Tank Area (items 20 to 27)	**95,000**	**95,000**	**5,000**
Roads, Safety, Maint Access, park: (29 to 34)			
29. Roads-driveways: based on 2001 layout and similar facilities	**50,000**	**35,000**	**35,000**
30. Gas Mgt Safety areas: based on 2001 layout and similar facilities	**20,000**	**20,000**	**0**
31. Dewat/product Loadout Area: based on 2001 layout and similar facilities	**10,000**		**10,000**
32. Parking areas: 20 spaces for total site, and 12 spaces for each separated area.	**8,000**	**5,000**	**5,000**
33. Entrance area/gate and related: based on 2001 layout and similar facilities	**5,000**	**5,000**	**4,000**
34. Total Roads/Safety, Mn, Park (total of items 29 through 33)	**93,000**	**65,000**	**54,000**
Total of 19 + 28 + 34 (square feet)	376,000	238,000	182,000
Total in acres	8.6	5.5	4.2