CITY OF TAMPA

Bob Buckhorn, Mayor **CONTRACT ADMINISTRATION DEPARTMENT**

Michael W. Chucran, Director

ADDENDUM 1

DATE: March 26, 2018

Contract 18-C-00003; David L. Tippin Water Treatment Facility Chemical System Improvements – Design-Build

Submitters on the above referenced RFQ are hereby notified that the following addendum is made to the RFQ:

Item 1: Attached is a copy of the Pre-Submission Conference sign-in sheet.

Item 2: Attached is a copy of the Pre-Submission Conference presentation.

Item 3: Attached is a copy of a chlorine study.

All other provisions of the RFQ not in conflict with this Addendum remain in full force and effect. Questions may be e-mailed to Contract Administration@tampagov.net.

Jim Greiner

Jim Greiner, P.E., Contract Management Supervisor

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CALCULATION

Project: PRE-SUBMISSION CONF
Client:
Subject: 18-C-00003 DESIGN-BUILD

Proj. No.:
Date: 3-22-18
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McKIM&CREED

DLTWTF Chemical System Improvements – RFQ 18-C-00003

DLTWTF Chemical System Improvements – RFQ 18-C-00003

- Design-Build Project Delivery
- Estimated project cost $12 million
- Submission Deadline: 4/5/2018 2:00PM
- PDF must be e-mailed to

  ContractAdministration@tampagov.net
- Design Criteria can be found here:

  https://www.tampagov.net/sites/default/files/contract-administration/files/18-c-00003rfqe.pdf

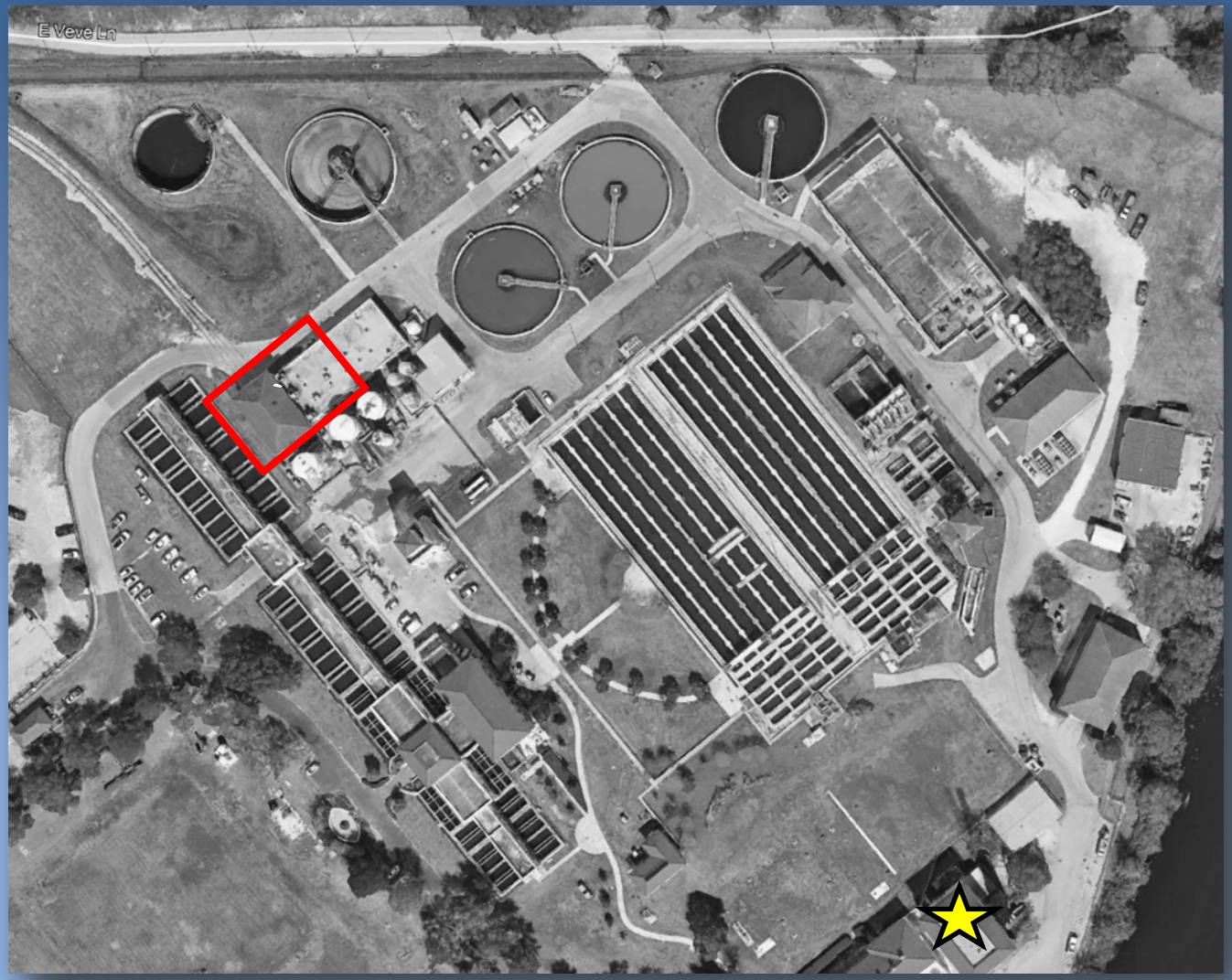
DLTWTF Chemical System Improvements – RFQ 18-C-00003

- Typically select (3) firms for presentations
- Submission scoring
  - Successful Comparable Project Experience – 40
  - Successful Comparable WTP Experience – 35
  - Workload / Availability – 5
  - Past Performance / Low Amount of City Work – 5
  - WMBE/SLE Solicitation & Utilization – 10
  - Standard Form #A305 - 5

DLTWTF Chemical System Improvements – RFQ 18-C-00003

- Sodium Hypochlorite Conversion
- Aqueous Ammonia Conversion
- Ozone Contactor Rehabilitation
- Chemical Trench Rehabilitation and Expansion

Sodium Hypochlorite Conversion

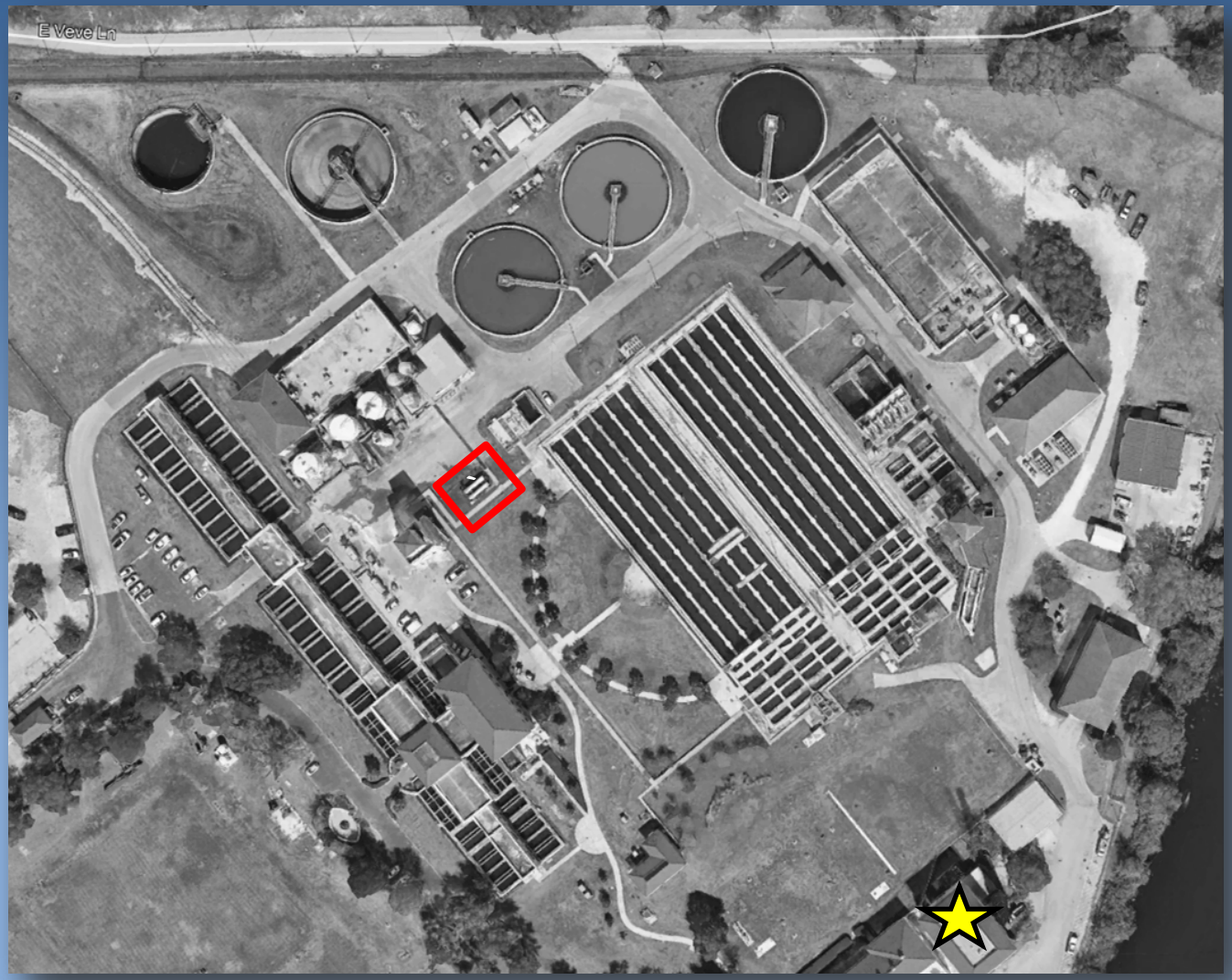


Sodium Hypochlorite Conversion

Sodium Hypochlorite Conversion

Sodium Hypochlorite Conversion

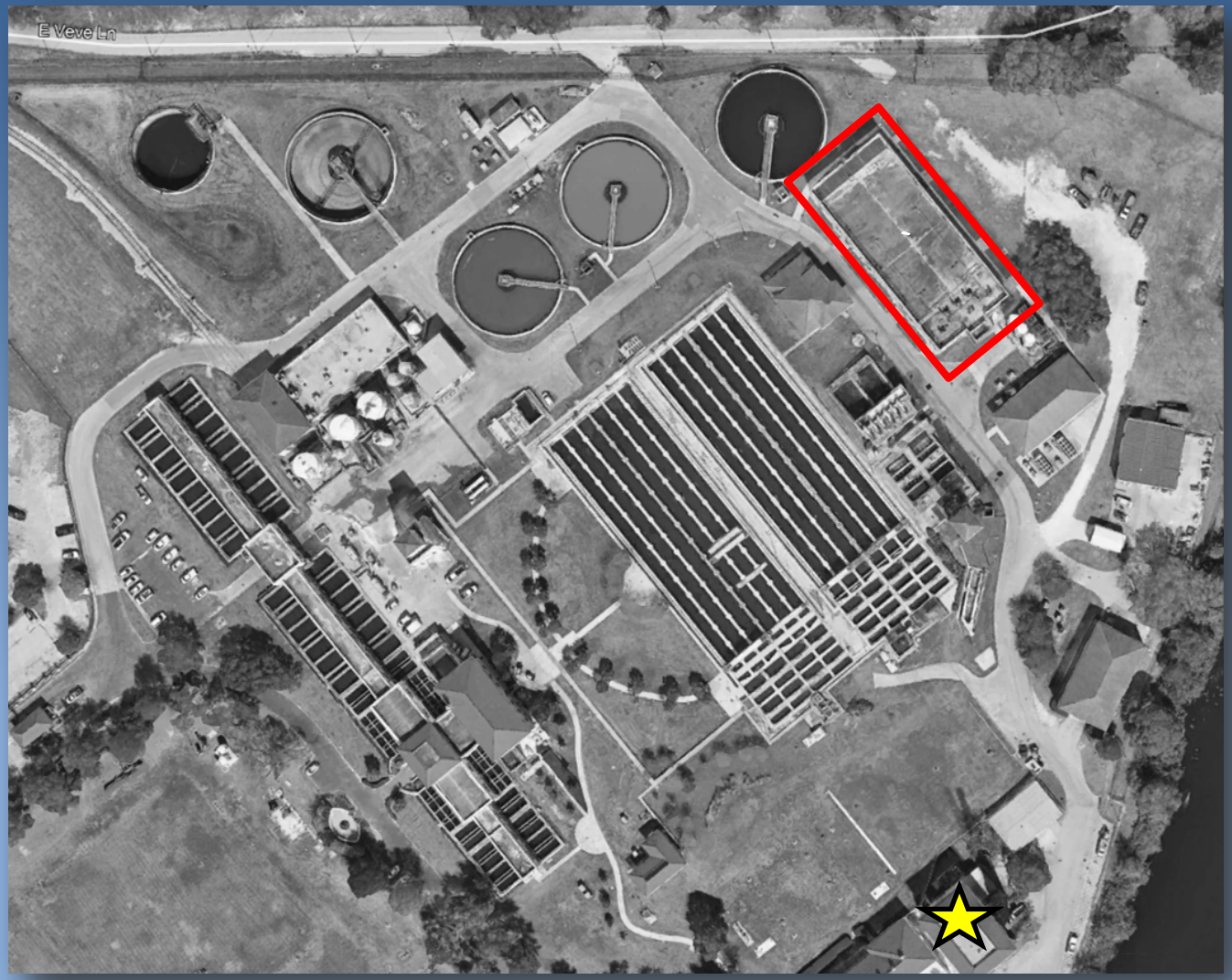
Aqueous Ammonia Conversion



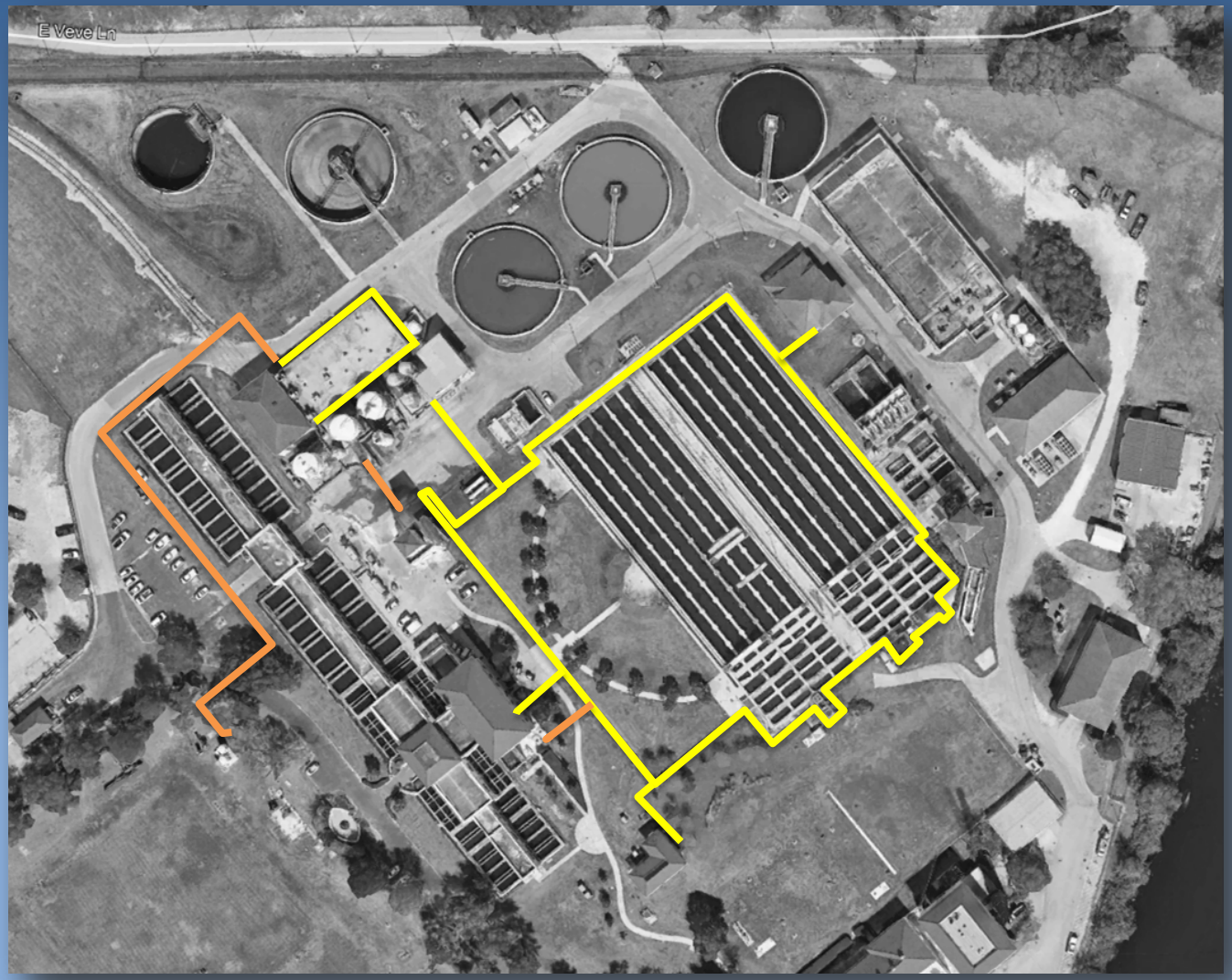
Aqueous Ammonia Conversion

Aqueous Ammonia Conversion

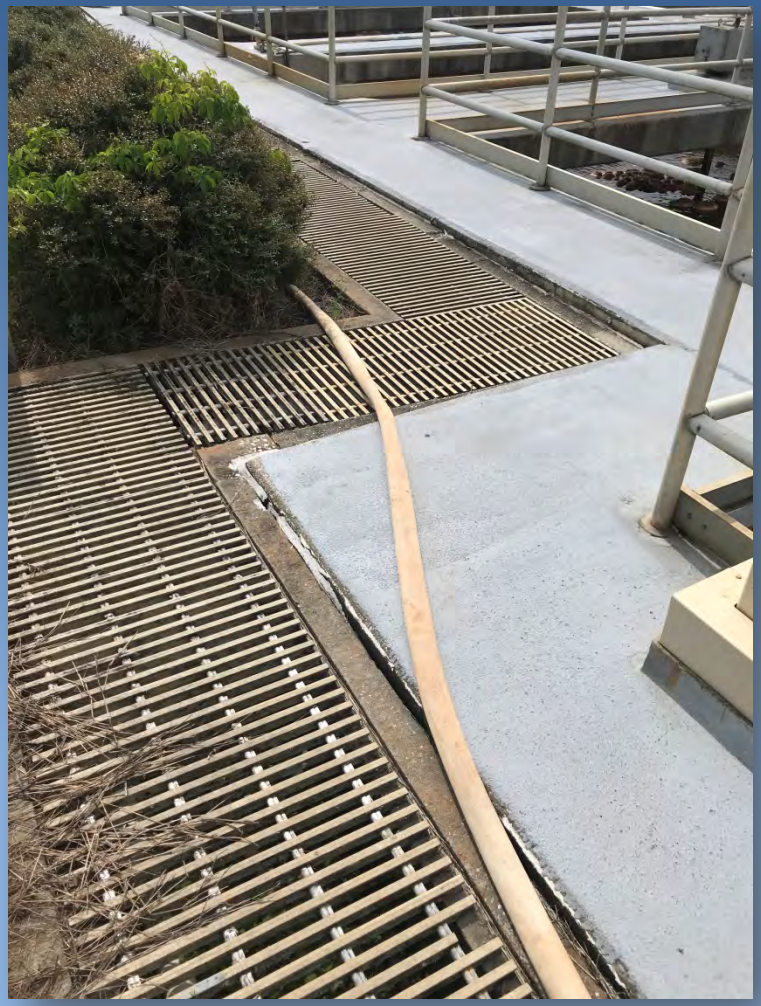
Ozone Contactor Rehabilitation



Chemical Trench Rehabilitation and Expansion



Chemical Trench Rehabilitation and Expansion



Chemical Trench Rehabilitation and Expansion

Key Points and Concerns

- Safety
- We do not want to pursue bulk storage
- High Strength vs. Low Strength
- Industrial Plant within a Plant
- Construction sequencing; Plant needs to stay operational 365/24/7
- Keep railroad
- Utilize existing building as much as possible; not opposed to expansion if necessary
- Will require 3D AutoCAD plans / as-builts

Questions?

This document is released for the purpose of information exchange review and planning only under the authority of Larry E. Elliott February 22, 2017, Florida PE No. 65224.

CITY OF TAMPA

DAVID L. TIPPIN WATER TREATMENT FACILITY MASTER PLAN

TECHNICAL MEMORANDUM NO. 5A CHLORINE STORAGE AND FEED SYSTEM ALTERNATIVES EVALUATION

DRAFT
February 2017

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CITY OF TAMPA

DAVID L. TIPPIN WATER TREATMENT FACILITY MASTER PLAN

TECHNICAL MEMORANDUM
NO. 5A
CHLORINE STORAGE AND FEED SYSTEM ALTERNATIVES EVALUATION

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CHEMICAL STORAGE EVALUATION

1.0 INTRODUCTION

The purpose of this Technical Memorandum (TM) is to present the options regarding increased safety and security surrounding the existing 90-ton chlorine rail car storage and feed system located at the David L. Tippin Water Treatment Facility (DLTWTF). Most notably, this system is not equipped with a scrubber system to abate a leak of chlorine gas, particularly a catastrophic leak that could endanger plant staff, visitors, and the neighboring community. It is the City's desire, and the recommendation of Carollo Engineers, that the plant either be equipped with a state-of-the art scrubber system, or alternatively, the chlorination system be replaced with an on-site storage system of sodium hypochlorite (delivered in bulk to the facility), or a system capable of generating (on-site) sodium hypochlorite to be used for disinfection. These three options are noted herein as follows:

- Option A - Retain the existing 90-ton rail car storage system, along with the evaporators and chlorinators (suitable for plant flows of 140 mgd), and install a new 90-ton chlorine scrubber facility
- Option C - Replace the chlorine system in its entirety with a new sodium hypochlorite storage and feed system that relies on routine bulk delivery of sodium hypochlorite
- Option B - Replace the chlorine system in its entirety with a new on-site sodium hypochlorite generation and storage system, together with new chemical feed pumps

This TM summarizes the evaluation of each of these three options, in consideration with their costs, and provides a recommendation on the most appropriate option for the City moving forward. After review and confirmation of the selected option with the City, the costs and timing of this recommendation will be incorporated into the DLTWTF Master Plan.

2.0 BACKGROUND

2.1 Chlorine Chemical Hazard Assessment

There are a number of chemical hazard classifications and required protective measures for chlorine in the current regulations codes and standards, which are as follows:

- MSDS – Chlorine is a corrosive, poisonous, greenish-yellowish, suffocating gas which can cause burns to skin and eyes, and may be fatal if inhaled. Chlorine is typically stored under pressure as an amber colored liquid. Chlorine has a strong pungent irritating odor. Severe exposure to chlorine vapors may cause pneumonitis and pulmonary edema. Use of tepid water is recommended for flushing eyes and skin in the event a person comes in contact with chlorine. Use of dry chemical or CO_2 fire

suppression is recommended for small fires and water spray or foam for large fires; however care shall be taken to ensure that water is unable to get inside storage container. Water runoff should be contained due to potential contamination.

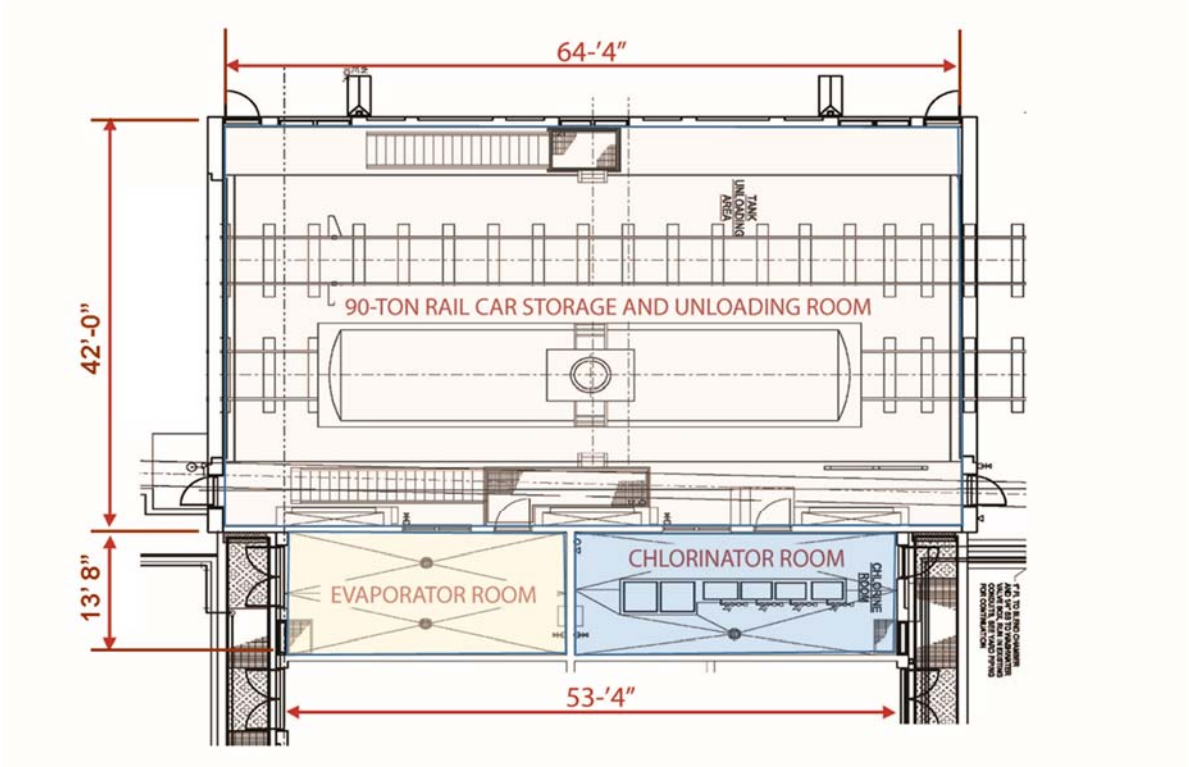
- Chlorine is listed as a regulated toxic substance by Title 40 Code of Federal Regulations (CFR) 68.130, as well as an Extremely Hazardous Substance (EHS) in Section 302 of the Emergency Planning and Community Right-to-Know Act (EPCRA).
- Chlorine is a heavier than air gas, and all ventilation control systems must be designed appropriately to capture chlorine at low points in the room where the chlorine gas can leak.
- NFPA Hazard Rating – Health Hazard – Chlorine has a Health Hazard Rating of 4 (Extreme Hazard – Highly Toxic); Fire Hazard – Chlorine has a Fire Hazard Rating of 0 (Minimal, will not burn under normal conditions).
- Building Code Rating – Chlorine is listed as a CORROSIVE and OXIDIZER chemical in the codes. Chlorine is also a TOXIC chemical per the building codes. The International Fire Code (IFC) defines a chemical as TOXIC whenever its median lethal concentration (LC 50) falls between 200 ppm and 2,000 ppm by volume of gas or vapor. Chlorine has LC50 = 293ppm (refer to MSDS) so it clearly falls within the code defined TOXIC range. Chlorine is a TOXIC chemical per the building codes.
- Other National Regulations – The national standards and regulations, such as OSHA and SARA, list chlorine as a hazardous chemical. Chlorine is listed as an extremely hazardous chemical per the SARA Title III.

Each of these regulations and standards must be taken into careful consideration when determining the most appropriate chlorine chemical storage and feed system for a facility.

2.2 Existing Storage and Feed System

Two 90-ton chlorine rail cars are housed side-by-side in the existing chlorine storage building which has a single rolling door that remains closed when rail car deliveries are not in progress. The general site layout of the chlorine building is shown in Figure 5.1A. Adjacent to the storage area is a chlorine evaporator room and a chlorinator room. Chlorine gas, which has been converted from liquid to gaseous chlorine (under pressure) via the evaporators, is in turn converted from a pressured gas to gas under vacuum using vacuum regulating valves before it enters the chlorinator room. As such, the areas that would require scrubbing would include the 90-ton rail car storage area as well as the evaporator room.

Currently, in the event of a leak, automated shut off valves on the feed lines from the rail car close via a signal from the leak detector(s) and the ventilation fan is turned off in order to contain a leak. This system is not adequate in ensuring the protection of plant staff in the event of a leak.



GENERAL SITE LAYOUT OF EXISTING CHLORINE BUILDING

FIGURE 5.1A

CITY OF TAMPA
DAVID L. TIPPIN MASTER PLAN

pw:\\Carollo/Documents\Client/FL/Tampa/10194A00/Deliverables/TM05\Figure 5.1A

3.0 CHLORINE STORAGE AND FEED SYSTEM ALTERNATIVES

3.1 Option A - Chlorine Scrubber System

The DLTWTF follows the Florida Fire Prevention Code (FFPC) and the National Fire Protection Association (NFPA) where, under the NFPA 55: Compressed Gases and Cryogenic Fluids Code, Section 7.9.3.3, is it required to have a system capable of the following:

- Treatment system capable of handling the maximum anticipated pressure of release.
- Treatment system capable of reducing the allowable discharge concentrations to one-half the immediately dangerous to Life or Health (IDLH) threshold at the point of discharge (10 ppm for Chlorine).
- Treatment system sized to process maximum worst case release of gas based on the maximum flow rate of release from the largest vessel.

The chlorine scrubber would be designed to handle a gaseous chlorine leak rate of 15,000 lbs/hr from the excess flow valve on the rail car and will operate at a ventilation rate of 5,000 cfm. A ventilation rate of 5,000 cfm is a standard rate among major equipment manufacturers and would provide a negative pressure in the room being scrubbed. The chlorine scrubber system would serve the chlorine storage room and the evaporator room.

When a chlorine leak is detected by the leak detector(s), motorized louvers would automatically shut to prevent chlorine from leaving the building. The scrubber system exhaust fan will then initiate, creating the negative pressure required to draw chlorine from the chlorine storage and evaporator rooms through the ventilation duct. Contaminated air would enter the scrubber unit where the recirculation pumps will provide caustic from the caustic storage tanks. The chlorine in the contaminated air would chemically react with the caustic and become neutralized. The system will continue to operate until chlorine is no longer detected by the detector.

Aqueous sodium hydroxide (NaOH), or caustic, solutions are typically manufactured at 50 percent and 70 percent concentrations. However, concentrations used for scrubbing solutions range from 15 percent to 25 percent, with 20 percent being the most common. At this concentration, caustic solution has its lowest freezing point of -17 degree Fahrenheit (F). The freezing points at 15 percent and 20 percent solution are 4 degree F and 0 degree F respectively. Using a 20 percent solution will therefore minimize heat tracing and insulation required for the system. In addition, at concentrations above 25 percent the solution becomes more viscous and would be too hot during neutralization, and the resulting salts would not be soluble in the solution.

Caustic reacts with chlorine to produce sodium hypochlorite (NaOCl), salt (NaCl) and water (H_2O). Two moles of caustic (80 pounds) are required to neutralize each mole of Cl_2

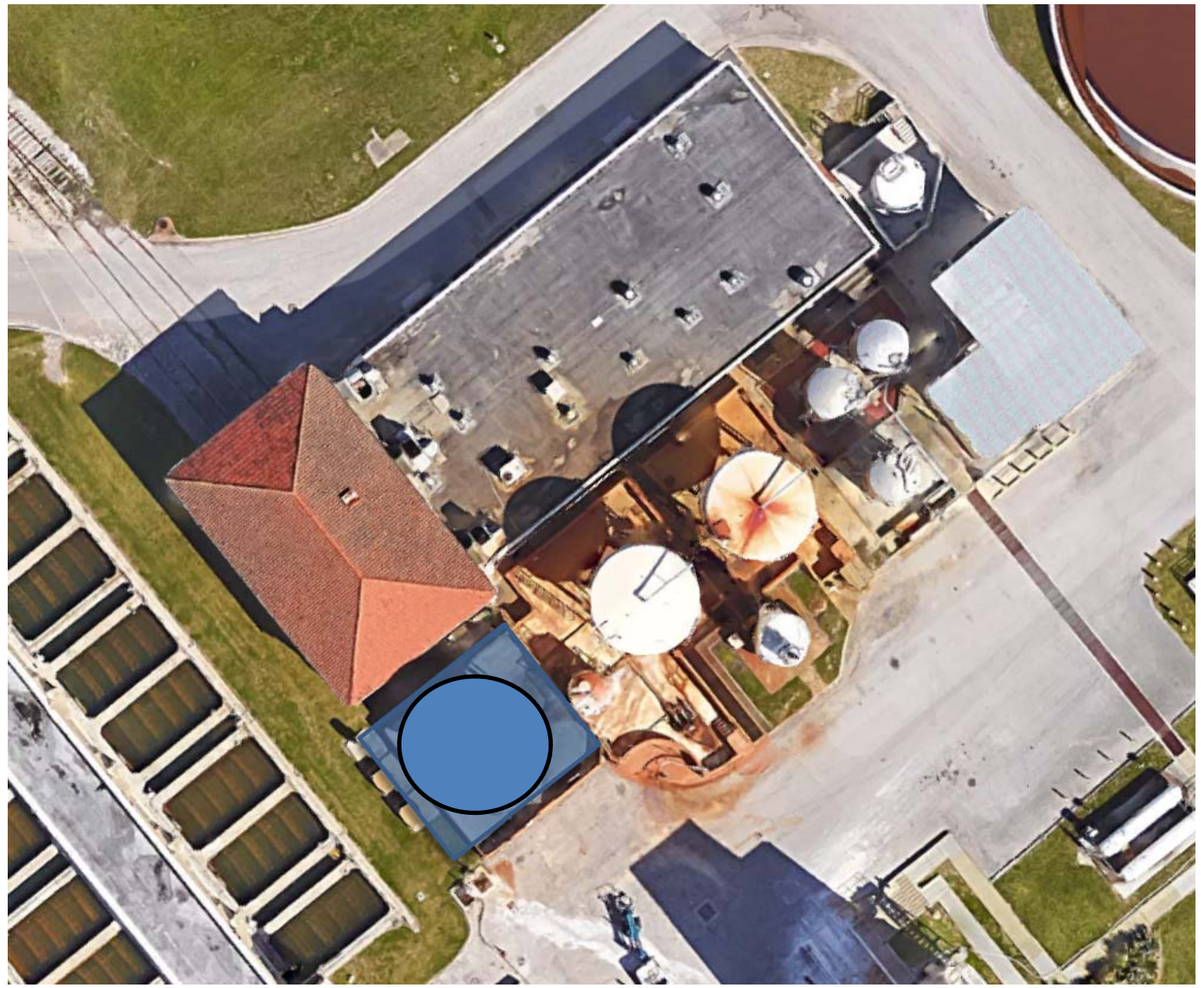
(70.9 pounds). Each gallon of 20 percent solution contains 2.04 lbs of NaOH. Additional caustic volume is provided so that the final caustic concentration will not drop below a minimum desired value of 4 percent. At concentrations lower than this, decomposition of the solution may occur, terminating the absorption of chlorine.

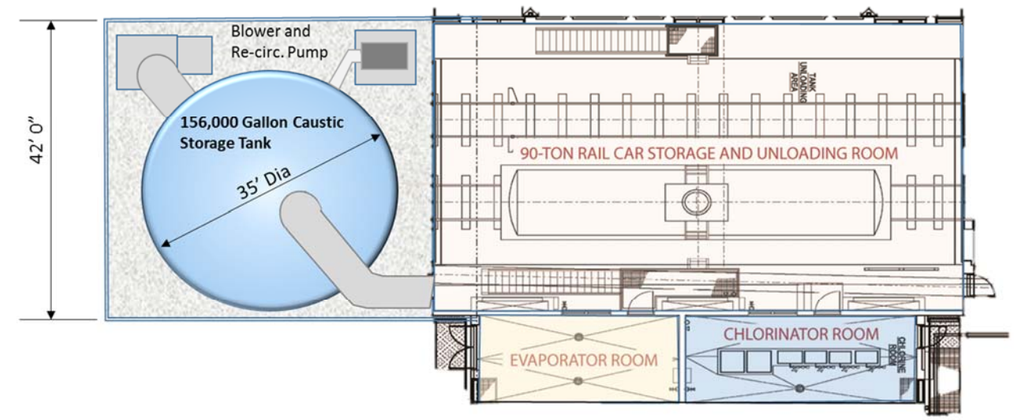
Also, excess caustic solution is typically added to the required quantity to account for fugitive leaks and for caustic depletion due to reaction with carbon dioxide (CO_2) in the atmosphere. If an adequate quantity of excess caustic is not supplied and is subsequently consumed for fugitive leaks and reaction with CO_2, the entire caustic inventory may be drained. The scrubber system would therefore be designed to hold a conservative quantity of excess caustic for the given leak event.

The scrubber system option evaluated provides for treating the entire contents of either rail car (90 tons) with ample caustic that is stored in a single tank and equipped with a recirculation pump and a blower. The tank would need to store approximately 156,600 gallons of 20 percent caustic to be stored in one storage tank, with the option to mount the scrubber unit on top of the tank or adjacent to the tank. Both mounting options are depicted in Figure 5.2A. The storage tank would be 35 ft in diameter and 22 ft tall. It should be noted that the size of the scrubber unit itself, 5,000 cfm, is the same whether caustic is stored in a single tank or multiple tanks. The decision to use multiple tanks versus one tank comes with inherent advantages and disadvantages related to system flexibility, handling and replacing spent or degraded caustic, and cost. This type of decision should be part of a more detailed preliminary design study should this option be implemented.

The proposed location of the scrubber is also shown in Figure 5.2A, and assumes that continued use of other chemicals in the area of the chemical building (lime, sulfuric acid, and sodium hydroxide) will be maintained (or increased in volume due to capacity expansion) in keeping with the concept of enhanced coagulation treatment. In the scenario shown, one of the ferric sulfate tanks would need to be relocated or replaced in an alternate location to avoid long runs and road crossings of duct from the building to the new caustic tank.

Should an alternate treatment method (other than enhanced coagulation) be adopted as part of this Master Plan, then the area now used for the bulk of these chemicals could be repurposed for the caustic storage for the scrubber system (Option A), or perhaps for sodium hypochlorite storage associated with Options B and C.





OPTION A MOUNTING OPTION AND PROPOSED LAYOUT

FIGURE 5.2A

CITY OF TAMPA
DAVID L. TIPPIN MASTER PLAN

carollo

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3.1.1 Option A - Advantages and Disadvantages

The major drawback of the scrubber system is the need to maintain high volumes of caustic soda which has a limited shelf life and represents a chemical that is hazardous in and of itself, albeit it is a chemical plant staff are accustomed to handling given the plant's current treatment process that uses caustic as one of the two chemicals for pH adjustment. A second concern is the need to exercise the equipment regularly to ensure its reliability and functionality and the likelihood that this system would need a reliable source of backup power.

The obvious single advantage of the system is the chemical costs are far less than purchasing bulk sodium hypochlorite (Option B). A second advantage (over Option C) is that it is simpler to operate than an on-site sodium hypochlorite generation system.

3.1.2 Option A - Capital and Operating Costs

The estimated capital costs for a 90-ton chlorine scrubber system, as well as the average annual operating and maintenance (O&M) costs for chlorine and maintaining a fresh supply of caustic soda, is shown on Table 5.1A

Table 5.1A Option A Capital and Operating Costs
David L. Tippin Water Treatment Facility Master Plan
City of Tampa

Item	Capital Costs (x 1,000)	Annual O&M Costs (x 1,000)	Total Present Worth Costs (x 1,000)
Chlorine Scrubber System (includes installation)	$1,850	$50	$2,594
Electrical & Instrumentation	$225	$0	$225
Structural (tank foundation, spill containment)	$200		$200
Replacement Ferric Sulfate Tank	$80	$0	$80
Annual Costs (Chlorine)	$0	$485	$7,214
Demurrage on Rail Cars/Track Maintenance (??)	$0	$0	$0
Annual Costs for Refreshed Caustic Soda	$0	$162	$2,414
Contingency and Contractor Overhead and Profit	$470	$0	$470
Total	**$2,825**	**$697**	**$13,197**

3.2 Option B - On-Site Storage of Sodium Hypochlorite

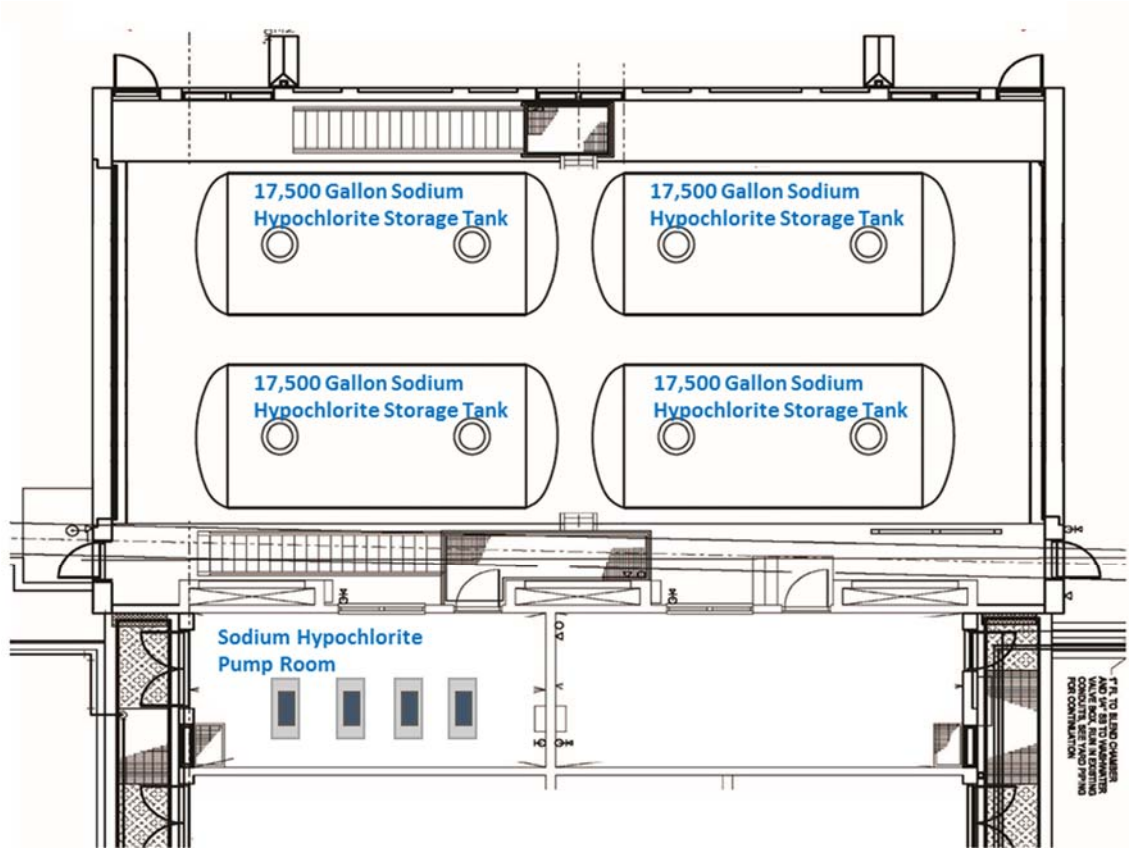
The option to purchase sodium hypochlorite in bulk and have regular deliveries to the plant is common in the industry, particularly for smaller treatment plants. Should this option be implemented, the sodium hypochlorite tanks could be located in the existing rail car storage facility, and the existing chlorinator and/or evaporator room converted to a pump room for the chemical feed pumps associated with this system. A conceptual layout of this option is shown on Figure 5.3A.

This option depicts four 17,500 gallon storage tanks in the location where the 90-ton rail cars now reside. This volume of storage (70,000 gallons) would provide approximately 12 days of available storage at 140 mgd using an average chlorine dosage of 6.5 mg/l and a 12.5 percent solution of sodium hypochlorite. The storage times at 2027 average plant flow rates (mid-point of 20-year life cycle) would be approximately 19 days.

3.2.1 Option B - Advantages and Disadvantages

The advantages of this option rest largely with its simplicity and improved safety from the standpoint of leaks of chlorine gas, although storing and feeding sodium hydroxide still must be approached with extreme caution as this chemical is hazardous, particularly at 12.5 percent concentration. The operation with simple feed pumps resembles many of the other types of feed systems, eliminating the two stage process with liquid chlorine where the chlorine is first vaporized with evaporators and then fed with gaseous chlorinators/injectors to the points of application.

The major disadvantage of this option is the cost of sodium hypochlorite, which increases the annual cost for disinfection as shown on the summary tables at the end of this TM.



OPTION B PROPOSED LAYOUT

FIGURE 5.3A

CITY OF TAMPA
DAVID L. TIPPIN MASTER PLAN

3.2.2 Option B - Capital and Operating Costs

The costs for a new on-site storage and feed system to accommodate bulk deliveries of sodium hypochlorite are shown in the Table 5.2A. These costs assume $0.55/gallon for bulk sodium hypochlorite, which is the actual contracted costs (plus 5 percent) that Manatee County now pays for this same chemical. Of note, this cost is much lower than most other areas of the U.S.

Table 5.2A Option B Capital and Operating Costs
David L. Tippin Water Treatment Facility Master Plan
City of Tampa

Item	Capital Costs (x 1,000)	Annual O&M Costs (x 1,000)	Total Present Worth Costs (x 1,000)
Sodium Hypochlorite Storage Tanks (includes installation)	$245	$0	$245
Sodium Hypochlorite Feed Pumps	$34	$0	$34
Chemical Building Renovation (three rooms)	$190	$0	$190
Annual Costs Sodium Hypochlorite	$0	$750	$11,162
Contingency and Contractor Overhead and Profit	$120	$0	$120
Total	**$589**	**$750**	**$11,751**

3.3 Option C - On-Site Generation of Sodium Hypochlorite (OSHG)

The option of generating sodium hypochlorite on-site is a proven technology, yet one that has had problems in the past largely due to designs that failed to properly vent the byproduct hydrogen gas from the generation system. Pockets of gas allowed to accumulate caused explosions at some installations. Some utilities, such as Palm Beach County WUD, decommissioned their on-site generation system over concerns of such an occurrence. Modern day designs however, have recognized this gas accumulation potential and incorporate provisions to properly vent this gas to the atmosphere.

Two types of systems are now commonly marketed and employed in the waterworks industry for on-site generation of sodium hypochlorite with the major difference being the concentration of sodium hypochlorite in the generated product; 12.5 percent solution or 0.8 percent solution.

3.3.1 On-Site Generation of 0.8 Percent Sodium Hypochlorite

On-site sodium hypochlorite generation involves use of salt, softened water, and electricity to generate chlorine equivalent (CE) solution on site, typically at 0.8 Solution strength of

0.8 percent is considered non-hazardous thus eliminating the need for OSHA risk management planning requirements associated with gaseous chlorine. A typical layout (sized for the DLTWTF) as offered by ClorTec® is shown in Figure 5.4A. The overall dimensions of this building are approximately 94 feet x 64 feet, or about 6,000 square feet (sq ft). The size of the existing rail car storage room, evaporator room, and chlorinator room combined is about 3,400 sq ft, slightly more than half of the needed space for the 0.8 percent solution alternative. As a result, a new on-site generation building would likely be necessary for this option.

3.3.2 On-Site Generation of 12.5 Percent Sodium Hypochlorite

Generation of high strength (12 percent) sodium hypochlorite is also an option. One example of a recent design by Carollo is the 15,000 ppd facility for Miami-Dade's new Northwest Wellfield 125 mgd (165 mgd ultimate) Nanofiltration WTP. This OSHG facility is nearly identical in size as what would be needed for the DLTWTF. Due to the additional complexity of the system (compared to the 0.8 percent option), the overall building dimensions are approximately 200 feet by 130 feet, hence, like the low strength option, a new building would be needed.

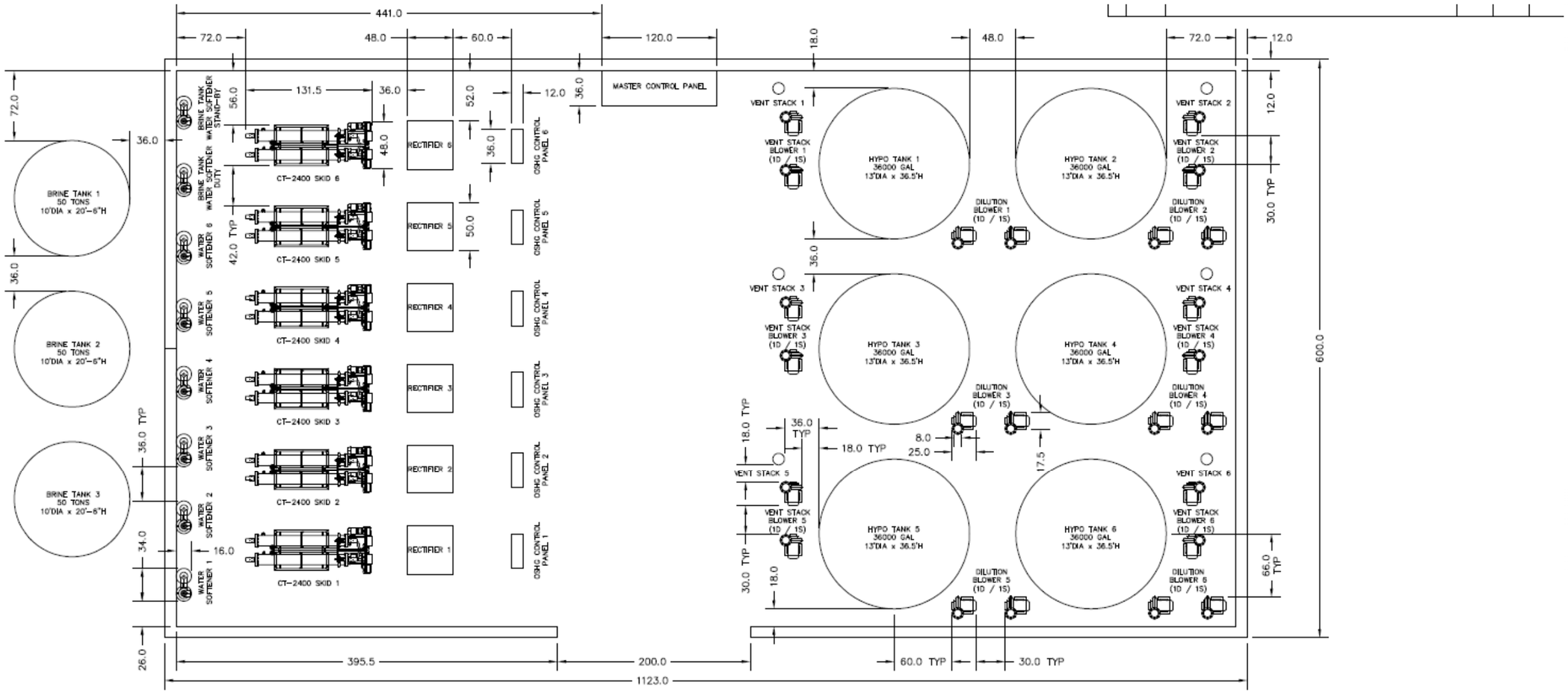
Figures 5.5A, and 5.6A are 3-D scalable drawings of this facility depicting the extensive amount of equipment and size of the building needed. Figure 5.6A depicts the building (less the roof) along with the housed equipment and tankage and one view shows predominantly the equipment without the walls, roof, and second floor slab in order to better visualize the system components.

3.3.3 Option C - Advantages and Disadvantages

Like the on-site storage of sodium hypochlorite delivered in bulk, this option also eliminates concerns regarding releases of chlorine gas from a catastrophic leak. Unlike the on-site storage option (Option B), however, the operation is not simple and both the low strength and high strength alternatives do have extensive equipment needs and require operator training and experience.

The key advantages rely almost entirely on reduced annual operating cost by eliminating the purchase of chemicals (liquid chlorine or sodium hypochlorite) in favor of the purchase of salt and electricity.

The major drawback of on-site generation is the capital cost of the equipment and building, along with the annual costs of salt and electricity.



OPTION 3 CLORTEC LAYOUT

FIGURE 5.4A

CITY OF TAMPA
DAVID L. TIPPIN MASTER PLAN

carollo

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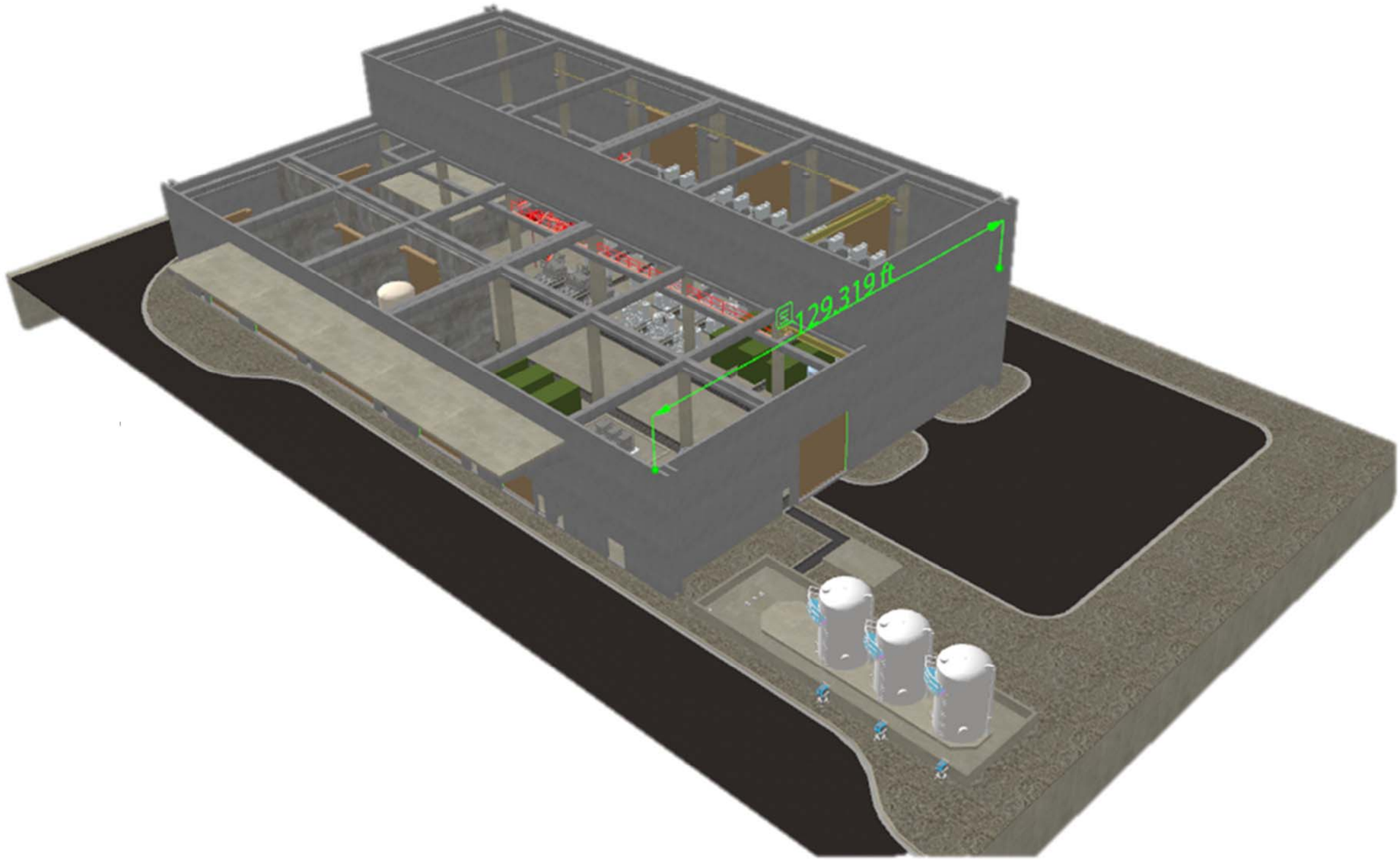

3D RENDERING OF OSHG FACILITY FOOTPRINT

FIGURE 5.5A

CITY OF TAMPA
DAVID L. TIPPIN MASTER PLAN

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3D RENDERING OF OSHG FACILITY AND EQUIPMENT

FIGURE 5.6A

CITY OF TAMPA
DAVID L. TIPPIN MASTER PLAN

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3.3.4 Option C - Capital and Operating Costs

Table 5.3A, shown below, is based largely on the less expensive 0.8 percent OSHG option. This option is somewhat less efficient than the 12.5 percent OSHG system, but comes with a lower capital cost.

Table 5.3A Option C Capital and Operating Costs
David L. Tippin Water Treatment Facility Master Plan
City of Tampa

Item	Capital Costs (x 1,000)	Annual O&M Costs (x 1,000)	Total Present Worth Costs (x 1,000)
Decommission Existing Chlorine Storage and Feed System	$300	-	$300
New On-Site Sodium Hypochlorite Generation Building	$1,200	-	$1,200
Six 2400 lbs. /day on-site sodium hypochlorite generators and associated equipment and tankage (includes installation)*	$3,640	-	$3,640
Salt Usage	-	$284	$4,231
Power Consumption	-	$279	$4,154
Sitework, Electrical & Instrumentation	$500	-	$500
Contingency and Contractor Overhead and Profit	$1,300	-	$1,300
Total	**$6,940**	**$564**	**$15,326**

4.0 SUMMARY AND RECOMMENDATIONS

4.1 Comparison of Options and Costs

The comparative capital, annual O&M, and present worth costs of the three options described in this technical memorandum are included in Table 5.4A, along with comments regarding key advantages and disadvantages of each alternative.

Table 5.4A Comparison of Options and Costs David L. Tippin Water Treatment Facility Master Plan City of Tampa				
Option & Description	**Capital Costs (x 1,000)**	**Annual O&M Costs (x 1,000)**	**Total Present Worth Costs (x 1,000)**	**Comments**
Option A - Chlorine Scrubber and Maintain the Existing Storage and Feed System	$2,825	$697	$13,197	Maintains existing method of chlorination Requires storage of large volumes of Caustic Soda that must be protected from degradation Risk of chlorine gas release still potential if the scrubber system fails or loses power
Option B - On-Site Storage of Sodium Hypochlorite (delivered in bulk)	$589	$750	$11,751	Simplest operation with bulk storage and feed pumps similar to other plant systems Price for Sod Hypo in Florida is much lower than most of the U.S. leading to concerns of future price escalation Size of tankage evaluated will require deliveries between two and three times each month
Option C - New On-Site Sodium Hypochlorite Generation System	$6,940	$564	$15,326	Most costly of all options on both capital and present worth costs; least costly on annual operating costs Most complex of all operating systems and additional O&M labor is <u>not</u> included in these costs.

4.2 Recommendations

Based on the comparative costs, operating parameters, and overall system complexities, it is recommended that the City convert to on-site storage of sodium hypochlorite. The biggest risk that could impact the cost effectiveness of this option is the cost of the delivered chemical. For example, if costs for Sodium Hypochlorite were closer to that in other areas examined as part of this evaluation (i.e., Texas) where the costs were much higher ($0.85/gallon versus $0.55/gallon), then this option would have a total present worth cost of about $17 million; an increase of about 50 percent over the value shown in the table. Thus, over the long term, the attractiveness of this alternative is almost solely dependent upon future price indices of this chemical.