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Technical Memorandum

Prepared for: City of Sunnyvale, California

Project Title: Water Pollution Control Plant Strategic Infrastructure Plan

Project No: 135083

Technical Memorandum

Subject: Headworks and Primary Sedimentation Upgrades Alternatives Evaluation

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1. EXECUTIVE SUMMARY

The Sunnyvale Water Pollution Control Plant (WPCP) requires a major upgrade to headworks and primary sedimentation facilities. A prior technical memorandum established the need and rationale to proceed immediately with an upgrade project on a timeline that does not wait for completion of the Strategic Infrastructure Plan (SIP). An outstanding decision for the upgrade project is whether to rebuild the headworks and primary sedimentation processes in the existing locations with existing or new structures or to construct new structures and processes in a new location on the existing WPCP site. There are a significant enough number of deficiencies with the existing structures exist that, for either approach, completely new structures and equipment will be required to satisfy listed project objectives.

Comparing the cost of constructing identical new process facilities at a new location (current sludge drying beds) to the cost of constructing them in the current headworks and primary sedimentation areas suggests that there may be up to $10 million saved by executing the project in the new location. Other factors favoring the new location include less disruption to plant activities, easier commissioning of new facilities, and a rearranged plant site that leaves space available for tertiary and recycled water upgrades more proximate to the areas where these functions are currently served. It is recommended that the following new facilities be implemented predominantly in the area that is currently used for sludge drying:

- Raw sewage screening and screened debris processing / disposal facilities
- Raw sewage pumping
- Aerated grit removal and grit washing / disposal facilities
- Primary sedimentation tanks and primary sludge pumping facilities
- Primary sludge thickening facilities

It is also recommended that the following two components be implemented to ensure reliable power for the plant, to move critical electric power supply equipment above the 100 year flood plain, and to initiate a plant power architecture based upon the reliable dual circuit feed, split bus distribution model recommended by EPA standards for wastewater treatment plants.

- Diesel fuelled emergency power generation facilities
- Main plant power station and power distribution center

2. INTRODUCTION

This Technical Memorandum (TM) examines strategic planning for the renewal of the headworks and primary sedimentation processes at the Sunnyvale WPCF. Specifically, the alternative of renewing these processes in their current location is compared to the alternative of renewing the processes with new structures in a new location on the plant site.

2.1 Background

Needed improvements at the City of Sunnyvale Water Pollution Control Plant (WPCP) are being evaluated with a Strategic Infrastructure Plan (SIP). The SIP will evaluate overall strategic alternatives for renewal of deteriorated facilities and will recommend a specific plan for executing the selected alternative for facilities renewal. The overarching approach of the SIP is to compare the broad alternative of renovating and

optimizing the existing plant facilities against the broad alternative of replacing the existing facility with new treatment processes.

Another TM, titled Early Execution Projects, determined that Headworks and Primary Sedimentation processes should be renewed on an expedited schedule that would commence in advance of full completion of the SIP. These process renewal projects were recommended for early execution because the existing structures and equipment are extremely deteriorated and in need of renewal and these processes are certain to be required in both of the major alternatives being analyzed in the SIP, in fact for any reasonable treatment process alternative.

While the concept of renewing these processes in their current locations seems a reasonable planning choice, there are some considerations suggesting that relocating these processes with new structures and equipment at a new location on the WPCP site might be a superior strategic choice. This TM focuses on identifying the characteristics, advantages, and disadvantages of each of these two major approaches for renewing the headworks and primary sedimentation processes.

2.2 Purpose and Objectives of TM

The purpose of this TM is to evaluate two major approaches for an early execution project that renews the plants headworks and primary sedimentation processes and to recommend one of the approaches for moving forward.

- One major approach is to renew these processes in their current locations by either building new structures or completely rehabilitating existing structures along with providing new mechanical equipment, piping, electric power supply, and controls as needed.
- The other major approach is to rebuild all of these processes with new structures at a new location on the existing WPCP site along with provision of new equipment, piping, electric power supply and controls as needed.

The following are the objectives of this TM:

- Describe the drivers, goals, objectives, and desired level of service for the renewed headworks and primary sedimentation processes.
- Describe the characteristics of the existing processes locations, structures, equipment, electric power supply, and control systems.
- Describe a project alternative that renews the processes in their existing location and that meets the goals, objectives, and desired level of service for the processes.
- Describe a strategy for rebuilding the processes in a new location on the WPCP site.
- Describe a project alternative that renews the processes by building new structures in a new location that meets the goals, objectives, and desired level of service for the processes.
- Compare the project alternatives with respect to the following considerations:
  - Technical feasibility
  - Compatibility with future plant requirements and plans
  - Constructability
  - Capital cost
  - Operational cost
  - Resource consumption

- Recommend and justify a selected approach

3. DRIVERS, GOALS, OBJECTIVES, AND LEVELS OF SERVICE FOR HEADWORKS AND PRIMARY SEDIMENTATION PROCESS RENEWAL

3.1 Drivers

3.1.1 Headworks (Existing Primary Control Building and Auxiliary Pump Station)

The existing Primary Control Building is where raw sewage interceptors enter the site. Incoming sewage passes through in-channel grinders in a below grade wet well and then passes to raw sewage pumps that lift the sewage to the primary sedimentation processing area. There is an auxiliary pump station adjacent to the pump control building that was originally designed to supplement the capacity of the pumps in the pump control building. The following considerations drive the need to renew these facilities:

- The structure was built in 1956. It is the oldest and most obsolete structure on the site.
- The condition assessment study from August, 2006 indicated that, based upon preliminary evaluation, the structure does not meet current seismic codes and that the structure is considered critical with respect to protection of public health and safety and protection of WPCP reliability and function.
- Ther condition assessment study from August, 2006 reported the concrete building to exhibit a moderate degree of deterioration. Instances of exposed aggregate, spalling, and unsatisfactory rebound hammer tests were reported.
- The ground floor elevation of the building is preliminarily estimated to be 1.75 feet below the 100 year flood elevation. All of Sunnyvale experienced highly unusual land subsidence during the 20th century, from unreplenished groundwater withdrawal. Documented measurements of total subsidence exceed 7 feet. Preliminary review of historical vertical survey information at the plant indicates overall subsidence of up to 5 feet may have occurred since the original plant was constructed. Flood inundation of the ground floor of this building would likely result in complete shutdown of sewage pumping from the wastewater collection system for an extended period of time.
- The raw sewage pumps and gas-fuelled engine pump drivers are as old as the structure and it is very challenging to maintain the outdated equipment.
- The condition assessment study from August, 2006 indicated that electric power components and controls for raw sewage pumping equipment are extremely outdated, are critical to essential plant operations and should be replaced as soon as possible.
- The gas-fuelled engine pump drivers are a continuous air pollutant emission source and are anticipated to be subject to new source standards that they will likeley be unable to comply with, possibly as soon as 2012.
- The in-channel grinders are an operational bottleneck. Debris clogging is common, the grinders cannot operate when utility supplied electric power is unavailable, and the cutting heads are a frequent and expensive maintenance concern. Because the grinding process does not remove debris, ground up debris materials continue to cause downstream equipment and process challenges and end up as a deleterious component of biosolids intended for recycling or reuse.

3.1.2 Primary Sedimentation Area

The primary sedimentation area includes the raw sewage pump outlet structure, the primary influent distribution channel, pre-aeration grit removal tanks, primary sedimentation gallery, primary sedimentation tanks, primary effluent channel, and primary effluent pipeline. Other than the common inlet distribution channel and common outlet collection channel / effluent pipeline, the primary sedimentation area is generally organized in 10 modular tank combination arrangements that were constructed and / or modified in several stages spanning from 1956 through 1983. Tank modules 1 – 6 date back to the mid 1950's and early 1960's. Tank modules 7-9 date back to 1970. Tank module 10 was constructed in 1983. Accordingly, the drivers for renewal are principally driven by infrastructure deterioration and outdated design features (standards, codes, supportable systems, etc.):

- The condition assessment report from August, 2006 indicated that tank modules 1-6 do not comply with current structural codes based on assessment of wall thicknesses and concrete reinforcement quantities.
- Additional seismic vulnerability exists as a consequence of the arrangement of the primary sedimentation gallery structurally separating the pre-aeration grit removal tanks and the primary sedimentation tanks with approximately 60 fiberglass pipes that span between the tanks across the gallery. The potential for independent movement of the tank structures in an earthquake could result in rupture of many of these raw sewage conduits that could result in rapid gallery flooding and a potential crippling of the entire primary sedimentation processing area. See Figure 1.

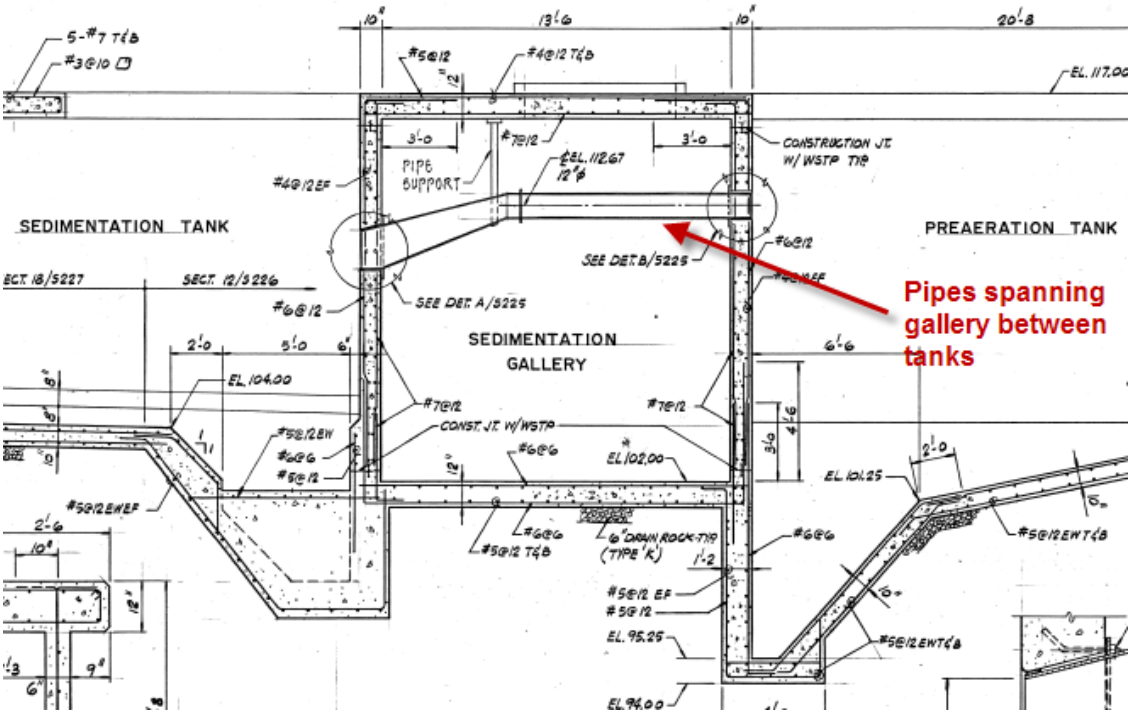


Figure 1 - Fiberglass pipes that convey primary influent across below grade equipment gallery between process tanks. Typical of approximately 60 pipes.

- The condition assessment report from August, 2006 indicated that the common primary effluent channel does not meet current seismic design codes and has high vulnerability because a failure could cripple plant operations. Replacement as soon as possible was recommended.
- A similar assessment and recommendation for immediate replacement was made for the primary effluent pipeline.
- The tank structures have many noted areas of deterioration including the following(as reported by Kennedy Jenks' Primary Sedimentation Tanks Evaluation, 2003):
  - Cracked concrete
  - Settled slabs-on-grade
  - Exposed aggregate
  - Exposed and corroding reinforcement steel
  - Water leakage into galleries
  - Soft and delaminated concrete in gallery walls
  - Bubbled and peeled coatings on tank walls
  - Corroded grates at concrete openings
  - Corroded guardrail
  - Corroded access hatches and cracked skylights
- All in-tank equipment is deteriorated and in need of replacement.
- Gallery equipment is deteriorated and in need of replacement
- Electric power supply is via a below grade motor control center that is at risk from gallery flood. Gallery flooding may be caused by seismic rupture of the hydraulic conduits discussed above or by the occurrence of a flood in the 100 year return frequency range of magnitude.
- Electric power supply equipment is deteriorated and in need of replacement.
- Electric power supply equipment is not designed with dual circuit feed, split bus distribution design recommended by EPA for wastewater treatment plants.
- Electric power supply equipment is not fed by a reliable source of emergency power generation.
- Controls for the process components are deteriorated, outdated, and in need of replacement.

3.1.3 Standby Power

Standby power creates the plant's ability to fulfill its immediately critical functions during an interruption of power from the utility power supply, Pacific Gas & Electric (PG&E). Detailed description of power generation at the WPCP is described in other SIP TMs, so only a summary of the drivers for a new diesel fuelled standby power is provided here.

The plant purchases relatively small amounts of power from PG&E. Instead the plant uses landfill biogas, anaerobic digester biogas, and utility purchased natural gas to fuel gas engine driven electric generators that provide electric power to WPCP equipment (power generation facility) or to fuel stationary reciprocating engines that directly power pumping equipment (engine driven raw sewage pumps). Additionally, heat is recovered from operation of the gas fuelled engines and utilized for heating plant processes and building spaces. This form of energy production is typically referred to as either cogeneration or combined heat and power production (CHP).

The CHP components in the power generation building are typically controlled to export a constant trickle of power back into the PG&E grid. In this manner, the on-site electric generators normally supply all the power required by the WPCP and the plant electrical grid remains synchronized with the power generation frequency of the massive PG&E electrical grid. Operating in synchronicity, or in parallel, with the massive power mass of the PG&E grid allows for the PG&E grid to be able to instantly assume WPCP loads if one or more of the plant generators operation is interrupted and it allows for large instantaneous changes in WPCP power demand to be easily and stably accommodated by the on-site generators operating in unison with the massive PG&E power grid.

When there is an interruption of PG&E power, the on-site generators operate in a self synchronized or "islanded" mode of operation. In this mode, any changes in WPCP electric load impose dramatic load changes on the engine driven generators that have proven to be beyond their capability to absorb without shutting down. They are optimized as continuous parallel power generation units and are generally unusable as stable standby island power generation units. Typically, diesel fuelled standby generators are far more reliable for emergency island operation because they utilize a fuel with greater energy density and they need not be optimized for low air pollutant emissions because they are intended for infrequent emergency only operation.

The engine driven raw sewage pumps are generally unaffected by the plant electric power grid, other than certain support and control equipment, and have generally been relied on as the principal standby power component to ensure that incoming sewage can be continuously transferred to the oxidation ponds (where there is buffering storage available) during a PG&E power outage.

With the aforementioned as background, the following considerations drive the need for a new diesel standby power generation system to be included with headworks and primary sedimentation processes renewal:

- The engines driving the raw sewage pumps will soon be (maybe as soon as 2012) prohibited from operation because they continuously generate unacceptable air pollutant emissions.
- It is improbable that new engines would be provided for the pumps because modern CHP engine systems are optimized for electric power generation. Current industry practice leads to replacing the drivers for raw sewage pumps with electric motors.
- Replacement of engines on raw sewage pumps with electric motors increases the need for emergency electric power and leaves the WPCP without any stable form of stand-alone power production.
- Provision of new diesel fuelled engine standby power generating units is a solution that is more reliable and sensible than attempting to rely on the power generation building continuous parallel generators to operate in an islanded mode.

3.2 Goals

Based, in part, on general Levels of Service described in the Levels of Service Measures TM and on the drivers discussed here, the following are overriding goals to develop headworks and primary sedimentation process facilities that are reliable, safe, and compatible with current codes, standards, and guidelines:

- Renew the processes such that they are comprised of modern structures that have a substantial future useful life, as opposed to the current condition where virtually all components are past, at, or very near the end of their anticipated useful lives.
- Replace deteriorated mechanical components with current industrial standard design equipment that is generally serviceable for the foreseeable future through current service vendor capabilities and having replaceable parts that are readily available in the current parts market supply chains.

- Replace electric power supply components with modern equipment that is generally serviceable for the foreseeable future.
- Replace process and equipment control components with modern equipment that operates in harmony with current programmable logic controller technology in a modern controls communications environment.
- Eliminate or reduce vulnerabilities to seismic events and flood events. Design to a critical facility standard.
- Provide facilities that achieve optimum unit process performance levels and that are energy efficient.
- Provide facilities that achieve desired functions with the lowest estimated life cycle costs.
- Provide process design solutions that are commensurate with sustainability principles and minimization of resource consumption.
- Mitigate process bottlenecks or operational difficulties.
- Provide for appropriate levels of process redundancy and standby power commensurate with the "24 / 7" reliability expectations for community sanitation and environmental protection.
- Provide facilities that will integrate well with other secondary and tertiary treatment improvements that will be executed from recommendations in the Strategic Infrastructure Plan.
- Provide facilities with staged capacities to accommodate current through projected 2035 flows and loads and with layouts planned for expansion of facilities to ultimate flows and loads that are limited by the current NPDES permit for Sunnyvale.

3.3 Objectives and Levels of Service

3.3.1 Flows and Loads

Headworks and primary sedimentation processes must handle the full range of flows and loads from the wastewater collection system because there is no equalizing storage available until wastewater is deposited in the oxidation ponds or some other primary effluent equalization system that may be provided should the oxidation ponds not be used for secondary treatment in the future. Flows and loads for the SIP planning process are descibed in the Influent Flows and Loads Technical Memorandum. Table 3-1 presents flows and loads that are of concern with respect to headworks and primary unit processes.

Table 3 – 1. Flows and Loads for Headworks and Primary Processes Planning

Criterion	2010 Projection	2035 Projection	Ultimate for Future Planning Allowance
Average Dry Weather Flow (mgd)	15.7	16.7	29.5
Maximum Month Flow (mgd)	21.0	22.4	39.5
Maximum Daily Flow (mgd)	30.1	32.0	56.6
Maximum Hourly Flow (mgd)	47.0	50.0	88.5
Average Dry Weather Total Suspended Solids Loading (lb/day)	18,485	21,732	38,400
Maximum Month Total Suspended Solids Loading (lb/day)	33,467	39,346	69,520
Maximum Day Total Suspended Solids Loading (lb/day)	85,107	100,057	176,700

3.3.2 Raw Sewage Pumping Objectives

- Pump a variable range of raw sewage inflows lifting from the water surface elevations corresponding with normal flow depths of the incoming interceptor sewers to a raised water surface elevation sufficient to drive gravity flow through preliminary and primary treatment processes and through to the maximum operating depth of the oxidation ponds or a raised water surface elevation sufficient to drive gravity flow through preliminary treatment, primary treatment, new secondary treatment, and through to the maximum operating depth of the existing dual media filtration units.
- Provide a number of operating units sufficient to accommodate minimum flows with one unit operating within recommended minimum limits and to accommodate maximum hourly flows with one of the largest operating units out of service.
- Provide pumping equipment driven by variable frequency drive electric motors.
- Provide a safe and readily maintainable influent wet well environment with self cleaning features for removal of accumulated scum and debris.
- Provide for easy maintenance and /or maintenance related removal of pump equipment and pump drivers.
- Provide capability to maintain pumping operations when WPCP is separated from PG&E electric power grid.
- Provide for preservation of the facility's function during and / or after seismic and flooding events.
- Provide for protective emergency gate isolation of influent wet well from incoming sewage in the event of failure of the pumping units and other power system supplies in the WPCP.
- Provide redundant electric power feeds to a pumping station motor control center.
- Provide pumping system controls based on PLC architecture and a plant wide controls system communications infrastructure.

3.3.3 Raw Sewage Screening and Screenings Debris Processing / Removal

Since its inception, the WPCP has dealt with incoming debris by grinding it and reintroducing it into the treatment stream. In early years, mechanically cleaned 1-inch opening bar screens were located in the below grade wet well area of the primary control building. Screened debris from the bar screens were mechanically ground and conveyed to the anaerobic digesters. In 1983, the auxiliary pump station was constructed with a 1-inch opening mechanical bar screen and screened debris from it were ground and transported to a dewatering screen for separate disposal, with accommodations for the original influent wet well screened debris to also be routed to the dewatering screen for separate disposal. We understand that the system for transporting ground screened debris from the pump station wet wells to the screenings processing area was problematic. In 1990, the main pump station wet well screens were replaced with in-channel grinders that capture large debris, grind it, and pass it through to the raw sewage pumps. The auxiliary pump station is no longer used in normal operations.

Sewage debris, ground or otherwise, is a recognized problem in wastewater treatment works. Unground, it can clog some pumping equipment and accumulates on mechanical equipment and in hydraulic passages. Rags, tampon applicators, prophylactics and other unsightly materials accumulate all about treatment process tanks impeding operations and making maintenance more difficult. Grinding debris mitigates some of the issues with nuisance accumulations, however grinding is not a consistent and uniform process and difficulties with long stringy materials still tend to confound operations of various mechanical equipment systems. Additionally, ground plastics end up visible in treated biosolids and can be a discouragement to the

acceptance of treated biosolids for some reuse options. Plant staff has expressed frustration with ground debris in the treatment plant flows.

It is recommended to mitigate operational issues with sewage debris by moving to a modern sewage screen system that removes small debris and provides separate processing of screened debris for separate haul away and disposal from the WPCP. With the aforementioned issues and our knowledge of peer agencies having successful screenings removal systems, we recommend providing such a system with the upgrade of the headworks and primary sedimentation processes.

The following objectives and levels of service are recommended:

- Provide 3/8 –inch bar screens with continuous automatic mechanical removal of debris from the screens.
- Screens may be located upstream of raw sewage pumping equipment with the commensurate requirement to lift screenings from below grade wet well or, alternatively, screens may be located downstream of solids handling raw sewage pumps at an above grade elevation that simplifies the collection, processing, and haul out of screened debris. Figure 2 shows a facility with these features.
- Provide screenings debris transport equipment that moves debris from the mechanical screen cleaning discharge point to screenings washing, dewatering, and compacting unit(s).
- Provide screenings washing, dewatering, and compacting units that strip fecal and other organic material from screened debris before discharging dewatered and compacted screening debris to temporary storage in a haul-out bin. The appearance of washed and compacted debris is seen in Figure 3.

Figure 2 - Mechanically cleaned bar screens with short sluice to screened debris washer / compactor.

Figure 3 – Washed and compacted screened debris in haul-out storage bin.

3.3.4 Grit Removal and Grit Processing

Since its inception, the WPCP has employed pre-aeration grit removal. Grit removal is important in sewage treatment to avoid abrasive wear problems in mechanical processing equipment and to prevent the nuisance accumulation of inert grit deposits in process reactors that can diminish tank volume and treatment capacity.

Other options for grit separation are available, including vortex tanks and vortex tanks with plate settlers. Brown and Caldwell continues to recommend pre-aeration grit removal because it has proven to be most effective over a wide range of flows and grit loads, the separation process avoids the need for grit to contact and abrade moving mechanical collectors, and the pre-aeration of sewage is generally perceived to be a beneficial process enhancement that improves distribution of solids / floatable materials and mitigates odor and corrosion issues at other areas of the plant.

The geometry of pre-aeration tanks in existing Tank Modules 7 – 10 is similar to geometry that is employed today, with steeply sloped floors in all portions of the tank leading to a sump that collects concentrated grit for pumped removal as a grit slurry. Tank modules 1 – 6 have flatter bottomed tanks that are not as effective for moving grit to the collection sump. Today's grit tank designs also include the ability to taper the feed of aeration air along the length of the tanks in order to optimize the separation of organics and inert grit materials.

Today, there is a one to one relationship with pre-aeration grit tanks and primary sedimentation tanks. In 1970, a single 3 hopper pre-grit removal tank was constructed in association with individual primary sedimentation tanks 7 through 9. We understand that this arrangement resulted in flow distribution problems to primary sedimentation tanks 7 through 9 and, ultimately, the common tank was converted to 3 individual tanks along with the construction of new tank module 10. It would be possible, with construction of a new arrangement of tanks, to decouple pre-aeration grit tanks from primary sedimentation tanks and still accomplish proper flow distribution.

The current coupled relationship between pre-aeration and primary sedimentation tanks is also a significant element of the seismic vulnerability, with numerous sewage conveyance pipes spanning the below grade equipment gallery between the pre-aeration tanks and the primary sedimentation tanks. Coupling of these processes in an alternative manner can create an opportunity to eliminate this vulnerability. A de-coupled facility is shown in Figure 4.

Grit processing is accomplished with traditional grit cyclones, that concentrate pumped grit slurries, and grit classifiers that attempt to separate organics from grit and dewater the grit prior to storage in haul out containers. Today, we recommend grit processing with fluidized bed grit washers that have proven to be superior in removal of organics and dewatering of grit. The benefits of this improved process are a great reduction in the moisture and odors of stored grit and a substantial reduction in the quantity of grit that needs to be hauled from the WPCF. Additionally, maximizing return of organic materials to the liquid stream results in more organic feed to digesters for greater biogas production. Figure 5 shows an installation with the recommended equipment. Figures 6 and 7 show the quality of washed grit from an installation with the recommended equipment and the quality of grit from the current Sunnyvale WPCP process, respectively.

Figure 4 – Pre-aeration grit removal tank de-coupled from primary sedimentation tanks

Figure 5 – Fluidized bed grit washing / dewatering unit

Figure 6 – Dry clean grit from fluidized bed washer.

Figure 7 – Stored grit at Sunnyvale WPCF with entrained moisture and organic materials.

The following objectives and levels of service are recommended:

- Provide pre-aeration grit removal tanks with steeply sloped floors and grit slurry pump suction pits.
- Provide for tapered aeration feed in tanks to optimize in-tank separation of organic solids from inert grit.
- Eliminate the seismic vulnerability associated with the current configuration of multiple conveyance pipes spanning the below grade gallery between the pre-aeration tanks and the primary sedimentation tanks.

- Provide new grit processing equipment incorporating fluidized bed grit washing / dewatering unit(s) and haul-out storage bins.
- Provide redundant tankage and processing equipment such that maximum day flow rates are processed with one unit out for service.

3.3.5 Primary Sedimentation

Primary sedimentation removes readily settleable and floatable solid materials from the sewage flows, thereby leaving downstream secondary treatment processes to treat predominantly dissolved and non-settleable waste materials. A further important consideration of primary sedimentation is that the organic material separated in the process is ultimately stabilized with energy producing anaerobic digestion processes as opposed to the energy intensive processes that are typically applied for secondary and tertiary treatment processes. This is an important driver with relation to optimizing the fraction of waste removal that can be accomplished with primary sedimentation.

The general configuration of existing primary sedimentation tanks is reasonable. However, there are some configuration design details that we recommend doing differently today to save on cost of operations and mechanical equipment. The deep primary sludge hoppers are located one per tank at the side of the upstream end of the tank. This arrangement creates the need for additional cross collectors for sludge at the end of each tank. The need for this equipment could be eliminated with the construction of two deep hoppers at the end of each tank, as shown by the example in Figure 8.

Primary scum is collected at the upstream end of the primary sedimentation tanks. Floating scum is pushed to this end of the tank by an extensive array of air nozzles distributed over each tank that constantly blow on the water surface. Energy costs and maintenance of the air compressor components could be eliminated by moving to a return flight skimming concept in the primary tanks. In this arrangement the sludge collector flights are guided to the surface for their return trip to the downstream end of the tank, pushing floatable materials along with them. At the downstream end of the tank a scum baffle and collection tube removes the scum from the tank surface. Such an arrangement requires scum collection and conveyance facilities to be located at the other end of the tanks than they are today. Figure 9 shows an example of a return flight skimmer arrangement with a tipping trough scum collector.

Current practice at the WPCF is to thicken sludge in the primary sedimentation tanks. Based upon review of historical performance data, it appears that the disadvantage of this practice is a wide variation in the percent solids removal performance of the sedimentation tanks. Many agencies seek to optimize percent removal performance in primary sedimentation by continuously pumping thin sludge from the primary sedimentation tanks and routing the thin sludge to a separate thickening process. To maximize the process energy efficiency obtained from separate sludge thickening, we recommend that the renewed process include this practice. Figure 10 shows a primary sedimentation tank complex with separate gravity sludge thickeners.

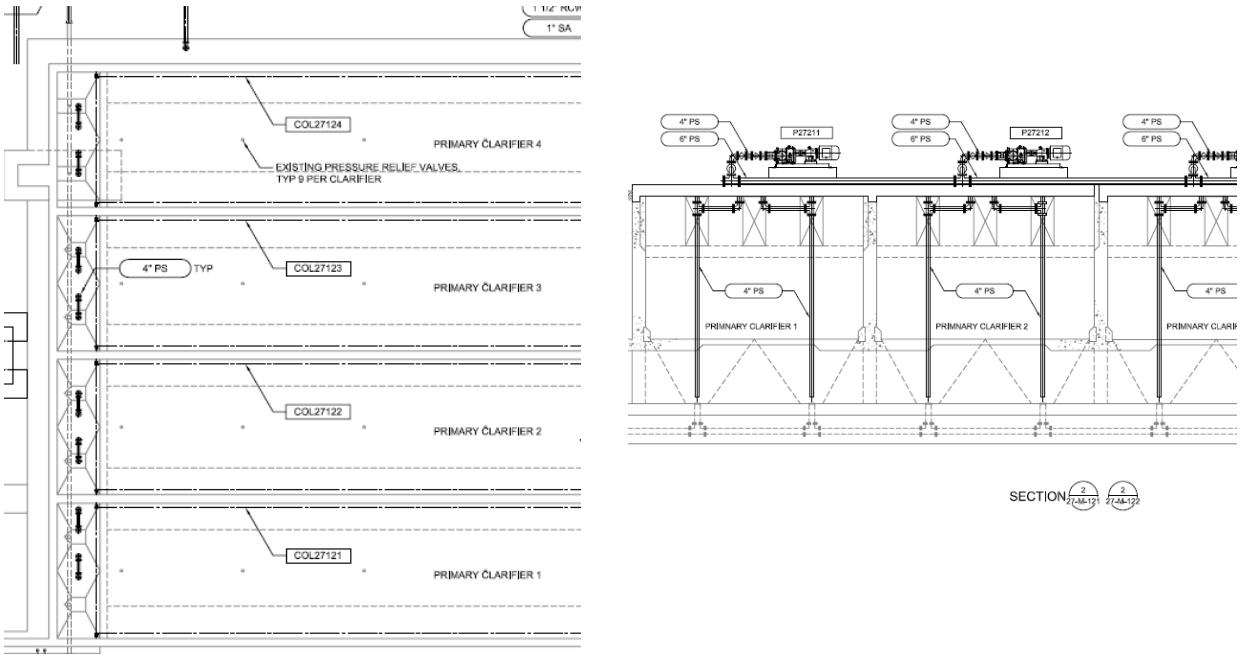


Figure 8 – Example of 2 hopper sedimentation tank arrangement with out cross collectors.

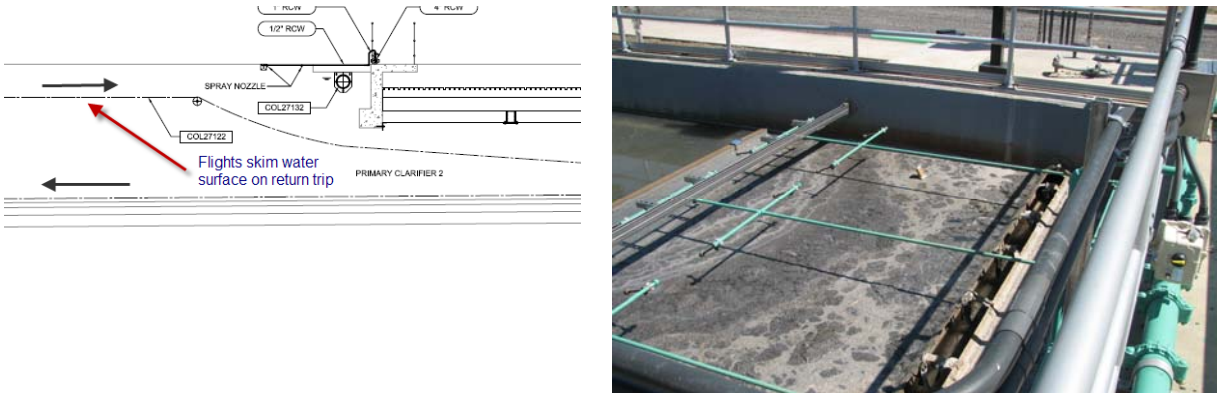


Figure 9 – Example of return flight skimming and tipping trough scum collector at downstream end of primary sedimentation tank

The following objectives and levels of service are recommended:

- Provide new primary sedimentation tanks structures with simple longitudinal chain and flight collectors and gravity sludge hoppers.
- Simplify scum removal with return flight skimming features incorporated into the longitudinal chain and flight collectors.

Figure 10 – Example of separate gravity thickeners for thin sludge pumped from primary sedimentation tanks.

- Provide tankage sufficient to pass maximum month flows with one tank out of service.
- Provide integral primary influent distribution channels that balance distribution of flows to operating tankage.
- Provide integral primary effluent channel and new primary effluent pipeline to existing oxidation ponds with potential future optional routing to new secondary treatment process that may be recommended by the SIP.
- Provide for thin sludge pumping and separate primary sludge thickeners. Thickeners may be delayed until final SIP decisions on secondary treatment process are made.
- Provide new electric power distribution facilities that are above grade and not vulnerable to flooding.
- MCCs should be double ended fed from an improved electric power distribution system that is master planned for the entire SIP improvement program.
- MCCs should be powered by emergency standby power generators to maintain screening, pre-aeration grit removal, and primary sedimentation processes during a PG&E power interruption.
- Provide controls based on PLC architecture and a plant wide controls system communications infrastructure.

3.3.6 Electric Power Distribution and Standby Power Center

The existing main electric power distribution center is an outdoor switchgear arrangement that is currently set at a grade elevation that would be inundated 1-2 feet deep during a 100 year flood event. The switchgear is the foundation of a single circuit feed radial feed distribution system. Brown and Caldwell recommends construction of a new main power distribution center that is protected from flooding and that serves as the backbone of an ultimate dual circuit feed, split bus power distribution system that is recommended by EPA guidelines for wastewater treatment plants. An example dual circuit fed, power substation is shown in Figure 11.

A new diesel fuelled standby power generator system is required to provide reliable emergency power generation for essential plant functions during interruptions of power supply from PG&E.

The following objectives and levels of service are recommended:

- Provide 2 – 2 MW diesel fuelled engine electric generators with controls for automated start-up in the event of interruption in PG&E power.

- Provide controls to support a short-term parallel operation interconnection agreement with PG&E to allow switching from emergency power back to PG&E without a power interruption to the operating processes. This also allows periodic load tests of standby power generators without interrupting power to operating processes.
- Provide new main power distribution switchgear with split distribution bus allowing dual circuit feeds to new power substations and MCCs that will be built with this and future plant improvement projects.
- Provide environmentally controlled building for main switchgear that protects switchgear from temperature extremes and flood events.

Figure 11 - Electric power substation with dual circuit feed and dual transformers.

3.3.7 Other Considerations

The Primary Control Building contains a few other administrative functions besides wastewater processing. The principal training / conference room for the facility is located on the 2nd floor as are a number of office spaces for senior operators. There is also an area control center located on the first floor.

Immediately south of the Primary Control Building there is a trailer office installation housing an instrumentation workshop.

Replacement of these functions will ultimately be addressed in comprehensive plans for new administrative and maintenance support facilities in the Strategic Infrastructure Plan. Depending on the status of the SIP effort as the design process for the Headworks and Primary Sedimentation Project Proceeds, these functions may need to be relocated to temporary facilities, in conjunction with the project, until the project that includes permanent new administrative and maintenance facilities is executed.

4. DESCRIPTION OF ALTERNATIVES

4.1 Renew Processes in Existing Locations And / Or With Existing Structures

4.1.1 Characteristics of Existing Processes

4.1.1.1 General Layout

Figure 12 describes the general layout of the WPCP components that comprise the existing headworks and primary sedimentation processes.

The raw sewage pumping area consumes more space than necessary as a consequence of the arrangement of auxiliary pump station and the original raw sewage pump station in the substructure of the original primary control building. With current flows and loads, the supplemental capacity of the auxiliary pump station is virtually never required. The auxillary station is currently recognized by operations staff as an emergency back-up for some catastrophic failure of the 3 pumps in the primary control building. In general, the raw sewage pumping area is an awkward arrangement.

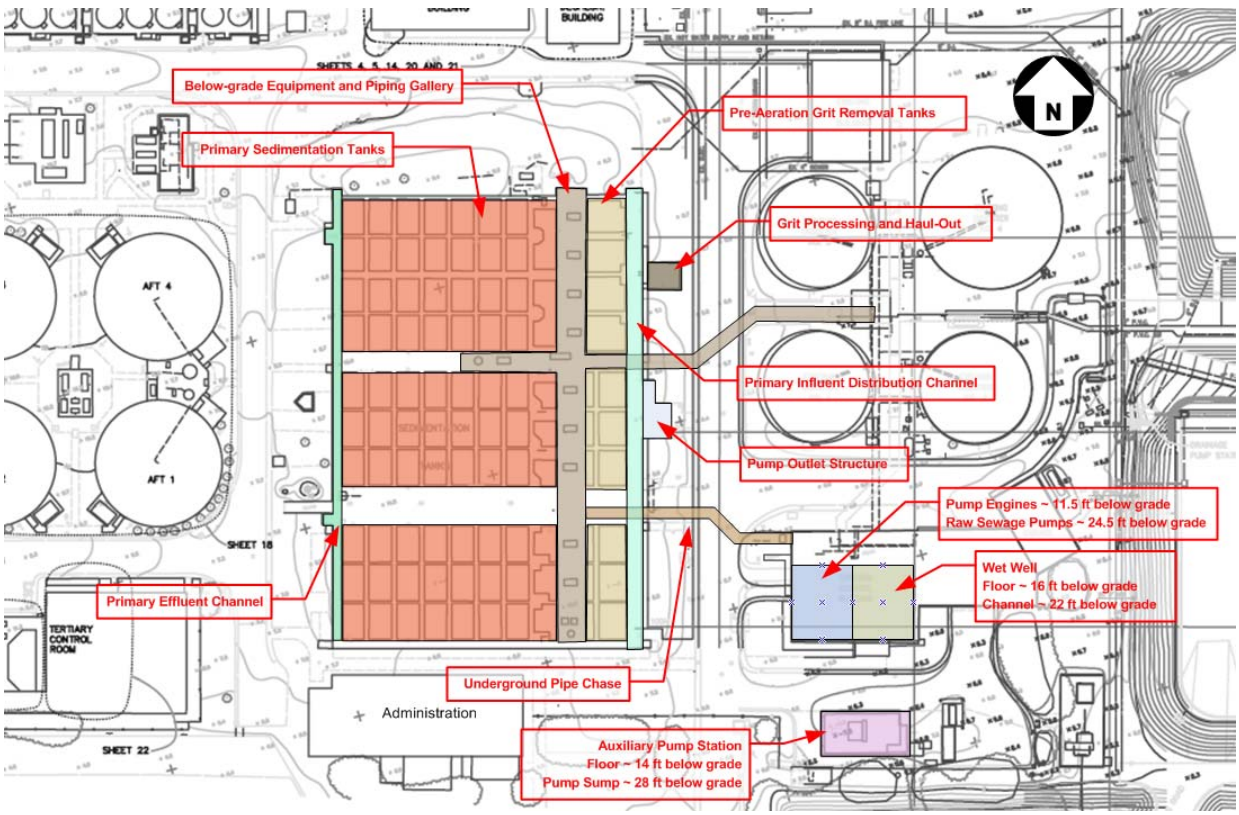


Figure 12 – Location arrangement of existing headworks and primary processes components.

The most significant aspect of the current general location of the primary sedimentation area is that it is tightly fit in between the space constrained tertiary treatment processes to the west and more spacious anaerobic digestion and sludge dewatering / drying areas to the east. Current SIP evaluations indicate more need for additional process area in the tertiary / recycled water processes than in the solids processing areas. Also of note is the tight internal arrangement of the primary sedimentation area. Little buffer space is

available for possible rearrangements of the coupled processes to mitigate the issues associated with equipment gallery lying between the pre-aeration grit removal and primary sedimentation tanks.

4.1.1.2 Primary Control Building

The primary control building has 4 major levels:

1. Deep structure with influent wet well adjacent to dry pit pump room.
2. Mid-depth structure with stationary engines / gear drives for pumps and wet well support equipment.
3. Mezzanine level at grade with motor control centers, steam separators, and operations service areas.
4. Upper level with plant training room, personnel service area, and roof mounted plant hydronic loop equipment.

Figure 13 illustrates the vertical layout of the below grade structure in the primary control building. The centerline of the raw sewage pumps is at roughly the same elevation of the water surface of the incoming sewage. This is a condition that would be avoided today as modern pumping equipment is designed to more stringent design tolerances and are more susceptible to cavitation that results from operating with low suction head in the impeller. In today's designs, several feet of impeller submergence are typically provided to ensure that "net positive suction head available" (NPSHA) exceeds the pump's "net positive suction head required" (NPSHR) by a comfortable margin.

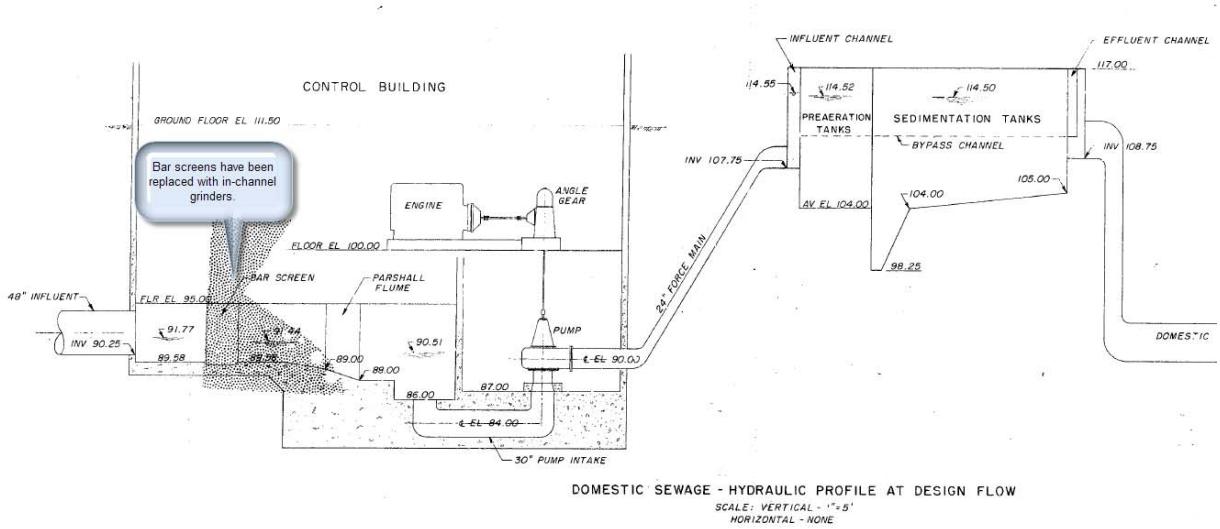


Figure 13 – Vertical arrangement of headworks and primary processes

Figure 14 illustrates the plan arrangement of the below grade structure in the primary control building. The existing spaces are filled to capacity for their current function. There is no room for additional screen channels and there is no room for additional pumping units.

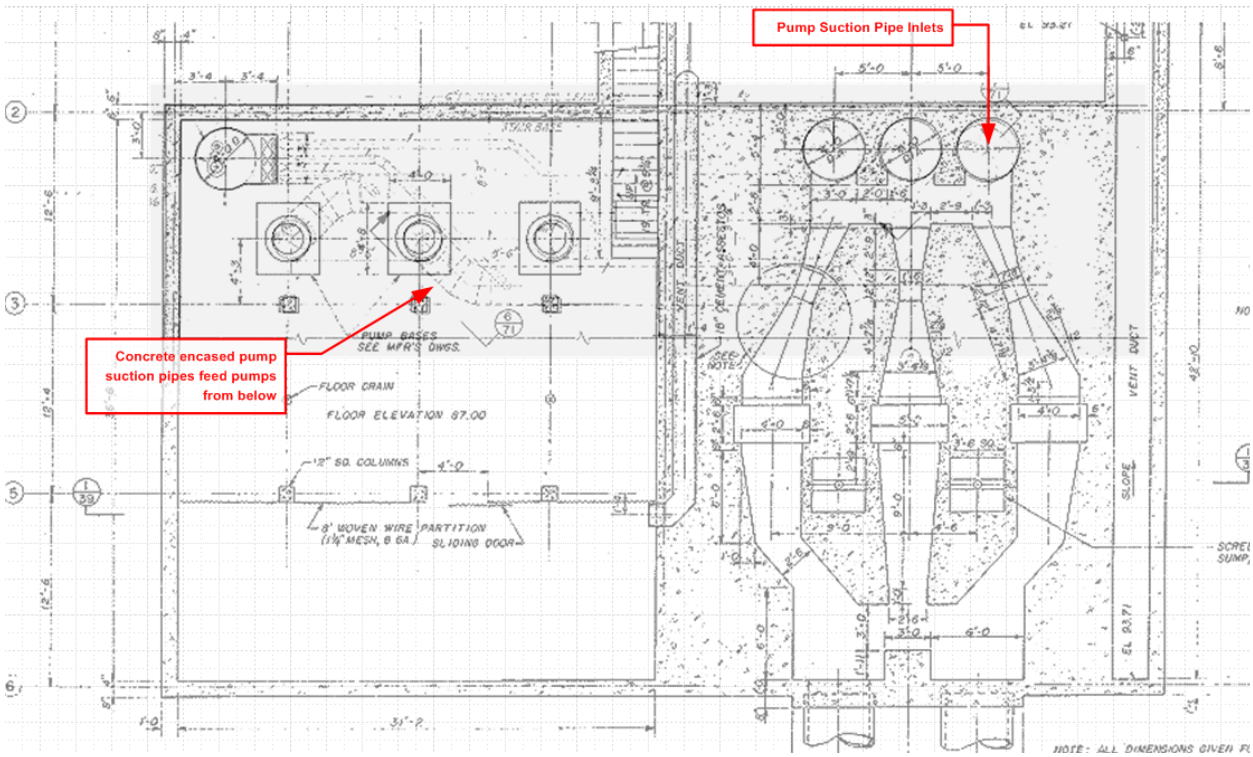


Figure 14 – Plan layout of wet well room and pump room in Primary Control Building

A major challenge in using the existing structure to fulfill the goals and objectives of headworks renewal is introducing the ability for removal of screened debris. The existing wet well requires debris removal or grinding because the pump suction inlets are virtually inaccessible. Alternative wet well designs with, more ready access to the properly arranged suction inlets, can allow much debris to pass through large solids handling raw sewage pumps with impassable debris being manually removed from the wet well on a periodic basis. This wet well requires screens or grinders.

The existing channels previously accommodated 1-inch opening bar screens. It is not uncommon for such a large screen to be loaded at rates of 2 – 2.25 mgd / square foot of submerged screen. At this loading the existing channels, having approximately 15 sq ft of submerged screen face area available, could accommodate up to 30 mgd per channel. This matched well with the nominal 25 mgd per pump rating.

Today, 3/8 inch opening bar screens are commonly used as a level of service for debris removal. This level of debris removal is beneficial for operation of downstream process equipment and for the improvement and long term acceptability of biosolids residual products for reuse. From recent designs, we find that a loading parameter for these smaller opening screens is on the order of 0.95 mgd / square foot. Attempting to install such a screen in the existing channels would limit the peak capacity to 14.25 mgd per channel or a firm (with a unit out of service) pump station capacity of 28.5 mgd. This capacity is far less than the 2035 peak hourly flow requirement of 50 mgd.

The existing pump station structure is unusable for a system in which removal of screened debris is desired.

The existing structure and surrounding grade are at an elevation that is preliminarily understood to be approximately 1.75 feet below the elevation of the 100 year flood. This condition has many cascading

consequences as the building has underground gateways to other areas of the plant that would be compromised by flood inundation.

The number and significance of major problems associated with the existing primary control building are such that it is deemed infeasible to consider renewal of that process function with the existing structure. This also means that the current location is unusable because the existing process function must be maintained while a new structure is built. Consequently, it is assumed that the alternative that seeks to maintain existing structures and / or locations will include a new location and structure for the raw sewage pumping and screened debris removal functions. The new location will be selected to be compatible with the existing primary sedimentation area.

4.1.1.3 Primary Sedimentation Area

The existing primary sedimentation area has sufficient space to provide for this process function now and in the future. The current gallery arrangement is associated with several risks to reliable functionality that have been described previously. The majority of concrete structures and equipment components are deteriorated beyond useful life. The existing structural arrangement precludes the ability to provide some simplifying and desirable process improvements that have been described above. Consequently, it is recommended that the alternative that seeks to maintain existing structures and / or locations presumes that existing tank and gallery structures will be completely demolished and rebuilt in the existing location. There is sufficient reserve processing capacity in the existing primary sedimentation area that a phased process of partial demolition and rebuilding can accomplish the renewal goals while continuously maintaining operation of the pre-aeration grit removal and primary sedimentation processes.

4.1.1.4 Primary Effluent Pipeline

The existing primary effluent pipeline is a 66-inch and 60-inch diameter pipeline installed in the 1980's. It is constructed of reinforced concrete pipe except for some inverted siphon sections that are constructed of steel pipe. This pipeline replaced a 30-inch and a 48-inch pipeline that were constructed with the original plant in the mid-1950s. The route of the existing and former pipelines is illustrated in Figure 15.

Prior inspection reports indicate that a new pipeline is recommended. Provision of a new – parallel pipeline could be provided with a junction box that allows switching to the old pipeline in emergency conditions.

Figure 15 - Primary Effluent Pipeline Routes

4.1.2 Conceptual Plan to Renew Processes in Existing Locations And / Or With Existing Structures

A graphical presentation of a project plan for renewing the headworks and primary sedimentation processes in existing locations and / or with existing structures is presented in Appendix A. For reasons described in the preceding sections, the project is composed principally of new structures in roughly the same locations as the processes exist today.

- The plan results in new facilities that should meet all the objectives outlined in the preceding sections.
- The plan includes 4 major phases that are required in order to maintain headworks and primary treatment processes while the new structures are being built immediately proximate to the existing facilities.
- The plan includes a certain amount of disruption, partial demolitions, and redirection of existing utilities that, while accomplishable, may create additional challenges for operating the facilities during the construction period.

4.2 Renew Processes in New Location with New Structures

A graphical presentation of a project plan for renewing the headworks and primary sedimentation processes in new locations with new structures is presented in Appendix B.

- The plan results in new facilities that should meet all the objectives outlined in the preceding sections.
- The plan requires, essentially, one major construction phase followed by one major demolition phase. The initial preparatory demolition phase for this plan will be much less disruptive to continuing plant operations.
- The plan requires one major commissioning phase where all new facilities are commissioned and old facilities are decommissioned in one step.

5. EVALUATION OF ALTERNATIVES

5.1 Non-Economic Factors

5.1.1 Technical Feasibility

Both alternatives are technically feasible. Both alternatives provide facilities that meet objectives that have been discussed in this document for the headworks and primary sedimentation processes and previously established general Levels of Service. In each alternative the functional end products will be virtually identical.

5.1.2 Compatibility with Existing Operations

The end products of each alternative will interface with existing operations in a similar manner. The existing locations alternative will be more disruptive to the continuing operations of the treatment plant during the construction period that may last up to 3 years, causing additional unscheduled operations and maintenance costs for addressing various contingencies needing during the disruptive period.

5.1.3 Compatibility with Strategic Infrastructure Plan Improvements

The new locations alternative is deemed more compatible with Strategic Infrastructure Plan (SIP) improvements. The most significant SIP improvements are likely to involve changes in the following areas:

- Potential replacement of oxidation ponds with new secondary treatment process.
- Potential replacement of existing DAF process structures with new high rate DAF process units.
- Provision of new facilities to support parallel production of recycled water with greater production capacity.

Every one of these potential SIP improvements would be better integrated with existing secondary and tertiary facilities if they were sited in the existing primary treatment area. If the Existing Location Alternative is built, new secondary and tertiary improvements would need to be sited on the east side, opposite from where both final effluent and recycled effluent currently exit the plant. This would be an awkward arrangement and would add additional cost for achieving the SIP improvements cited above.

5.2 Economic Factors

5.2.1 Capital Cost

The conceptual estimates of probable construction cost for each of the alternatives are as follows:

Table 5-1. Alternatives Cost Summary

	Existing Location Alternative				New Location Alternative	
	Phase 1		Phase 2		Phase 1	Phase 2
Start Date	2/15/2011	6/15/2011	2/15/2014	4/15/2014	2/15/2011	10/15/2013
End Date	6/15/2011	2/15/2014	8/15/2014	9/15/2014	10/15/2013	2/15/2014
Projects	Demo	Construction	Demo	Construction	Construction	Demo
Civil/Site Work Existing Plant Area		2,492,000				
Civil/Site Work New Facilities Area[1]						1,504,000
Raw Sewage Pumping		5,973,000			5,060,000	
Debris Removal		3,485,000			3,280,000	
Grit Removal		4,383,000			4,030,000	
Landfill Gas Booster and Flare System and Demo		771,000	77,000		732,000	62,000
Primary Sedimentation Tanks		17,784,000			16,143,000	
Electrical Building – Headworks/Primaries		3,342,000			3,172,000	
Demolition - Auxiliary PS	3,961,000[2]					200,000
Demo - Sludge Dewatering Beds			5,348,000[3]		965,000	
Demo - Primary Sed. Basins 1-5	1,678,00					1,371,000

Table 5-1. Alternatives Cost Summary

	Existing Location Alternative				New Location Alternative	
	Phase 1		Phase 2		Phase 1	Phase 2
Demo - Primary Sed. Basins 6-10			1,990,000			1,371,000
Construct 60" Primary Effluent Pipeline		3,294,000			3,027,000	
Demo - 66" RCP			67,000			
Demo - 24" and 30" Pipe			204,000			158,000
Demo – Primary Control Building			2,459,000			1,946,000
Relocated Utilities Building		1,577,000			1,380,000	
Civil/Site Work Greenfield Area					5,680,000[3]	
Gravity Thickening				2,516,000	1,745,000	
Standby Power		2,583,000			2,504,000	
Electrical Power Distribution		3,141,000			2,985,000	
Sub Totals	5,639,000	48,825,000	10,145,000	2,516,000	49,738,000	6,612,000
Alternative Total	67,125,000				57,315,000	

[1] Cost includes repaving roads, finish grading and seeding allowance
[2] Demolition includes $3,753,000 in by-pass pumping costs
[3] Includes earthwork costs for 53000 cy of imported fill. Fill is for restoring the dewatering bed area as well as bringing the old sludge drying bed area up to top of dike elevation. Fill costs not required for existing location alternative.

In summary, the new location alternative carries some additional construction scope for a significant quantity of imported fill materials that will be required to convert the existing, low lying sludge drying area into a new headworks and primary sedimentation area that is appropriately protected from 100 year flood conditions. The cost of additional fill for the new locations alternative is offset and overcome by a variety of additional cost sources for the existing locations alternative including:

- Excavation and shoring costs for construction in close proximity to existing processes.
- Escalation and contractors overhead costs resulting from a longer overall construction period and the inefficiencies of construction phasing.
- Various temporary facilities and accommodations to keep existing parts of the plant operational while companion parts are demolished and reconstructed.
- Higher probability of unforeseen conditions change order costs associated with keeping existing processes operating while major construction upgrades are immediately proximate.

5.2.2 Operational Cost

Due to the identical functional aspects of the two alternatives they should have no significant difference in operational costs for the end product facilities. As discussed previously, some additional management and operational costs during the construction period can be attributed to the existing locations alternative.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

- An alternative to renew headworks and primary sedimentation processes in existing location with existing or new structures ends up employing all new structures in existing locations as a result of a cumulative list of deficiencies with the existing structures.
- Conceptual plans are presented to satisfy process renewal objectives completely with siting at the existing process locations or at a new location on the east side of the plant in the current sludge drying area.
- The existing location alternative is more expensive to construct.
- The existing location alternative is more disruptive to on-going operations and will involve more difficulty to fully commission new facilities and to decommission old facilities.
- The new site alternative provides space within the existing process area to meet other SIP goals.
- It is advisable to include provision of a new main power distribution center with the provision of new diesel standby power generators in order to address the current risks of flood inundation that exist with the current main power distribution center.
- All project elements described here, except primary sludge thickening, can be executed prior to final alternatives selection in the SIP. If the SIP decision is to renew the existing plant processes, than the project described here could easily have primary sludge thickeners added in a timely manner. If the SIP decision is to replace the oxidation ponds with a new secondary treatment process, then the sludge thickening function may be delayed for consideration of a co-thickening process that deals with both primary and waste secondary sludge.

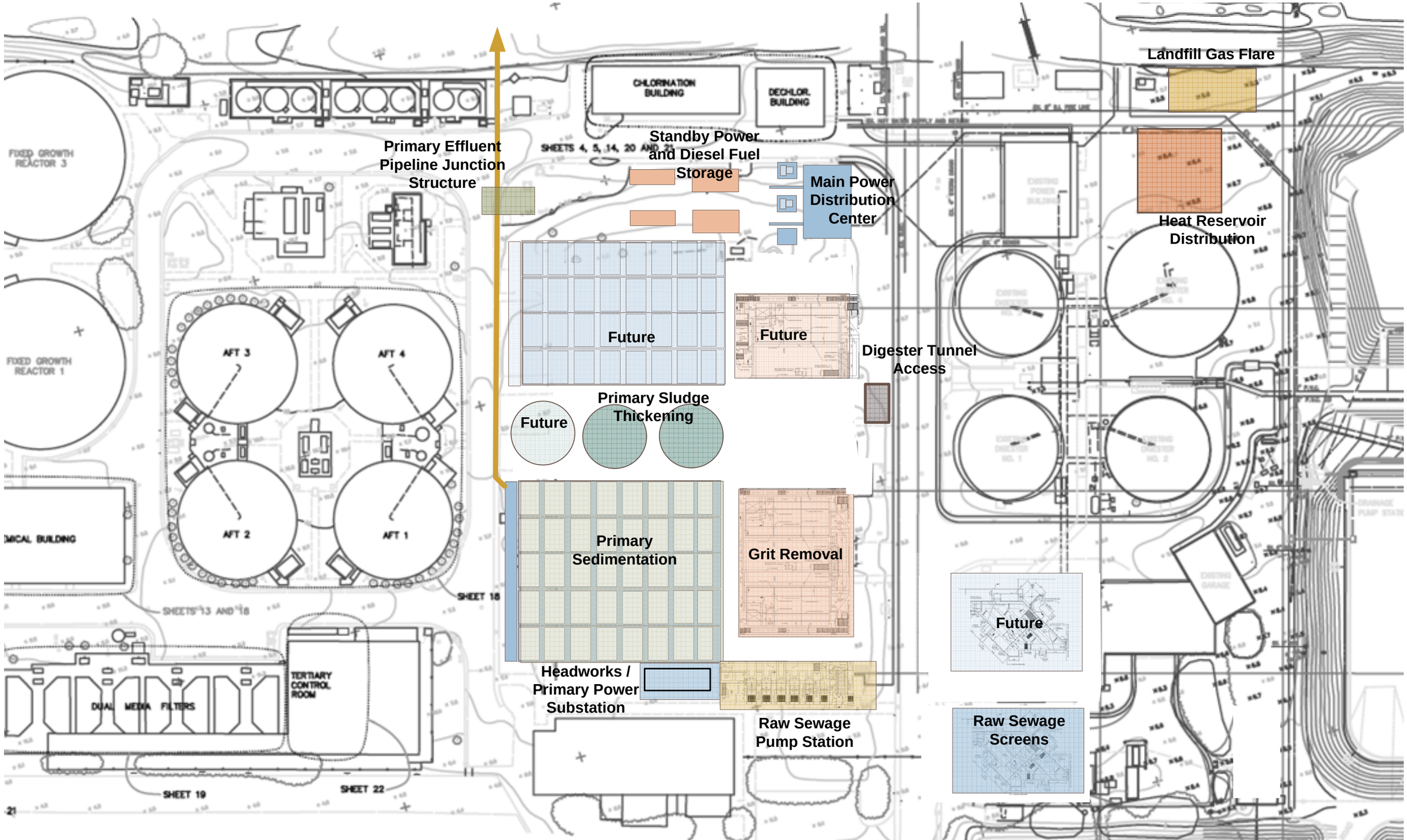
6.2 Recommendations

- Build new headworks and primary sedimentation processes with new structures at a new location in the current sludge dewatering area.
- Include a new main power distribution center along with the diesel standby power units that are required with this project.
- Build new facilities with structures that are elevated sufficiently to withstand inundation and damage during the 100 year flood event.
- Build new facilities that meet the objectives described in this document.
- Remain flexible on inclusion of primary sludge thickening process until the decision on major SIP alternatives has been made.

  Utilize Value Engineering during the design process to seek further optimization of design approaches.

APPENDIX A

CONCEPTUAL PLAN FOR EXISTING LOCATIONS ALTERNATIVE

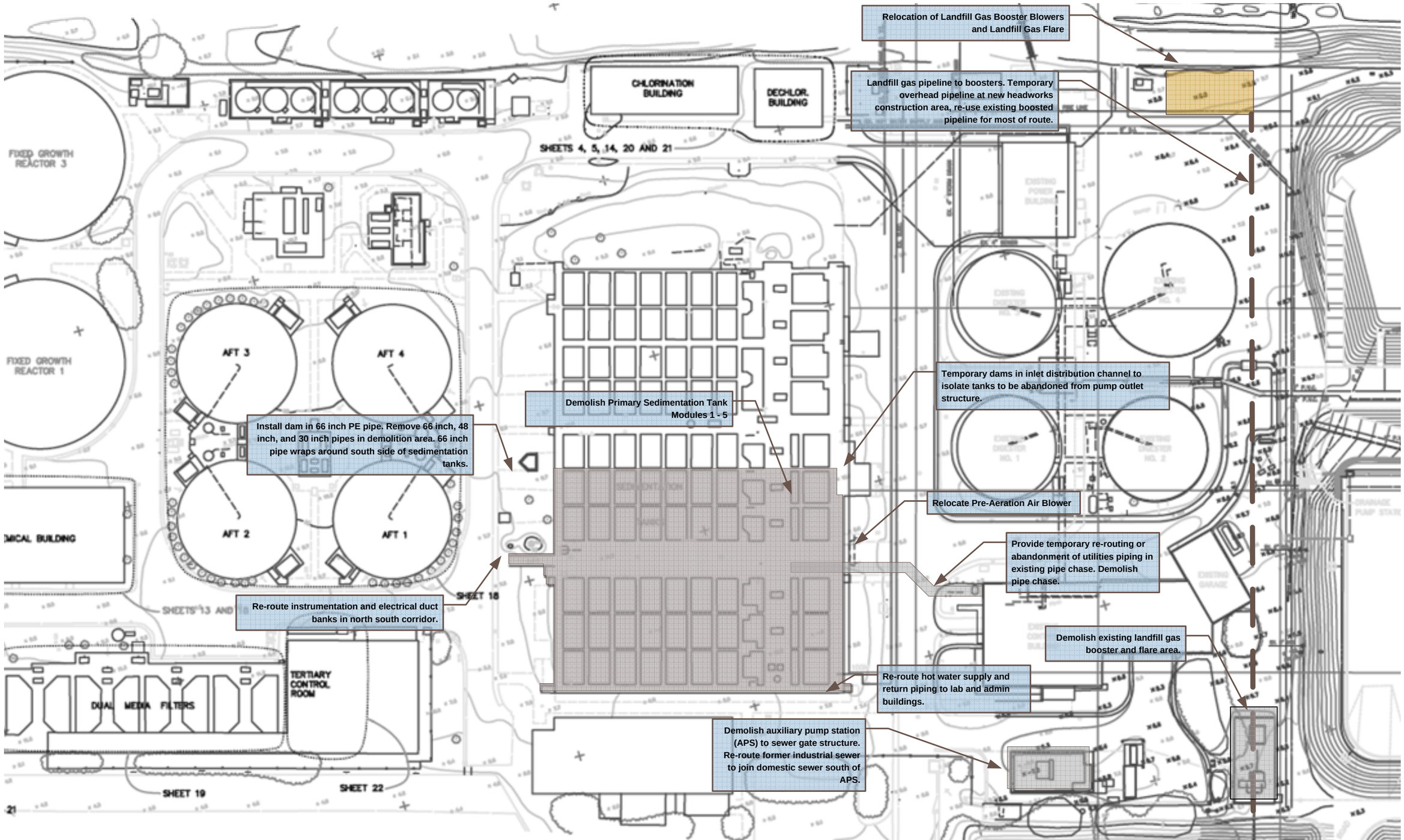


BROWN AND CALDWELL

Existing Structures / Locations – Project Layout

Sunnyvale Headworks and Primary Sedimentation Improvements

10/1/2009

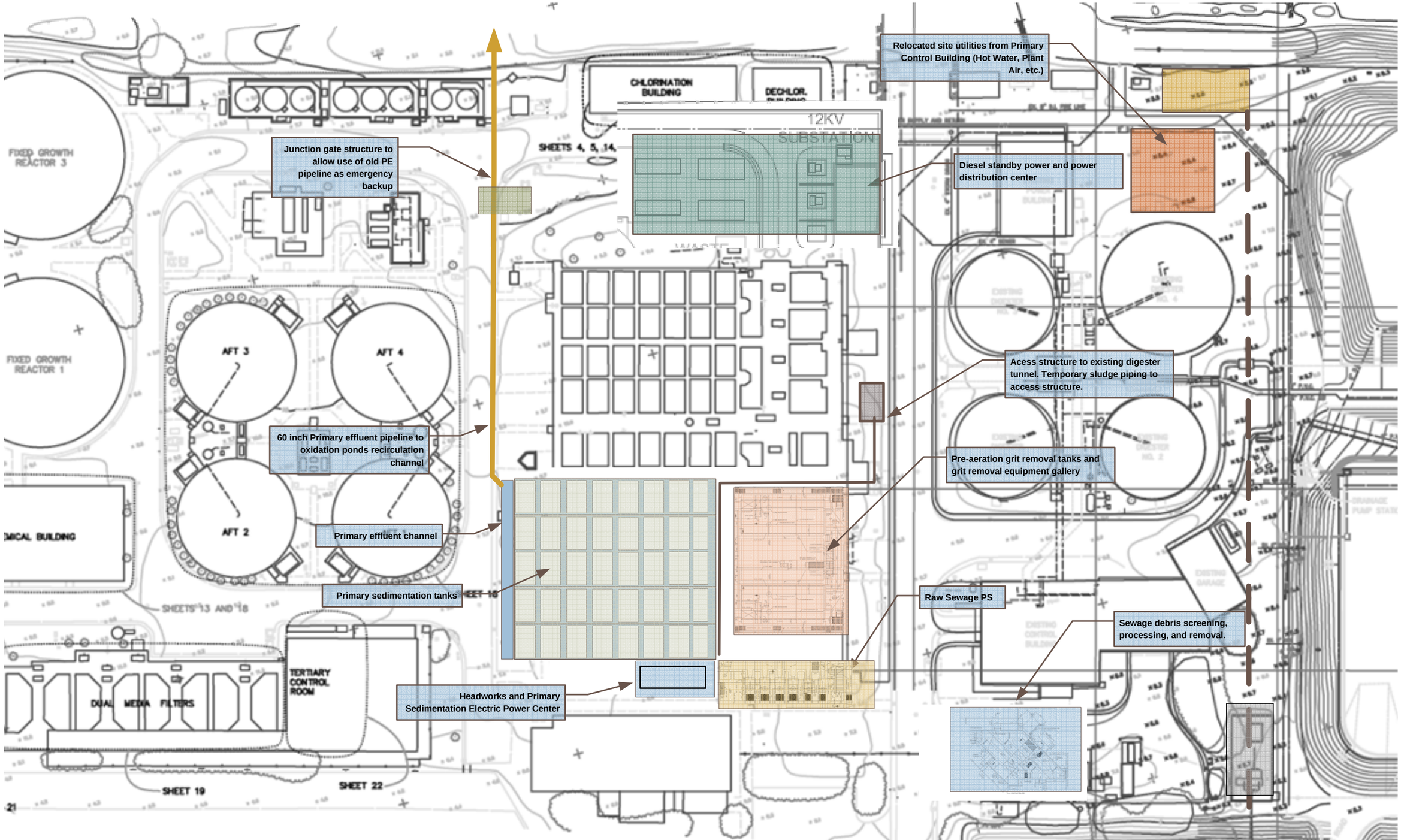


BROWN AND CALDWELL

Existing Structures / Locations – Phase 1 Demolition

Sunnyvale Headworks and Primary Sedimentation Improvements

10/1/2009

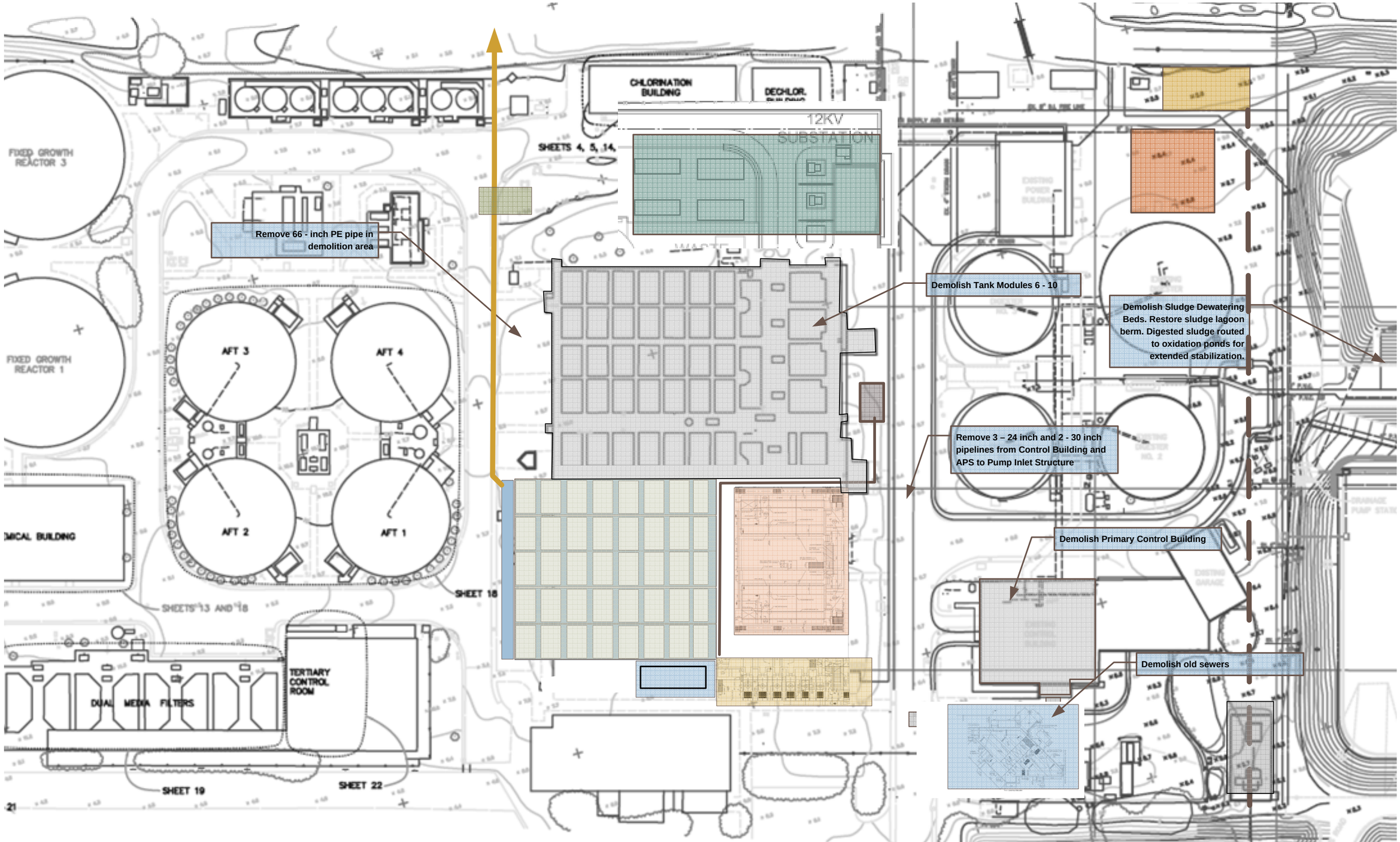


BROWN AND CALDWELL

Existing Structures / Locations – Phase 1 Construction

Sunnyvale Headworks and Primary Sedimentation Improvements

10/1/2009

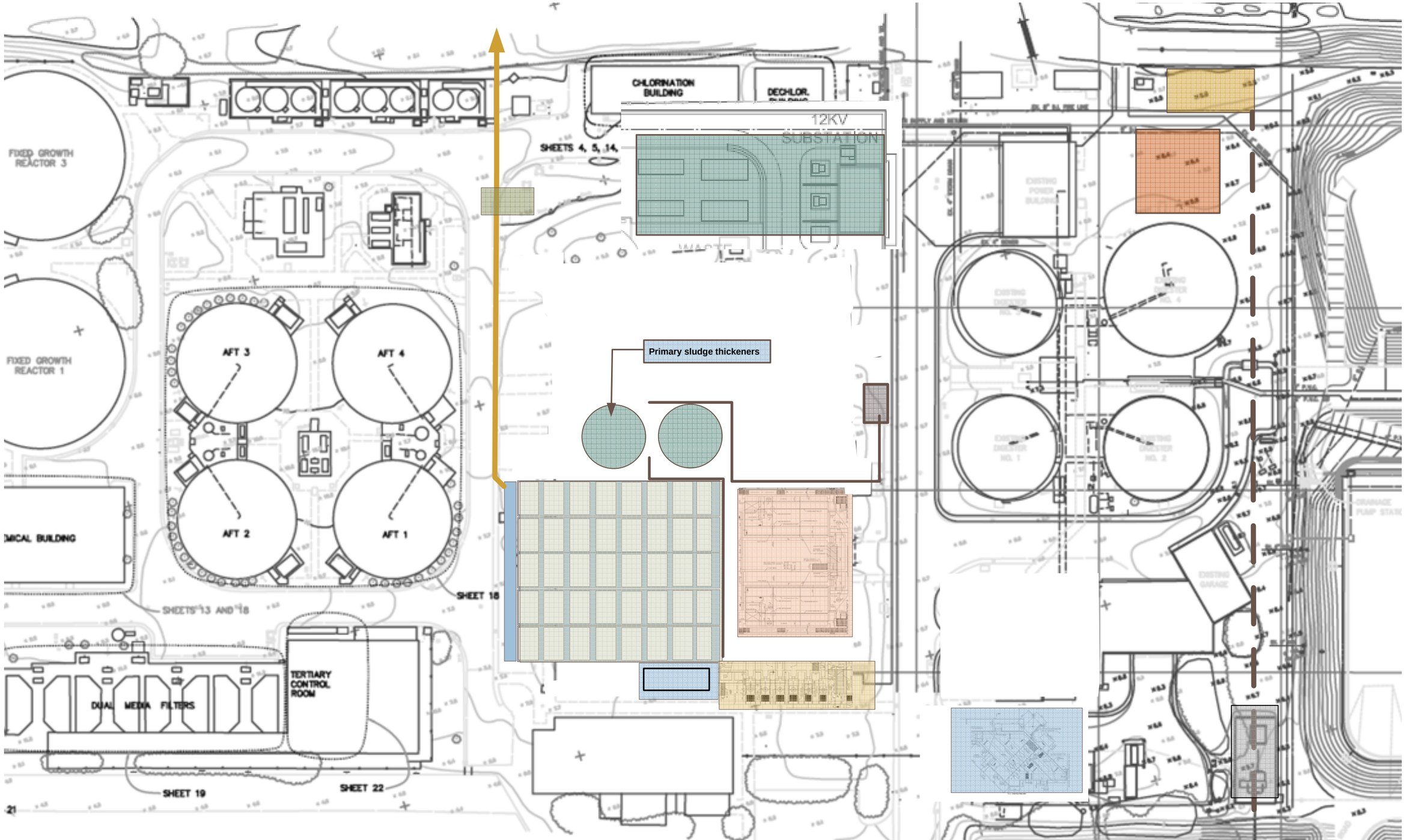


BROWN AND CALDWELL

Existing Structures / Locations – Phase 2 Demolition

Sunnyvale Headworks and Primary Sedimentation Improvements

10/1/2009

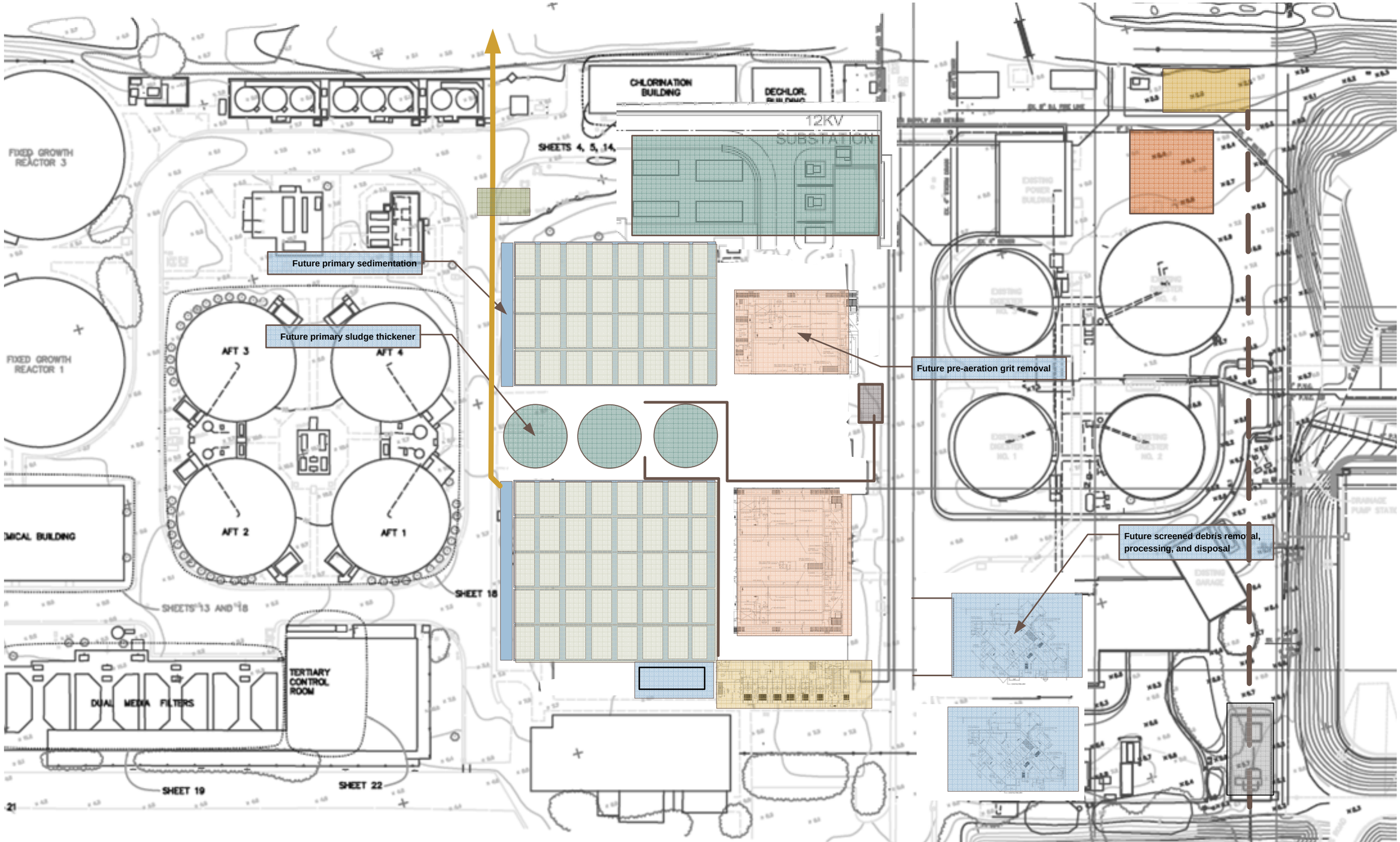


BROWN AND CALDWELL

Existing Structures / Locations – Phase 2 Construction

Sunnyvale Headworks and Primary Sedimentation Improvements

10/1/2009



BROWN AND CALDWELL

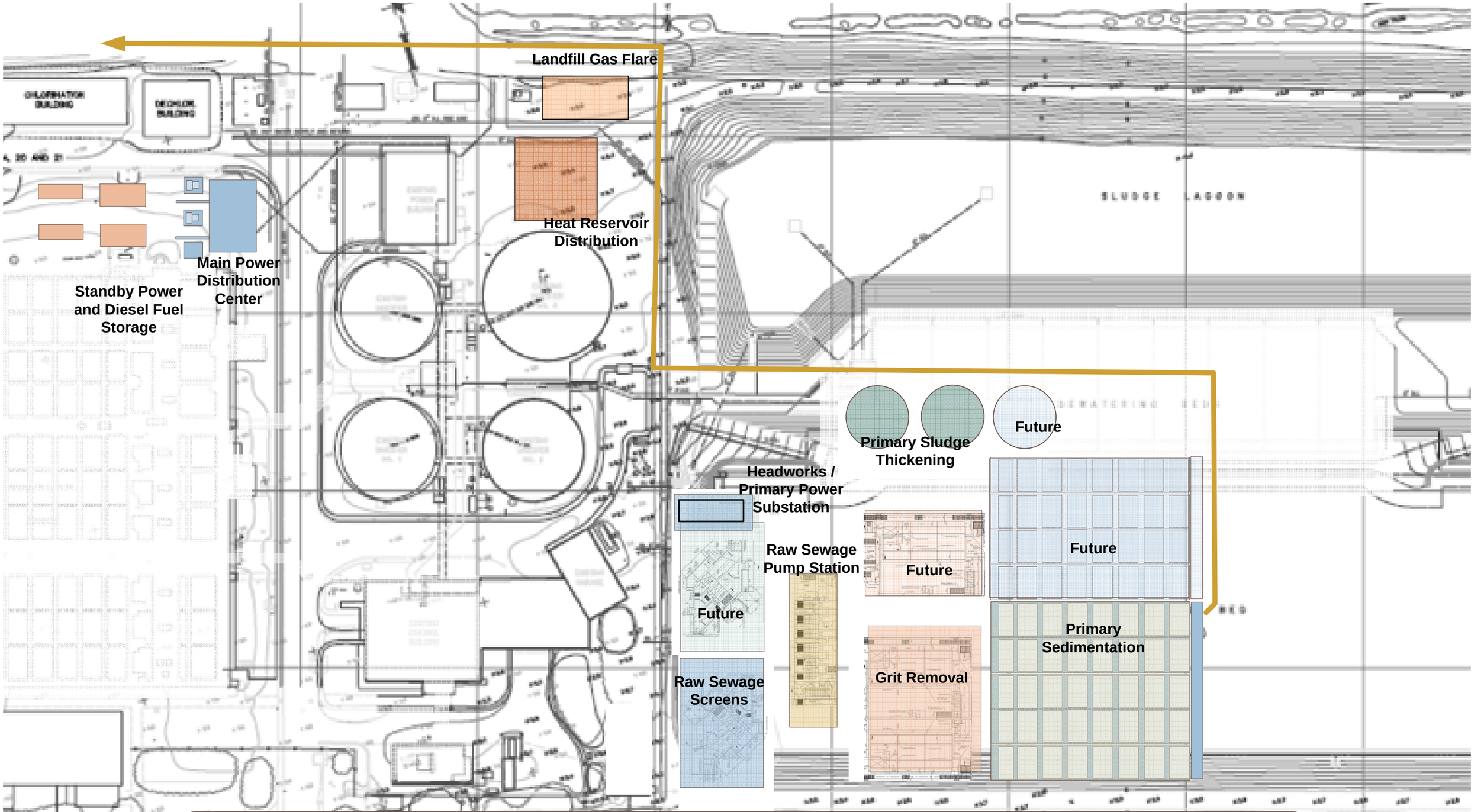
Existing Structures / Locations – Future Site Allocation

Sunnyvale Headworks and Primary Sedimentation Improvements

10/1/2009

APPENDIX B

CONCEPTUAL PLAN FOR NEW LOCATIONS ALTERNATIVE

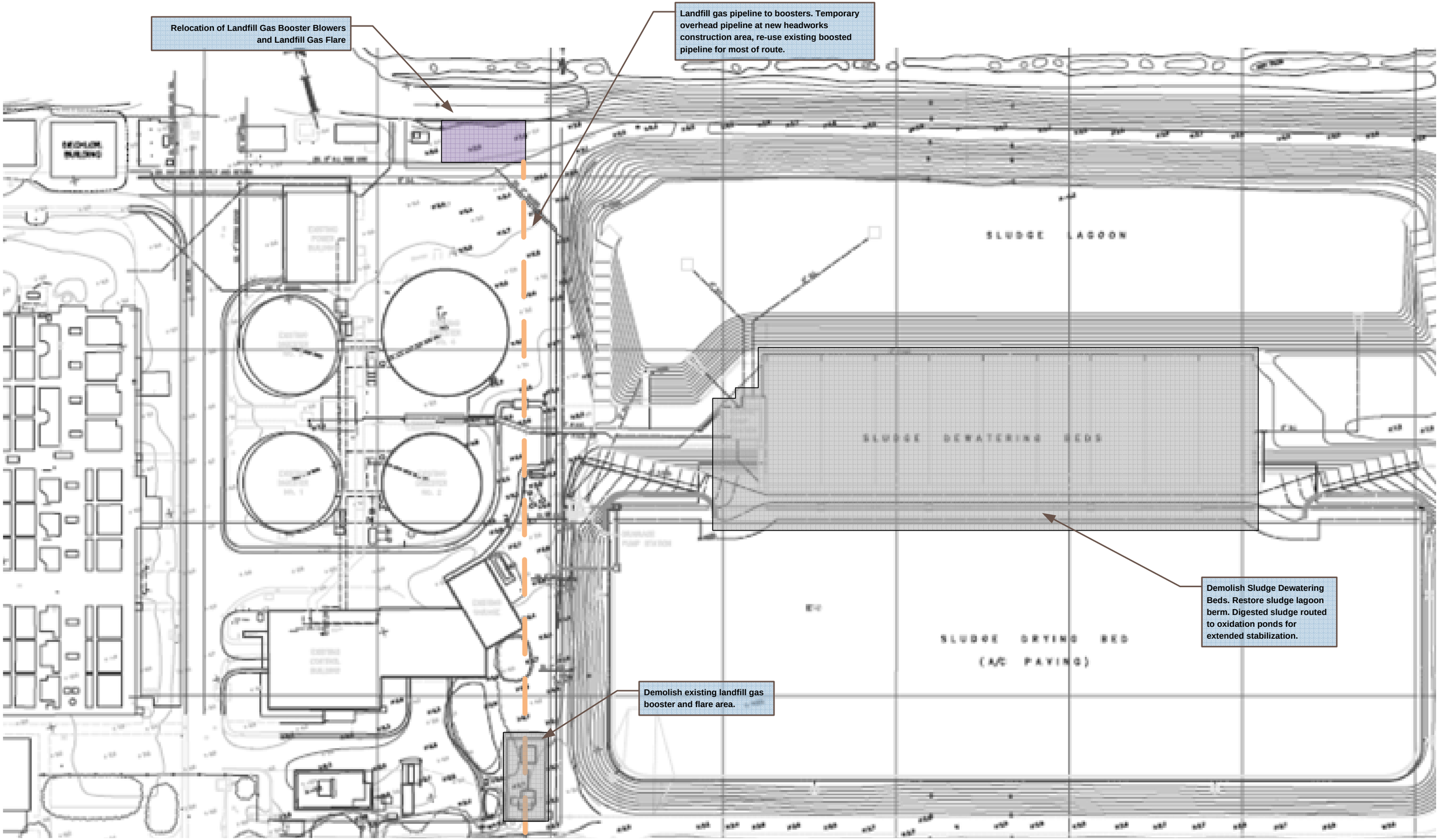


BROWN AND CALDWELL

New Locations – Project Layout

Sunnyvale Headworks and Primary Sedimentation Improvements

10/1/2009

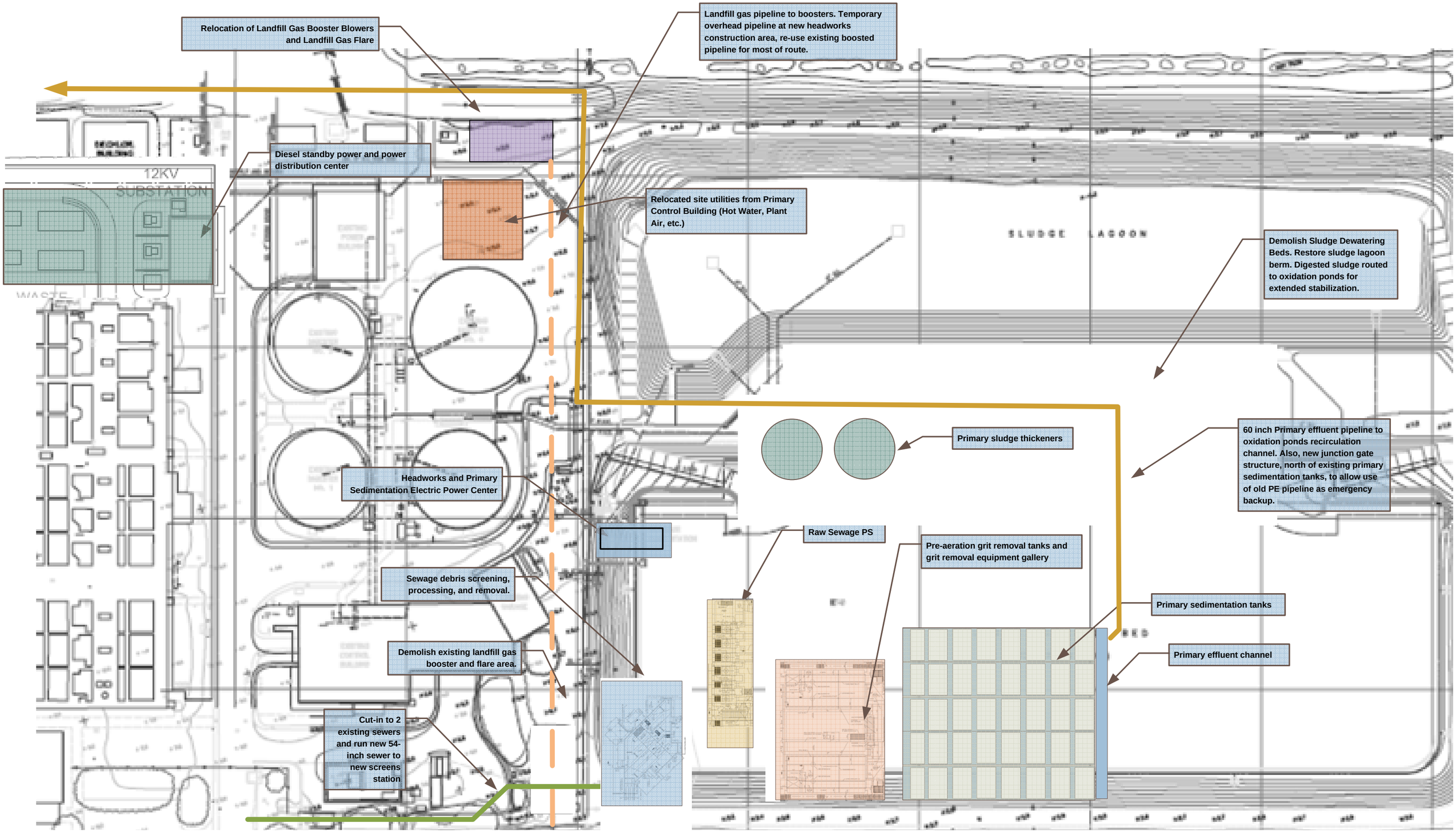


BROWN AND CALDWELL

New Locations – Phase 1 Relocations / Demolition

Sunnyvale Headworks and Primary Sedimentation Improvements

10/1/2009

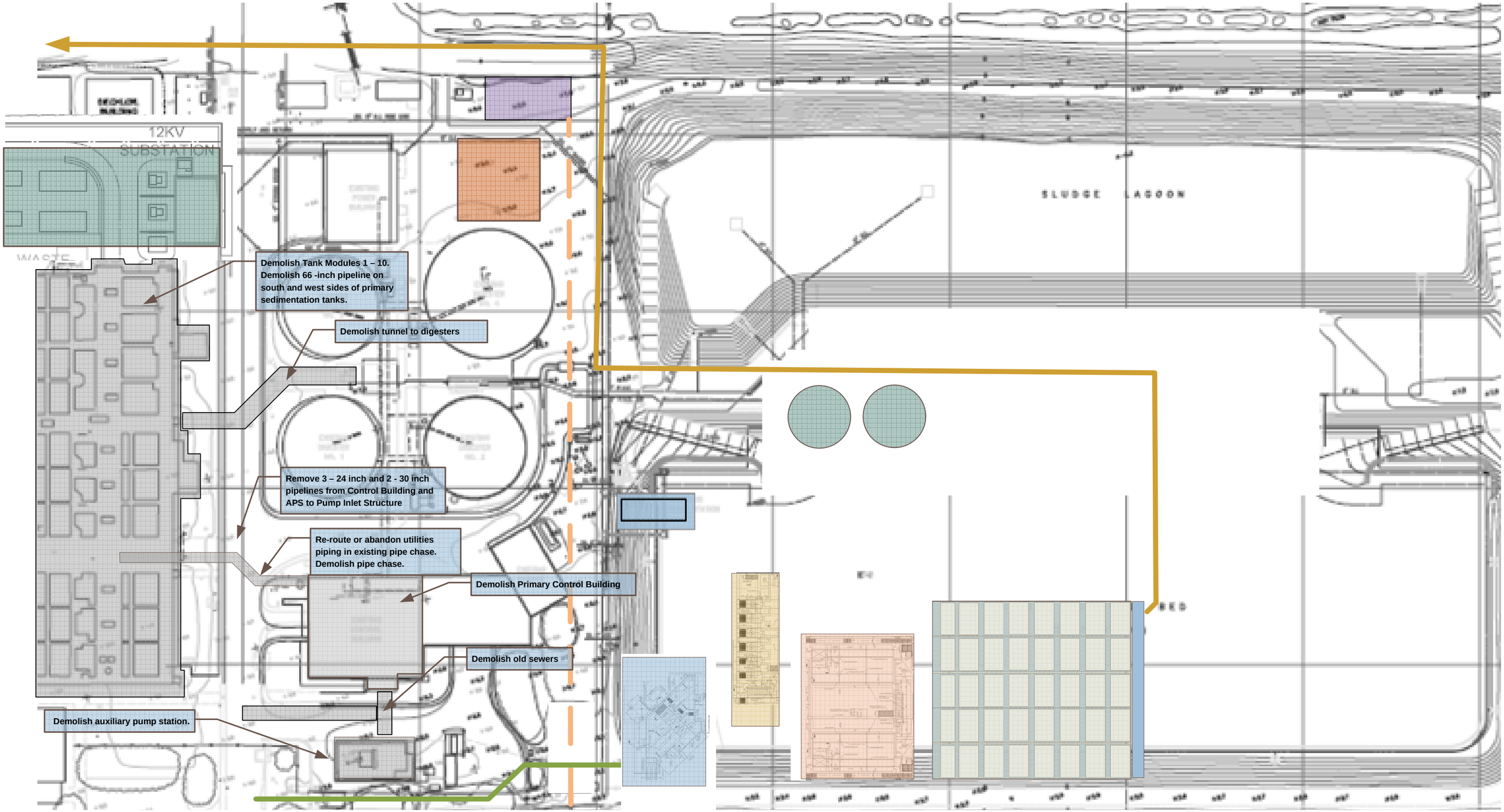


BROWN AND CALDWELL

New Locations – Phase 1 Construction

Sunnyvale Headworks and Primary Sedimentation Improvements

10/1/2009

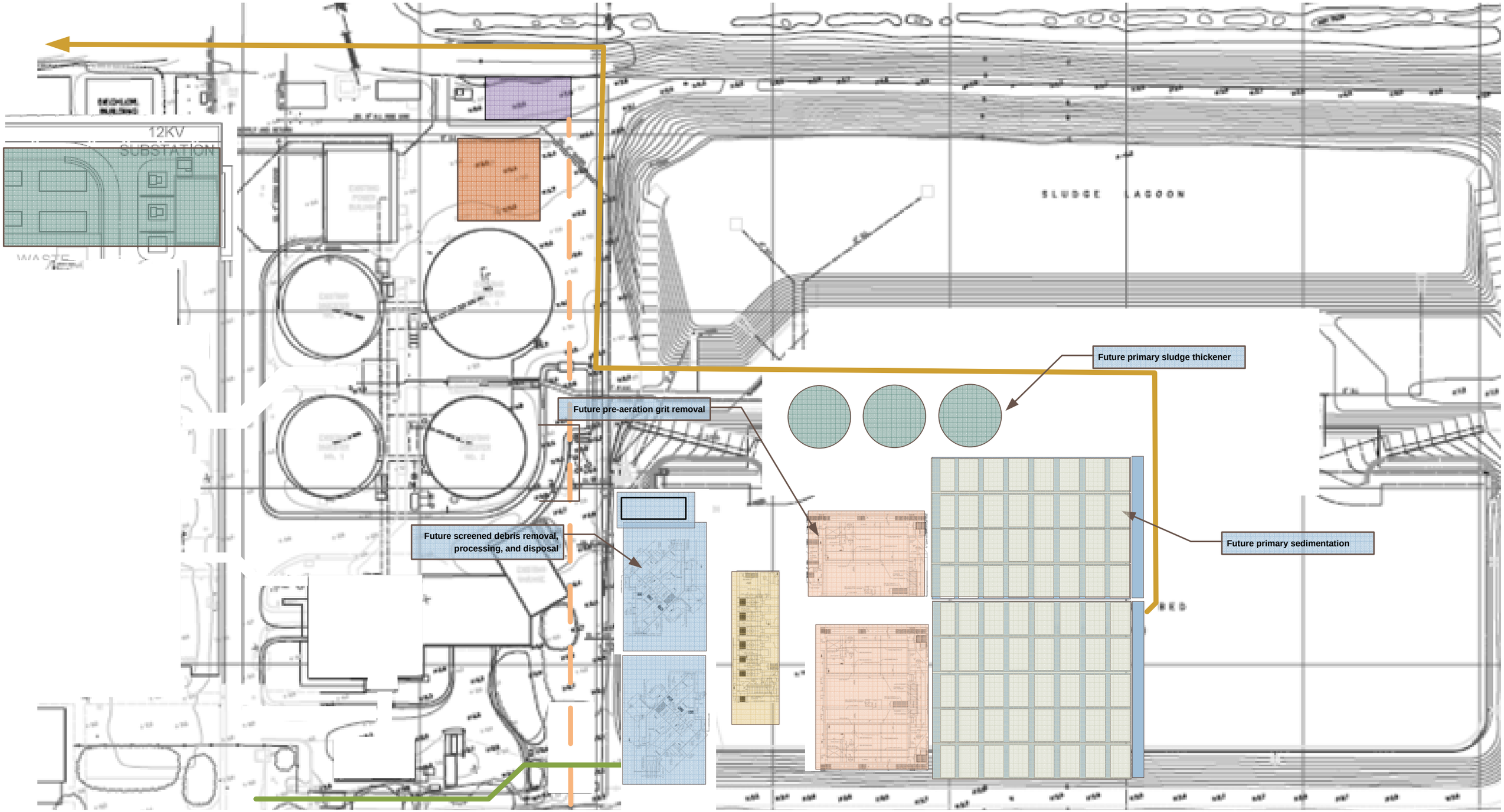


BROWN AND CALDWELL

New Locations – Phase 2 Demolition

Sunnyvale Headworks and Primary Sedimentation Improvements

10/1/2009



BROWN AND CALDWELL

New Locations – Future Site Allocation

Sunnyvale Headworks and Primary Sedimentation Improvements

10/1/2009