City of Foster City

Lagoon Management Plan

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City of Foster City

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List of Abbreviations

APAP	Aquatic Pesticide Application Plan
Bay	San Francisco Bay
CDFW	California Department of Fish and Wildlife
Cfu	Colony forming units
City	City of Foster City
COC	Chain of Custody
DO	Dissolved Oxygen
DPR	California Department of Pesticide Regulation
E. coli	Fecal coliform
EMID	Estero Municipal Improvement District
EOA	EOA, Inc.
EST	Natural Estuarine Habitat for Fish and Migrating Birds (Beneficial Use Designation)
FEMA	Federal Emergency Management Agency
FIB	Fecal Indicator Bacteria
GM	Geometric mean
HSUS	Humane Society of the United States
IPM	Integrated Pest ivManagement
LMP	Lagoon Management Plan
MSL	Mean Sea Level
NPDES	National Pollutant Discharge Elimination System
NPS	Non-Point Source
PAA	Peroxyacetic Acid
PCA	Pest Control Adviser
Ppt	Part per thousand
QAC	Qualified Applicator Certificate
QAL	Qualified Applicator License
REC1	Water Contact Recreation (Beneficial Use Designation)
REC2	Non-Contact Water Recreation (Beneficial Use Designation)
RWQCB	Regional Water Quality Control Board
SCP	Sodium Carbonate Peroxyhydrate
STV	Statistical Threshold Value
SWRCB	State Water Resources Control Board
USFWS	U.S. Fish and Wildlife Service
WILD	Wildlife Habitat (Beneficial Use Designation)
WQO	Water Quality Objective

Limitations

The services used to prepare this document were performed consistent with our agreement with Waterworks Industries, Inc. for the City of Foster City and were rendered in a manner consistent with generally accepted professional consulting principles and practices using the level of care and skill ordinarily exercised by other professional consultants under similar circumstances at the same time the services were performed. No warranty, express or implied, is included. This document is solely for the use of our client unless otherwise noted. Any use or reliance on this document by a third party is at such party's sole risk and such party agrees to indemnify and defend Blankinship & Associates.

1 Introduction

Foster City Lagoon is a man-made estuary that follows the shape of earlier sloughs in the area, located in the middle of the City of Foster City (City), in San Mateo County, California (**Figure 1**). Completed in 1971, its sources of water are South San Francisco Bay and the Belmont Slough watershed (via Belmont Slough) and storm water runoff from the City's storm drainage system. The lagoon serves as a floodwater detention basin and a recreation site, and seasonally experiences problems with excessive aquatic weed growth, algae blooms, and excessively high bacteria levels which prevent or diminish recreational use. Investigative studies have previously been conducted, and several management approaches have been tried with little or no success relative to bacteria. Algae and aquatic weed growth are occasional nuisances that are actively addressed by City staff using Integrated Pest Management (IPM).

1.1 Purpose

The purpose of this Lagoon Management Plan (LMP) is to provide a comprehensive document that will guide the management and operation of the lagoon. The first and primary objective and goal of this LMP is to direct the management of the lagoon in a manner that preserves the lagoon's beneficial uses, while reducing reliance on chemical treatment of the lagoon's waters to control aquatic weeds, algae, and bacteria. The second objective of this LMP is to function as a working document that can be readily referred to and understood by City Staff and serve as a guide for implementation of management activities.

Historically, the LMP served as the City's plan document to allow for the application of algaecides or aquatic herbicides during the 1980's and 1990's prior to the adoption of the previous and current Statewide General National Pollutant Discharge Elimination System (NPDES) Permit for Residual Aquatic Pesticide Discharges to Waters of the United States from Algae and Aquatic Weed Control Applications (Water Quality Order 2013-0002-DWQ) (herein referred to as "Aquatic Weed NPDES Permit") by the State Water Resources Control Board (SWRCB). In June 2022, the City submitted an Aquatic Pesticide Application Plan (APAP) and Notice of Intent to comply with the current Aquatic Weed NPDES Permit. The City's APAP describes how permit compliance will be achieved through the application of IPM, water quality monitoring and reporting, and various algae and widgeongrass best management practices. The APAP focuses on algae and aquatic vegetation management and permit compliance; the LMP includes additional details about fecal indicator bacteria (FIB), potential source management and routine water quality monitoring City staff will conduct.

In June of 2020 one of the lagoon beaches (Erckenbrack Park), was listed on the 2019-2020 Beach Bummer List that is included in the Heal the Bay annual Beach Report Card (Ginger 2021). The Beach Bummer List names the ten (10) beaches along the West Coast, from Washington to Mexico, with the poorest water quality based on three types of fecal indicator bacteria (FIB): total coliform, fecal coliform (*E. coli*), and Enterococcus species (Ginger 2021). In 2021, three (3) of the ten (10) beaches listed on the 2020-2021 Beach Bummer List were lagoon beaches: Erckenbrack Park (ranked #2), Gull Park (#4), and Marlin Park (#8) (Ginger 2021). All grades are based on routine water quality sampling conducted by local and state health agencies, sanitation departments, and dischargers. Reduced lagoon monitoring due to COVID-19 stay at home orders in 2020 and poor water quality conditions resulted in low grades for the three lagoon beaches listed in 2021.

Figure 1 – Foster City Lagoon Map

In response to the Beach Bummer Listing, the City contracted with EOA, Inc. (EOA) in 2021 to develop a lagoon FIB monitoring program and assist in a preliminary evaluation of potential sources of FIB to the lagoon, with a focus on Erckenbrack Park. Analytical results of Foster City Monitoring and County Environmental Health Services Monitoring for enterococci at Erckenbrack Park from March to August of 2021 were gathered by EOA and showed consistent exceedances of the FIB water quality objective (WQO) set by the San Francisco Regional Water Quality Control Board (RWQCB). A discussion of potential FIB sources to the lagoon and recommendations for mitigation measures were reported in the EOA technical memorandum (**Appendix A**). An additional component of the measures to address FIB and other water quality and management challenges in the lagoon is this 2022 revision to the Lagoon Management Plan.

Please note, this is a working document, subject to routine updates.

1.2 Integrated Pest Management Overview

Management of aquatic vegetation, algae, and bacteria by the City will be determined by the implementation of IPM. One of the fundamental components of IPM is to establish a general and reasonable set of control measures that not only aid in managing algae, aquatic vegetation, and bacteria but also address public health and safety, economic, legal, and operational requirements. This typically involves evaluating a variety of alternative control techniques and implementing a combination of controls.

Control techniques are generally described as physical/mechanical, cultural, chemical (i.e., herbicide application), or biological tools or strategies for pest management. In addition to identifying a reasonable set of pest control measures, IPM involves establishing action thresholds. An action threshold is the point at which action should be taken for the control of aquatic weeds, algae and/or bacteria to prevent unacceptable impacts to water quality, lagoon operations and/or recreation use. When sampling results or observations indicate that an action threshold has been exceeded, City water quality staff will respond by identifying the source of the problem and a control action may be implemented to mitigate the effect of aquatic vegetation, algae, or bacteria presence.

Control actions may also be made prior to threshold exceedance. Based on predicted growth rate and density, historical algae, aquatic vegetation and/or bacteria trends, weather, water flow, herbicide properties, and site-specific experience, aquatic weeds, algae and/or bacteria may reasonably be predicted to cause future problems. Accordingly, they may be treated soon after emergence or when deemed appropriate based on the control activity to be used. For example, fluridone works by inhibiting a submersed aquatic weed's ability to produce carotene, resulting in the degradation of chlorophyll and finally the death of the plant. Because this is a slow process, it is necessary to maintain an adequate concentration of the chemical for a sufficient period of time to effectively control aquatic weeds. Therefore, fluridone-based herbicides may be applied to the lagoon when submersed aquatic vegetation begins active growth as opposed to when recreational use control tolerances are exceeded. Even though algae and/or nuisance vegetation may not be an immediate problem at this phase, treating them before they mature, reproduce, or spread reduces the total amount of algaecide or aquatic herbicide needed because the younger aquatic plants or less dense algae mats are more susceptible and there is less plant biomass to target. Furthermore, treating aquatic vegetation or algae within the ideal time frame of its growth cycle enhances the likelihood that the selected control measures will be most effective. Managing aquatic plant populations before they produce seeds, tubers or other reproductive organs is an important step in IPM. Generally, treating algae and aquatic weeds earlier in their growth cycle results in fewer control actions needed and less total algaecide or aquatic herbicide used.

When chemical controls are used, selection of appropriate algaecide and/or aquatic herbicide(s) and rate of application is done based on the identification of the algae and aquatic weed, its growth stage, and the appearance of that algae or aquatic weed or a related species on the product label. The selection of and decision to use an algaecide or aquatic herbicide is based on the recommendation of a California Department of Pesticide Regulation (DPR)-licensed Pest Control Adviser (PCA). The PCA considers a variety of control options that may include mechanical and/or cultural techniques that alone or in combination with algaecide or aquatic herbicide use are the most efficacious and protective of the environment.

2 Facility Description

The Foster City Lagoon design originated in a Master Plan for the development of what was known at the time as Brewers Island, a 2,600-acre parcel of land located on the San Francisco Bay (the Bay) front east of the City of San Mateo. The Master Plan for what was to become the City, was adopted by the San Mateo County Board of Supervisors in 1960. This Master Plan provided for a central lagoon which was to serve two functions. The first and primary function was for a storm drainage detention basin for a city with a population of 36,000. The second function was for recreational use.

By a special act of the California Legislature in 1960, the Estero Municipal Improvement District (EMID) was created. Subsequently, in April of 1971, the City was incorporated and assumed the responsibility for management of the lagoon. All other responsibilities for EMID functions related to potable water and sanitary sewage remained under the jurisdiction of the EMID. Staff for EMID serve a dual role as they also function as staff for the City.

2.1 Lagoon Description

The lagoon is a man-made estuary which divides the City. Shaped like the number two (2), it extends from north to south in a meandering alignment. Its surface area is approximately 212 acres. The volume of water at the summer operation level is up to approximately 1,300 acre-feet. The main channel ranges in width from about 200 feet along most of its length to over 1,000 feet at the lake near East Hillsdale Boulevard. After dredging in 2004, the average depth is six feet at summer water level.

There are seven parks about the shoreline (see **Figure 1**). These parks and their amenities make the lagoon the aesthetic and recreational centerpiece of the City. See **Table 1** below for details. Many of these parks have beaches and/or boardwalks, as well as picnic tables, lawn areas and play areas. There are also two boat launching ramps which encourage use of the lagoon for water sports activities with the limitation that no gas-powered boats, other than City/EMID maintenance and safety boats, are authorized. This restriction minimizes the potential for fuel spillage and minimizes shoreline damage from boat wakes.

Table 1. Lagoon Waterfront Parks and Amenities

Park Name	Location	Amenities
Leo J. Ryan Memorial Park	East Hillsdale Blvd & Foster City Blvd.	1, 2, 3, 4, 6, 7, 8, 11, 14
Boat Park/Dog Park	Bounty Dr. & Foster City Blvd.	1, 2, 3, 4, 6, 11
Erckenbrack Park	Niantic Dr.	2, 4, 5, 6, 11, 12
Gull Park	Gull Ave. between Mallard & Plover St.	4, 5, 6, 11, 12
Marlin Park	Marlin Dr. across the street from Pompano Cir.	4, 5, 6, 11, 12
Catamaran Park	Catamaran St. & Shell Blvd.	3, 4, 5, 6, 7, 8, 10, 11, 12, 13
Sea Cloud Park	Pitcairn & Sea Cloud Way	2, 4, 6, 9, 10, 11, 12

Amenities Key:

1. Boat launching facilities
2. Parking
3. Boardwalk
4. Picnic Tables
5. Beach
6. Lawn Area
7. Basketball court
8. Tennis court
9. Baseball diamond
10. Soccer Field
11. Restrooms
12. Tot Lot/Play Apparatus
13. Volleyball court
14. Skate park

2.2 Facilities Design Description

The typical land elevation within the City is ≥100 ft. Because City land has been subjected to tidal elevations of up to 106 feet, the City must follow Federal Emergency Management Agency (FEMA) requirements intended to minimize impacts of sea level rise on residents. In compliance with these requirements, the network of levees surrounding the City are being raised to account for possible sea level rise and to reduce future flood potential in the city.

Note that historical data on lagoon surface level elevation is based on 1929 Mean Sea Level (MSL) and that 100 feet was added to this baseline to eliminate negative elevations. Thus, elevation 100 feet or sea level for Foster City is equal to elevation 0 feet or 1929 MSL.

Table 2 shows typical lagoon operating elevations throughout the year.

Table 2. Typical Lagoon Operating Elevations by Season

Season	Elevation (feet)
Winter	98.5 – 98.7
Spring-Early Summer	99.0
Summer	99.2

The City operates and maintains the lagoon system. Components of the system include an intake structure at the south end (Belmont Slough) and a drainage pumping station at the north end (San Francisco Bay along East Third Avenue). The drainage pump station includes two pumps, connected to a 66-inch steel pipe that discharges into a large, concrete forebay. A triple 5-foot by 12-foot box culvert connects the forebay under East Third Avenue and through the levee to the south San Francisco Bay. Flap gates are installed on the pipes so that no tidal waters can backflow into the lagoon. In the lagoon pump station's original design, no lagoon water could be discharged other than by pumping. Thus, the lagoon at that

time was physically separated from Bay waters and was completely independent of tidal cycles. The current lagoon control structures provide for a constant water surface elevation by setting of controls for the specified elevation, allowing discharge pumps cycle on when needed to maintain the water level in the lagoon. The controls are adjustable so that a variety of water surface elevations may be obtained throughout the year.

Trash bars at the Belmont Slough water intake structure prevent floating debris from entering the lagoon. Trash bars at the lagoon pumping station prevent discharge of debris from the lagoon into the Bay while at the same time providing physical protection for the pumps.

2.3 Beneficial Uses

The California State policy for water quality control is aimed at achieving the "highest water quality consistent with the maximum benefit to the people of the state." The State's Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan) identifies potential beneficial uses of Lower San Francisco Bay and adjacent inland surface waters like the Foster City Lagoon. Beneficial uses, which must be considered in management of lagoon, include:

- Water contact recreation (REC1)
- Non-contact water recreation (REC2)
- Natural estuarine habitat (EST) for fish and migrating birds
- Wildlife habitat (WILD)

The primary function of the lagoon is to be a storm drainage detention basin for the City. Its sources of water are the South San Francisco Bay through the Belmont Slough watershed via Belmont Slough intake structure, and storm water runoff from the City's watershed. The lagoon receives runoff from a watershed of approximately 2,313 acres.

The secondary function of the lagoon is recreational use. The lagoon has about 16.5 miles of shoreline, much of which is made up of residences and developments. Interspersed among the developments are several small parks, many of which have a community beach, picnic areas, lawn, and other amenities (refer to **Section 2.1**). These parks and their amenities make the lagoon the aesthetic and recreational centerpiece of the City. The lagoon also has two public boat launch ramps, hundreds of private boat docks, and launching ramps.

3 Lagoon Water Quality Challenges and Action Thresholds

3.1 Aquatic Vegetation

The plant, widgeongrass (*Ruppia maritima* L.), has historically been found in the lagoon. Widgeongrass is a native perennial submersed aquatic plant that is commonly found in brackish or saltwater. While it can provide valuable food for wildlife like migrating waterfowl and habitat for fish, it also creates nuisance conditions in managed water bodies like the lagoon if not managed. Additionally, it is suspected, based on information from the City of San Mateo, that dense stands of widgeongrass can harbor FIB in the plant canopy, potentially increasing the occurrence of FIB detections and further impairing a waterbody.

In the San Francisco Bay Area, widgeongrass typically begins growing in late March to April as water warms and days get longer. Widgeongrass grows from rhizomes in the sediment or seeds from the lagoon bottom. Widgeongrass emergence timing and growth rate is influenced by water turbidity and water temperature. It can grow in water depths of over 10 feet, so it could inhabit all areas of the lagoon.

Widgeongrass can reach the water's surface and begin producing flowers by June. The plant can reproduce by seed, or vegetatively from rhizomes or stem fragment that break off due to wind/wave action, harvesting or boat propellers. The stem fragments can drift to new areas of the lagoon and establish roots to create a new stand of widgeongrass.

When widgeongrass reaches the surface of the lagoon and growth is in dense stands, it can impede boating and swimming in the lagoon. This occurred in the lagoon during past summers when no light-shading dye or aquatic herbicides were used. The lagoon's relatively shallow maximum depth of 6 feet, warm summer water temperatures, and abundant nutrient supply can allow for unchecked growth of widgeongrass. Widgeongrass can interfere with the flow of water necessary for the lagoon to operate as a stormwater detention basin, impede efforts at flushing lagoon water through the system, and impair recreational uses (e.g., motor boating and swimming). After producing flower and as water temperatures cool in the late summer or fall, the foliage of widgeongrass plants will senesce and decompose, with the potential to result in odor complaints and impacts to visual aesthetics of the lagoon. This decomposition process can deplete the amount of dissolved oxygen in the lagoon which can, in turn, be detrimental to fish and other animal life in the water.

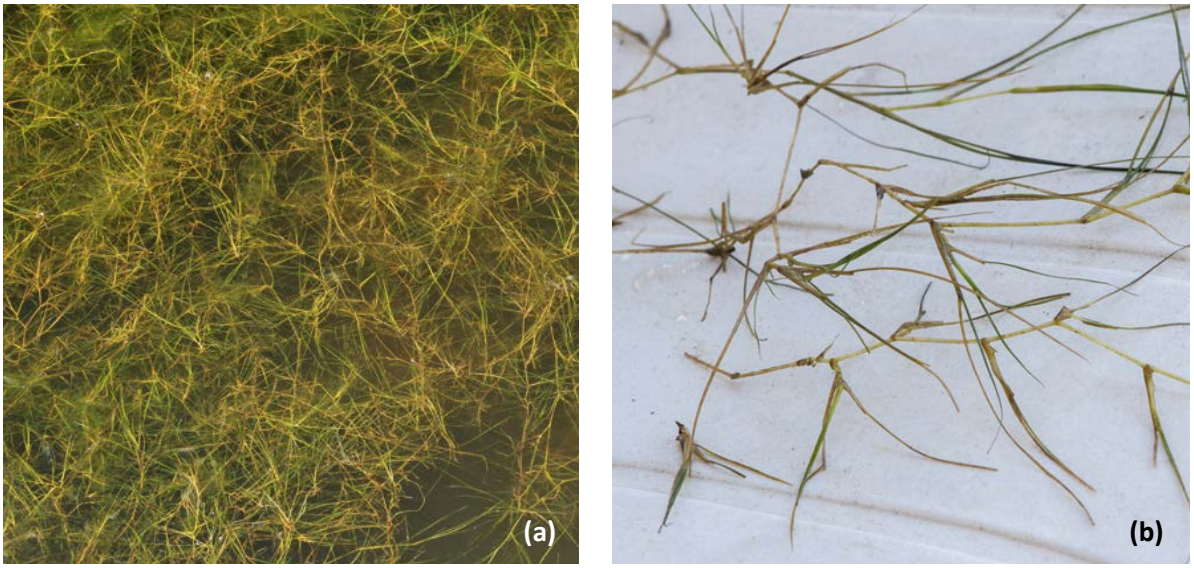

Figure 2. Images of widgeongrass (*Ruppia maritima* L.), courtesy of Lady Bird Johnson Wildflower Center, University of Texas, https://www.wildflower.org/plants/result.php?id_plant=RUMA5

The action threshold for widgeongrass management is defined as 1) when widgeongrass reaches a height and density in the water column that interferes with boating or swimming, or 2) the location and growth rate of widgeongrass is anticipated to interfere with boating or swimming. Once at or above these growth levels, widgeongrass also has the potential to fragment and wash ashore to form aesthetic and odor nuisances.

A thatch rake or double-sided rake with the handle removed and tied to a rope is a commonly used piece of equipment to sample submersed aquatic plants. To determine if the action threshold is met, City staff should 1) make regular observations for free-floating fragments of widgeongrass throughout the lagoon when conducting inspections, and 2) throw a weed rake into the lagoon at historic widgeongrass hotspots one to three times to determine if widgeongrass is present, and if so, at what density and growth stage. Record these observations on the Routine Monitoring Data Sheet found in **Appendix B**. When rake

samples indicate a grass length of 12 to 18 inches and/or the plant is actively growing will create nuisance conditions, City staff should plan to implement a control action.

3.2 Algae

By mid-summer, filamentous algae becomes noticeable along the shallow areas of the lagoon. Eventually, these mats become dislodged, float to the surface, and begin to decay. The subsurface growth of this algae is aesthetically offensive, particularly around the swimming beaches. Decaying algae mats also produce noxious odors as hydrogen sulfide. Untreated, the filamentous algae discourages boating and swimming in the lagoon, and causes complaints from residents downwind of its undesirable odors.

The action threshold for filamentous algae is defined as the point at which an accumulation of algae on the water surface interferes with motor craft or swimming, or creates nuisance conditions that result in odor complaints by lagoon users. Threshold exceedance may be realized when City staff may make visual observations of floating algae mats accumulating on the surface or receive multiple nuisance algae complaints via the City's SeeClickFix app (https://seeclickfix.com/foster-city-ca). The weed rake may be used to pull up filamentous algae mats for confirmation of threshold exceedance.

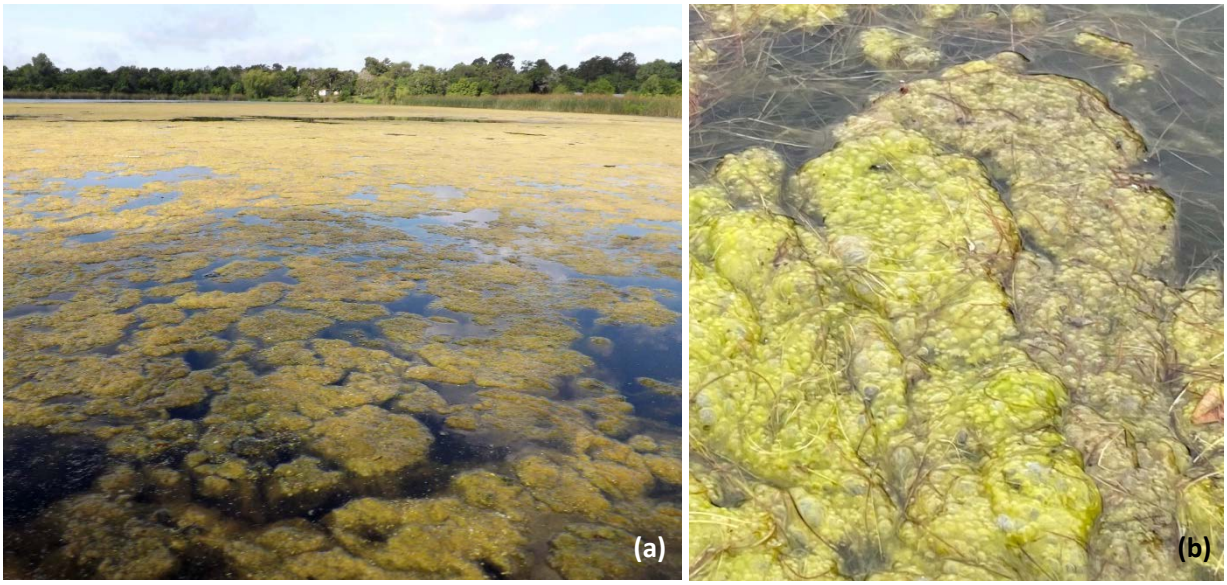

Figure 3. Images of a filamentous algae courtesy of (a) Janet Fitzsimon and AquaPlant; https://aquaplant.tamu.edu/plant-identification/alphabetical-index/filamentous-algae/ and (b) Stephen Burkholder.

3.3 Fecal Indicator Bacteria

Bacteria levels have become increasingly problematic in the lagoon and can get high enough during the summer months to warrant closing the beaches to swimming for the protection of public health. Three lagoon beaches (Erckenbrack Park, Gull Park, and Marlin Park) appeared on the 2020-2021 annual Beach Bummer List. The list assigns water quality grades based on three FIB: total coliform, fecal coliform (*E. coli*) and Enterococcus species. The aforementioned lagoon beaches received three of the then worst Beach Bummer water quality grades on the West Coast (Ginger 2021). The source(s) of the bacteria is not yet fully known and may vary by season but appears to be mostly a result of animal waste from the large numbers of waterfowl (e.g. Canada geese) inhabiting the lagoon. Other potential sources of bacteria is domestic animal waste washed into the City's storm drain system and discharged to the lagoon during

winter rains, as all street drainage in the City ends up in the lagoon. Bacteria levels around public beaches are assumed to be exacerbated by the tendency for people to feed the waterfowl which congregate at these locations. The longer the period of lagoon water holding during the summer months, the more likely it is that the bacteria levels will rise to levels potentially dangerous to human health (EOA 2021).

In February of 2019 the SWRCB published bacteria WQOs to be added to the Water Quality Control Plan for Inland Surface Waters, Enclosed Bays, and Estuaries of California (SWRCB 2019). The bacteria WQO for all waters where the salinity is greater than 1 part per thousand (ppt) for 5% of the time during the calendar year, including the lagoon, is a six-week rolling geometric mean (GM) of enterococci not to exceed 30 colony forming units (cfu) per 100 mL, calculated weekly, with a statistical threshold value (STV) of 110 cfu/100 mL not to be exceeded by more than 10% of the samples collected in a calendar month. Analytical results of San Mateo County EHS Monitoring for enterococci at Erckenbrack Park, Gull Park and Marlin Park from March to August of 2021 were gathered by EOA, Inc. and are presented in **Table 3** below (EOA 2021), along with six-week GMs. The WQO for the GM and the STV are consistently exceeded both Erckenbrack Park and Marlin Park, a trend continuing in 2022. Because of these exceedances, the SWQCB may eventually add the Lagoon to the 303(d) List of Impaired and Threatened Water Bodies in the San Francisco Bay Region. The City acknowledges that it will need to develop a control plan to address this issue and avoid being added to the 303(d) list.

Table 3. Enterococci levels at select waterfront parks from March to August of 2021

	Erckenbrack Park		Gull Park		Marlin Park	
	Enterococci (MPN/100 mL)	**6 week GeoMean**	**Enterococci (MPN/100 mL)**	**6 week GeoMean**	**Enterococci (MPN/100 mL)**	**6 week GeoMean**
State WQO:	*110*	*30*	*110*	*30*	*110*	*30*
3/15/2021	52	NA	10	NA	20	NA
3/22/2021	**441**	NA	20	NA	**644**	NA
3/29/2021	20	NA	75	NA	30	NA
4/5/2021	**211**	NA	10	NA	31	NA
4/12/2021	51	NA	20	NA	10	NA
4/19/2021	**581**	**119.19**	20	19.79	52	**42.89**
4/26/2021	20	**101.65**	41	25.03	10	**38.21**
5/3/2021	41	**68.41**	72	**30.99**	**465**	**36.20**
5/10/2021	10	**60.95**	62	**30.02**	52	**39.67**
5/17/2021	10	**36.67**	10	**30.02**	31	**39.67**
5/24/2021	97	**40.81**	30	**32.12**	41	**50.19**
5/31/2021	**121**	**31.42**	20	**32.12**	31	**46.04**
6/7/2021	20	**31.42**	20	28.50	52	**60.60**
6/14/2021	**275**	**43.15**	50	26.82	10	**31.96**
6/21/2021	95	**62.80**	41	25.03	74	**33.89**
6/28/2021	**185**	**102.13**	97	**36.56**	63	**38.15**
7/5/2021	NS	**103.18**	NS	**38.03**	NS	**37.60**
7/12/2021	63	**90.56**	52	**46.04**	52	**41.70**
7/19/2021	**299**	**155.54**	1	25.29	30	**37.35**
7/26/2021	52	**111.48**	10	18.33	31	**46.84**
8/2/2021	**288**	**139.16**	41	18.33	52	**43.65**
8/9/2021	31	**97.35**	20	13.36	41	**40.05**
8/16/2021	86	**95.36**	31	15.38	10	**31.78**
8/23/2021	85	**100.24**	<10	11.68	**241**	**41.04**

Notes
NA – Not Available
NS – Not Sampled
Bold – Above WQO

4 Recommended Routine Monitoring

The routine monitoring for the lagoon should consist of visual observations and collection of water samples at six locations on a monthly basis during times of the year when nuisance conditions may be observed. Typically, this would occur from March through October. These sampling locations are listed below and shown in **Figure 4**:

1. Leo J. Ryan Park
2. Center of Lagoon Near Leo J. Ryan Park
3. Marlin Park
4. Erckenbrack Park
5. Gull Park
6. Belmont Slough intake facility (outside lagoon)

It is recommended that the City purchase a YSI ProODO/CT optical dissolved oxygen (DO), temperature and conductivity meter, a WaterMark Limnological Weighted Secchi Disc, and an aquatic weed rake. Purchase information for these items can be found in **Appendix C**.

4.1 Water Quality Parameters

Four water quality parameters (i.e., temperature, conductivity, DO and water clarity via secchi depth) should be measured monthly at all sites and be recorded by city staff using the Foster City Lagoon Routine Monitoring Data Sheet, provided in **Appendix B**. Data should be compiled in an Excel spreadsheet with formatted tables and graphs to create a dataset that will allow observation and identification of trends of all four parameters. The dataset should be updated monthly.

4.1.1 Water Temperature

Water temperature is one of several factors that influence the germination, emergence, and growth rate of aquatic plants and algae. While the optimal temperature ranges vary by species, a temperature range of approximately 65°F – 86°F is considered optimal for widgeongrass. Algae species present change throughout the year based on many factors, but in general, the warmer the water, the faster its potential growth rate.

4.1.2 Conductivity

Conductivity provides a measure of what is dissolved in water. A higher conductivity value indicates that there is a higher concentration of dissolved salts and other chemicals in the water, which may occur from evaporative losses after holding the lagoon closed during the summer. This could inform decisions about operation of the water intake pipes and outfalls to prevent evaporation from substantially changing salinity conditions in the lagoon.

4.1.3 Dissolved Oxygen

Oxygen is produced by plants and algae during photosynthesis. When the algae population is growing at a fast rate, it may block sunlight from reaching other aquatic plants and cause a change in DO levels. Additionally, oxygen is consumed by bacteria during the aquatic weed and algae decomposition process, like what may occur after treatment with algaecide or aquatic herbicide. Levels of DO lower than 3.0 to 5.0 mg/L can result in the death of fish, especially those that need high levels of DO. The Basin Plan DO objective for the lagoon is greater than 5.0 mg/L.

Figure 4 – Lagoon Water Quality Sampling Stations

4.1.4 Water Clarity and Secchi Depth

A Secchi disk is used to measure water clarity. The lowest depth a Secchi disk is still visible is a direct measure of how deep sunlight is penetrating the water and an indirect measure of the amount of suspended material in the water. Water clarity is primarily affected by algae, suspended sediments, and if applied, dye. Too much algae growth, sediment carried by stormwater runoff or resuspension of bottom sediments, and the use of dye can all decrease the clarity of the lagoon water. Low water clarity can be beneficial by limiting the ability of algae or aquatic plants to photosynthesize.

How to Measure Secchi Depth[a]:

1. Position yourself with the sun at your back, preferably on the shaded side of the boat. Do not wear sunglasses.
2. Lower the Secchi Disk into water until it just disappears.
3. Read the depth from a calibrated line[b].
4. Raise the Secchi Disk until it just appears. Read the depth.
5. Add readings from Steps 1 and 2. Divide by 2.
6. Record the result of Step 5 as Secchi Disk Depth.

Notes:
[a] Adapted from SWRCB Standard Operating Procedure 3.1.5.1 (Gregorio 2010)
[b] To calibrate a line, mark standard intervals (in feet or meters) with an indelible marker.

4.2 Visual Monitoring

City staff should conduct visual observations of the entire lagoon monthly during the growing season to identify emerging nuisance conditions and need for treatment. The following actions should be employed:

- Initiate inspections in March and conduct monthly through October, or as needed based on the weather and/or lagoon condition.
- Observe for indicators of nuisance growth, such as accumulation of benthic or floating algae, and throw a weed rake for evidence of widgeongrass or other growth if not otherwise visible.
- Observe for indicators of high bacteria levels, such as waterfowl and dog fecal matter.
- Utilize action thresholds to inform implementation of control actions.
- Measure and record ambient environmental conditions and physical water quality characteristics that may provide insight to potential nuisance conditions.
- Record the inspection event using the Foster City Lagoon Routine Monitoring Data Sheet, shown in **Appendix B**

  Schedule subsequent inspection and/or control actions as applicable.

4.3 Enterococci Monitoring

In addition to measurement of water quality parameters and visual assessment, City staff should conduct monthly sample collection for enterococci at the six locations for submittal to a qualified analytical laboratory. This monitoring will augment the weekly San Mateo County Health Department monitoring at City beaches.

If high concentrations of enterococci are observed in the weekly beach sample results by San Mateo County, and the source of FIB is unknown, the City may elect to conduct “targeted” monitoring at select

locations for DNA analysis. Targeted sampling will be used to determine what organisms are contributing bacteriological pollutants using CEL Laboratory's DNA analysis of FIB sources. The Chain of Custody (COC) form for CEL Laboratory is provided in **Appendix D**. The supplementary information on FIB source may trigger additional actions like enhanced geese hazing.

4.3.1 Surface Water Sampling Techniques

Samples will be collected at the approximate mid-depth. As necessary, a long-handled sampling pole will be used for locations that are difficult to access. Samples will be collected in a manner that minimizes the amount of suspended sediment, surface scum, algae, aquatic weeds and/or debris in the sample. Surface water grab samples will be collected directly by the sample container or by an intermediary container (poly, stainless steel or glass) if the sample container cannot be adequately or safely used.

5 Water Quality Management Options

Treatment of algae, aquatic plants, and sources of FIB is determined by the application of IPM, which involves the evaluation and implementation of a combination of control techniques. Thresholds are met when aquatic weeds or algae cause management challenges, nuisance conditions or result in complaints from lagoon users, and/or enterococci levels exceed the WQO (see **Section 3** above). For example, if a population of widgeongrass equals or exceeds a threshold, an aquatic herbicide application may be made. Problems regularly associated with aquatic vegetation and algae include impacts to contact (swimming, kite surfing) and non-contact recreation (boating), nuisance odors, and aesthetic impacts from floating weed fragments or algae mats in the lagoon. Human health concerns associated with coming into contact with enterococci and other fecal bacteria include a greater risk of contracting illnesses such as stomach flu, ear infections, upper respiratory infections, and rashes (Ginger 2021).

Water quality management options in the lagoon can generally be categorized as physical/mechanical, biological, cultural, and chemical controls. Physical/mechanical controls are practices that kill or damage a pest directly, physically block or prevent pest entry, or make the environment unsuitable for pests. Biological control is the use of natural enemies or other species to manage pests, typically in an effort to restore, enhance, or mimic naturally occurring conditions. Cultural controls are preventative measures that discourage damaging pest populations from developing by reducing a pest's ability to establish, reproduce, disperse, and survive. Chemical control is the use of pesticides which are intended to kill, prevent, repel, or mitigate pests.

Examples of chemical and non-chemical control tools considered for use in the lagoon are shown in **Table 4** and **Table 5** and briefly discussed below.

Table 4. Examples of Non-Chemical Control Tools Considered for Algae, Aquatic Vegetation, or FIB Management

	Algae		Aquatic Vegetation		Bacteria
Control Tool	***Filamentous***	***Cyanobacteria***	***Submersed***	***Emergent***	***Fecal Indicator Bacteria***
Physical/Mechanical Controls					
Benthic barriers	O	O	X	O	O
Hand removal	X	O	X	X	O
Mechanical harvesting	X	O	X	X	O
Raking/netting	X	O	O	O	O
Waterfowl fencing	O	O	O	O	X
Cultural Controls					
Aeration & Oxygenators	O	X	O	O	O
Nutrient management	X	X	X	X	O
Reduction of light	X	X	X	O	O
Sediment dredging	X	X	X	X	O
Water Level Manipulation	X	X	X	X	O
Water Circulation	X	X	X	O	X
Lagoon Flushing	X	X	O	O	X
Stormwater BMPs	X	X	X	O	X
SolarBee	O	X	O	O	O
Waterfowl Management	X	X	X	O	X
Public Outreach/Education	O	X	O	O	X
Biological Controls					
Herbivorous Fish	X	O	X	O	O

Notes: "X" indicates the tool may provide control of the associated biota. "O" indicates the tool is ineffective or unlikely to provide control of the associated biota. Efficacy of implementation is variable based on target species.

Table 5. Examples of Biota Controlled by Various Algaecides and Aquatic Herbicides

	Algae		Aquatic Vegetation	
Control Tool	***Filamentous***	***Cyanobacteria***	***Submersed***	***Emergent***
Diquat	X	X	X	X
Fluridone	O	O	X	X
Hydrogen Peroxide	X	X	O	O
Imazamox	O	O	X	X
Peroxyacetic Acid	X	X	O	O
Sodium Carbonate Peroxyhydrate	X	X	O	O

Notes: "X" indicates the tool may provide control of the associated biota. "O" indicates the tool is ineffective and/or not currently labeled for use for control of the associated biota. Target biota and efficacy may vary between products. Always read and follow the product label.

5.1 Aquatic Weed Management Options

5.1.1 Physical/Mechanical Controls

5.1.1.1 Benthic Barriers

Benthic barriers are typically rubber or plastic blankets that are placed on the bottom of the lagoon to prevent emergence of submersed aquatic vegetation like widgeongrass in targeted locations. The benthic barriers are made from negatively buoyant materials and typically deployed as sheets and laid out on the bottom of the waterbody and weighted or pinned to the lagoon bottom. These systems provide immediate and season-long control of all aquatic vegetation where they are placed.

One significant drawback to this alternative control is the generally high costs of materials. Benthic barriers cost from $0.75 to $1.25 per square foot, installed. The barriers generally need to be removed at the end of each growing season and reinstalled in the spring. Regular maintenance and inspections are required to keep the barriers clean of any buildup of sediment that could allow for widgeongrass growth on top of the barrier. The City is not currently considering the use of benthic barriers because widgeongrass has not been an issue in recent years.

5.1.1.2 Mechanical Cutting and Harvesting

Mechanical cutting and harvesting consists of direct harvesting of the aquatic plants in the lagoon and/or removing unattached plants that drift into intensively used areas or otherwise become a nuisance. Generally, these techniques are very labor intensive. Mechanical removal places personnel at risk of general water and boating hazards, drowning, risks the spilling of motor oil and fuel, and can increase air pollution. The cost per area of mechanical removal is significantly higher than the cost of labor, product and equipment of the application of algaecides or aquatic herbicides. The increased cost of mechanical aquatic weed abatement does not include the indirect costs associated with the aforementioned risks (pollution abatement, worker's compensation claims, etc.).

In some instances, the use of mechanical techniques may be necessary when the use of algaecides or aquatic herbicides is not practical, vegetation is not at an appropriate growth stage, or if the lagoon's recreational activities are significantly impacted. Blankinship & Associates estimates that mechanical removal is 10 to 25 times more expensive than using chemical controls. This additional expense does not include the cost for trucking and disposal of harvested material or for obtaining potentially necessary permits. Waste must be either hauled wet to a landfill or hauled wet and allowed to dewater and dry out at an upland site before disposal at a landfill. Trucking and tipping costs are higher for wet material and can greatly increase the cost of mechanical harvesting.

Widgeongrass can be spread through fragmentation, and mechanical control has the potential to increase the distribution of it throughout the lagoon. Environmental impacts due to the use of mechanical techniques include the creation of water-borne sediment and turbidity due to equipment working in the water. Disturbing sediment may cause additional problems such as expansion of areas vulnerable to widgeongrass establishment, fragmentation and re-establishment of aquatic weeds, and siltation.

Mechanical removal has been and will continue to be implemented by the City, as needed, to remove vegetation in some areas. While effective in the short-term, regrowth or reemergence of vegetation is common.

5.1.1.3 Hand Removal

Similar to the mechanical harvesting discussed above, hand removal of detached widgeongrass nuisance drift is conducted by City staff on an as-needed basis (e.g., when City staff observe it during weekly trash collection activities). This option has proven effective in localized areas of accumulation of widgeongrass and will be implemented to address accumulation of aquatic weeds around park beaches, docks, coves or other infrastructure.

5.1.1.4 Manual Raking/Netting

Widgeongrass can be removed by raking or removing it from the lagoon with a net. This method may be used by residents around their docks and shorelines. As with most nuisance aquatic plants, it will re-establish from any remaining plant roots or dislodged fragments. As such, this control method should be combined with other options described in this section for longer-term control.

5.1.2 Cultural Controls

5.1.2.1 Control Method Timing

Modifying the timing of aquatic herbicide and non-herbicide controls can prevent plants from reaching reproductive growth stages as well as reduce the amount of aquatic herbicides used. This approach can include making applications before the density of aquatic vegetation is high enough to require higher aquatic herbicide application rates, a larger application area, or additional applications to maintain aquatic weed populations below threshold levels.

5.1.2.2 Nutrient Management

Nutrient management involves limiting the introduction of or reducing existing levels of nutrients in water that support aquatic vegetation and algae growth. Nutrient input to the lagoon potentially occurs from the following sources: inflow water from San Francisco Bay and Belmont Slough, lawn and landscaping fertilizer in storm water runoff and irrigation overflow, yard debris blown or dumped into the lagoon, and excrement from waterfowl and pets.

<u>Public Education</u>

The City already has in effect a policy which prohibits landscape irrigation water runoff into the streets. Further educating the public regarding the consequences of over-fertilizing, blowing or dumping yard debris into the lagoon, and the role nutrient loading plays in lagoon conditions has proven helpful in the reduction of nutrient inputs from storm drain discharge and resident activities.

<u>Reducing Animal Excrement</u>

In June of 2022, City Parks & Maintenance staff found there to be 379 waterfowl within City facilities based on a point count survey. Animal excrement contributions to the nutrient load of the lagoon are believed to be mostly from the waterfowl that use the lagoon and congregate at the swimming beaches and picnic areas. To reduce this load, it is important that residents do not power wash animal excrement from their land and hardscape surfaces into Lagoon waters. City Parks & Maintenance staff have been trained to power wash excrement away from Lagoon waters into the grass.

Measures to mitigate waterfowl use of these areas are discussed in **Section 5.3** and **Appendix E**.

Floating Islands

Installation of floating islands with roots that extend into the water column that are capable of taking up nutrients has been considered as a technique to remove nutrients from the water column in the lagoon. The plants growing in the artificial islands remove nutrients that would otherwise be used by aquatic plants or algae. The islands can also act as a habitat for terrestrial and aquatic species and pollinator-friendly plants, increasing biodiversity in the lagoon. Challenges and limitations with this approach include impacts to aesthetics of the lagoon, potential disruption of boat and kite board travel, harvesting of the islands is required to actually remove nutrients from the system, and that nutrients in the sediment will be minimally or un-affected. The removal rate of nutrients from the lagoon by floating islands is low and any benefit would be localized to the root zone of the plants, not making a significant change in the amount of nutrients available.

Removing Phosphorus

Nutrient management by removing phosphorus from the water column and binding it in the sediment could improve water quality by limiting plant and algae growth. Nutrient management could be accomplished applying phosphorus-binding agents like alum or Phoslock®. Issues with this approach include the need to obtain a permit from the RWQCB, the cost of the product, the need to collect water and sediment samples to determine the application rate, and phosphorus in the sediment will be minimally or un-affected. Most of the phosphorus load in the Lagoon is likely contained in the sediment, so these products are not anticipated to be effective at reducing nutrients unless used to create a sediment "cap." Additionally, any lagoon flushing may reintroduce nutrients from the Belmont Slough source water to the lagoon.

5.1.2.3 Reduction of Light

The application of dye products to reduce sunlight penetration of the water column can reduce aquatic plant growth by limiting their ability to photosynthesize. This control practice is currently in use at the lagoon and has been effective at reducing widgeongrass and algae issues over the last ten or more years.

It should be noted that an increased frequency of flushing the lagoon would interfere with the effectiveness of this approach if implemented simultaneously, or would require additional application of dye to maintain the target dye concentration in the water column after flushing.

5.1.2.4 Sediment Dredging

Removal of accumulated sediment in the lagoon by dredging could reduce nutrient loading, and potentially reduce algae and aquatic weed issues. Sediment builds up in the lagoon naturally over time from erosion, breakdown of organic material, soil transported by stormwater runoff, and as suspended sediment settles after flowing in from Belmont Slough. The sediment often contains nutrients like nitrogen or phosphorus, and under certain conditions, these nutrients can be released back into the water column. These nutrients can be like fertilizer for algae and aquatic plants, fueling their growth. Sediment also reduces the lagoon's water capacity and depth. The lagoon was last dredged in 2004 and the City is working on long-term plans and funding to dredge the lagoon again. After the 2004 dredging, complaints and city staff time spent managing nuisance algae blooms and widgeongrass were almost eliminated. The lagoon was dredged to reestablish the summer water depth at about six (6) feet, which has allowed for effective use of dye and thermal insulation from an increase in ambient air temperature. Challenges associated with removing sediment by dredging include cost, having sufficient access to all parts of the

lagoon, disposal location for dredged material, and regulatory permitting. The City will evaluate accelerating the planned lagoon dredging project which is currently planned for the 2027-2028 fiscal year.

5.1.2.5 Water Level Manipulation

Increasing the water level in the lagoon to reestablish summer water depth at about six (6) feet will allow for effective use of dye and thermal insulation from changes in ambient temperature. It may also result in a small decrease in the shallow areas favored by filamentous algae. However, there is not enough freeboard available to make this the sole means of control; therefore, this would not result in an adequate degree of control and would require additional control methods to keep aquatic plants and algae below action thresholds.

5.1.2.6 Water Circulation

Artificial water circulation redistributes oxygen and nutrients throughout the water column, reducing the stratified layers and effectively reducing the optimal habitat for aquatic weeds and algae in the water column, depending on depth. This is often accomplished by air injection (pumping air into the bottom of the lagoon, which then mixes the water as it rises) or mechanical mixing (rotating propeller near the surface that pushes the water downward). Issues with this control method include the high cost of installing and maintaining a circulation system, as well as potentially harmful direct effects of propellors on aquatic organisms in the lagoon. Additionally, given the relatively shallow depth of the lagoon and the frequent wind it is exposed to, thermal stratification in the lagoon is unlikely to occur, thus eliminating the benefit of water circulation.

5.1.2.7 Native Species Establishment

No appropriate submersed aquatic native plants have been found to establish within lakes, reservoirs, or lagoons to out-compete aquatic weed species like widgeongrass and not create similar problems. As such, aquatic vegetation in the lagoon must be controlled to maintain the aquatic weed density tolerances established by the City.

5.1.3 Biological Controls

5.1.3.1 Grazing

Goats and sheep are often used for grazing in and along riparian areas or shorelines. Grazing may be suitable for emergent and terrestrial weeds but is not suitable for submerged aquatic weeds or algae. This option is not a suitable alternative control for the lagoon.

5.1.3.2 Herbivorous Fish

Stocking of herbivorous fish like triploid grass carp has been successful against some submersed aquatic plants in freshwater systems but is largely prohibited in California due to concerns about fish escaping impoundments. There are no known herbivorous fish that could tolerate the lagoon salinity. As such, this option is not a suitable alternative control.

5.1.4 Chemical Controls

The application of aquatic herbicides to control aquatic plants is consistent with lagoon maintenance activities in the past. During the 1970's and 1980's the City relied on chemical treatment for control of both widgeongrass and algae. Typically, simazine (i.e., Aquazine) was applied to the entire lagoon, in segments, over a period of several days. As better data became available on the negative environmental

impacts this herbicide may have on aquatic ecosystems, regulatory agencies began to push for alternative means of nuisance control. As such, in the late 1990's the City began to use a more integrated approach and aquatic herbicides with more selective toxicity.

Use of aquatic herbicides will address the adverse impact to aesthetics and recreation from widgeongrass, as well as the potential interference with the necessary flow of water for the lagoon to operate correctly as a stormwater detention basin. This approach should only be used after a preparation of a written recommendation by a DPR-licensed PCA. Issues with this approach include temporary reduction of DO due to decaying organic matter if dense stands are treated.

5.1.4.1 Diquat

Diquat is a non-selective contact herbicide that is absorbed by plant foliage and controls weeds by interfering with photosynthesis in plant cells. Treated plants are expected to display whitening/bleaching two to four days after application. Diquat will only kill the parts of plants it comes into direct contact with. Turbid or muddy water can significantly reduce efficacy of diquat as it is strongly attracted to silt and clay particles. Optimum results are achieved when diquat containing products (e.g., Tribune®) are applied to actively growing widgeongrass and at times of low turbidity. The pesticide label and the PCA recommendation will provide guidance on the rate of herbicide that should be applied.

5.1.4.2 Fluridone

Fluridone is a systemic herbicide that is applied to the entire waterbody. It is used at very low concentrations, with a long contact time (45 to 90 days). Fluridone acts by inhibiting carotene synthesis in the target weeds, in turn causing the chlorophyll to break down when the plants are exposed to sunlight. Treated plants will turn white or pink (chlorosis) at the growing tips after a week and will die in one to two months after treatment. Optimum results are achieved when fluridone containing products (e.g., Sonar A.S.®) are applied before weed growth or when weeds begin to actively grow. Increased control is expected to be observed after the second application, and widgeongrass should be suppressed and dying throughout the treatment area one to two months after application. Dilution of the treatment rate with water from the Bay or rainfall will decrease effectiveness. Targeting a late March to early April application, weather dependent and as feasible, allow for as much exposure time as possible before flushing the lagoon. The pesticide label and the PCA recommendation will provide guidance on the rate of herbicide that should be applied. Fluridone is not currently available for use in the lagoon due to a 2017 label change, but additional research and use authorizations are underway to allow for future use.

5.1.4.3 Imazamox

Imazamox is a foliar-applied or water-injected systemic herbicide that prevents plants from producing the enzyme acetolactase synthase, which prevents the synthesis of branch-chain amino acids, which leads to inhibition of DNA synthesis. Imazamox is a slow-acting herbicide. Treated plants will stop growing soon after application and are expected to display whitening/bleaching within two to four weeks. Full plant death should occur six to eight weeks after application. An aquatic labeled herbicide containing the active ingredient imazamox (e.g., Clearcast®) is effective at controlling aquatic weeds when applied any time during active growth. The pesticide label and the PCA recommendation will provide guidance on the rate of herbicide that should be applied.

5.2 Algae Management Options

Potential methods for controlling algae within the lagoon are similar to some of those described above for aquatic weeds. Select algae management options are further discussed below.

5.2.1 Physical/Mechanical Controls

5.2.1.1 Mechanical Harvesting

Refer to the discussion on mechanical harvesting in **Section 5.1.1.2** above. Mechanical removal of nuisance algae mats from the lagoon could help reduce algae densities to acceptable levels. Issues with this approach include the difficulty of removing attached or benthic algae mats, access and worker safety concerns, significant labor costs, the need for approximately weekly removal activities, nuisance odors from drying and decaying algae, finding an appropriate dumping site near the lagoon, adverse impacts to aesthetics, and potential complaints about aesthetics and/or odors by residents.

5.2.1.2 Hand Removal

Hand removal is not generally effective for algae control. While removing small patches of algae by hand from the swimming beaches may be possible, this is not a practical approach for most of the lagoon.

5.2.1.3 Manual Raking/Netting

While raking small patches of algae from the swimming beaches may be possible, this is not a practical approach for most of the lagoon. As such, this control method should be combined with other options described in this section for longer-term control and encouraged for residents.

5.2.2 Cultural Controls

5.2.2.1 Control Method Timing

Refer to the discussion on control method timing in **Section 5.1.2.1** above.

5.2.2.2 Aeration and Oxygenators

Aerators and oxygenators are designed to increase DO and enhance mixing in the water column. Low DO at the lagoon bottom can result in anaerobic degradation of organic matter, a process that resuspends phosphorus from the sediment and, as a result, adds to existing levels of nutrients in water that support aquatic vegetation and algae growth.

A benefit of aeration is increased water column mixing during calm conditions. This technique is most effective in deeper waterbodies (e.g., over 10 feet) and those that are thermally stratified. Aeration systems are generally either bottom diffusers that provide aeration at discreet locations or weighted tubing with perforations to release air bubbles. The bubbles released by aeration equipment serve to vertically mix the water column. This disrupts vertical temperature stratification and as a result lessens the conditions conducive to algal and aquatic plant growth. Increasing water column DO is also beneficial to fish present in the lagoon.

Aeration may be beneficial near beaches, but further study of the DO and temperature profile of the lagoon are needed. It is currently unknown if the lagoon has challenges with low DO during summer or fall. The lagoon likely experiences frequent mixing due to the afternoon winds prevalent in the area. The

City intends to begin monitoring DO at locations throughout the lagoon to make informed management decisions, which will influence the decision to further consider aeration.

5.2.2.3 Nutrient Management

Similar to aquatic weeds, nutrient management by way of public education, reduction of nutrient inputs from animal excrement, floating islands, and phosphorus removal can be an important component of algae management. For more information on these refer to the discussion of nutrient management in **Section 5.1.2.2** above.

5.2.2.4 Reduction of Light

Historically, a commercial dye called Aquashade was used for coloring water and restricting penetration of light needed for algae growth and was applied primarily for cosmetic purposes. Small coves and shorelines (out to 20-30 feet) may be treated with appropriately labeled dye prior to anticipated public events in the vicinity. The effect on algae in the Aquashade-treated areas was reported to have been minimal when use was limited to small coves or shoreline areas, although a reduced rate of growth is believed to have occurred in certain instances (WESCO 1992). As such, the City began treating the whole lagoon with dye, which has proved very effective in recent years. With no flushing or water exchange in the lagoon, the coloration lasts approximately three weeks before being augmented with additional dye. The City is currently planning to use Cygnet Select dye but may change brands depending on labelling and availability.

Refer to **Section 5.1.2.3** above for additional information on the use of dye to reduce sunlight penetration through the water column.

5.2.2.5 Sediment Dredging

Refer to the discussion of sediment dredging in **Section 5.1.2.4** above.

5.2.2.6 Water Level Manipulation

Refer to the discussion of water level manipulation in **Section 5.1.2.5** above.

5.2.2.7 Water Circulation

Refer to the discussion of water circulation in **Section 5.1.2.6** above.

5.2.2.8 Lagoon Flushing

Assuming a buildup of nutrients in the lagoon, a 7-day cycle of water exchange, or flushing, in which the lagoon water would be pumped out and replaced with Bay water from Belmont Slough would reduce the nutrient levels and might reduce the growth of algae. Limitations to this approach are that dye would need to be reapplied, and a hydraulic study of the lagoon would be needed to determine how much of the lagoon volume would be displaced during a 7-day fill and flush cycle or if more time is needed to replace the lagoon water. The use of this method to increase the degree of lagoon water exchange and lower nutrient concentrations may reduce the growth of algae but is not expected to control it to levels that won't impair recreational use of the lagoon. Additionally, nutrient levels in source water from the Belmont Slough are currently unknown.

5.2.2.9 SolarBee

SolarBee circulators create effective and efficient mixing in most types of reservoirs. The City tried this method in the late 2000's with little to no success in reducing presence of algae or public complaints.

5.2.3 Biological Controls

5.2.3.1 Grazing

Goats and sheep are often used for grazing in and along riparian areas or shorelines. Grazing may be suitable for emergent and terrestrial weeds but is not suitable for submerged aquatic weeds or algae. This option is not a suitable alternative control for the lagoon.

5.2.3.2 Herbivorous Fish

Stocking of herbivorous fish like triploid grass carp has been successful against some submersed aquatic plants in freshwater systems but is largely prohibited in California due to concerns about fish escaping impoundments. There are no known herbivorous fish that could tolerate the lagoon salinity. As such, this option is not a suitable alternative control.

5.2.3.3 Bio-manipulation

Bio-manipulation utilizes various natural mechanisms that can reduce planktonic algae through predation. The biological controls are typically done by top-down or bottom-up changes to the food-web structure aimed at increasing populations of algae-consuming zooplankton. Bio-manipulation is difficult to accomplish and can be affected by many variables, making it an inconsistent method to implement. Nuisance algae in the lagoon has been limited to filamentous species in the past, so this approach would not result in improved conditions and is not currently being considered for implementation in the lagoon.

5.2.4 Chemical Controls

The application of aquatic herbicides to control algae is consistent with lagoon maintenance activities in the past. Use of aquatic algaecides will address the adverse impact to aesthetics and recreation from algae, as well as the potential interference with the necessary flow of water for the lagoon to operate correctly as a stormwater detention basin. This approach should only be used after a preparation of a written recommendation by a DPR-licensed PCA. Issues with using chemical controls for algae include temporary reduction of DO due to decaying organic matter if significant amounts of algae are treated.

5.2.4.1 Diquat

Application of diquat-containing herbicides may enhance breakup of filamentous algae mats. Refer to **Section 5.1.4.1** above for additional information on diquat use.

5.2.4.2 Hydrogen Peroxide

Hydrogen peroxide is a colorless natural liquid with a chemical formula of H_2O_2. It is one of two active ingredients in the product GreenClean Liquid 5.0. Upon contact with organic material, the chemical reaction results in the destruction of algae on a cellular level. Algae mats are expected to break up and show signs of bleaching shortly after application. Dead algal mats should collapse and sink 4-7 days after application. Hydrogen peroxide rapidly decomposes into water and oxygen, leaving no harmful residue and potentially increasing the DO levels in the water system.

5.2.4.3 Peroxyacetic Acid

Peroxyacetic acid, also known as peracetic acid (PAA), is an organic chemical compound that combines acetic acid and hydrogen peroxide and is one of two active ingredients in the product GreenClean Liquid 5.0. PAA is an oxidizer that can control surface contaminants such as algae, bacteria, fungi, viruses, and spores. Algae mats are expected to break up and show signs of bleaching shortly after application. Dead algal mats should collapse and sink 4-7 days after application. PAA breaks down to acetic acid (vinegar), oxygen, and water, leaving no harmful residue and potentially increasing the DO levels in the water system.

5.2.4.4 Sodium Carbonate Peroxyhydrate

Sodium carbonate peroxyhydrate (SCP) is a white crystalline powder which dissociates into hydrogen peroxide and sodium carbonate in the presence of water. Upon dissociation of SCP, the hydrogen peroxide oxidizes the critical cellular components of the target organism, resulting in cell death. Algae mats are expected to break up and show signs of bleaching shortly after application. Dead algal mats should collapse and sink 4-7 days after application. Hydrogen peroxide rapidly decomposes into water and oxygen, leaving no harmful residue and potentially increasing the DO levels in the water system.

5.3 Fecal Indicator Bacteria Management Options

5.3.1 Cultural Controls

5.3.1.1 Water Level Manipulation

Partially draining the lagoon and refilling it with Bay water would remove some of the bacteria-laden surface water and possibly impede bacteria growth by increasing the salinity. The use of this method to increase the degree of lagoon water exchange will not adequately control bacteria levels through the summer. This has been tried for two years, with no success relative to FIB lowering concentrations. Further issues with this method are discussed in **Section 5.1.2.5** above.

5.3.1.2 Water Circulation

Artificial water circulation redistributes oxygen and nutrients throughout the water column, reducing the stratified layers and effectively removing the optimal habitat for aquatic herbicides and algae in the water column. This is often accomplished by air injection (pumping air into the bottom of the lagoon, which then mixes the water as it rises) or mechanical mixing (rotating propeller near the surface that pushes the water downward). Issues with this control method include the high cost installing and maintaining a circulation system, as well as potentially harmful ecological effects on plant and animal life. Additionally, given the relatively shallow depth of the lagoon and frequent wind it is exposed to, thermal stratification in the lagoon is unlikely to occur, thus eliminating the benefit of water circulation.

5.3.1.3 Lagoon Flushing

City staff has tried reducing the water column nutrient load and FIB levels in the lagoon during the summer months by a 7-day cycle of water exchange in which the lagoon water was pumped out and replaced with Bay water from Belmont Slough. When conducted in 2021, flushing did not have an effect on concentrations of FIB in the lagoon. Effects on nutrient levels in the lagoon were not measured at the time. Additional limitations to this approach are that dye, if used, would need to be reapplied, and a hydraulic study of the lagoon has not been completed to determine how much of the lagoon volume

would be displaced during the 7-day fill and flush cycle, or if more time is needed to replace the lagoon water.

5.3.1.4 Waterfowl Management

Waterfowl management can be implemented as a preventative approach to lessen FIB inputs into the lagoon. As with aquatic weed and algae management, waterfowl management is most successful when a combination of approaches is implemented. Knowledge of seasonal waterfowl behavior and biology is also an important component of effective waterfowl management. Resources that describe the seasonal biology and behavior of, and management activities for Canada geese, for example, include the Humane Society of the United States' (HSUS) (2019) *Solving Problems with Canada Geese* guide and GeesePeace's (2019) *Model Program for Communities*.

Please see **Appendix E** for the City's Goose Population Management Plan, approved by City Council in July of 2022.

Select waterfowl management approaches are described below.

Waterfowl Fencing

Installing sturdy fencing to a height of approximately 3 to 5 feet can be an effective method to prevent waterfowl access to certain areas of the lagoon such as parks and swim beaches, especially when they are molting (unable to fly) or rearing their young. Some material options include chicken wire or heavy plastic fencing. Installing fencing in February or March will help exclude some waterfowl prior to their nesting season.

While other types of fencing mechanisms have been considered, they are not considered suitable for long-term use at the lagoon. Overhead grids consisting of monofilament line or wire, for example, can be constructed over small bodies of water or agricultural crops to prevent waterfowl from landing. Alternatively, lines of mylar tape (shiny silver on one side and red on the other) strung 1 to 2 feet above the ground can be used to deter waterfowl away from certain areas. These control tools are likely not feasible options for the lagoon as they would prevent recreational use of the water, beaches, and/or parks. In addition, the use of mylar tape to direct waterfowl away from certain areas may not be effective if no alternative suitable resting or feeding area exists in close proximity (Maslo 2013).

Direct Waterfowl Population Management

If necessary, a domesticated waterfowl removal program can be instituted with the cooperation of California Department of Fish and Wildlife (CDFW). This may include hunting and/or a capture and euthanasia system and can be an effective strategy for reducing the number of resident waterfowl. It is important to gain public support for this type of lethal wildlife management before implementation. Also, as new individuals will continually migrate to the site, it is important to pair this waterfowl control method with habitat modification options described below (Maslo 2013).

Egg Addling

Reproductive control is a critical component of successful waterfowl management plans. Physical destruction of the nest and eggs will only provide short-term relief if done early in the breeding season, as waterfowl will have time to lay another clutch of eggs. As such, leaving the eggs intact but treating them so that they are inviable, known as addling, is a more effective approach. There are three approved addling techniques—shaking, oiling, and puncturing (Maslo 2013). For a detailed methodology on these

techniques, as well as registration information, consult the referenced HSUS (2019) *Solving Problems with Canada Geese* guide and the U.S. Fish and Wildlife Service (USFWS) website.

In 2022, the City addled 1,083 goose eggs. Following the nesting season, only 12 goslings were found within City facilities based on a point count survey. This indicates that addling is a very effective goose population management strategy. However, a regional partnership approach to addling eggs is necessary given the nearby suitable nesting habitat outside of City limits. After hatching and fledging, numerous additional young-of-the-year geese were observed in the lagoon from successful nests, likely located on Bair and/or Bird Island.

Waterfowl Habitat Modification

Well-manicured and fertilized lawns are extremely attractive to most waterfowl as they prefer to forage on short, nutrient rich vegetation in open areas. To discourage them from areas around the lagoon, turf lawns could be replaced with tall native vegetation, such as San Francisco Bay native plants and bunch grasses. Tall vegetation is also generally avoided by waterfowl, as it makes it more difficult for them to detect predators. If tall vegetation is not feasible, planting a native groundcover instead of mowed turf will reduce the quality of the landscape as a food resource (Maslo 2013).

As waterfowl typically consume aquatic vegetation or algae, open areas along the shoreline provide both an ideal foraging habitat and quick access to the water if they need to flee from potential predators. Therefore, water edges should be planted with native riparian vegetation (e.g., willows, sedges, and rushes) wherever possible to make shorelines unattractive to geese and other waterfowl. Vegetated shorelines should be surveyed for nests in the early spring however, and additional strategies implemented if eggs are found (Maslo 2013).

Waterfowl Hazing

Noisemaking and laser devices can be effective harassment measures to temporarily scare waterfowl away from the lagoon property. Some options include pyrotechnics, trained dogs, remote controlled vehicles, lasers, horns, and recorded goose distress calls. It is important to note local and/or state ordinances may prohibit the use of pyrotechnics or other explosive devices; therefore, consulting with local police before use is recommended. Trained dogs are most effective on properties that do not contain bodies of water and therefore would not be a feasible option for the lagoon. To increase effectiveness, scare tactics should be combined and the timing and location of disturbances should be changed often. Additionally, as waterfowl may return to the lagoon once disturbances pass, it is important to combine this waterfowl control method with other options described in this section (Maslo 2013).

Chemical Repellents

There are two chemicals registered in the United States for the use of repelling geese. Methyl anthranilate can be dispersed as a fog which irritates the geese so that they leave immediately. It can also be sprayed on grass, making it unpalatable to the geese. The second chemical, anthraquinone, irritates the digestive system of the geese when eaten, but treated areas are visibly recognizable by geese and they may eventually learn to avoid these areas (HSUS 2019).

5.3.1.5 Public Outreach

Aggregations of waterfowl and pet feces are not only aesthetically undesirable, but they pose human and environmental health risks, as well as contribute to other water quality problems, including the growth of

algae and aquatic weeds from added nutrients. Public outreach will inform and educate residents of the lagoon area and users of the lagoon public parks and spaces on the importance of avoiding feeding wildlife at the lagoon and picking up and properly disposing of pet waste. An outreach campaign may include, but not be limited to using webpage postings, flyers, invoice inserts, mailers or signage.

In addition to aiding in the reduction of animal feces-related nutrient loading in the lagoon, public outreach is also important to make lagoon users aware that feeding waterfowl bread and other human foods may cause them health problems (Maslo 2013) and is a violation of CDFW regulations that prohibit the harassment of animals (Title 14 California Code of Regulations Section 251.1).

Finally, it is important to make the public aware of resources available for reporting issues in the lagoon such as the City's SeeClickFix app: https://seeclickfix.com/foster-city-ca.

6 Review and Update of Management Plan

It shall be the responsibility of the City/District Engineer to ensure that the LMP is reviewed and updated as necessary as conditions and action thresholds in response to nuisance conditions change. This may be annually to once every five years. Should significant changes occur in the lagoon operational and/or maintenance procedures during mid-year, an immediate update to the LMP should be considered. The primary goal of the routine review and update shall be to gauge the effectiveness of the program components in maintaining the lagoon's beneficial uses, while seeking to minimize or eliminate the reliance on herbicides and algaecides to accomplish this. Each routine update shall attempt to adjust the LMP as appropriate to further reduce the application of herbicides and algaecides to the lagoon.

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Appendix

Appendix A
EOA Technical Memorandum

MEMORANDUM

TO: **Allen Smith and Greg Baeza, City of Foster City**

FROM: **Bonnie de Berry, EOA, Inc.**

DATE: **September 7, 2021**

SUBJECT: **Foster City Lagoon Monitoring (March – August, 2021)**

1. INTRODUCTION

On June 30, 2020, Heal the Bay published the 2019-2020 Beach Bummer List[1], a ranking of the ten most polluted beaches in California based on levels of Fecal Indicator Bacteria (FIB). Heal the Bay's data sources include weekly data collected by the County of San Mateo (County) Division of Environmental Health Services (EHS) at public beaches in the County. Erckenbrack Park, a beach on the Foster City Lagoon, appeared on the list for the first time, at number four (4). In response to this ranking, City of Foster City (City) staff contracted with EOA, Inc. (EOA) to assist in a preliminary evaluation of potential sources of FIB to the Foster City Lagoon, with a focus on Erckenbrack Park. On February 24, 2021, EOA, in coordination with City staff, developed the Foster City Lagoon FIB Monitoring Program.

This Technical Memorandum summarizes results from the Lagoon FIB Monitoring Program for the period of March 15 – August 23, 2021. It also includes a discussion on potential FIB sources to the Lagoon and recommends mitigation measures for consideration.

2. ENVIRONMENTAL SETTING

The Foster City Lagoon is a man-made system that follows the meandering shape of a historic sough that was once present in the area (Figure 1). It is an essential component of the original 1960 Master Plan for what was to become Foster City. The Lagoon was completed in 1971 and is designed for recreational use and to serve as a drainage detention basin to capture runoff from the 100-year storm event. The water within the lagoon consists of a mixture of water from the San Francisco Bay (via Belmont Slough) and stormwater runoff from the majority of the City (2,313 acres) collected and conveyed through curb inlets, catch basins, and storm drains, i.e., the municipal separate storm sewer system (MS4).

The Lagoon holds approximately 424 million gallons of water. Its main channel is about 4.5 miles in length and ranges from 200 to 1,000 feet in width. The average maximum depth is six feet. The water level of the Lagoon is managed by the City. Water is allowed to enter the Lagoon via tidal inflows from Belmont Slough, controlled by a system of motorized slide gates located at the southwest end of the channel (Figure 1). Water levels in the Lagoon are lowered by gravity outflow and pumping to San Francisco Bay. During the winter (November 15 through March 15), water level is maintained at an elevation of 97.75 to 98.25 feet. When a major storm is predicted, water level is lowered to 97.0 feet to provide storage capacity for stormwater runoff. During the summer (March 15 through November 15),

[1] https://healthebay.org/wp-content/uploads/2020/06/Report-2020_web.pdf

water level is maintained at an elevation of approximately 99.0 feet, which provides for maximum water oriented recreational opportunities and aesthetics.

Throughout the year, Lagoon water is exchanged with Bay water on a weekly or monthly basis. The frequency of water exchange is driven by competing water quality needs. More frequent exchange allows for higher dissolved oxygen, aeration, and reduction of stagnant corners; however, the high nitrogen in Belmont Slough waters can result in increased algae production. Algae is primarily controlled by application of commercial dye, which restricts penetration of light needed for algae growth and results in a pleasing color. On rare occasions (less than one time per year), the City has also used aquatic herbicides to control algae in the Lagoon.

The Foster City Lagoon is a treasured recreational amenity where residents engage in swimming, windsurfing, paddle boarding, kayaking, and electric boating. There are seven parks along its 16.5-mile shoreline, including three with swimming beaches (Erckenbrack Park, Gull Park, and Marlin Park). The majority of the shoreline is owned by private residents and businesses, many of which have private boat docks.

3. SUMMARY OF LAGOON FIB MONITORING PROGRAM

The Lagoon FIB Monitoring Program includes collection of grab samples from the beach at Erckenbrack Park approximately every other week, and analysis of the samples for FIB and genetic markers of FIB. The primary goal of the Monitoring Program is to begin investigating sources of bacteria to the Foster City Lagoon and the seasonal variability in such sources. A secondary goal is to confirm data collected by County EHS.

- **Sample Station**. The Erckenbrack Park beach monitoring station is considered representative of the types of conditions that also occur at other beaches within the Foster City Lagoon (i.e., Gull Park beach and Marlin Park beach). However, for reasons unknown, Erckenbrack beach frequently has higher bacteria levels than the other Lagoon beaches. The Lagoon and all three Lagoon beaches are shown in Figure 1.
- **Schedule**. Samples are collected approximately every other week on Monday mornings, which is when EHS collects their weekly samples that are used for beach warning notifications. City sampling commenced on March 15, 2021. Specific monitoring dates are listed in Table 1.
- **Parameters**. Samples are analyzed for FIB and genetic markers of FIB.
    - **FIB.** Samples are analyzed for enterococci using method SM9230D by Cel Analytical, Inc. (Cel Analytical), in San Francisco, CA. Enterococci is the sole indicator now used by the State Water Resources Control Board (State Water Board) for the protection of recreational uses from the effects of pathogens in brackish inland surface waters, enclosed bays, and estuaries, such as the Foster City Lagoon. For single samples, the State Water Board's water quality objective (WQO) for enterococci is 110 cfu/100 mL.[2] It should be noted that, in addition to enterococci, County EHS also analyzes samples for total coliform and *E. coli*, and bases beach notifications on these indicators. However, total coliform and *E. coli* are no longer used by the State Water Board when making decisions about Clean Water Act (CWA) Section 303(d) impaired waterbody listings or subsequent development of Total Maximum Daily Loads (TMDLs).

[2] Colony forming units (cfu)/100 mL is used interchangeably with most probable number of colonies (MPN)/100 mL.

- **Genetic Markers**. Samples collected by the City at Erckenbrack Park are analyzed by Cel Analytical for host-specific bacteroides using quantitative polymerase chain reaction (qPCR) techniques to measure DNA. All samples are analyzed for human markers (method HF183), dog markers (DogBac), and goose markers (CGOF1). A small subset of the samples are analyzed for sea gull markers. The qPCR results are provided in units of gene copies per mL (gc/mL), a unit that is not directly comparable to the enterococci results which are reported as MPN/100 mL. Table 1 lists the markers that were targeted during each monitoring event for the period of March 15 through August 23, 2021. Human sources of fecal contamination pose the greatest potential threat to recreational uses because they are more likely to contain human pathogens. Dog markers were included in the Sampling Design because, along with human sources, dog sources of bacteria are considered to be "controllable" types of sources. Goose sources of bacteria are likely in the Lagoon as goose presence at the beaches is well established. Sea gull markers were included in the Lagoon FIB Monitoring Program due to the proximity of the Lagoon to San Francisco Bay where sea gulls are commonly found.

- **Quality Assurance/Quality Control (QA/QC)**. The Lagoon FIB Monitoring Program includes QA/QC measures and Data Quality Objectives (DQOs) such that all data will be comparable with the California State Water Board Surface Water Ambient Monitoring Program (SWAMP). Field QA/QC samples include field duplicates and field blanks collected at the frequencies shown in Table 1. Field duplicates are used to estimate sampling and laboratory precision. Field blanks provide an assessment of the sample collection techniques. All samples are collected and analyzed using the methods and protocols specified by SWAMP, and are consistent with those implemented by EHS.

Table 1. Foster City Lagoon Monitoring Events and Parameters. All samples were collected at the Erckenbrack Park beach.

	Analytical Parameters (method)						
Monitoring Date (2021)	**Enterococci (SM9230D)**	**Human (HF183)**	**Dog (DogBact)**	**Goose (CGOF1)**	**Sea Gull**	**Field Duplicate**	**Field Blank**
Mar 15	X	X	X	X	X	X	X
Mar 29	X	X	X	X			
Apr 5	X	X	X	X			
Apr 19	X	X	X	X	X		
May 3	X	X	X	X		X	X
May 17	X	X	X	X			
Jun 7	X	X	X	X	X		
Jun 21	X	X	X	X			
Jul 12	X	X	X	X			
Jul 26	X	X	X	X	X	X	X
Aug 9	X	X	X	X			
Aug 23	X	X	X	X			

4. LAGOON MONITORING RESULTS

This section presents the Lagoon Monitoring Results. Recommendations for control of FIB in the Lagoon are presented in the next section. Analytical laboratory results from the twelve monitoring events are listed in Table 2. Table 2 also includes enterococci results for all three Lagoon beaches provided by County EHS (Erckenbrack Park, Gull Park and Marlin Park). The locations of the three parks are shown in Figure 1. Key observations noted by City staff about potential bacteria sources at the time of sample collection are shown in Table 3.

4.1. Enterococci

4.1.1. Data Results

Enterococci is the sole indicator bacteria now used by the State Water Board for the protection of water contact recreational uses. Three (3) of the twelve (12) samples collected by the City (April 5, June 21, and August 23) had enterococci concentrations above the WQO (i.e., 110 MPN/100 mL), and a fourth sample (March 15) had an enterococci concentration approaching the WQO. This represents an exceedance rate of 25% of the dataset. The County data for Erckenbrack Park beach, which was collected weekly and has 23 data points during the March 15 through August 23 monitoring period, has a WQO exceedance rate of 35%. The WQO exceedance rates for Gull Park and Marlin Park in the County dataset were lower, at 0% and 13% respectively. It is currently unknown why enterococci concentrations are lower at Gull Park and Marlin Park.

There were no obvious seasonal patterns in the City and County datasets for the March 15 through August 23 monitoring period. The samples with high enterococci concentrations were spread evenly throughout monitoring period in the City and County datasets. There is also a lack of an obvious seasonal pattern in enterococci concentrations in the full County dataset which began on March 6, 2017 (Figure 2). Although sampling by the City commenced during the wet season, conditions were remarkably dry throughout the monitoring period. The 2020-2021 wet season was one of the driest on record for most precipitation stations in California, including those in the Bay Area.

Field observations of potential bacteria sources, such as the presence of dogs, people, wildlife, and their feces are presented in Table 3. There is no apparent connection between the number of wildlife or feces observed and the concentration of enterococci.

Table 2. Analytical Results of Foster City Erckenbrack Park Monitoring. County EHS Beach Monitoring Data for all Lagoon beaches shown for comparison. Enterococci values above the WQO (110 MPN/100 mL) are highlighted with bold font.

	Foster City FIB Monitoring					**County Beaches Monitoring**			
	Erckenbrack Park					**Erckenbrack**		**Gull Park**	**Marlin**
	Human (HF183)	Dog (DogBact)	Goose (CGOF1)	Sea Gull (lee sea gull)	Enterococci (City)	Enterococci (County)	Relative Percent Difference (City vs. County)	Enterococci (County)	Enterococci (County)
	(gc/mL)	*(gc/mL)*	*(gc/mL)*	*(gc/mL)*	*(MPN/100 mL)*	*(MPN/100 mL)*	*(%)*	*(MPN/100 mL)*	*(MPN/100 mL)*
State Water Board Water Quality Objective (WQO):					*110*	*110*	--	*110*	*110*
3/15/2021	ND	ND	ND	**2135**	108	52	70%	10	20
3/22/2021	--	--	--	--	--	**441**	--	20	**644**
3/29/2021	ND	5.2 DBLOD	ND	--	31	20	43%	75	30
4/5/2021	ND	2 DBLOD	**19**	--	**144**	**211**	38%	10	31
4/12/2021	--	--	--	--	--	51	--	20	10
4/19/2021	ND	2 DBLOD	2 DBLOD	ND	<10	**581**	193%	20	52
4/26/2021	--	--	--	--	--	20	--	41	10
5/3/2021	ND	ND	ND	--	20	41	69%	72	**465**
5/10/2021	--	--	--	--	--	10	--	62	52
5/17/2021	ND	ND	ND	--	10	10	0%	10	31
5/24/2021	--	--	--	--	--	97	--	30	41
6/1/2021	--	--	--	--	--	**121**	--	20	31
6/7/2021	ND	ND	**2121**	ND	84	20	123%	20	52
6/14/2021	--	--	--	--	--	**275**	--	50	10
6/21/2021	ND	ND	**172**	--	**712**	95	153%	41	74
6/28/2021	--	--	--	--	--	**185**	--	97	63
7/5/2021	--	--	--	--	--	--	--	--	--
7/12/2021	ND	ND	ND	--	30	63	71%	52	52
7/19/2021	--	--	--	--	--	**299**	--	31	30
7/26/2021	ND	ND	ND	ND	20 *	52 *	89%	10	31
8/2/2021	--	--	--	--	--S	**288**	--	41	52
8/9/2021	ND	ND	ND	--	50	31	47%	20	41
8/16/2021	--	--	--	--	--	86	--	31	10
8/23/2021	ND	ND	ND	--	**121**	85	35%	<10	**241**
Percent of samples that exceed WQO (110 MPN/100 mL):					25%	35%	--	0%	13%

DBLOD = Detected Blow Limit of Detection (used for PCR analysis only), ND = Not Detected

* On 7/26/21, the City and County analyzed samples collected from the same bottle (i.e., a split sample). All other samples were collected in separate bottles.

Figure 1. Foster City Lagoon (image provided by City of Foster City with notations by EOA).

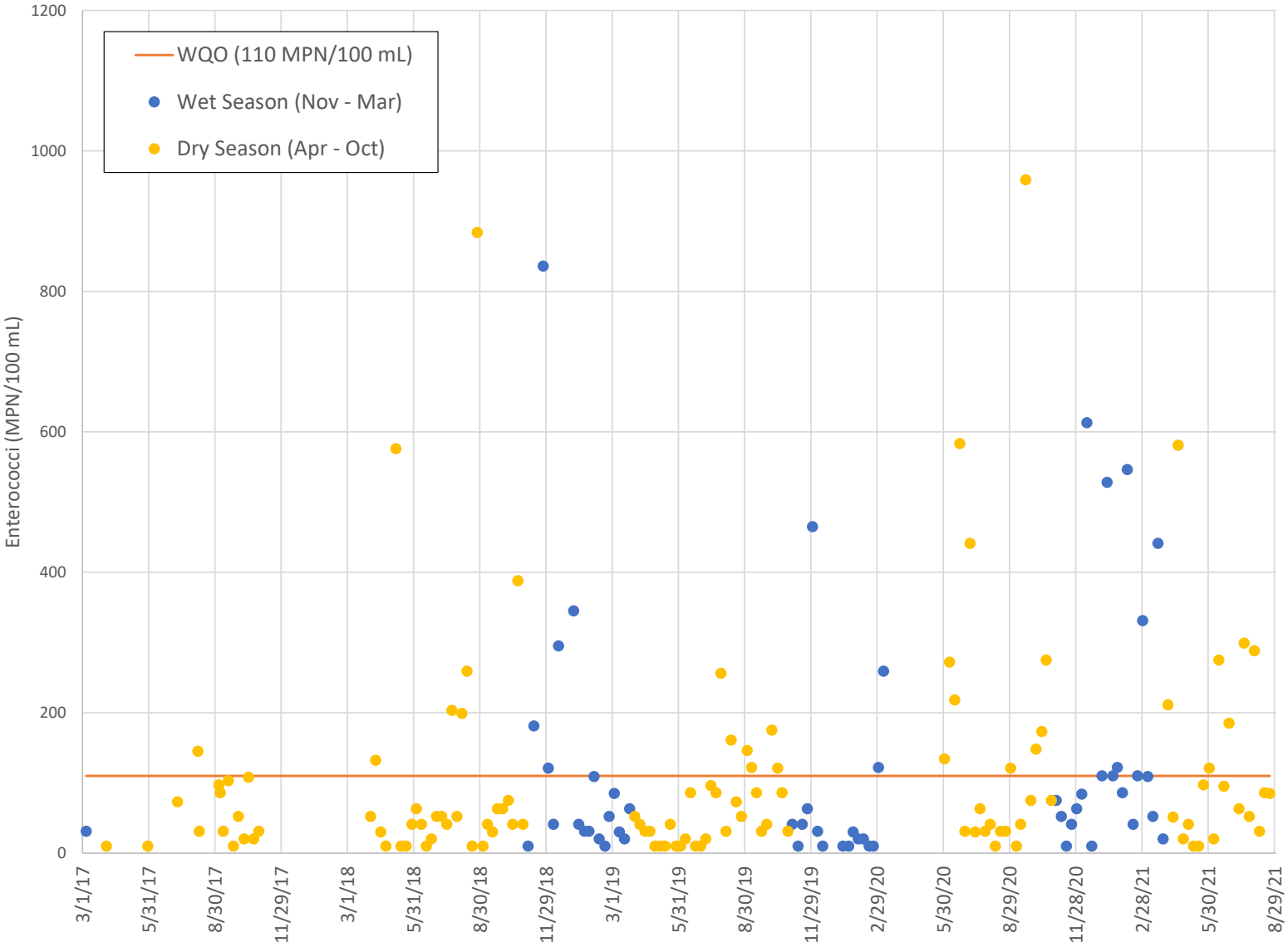

Figure 2. Enterococci Concentrations Reported by County EHS for Erckenbrack Park Beach, March 6, 2017 – August 23, 2021.

Table 3. Field Observations of Potential Bacteria Sources during Monitoring Events at Erckenbrack Park Beach. Dates with enterococci WQO exceedances are highlighted. Dates with detections of species-specific markers of goose, dog, and sea gull are highlighted in the relevant cells. No human markers were detected in this study.

	Potential Bacteria Sources							
Date (2021)	**Geese Present (Individuals)**	**Goose Feces Present on Beach**	**Goose Feces Present in Water**	**Goose Feces Level of Contamination**	**Dogs Present (Individuals)**	**Dog Feces Present (# of Waste Piles)**	**People Present (Individuals)**	**Other Animals Present**
Mar 15	5-20	Yes	Yes	Light	No	None	None	Ducks, 15 Seagull, 15
Mar 29	1-5	Yes	No	NR	Yes, 1	None	1-5	Ducks
Apr 5	None	No	No	No Visible Feces	No	None	1-5	None
Apr 19	None	No	No	No Visible Feces	No	None	None	None
May 3	5-20	Yes	No	NR	No	1-5	1-5	Seagulls, 2
May 17	None	No	No	No Visible Feces	No	None	1-5	None
Jun 7	5-20	Yes	Yes	Light	No	None	1-5	Ducks, Crows
Jun 21	>20	Yes	No	Light	No	None	None	Ducks, 5
Jul 12	None	Yes	No	No Visible Feces	No	None	1-5	None
Jul 26	5-20	Yes	No	Light	Yes, 2	NR	1-5	NR
Aug 9	None	Yes	No	Light	No	None	None	Duck, 5-10
Aug 23	None	Yes	No	Moderate	No	None	None	Ducks, Crows

NR = Not Reported (the field sheet was left blank for this parameter)

4.1.2. City County Comparison

Sample results by the City and County were compared by calculating the Relative Percent Difference (RPD)[3]. For the Lagoon FIB Monitoring Program an RPD of 100 percent is considered acceptable.

In June 2021, a preliminary review of the data suggested that there was sometimes poor alignment between the enterococci results from City samples and enterococci results at Erckenbrack Park from County samples. In particular, on April 19, the City sample had an enterococci concentration of <10 MPN/100 mL (i.e., the result was below the detection limit); whereas the County reported an enterococci concentration of 581 MPN/100 mL (Table 2). City staff confirmed that all samples were collected in close geographic proximity and near in time to those collected by the County, and the City's contract laboratory, Cel Analytical, confirmed that both laboratories use the same analytical method (SM9230D). As should be standard with microbial samples collected from brackish water, both laboratories dilute the samples by a factor of ten (10) to reduce potential interference in the analysis caused by high salinity.

In order to investigate whether the differences were caused by laboratory error, the City and Cel Analytical coordinated a split sampling event with the County field crew on July 26, 2021. The split

[3] The RPD is calculated by dividing the difference between the two samples by the average of the two samples.

sampling protocol involved collecting a single sample in the field and pouring that sample into two separate bottles for analysis by each lab. The enterococci results for the July 26 split sample were 20 MPN/100 mL and 52 MPN/100 mL for the City and County laboratories, respectively. The enterococci RPD on July 26 was 89%, which is within the expected range for natural variability in the enterococci method.

The RPD between the City and County samples is shown for the full dataset in Table 2. These overall RPD results combined with the findings from the July 26 split sample event highlight the high variability in FIB common to surface waters. In general, large sites, such as Erckenbrack Beach or the Lagoon, should be characterized using the geometric mean of several discrete samples collected at multiple locations (USEPA 2010). However, both the City and County monitoring programs are constrained by limited resources. Bacterial autoaggregation, or the formation of suspended bacterial clumps in the Lagoon, could also help explain the differences between City and County results (Trunk and others 2018). With the exception of the July 26 sample, the City and County collected separate samples from the Lagoon, albeit close in time and proximity. It is possible that clumps of bacteria were present in the Lagoon and were captured in one sample but not the other.

4.2. Human Sources of Bacteria

Human sources of bacteria represent the greatest threat to water contact recreation in the Lagoon because human fecal matter contains a greater number of human pathogens than other fecal sources. In addition, human sources of FIB (e.g., leakage from the private or municipal sanitary sewer system, discharge from recreational vehicles (RVs), homeless encampments, recreators defecating in the Lagoon, seepage from dumpsters containing human waste) are more controllable than many other FIB sources, such as wildlife, and therefore represent a potential opportunity for FIB reduction in the Lagoon. For this reason, the Lagoon Monitoring Program emphasizes the investigation of human sources of FIB by analyzing all samples for human-specific markers using the HF183 method.

Table 2 shows the results of the human marker analyses. None (0) of the twelve (12) samples collected by the City during the March 15 through August 23 monitoring period had detectable concentrations of human markers. These findings suggest that there were are no sources of human waste present at Erckenbrack Park beach during the monitoring events. Exceedances of the enterococci WQOs in the City and County datasets are likely caused by other sources of FIB.

4.3. Dog Sources of Bacteria

Dog (or canine) sources of bacteria in the Lagoon include wash-off of dog waste from upland areas to the Lagoon or MS4, dogs defecating in the Lagoon, and seepage from dumpsters containing dog waste. These sources of FIB are generally considered controllable because pet owners could be educated on proper pet waste management and encouraged to do so through incentive programs. All twelve (12) samples were analyzed for dog-specific markers.

Table 2 shows the results of the dog marker analyses. None (0) of the twelve (12) samples had concentrations of the dog marker above the method detection limit (MDL). However, three (3) samples collected early in the monitoring period (March 29, April 5, April 19) had detectable dog marker concentrations below the MDL. These concentrations are flagged in the dataset with “DBLOD” (Detected Below Limit of Dection), a qualifier that is used for PCR analysis only. The flagged results should be interpreted with caution because they are below the threshold that signifies confidence in the data. Nevertheless, it possible that there was a weak dog waste signal during the March 29, April 5, and April 19 monitoring events. On one of these days, March 29, the City field crew observed one (1) dog at Erckenbrack beach (Table 3). Two (2) dogs were observed on the morning of July 26 and a small number of dog waste piles (i.e., 1 to 5) were observed on May 3; no dog markers were detected on these dates.

Neither dogs nor dog waste piles were observed during any other monitoring events; however, monitoring occurred on Monday mornings and it is possible that dogs were brought to the beach at other times.

These findings suggest that there is opportunity for the City to control dog waste and potentially reduce the concentration of FIB in the Lagoon. However, full control of dog waste will likely not result in reductions of enterococci in Lagoon beach waters to below the WQO of 110 MPN/100 mL, as evidenced by enterococci WQO exceedances in samples collected by the City on two (2) days when no dog markers were detected.

4.4. Goose Sources of Bacteria

The presence of geese at the Foster City Lagoon beaches, and at other parks in the region, is a well-known problem that occurs year-round. As a result, the City has coordinated with the nearby Cities of Belmont, San Mateo, and Redwood City for the past seven (7) years to cooperatively track and attempt to control the goose population. Despite measures such as dog hazing, strobe lights, and egg addling, the Foster City goose population during the June 2021 census was 323 individual birds, almost double the count from June 2020, and well above the highest number that was observed over the last four (4) years of census records (Hall 2021). The entire region is experiencing growth in the goose population for unknown reasons.

Geese were present during six (6) of the twelve (12) Monday morning monitoring events (Table 3). Goose feces were observed on the beach at Erckenbrack Park during nine (9) monitoring events and in the water during two (2) events. These observations from the Lagoon Monitoring Program confirm that geese remain an issue at Erckenbrack Park. Furthermore, goose-specific genetic markers were detected in four (4) of the twelve (12) samples (Table 2). Although there was no obvious relationship between goose individual/feces observations and the enterococci concentrations or goose marker detections, these overall findings still suggest that goose waste is an ongoing contributor to FIB in the Lagoon. It is possible that control of goose waste could result in reductions of enterococci in beach waters to below the WQO of 110 MPN/100 mL.

4.5. Sea Gull Sources of Bacteria

Sea gulls are frequent visitors to the Lagoon and invariably contribute to FIB in the Lagoon and to the presence generic bird waste found all around the Lagoon. Although the City is not involved in actions to control sea gull or other non-goose avian/waterfowl populations, they occasionally implement bird waste clean-up actions. For example, on July 19, 2021, the City removed approximately 250 gallons of bird waste from the Lagoon abutment below Shell Bridge. City staff are careful to prevent discharge of bird waste to the Lagoon during these types of clean-up activities. Sea gull markers were included in the Lagoon Monitoring Program due to the proximity of the Lagoon to San Francisco Bay where sea gulls are commonly found and the availability of laboratory methods to detect the marker; however, due to resource limitations, only four (4) of the twelve (12) samples were analyzed for the sea gull marker.

Table 2 shows that sea gull markers were detected in one (1) (March 15) of the four (4) samples analyzed for this constituent. Table 3 shows that sea gull individuals were observed during two (2) of the twelve (12) Monday morning monitoring events, with the most individuals observed on March 15 when the sea gull marker was detected. These findings suggest that sea gull and other avian species (e.g., ducks, crows) contribute FIB to Erckenbrack Park beach. However, unlike geese, these avian wildlife species have not been identified as a nuisance at Lagoon parks, and options for control are likely limited.

5. SUMMARY AND RECOMMENDATIONS

5.1. Summary

The City of Foster City implemented a Lagoon FIB Monitoring Program from March 15 through August 23, 2021. Twelve (12) water samples were collected from the beach at Erckenbrack Park approximately every other week and analyzed for enterococci and several species-specific genetic markers (human, dog, goose, sea gull).

- Enterococci concentrations continue to be of concern in the Lagoon with exceedances of the WQO (i.e., 110 MPN/100 mL) at a rate of 25% in samples collected by the City. More frequent samples collected by County EHS (i.e., weekly) had a WQO exceedance rate of 35% during the monitoring period.
- Human sources of FIB, which would represent the highest threat to recreational use in the Lagoon, are unlikely based on the monitoring results. None (0) of the twelve (12) samples collected by the City had detections of human genetic markers. This finding supports what is already known about potential human FIB sources in the City. There is not a presence of unhoused people in the City. Furthermore, it is nearly impossible for the municipal sanitary sewer system (SSS) to leak into the MS4 because the SSS is below the ground water table.
- While human waste could contribute enterococci and other FIB to the Lagoon, there are many other sources of FIB, including wildlife and pets. These other sources of fecal material generally pose less of a threat to the health of swimmers compared to human waste because human viruses are generally unlikely to occur in animal feces (USEPA 2012).
    - Dog waste occasionally contributes to FIB in the Lagoon and represents a potential opportunity for control. Even a small amount of dog waste can contribute a large amount of enterococci to the environment. The USEPA estimates that the average dog produces about 0.75 pound (340 grams) of waste per day (USEPA 2001). Wright et al. (2009) estimates that each gram of dog waste contains approximately 3.9×10^7 colony forming units of enterococci (i.e., 39 million cfu; cfu is used interchangeably with MPN). Therefore, one dog could introduce about 13 billion cfu of enterococci to the Lagoon over the course of one day, which could easily result in an exceedance of the WQO of 110 cfu/100 mL in a localized area.
    - The primary source of FIB in the Lagoon appears to be wildlife (i.e., waterfowl such as geese, sea gulls, and ducks). Wright et al. (2009) estimates that bird waste contains approximately 3.3×10^5 cfu per gram (i.e., 330,000 cfu/g).

5.2. Recommendations

In order to reduce the amount of dog waste reaching the Lagoon, the City should review their current public outreach program for opportunities to improve messaging to pet owners. Other pet waste management opportunities include installation of dog waste cleanup stations at parks and along dog-walking trails throughout the City, a “pin-the-poo” program that targets repeat offenders, implementation of a pet waste pledge program with incentives, and direct mailers or emails to pet owners.

The City should continue to work with the nearby Cities of Belmont, Redwood City, and San Mateo to implement and improve the ongoing goose population control measures and goose waste cleanup activities.

5.3. Lagoon Management Considerations

Because FIB in the Lagoon appears to be caused primarily by wildlife populations that are difficult to control, the City should consider Lagoon management actions that create conditions that are favorable to bacteria die-off and/or eliminate/reduce conditions that are favorable to bacteria growth.

Bacteria that enter the Lagoon can continue to grow and increase in concentration through the formation of biofilms. Biofilms form on surfaces such as organic matter (i.e., leaves), structures, and sediments. Biofilms containing enterococci are likely to be found in the sediments on the bottom of the lagoon, in stagnant "corners" of the Lagoon, and on pipe walls in submerged sections of the MS4. Providing more water movement in the Lagoon through more frequent water exchange with Belmont Slough and San Francisco Bay could reduce the formation and growth of biofilms. However, as mentioned above, Belmont slough is relatively high in nutrients; therefore, this measure could result in increased algae growth. It is also possible that inflows from Belmont Slough contain enterococci concentrations above the WQO. Another method of increasing water movement in the Lagoon is the operation of fountains and/or aeration systems. If this measure is adopted, the City should avoid actions that disturb bottom sediments, which could result in resuspension of bacteria.

The City may also want to consider a commercial products advertised for the control of bacteria in lakes and ponds. For example, the City has already met with representatives from Earth Science Laboratories, Inc. to learn about their product, EarthTec, which is a highly biologically active form of copper ion (Cu^{2+}). EarthTec is registered by the USEPA as an algaecide and bactericide for use in lakes, ponds, reservoirs, sedimentation basins, and treatment lagoons. Representatives report that it can control of *E. coli* in laboratory studies within one to 8 hours of application depending on the amount used; however, it may be less effective at control of enterococci. It is possible that such a product could help keep enterococci concentrations at Lagoon beaches below the WQO of 110 MPN/100 mL.

Prior to use of a copper-containing chemical, the City should ensure that they are following required regulatory procedures. For example, all requirements in the State General Permit for the Discharge of Aquatic Pesticides (Order No. 2013-0002-DWQ as amended by Orders 2014-0078-DWQ, 2015-0029-DWQ and 2016-0073-EXEC) must be followed, including development and implementation of an Aquatic Pesticide Application Plan (APAP), compliance with applicable receiving water limitations (including those related to copper), and compliance with monitoring and reporting requirements. Adherence to this General Permit may require that the City request a short-term or seasonal exception from meeting copper receiving water limitations.

The copper receiving water limitations in the Aquatic Pesticides General Permit (Order No. 2013-0002-DWQ) are currently based on the California Toxics Rule. The copper limitation is expressed in dissolved concentration. For freshwater (salinity equal to or less than 1 part per thousand (ppt) 95% or more of the time) the copper limitation is dependent on the hardness of the receiving waters. For waters in which the salinity is equal to or greater than 10 ppt 95% or more of the time, the copper limitation is 3.1 ug/L. For waters in which the salinity is between 1 and 10 ppt, the more stringent limitation applies.

Isolation of the Lagoon from Belmont Slough and San Francisco Bay, which is the standard Lagoon condition when water exchange activities are not occurring, may be necessary during and after application, until copper concentrations have dropped below the Aquatic Pesticides General Permit copper limitations and/or the copper WQOs for San Francisco Bay. Copper WQOs in the segment of San Francisco Bay to which the Lagoon discharges are 6.0 ug/L (4-day average) and 9.4 ug/L (1-hour average) (SFBRWQCB 2017). Lagoon water containing copper concentrations above the copper WQOs should not be discharged to San Francisco Bay. This could impact the timing of the City's controlled water exchanges between the Lagoon and the Bay.

If the City decides to conduct a bacteria control pilot study with EarthTec (or a similar product) and/or if they install an aeration device, they should consider monitoring for enterococci at multiple locations in the Lagoon to assess the effectiveness of the treatment.

5.4. Next Steps

The City is continuing to collect samples approximately every other week through September and October. It is recommended that the City continue to implement the Lagoon Monitoring Program through March 2022 with the goal of generating a full year of MST data, including the wet season when stormwater runoff to the Lagoon is likely to occur.

6. REFERENCES

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Appendix B
Routine Monitoring Data Sheet

Foster City Lagoon
Routine Beach Monitoring

Beach *(Circle one)*: Erckenbrack / Gull / Marlin / Ryan A - Boat Rental / Ryan B – Lagoon Center

Project Personnel: _____ Monitoring Date: _____

Water Conditions

Clarity *(Circle one)*: Clear (see bottom) / Fair (1-2' visibility) / Poor (< 1' visibility)

Odor *(Circle one)*: None / Sulfides / Sewage / Petroleum / Mixed Other: _____

Water Temp (°F): _____ **Conductivity (mS/cm):** _____

Dissolved Oxygen (mg/L): _____ **Secchi Disk Depth (ft):** _____

Samples for Analytical Lab Collected: Yes ☐ No ☐

Potential Bacteria Sources *(circle as appropriate)*

Geese

Number of Geese Present: None / 1 – 5 individuals / 5 – 20 individuals / 20 or more individuals

Visible Goose Feces Contamination: No visible feces / Light fecal contamination / Moderate / Heavy

Location of Goose Feces: On beach / In water / Not applicable

Ducks

Number of Ducks Present: None / 1 – 5 individuals / 5 – 20 individuals / 20 or more individuals

Visible Duck Feces Contamination: No visible feces / Light fecal contamination / Moderate / Heavy

Location of Duck Feces: On beach / In water / Not applicable

Gulls

Number of Gulls Present: None / 1 – 5 individuals / 5 – 20 individuals / 20 or more individuals

Visible Gull Feces Contamination: No visible feces / Light fecal contamination / Moderate / Heavy

Location of Gull Feces: On beach / In water / Not applicable

Dogs

Number of Dogs Present: None / 1 – 5 individuals / 5 – 20 individuals / 20 or more individuals

Visible Dog Feces Contamination: No visible feces / Light fecal contamination / Moderate / Heavy

Location of Dog Feces: On beach / In water / Not applicable

Aquatic Vegetation and Algae *(circle or describe as appropriate)*:

Algae

Amount of Algae Observed: None / Light / Moderate / Heavy

Algae Location(s): Mats on bottom / Shoreline matting / Free-floating mats / Planktonic (pea soup appearance)

Other observations: _____

Widgeon Grass

Amount of Widgeon Grass Observed: None / Light / Moderate / Heavy

Widgeon Grass Location(s): Growth on bottom / Growth to Surface / Fragments / Rake Samples

Other observations: _____

Appendix C
Recommended Water Quality Equipment

xylem
Let's Solve Water

ProSolo ODO/CT

OPTICAL DISSOLVED OXYGEN, CONDUCTIVITY, AND TEMPERATURE METER

DON'T GO IT ALONE. GO SOLO.

The ProSolo DIGITAL handheld meter with ODO/CT offers exceptional affordability with unmatched durability. The user-friendly display delivers not only the industry's best DO, temperature, and conductivity data, but also calculated parameters such as salinity, specific conductance, and seawater density.

What do you get if you Go Solo?

- 3-year warranty on handheld, 2-year warranty on probe/cable assembly and ODO sensor cap
- Highly-accurate ODO® sensor technology with no stirring
- Real-time salinity compensation of DO measurements
- Rechargeable lithium-ion battery that supports a full day of sampling

YSI
a xylem brand

ProSolo OPTICAL DISSOLVED OXYGEN, CONDUCTIVITY, AND TEMPERATURE METER

WE KNOW D.O.

ProSolo Specifications

Dimensions	8.3 cm width x 21.6 cm length x 5.6 cm depth; 567 g (with battery)
Power	Rechargeable lithium-ion battery pack provides ~48 hours with the handheld only; Battery recharge time is ~ 9 hours with the AC power adapter; The instrument can also be powered via AC or external power through the USB port
Operating Temperature	0 to 50°C
Storage Temperature	0 to 45°C with battery installed; 0 to 60°C without battery installed
Display	Color, LCD graphic display; 3.9 cm width x 6.5 cm height
Memory	>100,000 data sets
Barometer Units: mmHg, inHg, mbar, psi, kPa, atm	Range: 375 to 825 mmHg; Accuracy: ±1.5 mmHg from 0 to 50°C; Resolution: 0.1 mmHg
Sites and Data ID	100 user-defined sites and 100 user-defined data ID tags; Site pictures can be sent to the handheld via KorDSS Software
Calibration Records	400 detailed calibration records can be stored and are available to view, download, and print (printing only available via KorDSS Software)
Languages	English, Spanish, German, French, Italian, Norwegian, Portuguese, Japanese, Chinese (Simplified & Traditional), Korean, Thai
Certifications	CEC, CE; RoHS; IP-67; WEEE; FCC; UN Part III, Section 38.3, Test methods for lithium-ion batteries (Class 9)
Warranty	3 years on handheld

ODO/CT Specifications

Size	2.46 cm diameter, cable options for 1, 4, 10, 20, 30, 50, and 100 m lengths
Dissolved Oxygen (Optical luminescence) Units: % saturation, % saturation local, mg/L, ppm	Range: 0 to 500%, 0 to 50 mg/L; Accuracy: 0 to 200%: ±1% of reading or 1% saturation, whichever is greater; 200 to 500%: ±8% of reading; 0 to 20 mg/L: ±0.1 mg/L or 1% of reading, whichever is greater; 20 to 50 mg/L: ±8% of reading Resolution: 0.01 mg/L and 0.1%, or 0.1 mg/L and 1% (auto-adjusts based on range)
Temperature (Thermistor) Units: °C, °F, K	Range: -5 to 70°C (temperature compensation range for DO mg/L measurement: -5 to 50°C); Accuracy: ±0.2°C; Resolution: 0.1°C or 0.1°F (auto-adjusts based on range)
Conductivity (Four nickel electrode cell) Units: µS/cm, mS/cm	Range: 0 to 200 mS/cm; Accuracy: 0 to 100 mS/cm ±0.5% of reading or .001 mS/cm, whichever is greater; 100 to 200 mS/cm ±1.0% of reading; Resolution: 0.001, 0.01, or 0.1 µS (range dependent)
Salinity (See YSI.com for additional calculated parameters) Units: µS/cm, mS/cm	Range: 0 to 70 ppt Accuracy: ±1.0% of reading or ±0.1 ppt, whichever is greater Resolution: 0.01 ppt
Warranty	2 years on cable, probe, and ODO sensor cap

xylem
Let's Solve Water

YSI, a Xylem brand
1725 Brannum Lane
Yellow Springs, OH 45387
Tel +1.800.897.4151

www.xylem.com

YSI.com/ProSolo-ODOCT

WATER•MARK®

WaterMark® Limnological Weighted Secchi Disc

Availability: Out of Stock – No ETA from Vendor
Click to Receive Notification When Available

Stock Number: 77912

Quantity	Price
1+	$71.95
5+	$68.50

Quantity: 1 Add To Cart

Add To My Equipment List

Share on:

Description | Specifications | Reviews | Q&A (1)

WaterMark Limnological Weighted Secchi Disc, Black/White
Silk screened with black and white quadrants, this 20 cm diameter secchi disc is made of Sintra® PVC. Unit includes: stainless steel hardware and built-in 24 oz. zinc sounding weight.

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US 800-647-5368 Canada 800-647-6450

Solid Braided Rope

Availability: In Stock

Stock Number: 77909

Size: 100' Spool

Price: $13.95

Quantity: 1 Add To Cart

Add To My Equipment List

Share on:

Description | Specifications | Reviews | Q&A

3/16" Solid Braided Rope, 100' Spool
Ideal for lowering or retrieving bailers in wells. Durable, 3/16" rope stays flexible and easy to handle. Holds knots well and is not affected by UV light. Tensile strength: 620 lbs.

Note: Reel is not included with the 500' model.

Aquatic Weed Eradicator

Excellent for controlling lake weeds

Availability: In Stock

Stock Number: 77779
Ben Meadows: 60790

Quantity	Price
1+	$162.50
3+	$152.75

Quantity: 1 Add To Cart

Add To My Equipment List

Share on:

Description | Specifications | Reviews | Q&A | Documents

Midwest Rake Company Aquatic Weed Eradicator
The 28" serrated cutting blade is reinforced ensuring the blades won't bend under a heavy load of weeds. To use, simply skim the eradicator across the water, let it sink, retrieve it in a short push-pull action, and drop the weeds off. 11' Powder-coated aluminum handle comes in two pieces.

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36" Lake Rake

Availability: Pre-order (Ships in 1-2 weeks)
Click to Receive Notification When Available

Stock Number: 77773
Ben Meadows: 224885

Quantity	Price
1+	$150.25
3+	$142.95

Quantity: 1 Add To Cart

Add To My Equipment List

Share on:

Description | Specifications | Reviews | Q&A

Midwest Rake Company 36" Lake Rake
Use to skim floating aquatic vegetation and algae from the water with the included float attachment. The float can also be removed for submerged aquatic weeds. This 36" wide aluminum rake comes with a 2-piece, 11' rust-proof powder-coated aluminum handle, detachable polyethylene float and 20' of rope. Shorten the handle and remove the float for use as a professional-grade landscaping rake.

Appendix D
CEL Laboratory Chain of Custody Form

cel analytical, inc.
water, wastewater, and soil laboratory services

82 Mary Street Suite #2
San Francisco, Ca 94103
Tel: (415) 882-1690
Fax: (415) 882-1685

Chain of Custody Record

Lab ID_____

Custody and Sample Information - Print ALL information. Put N/A in blanks not applicable.

Page_____**of**_____

Report to:
Allen Smith, Foster City
asmith@fostercity.org

Greg Baeza, Foster City
gbaeza@fostercity.org

Send Invoice to:
City of Foster City
100 Lincoln Centre Dr.
Foster City CA 94404

Project Name:
Lagoon Beaches FIB Monitoring

Turn Around Time
- ☐ Standard (7-10 d)
- ☐ 72 hrs
- ☐ 48 hrs
- ☐ 24 hrs

SOP#SP 02 Rev.5
Effective Date 4.21.2021

Sampler's Signature / Date / Time:

Indicate Analysis Requested

Item No.	Sample Identification	Sampling Date / Time	Total # of Sample Containers	Sample Type: G=Grab C=Composite	Preservative: $Na_2S_2O_3$	HCL	H2SO4	HNO3	NONE	Enterococci	Human	Dog	Goose	Sea Gull					
1																			
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			

Released By:	Date	Time	Received By:	Date	Time

Comments: Client Comment Area

Sample condition: ☐ Accepted ☐ Rejected

Temperature at the time of receipt:_____ºC

☐ Ice pack ☐ Blue Ice ☐ Wet Ice

Holding Time Preserved: ☐ Yes ☐ No

Sample Matrix: ☐ **Swab**

Sample Matrix: ☐ **Solid**

Solid Type: ☐ Soil ☐ Biosolid

Sample Matrix: ☐ **Water**

Water Type:
- ☐ Drinking water (DW)
- ☐ Ambient Water (AW)
- ☐ Wastewater (WW)
- ☐ Reagent Grade Water (RGW)
- ☐ Other Water

Appendix E
City of Foster City Canada Goose Population Management Plan

City of Foster City

CANADA GOOSE POPULATION MANAGEMENT PLAN

Overview

In response to the rising concerns about the number of Canada goose and the excrement they leave on Foster City beaches, playfields, parks, and walkways, creating a potential public health hazard and diminishing the community's ability to safely enjoy outdoor recreational amenities, the *Foster City Canada Goose Population Management Plan* is a framework by which the City may respond to public safety issues and work towards reducing overpopulation of Canada Goose. This plan provides an update on actions taken to date and identifies the next steps towards mitigating the geese population in Foster City.

The plan outlines strategies for population reduction and also provides a guide for City staff and members of the public to address Canada goose removal if necessary. It should be noted that the purpose of this plan is to be a guiding document and as such, the techniques prescribed will only be implemented as needed.

Background and Past Efforts

Most regional surveys show that Canada goose numbers are either increasing or stable, but overall they are at unprecedented numbers due to overpopulation. In the City of Foster City, the increasing number of Canada Goose has led to increased conflict and concern among human residents.

To keep the goose population at appropriate levels, for many years the City has implemented several management tactics. Some of these techniques have been implemented independently, as well as in conjunction with others, all with varying degrees of success. The chart below provides a summary of measures attempted through the years.

PAST AND CURRENT EFFORTS TO ADDRESS GEESE POPULATION MANAGEMENT		
Method	**Description**	**Did it Work?**
Dog Hazing	Dogs used to harass and 'stalk' geese making them feel less secure from predators.	Yes. This approach is temporary and tends to push geese to other properties.
Strobe Lights	Currently the City uses two strobe lights that were strategically placed at Leo J. Ryan Park.	No. No noticeable effects on the Goose behavior and bothersome to public.
Egg Addling	Keeping goose eggs from hatching curtailing reproduction so fewer geese will nest at a given site in the future.	Yes. Noticeable reduction in goose population can take several years as geese can live for upwards of 20 years.
Fence Barriers	Installation of various fencing to deter geese from entering water, limiting their access.	Yes. Fairly effective, but time-intensive to install and adjust as geese adapt, and barriers detract from parks.
Goose Deterrent	Liquid deterrents applied to lawn areas that is repulsive to geese.	Yes. Minor effectiveness and mixed results for a short-term basis, but strong odor.

While control efforts, both in Foster City and throughout the region, have been extraordinary, the regional non-migratory goose populations continue to increase.

Concerns

Canada Goose present an inherent concern in that they may cause damage to City areas as a result of overgrazing turf grass and landscaping, excessive bird-fecal accumulations, aggressive nesting behavior towards the public, and human health and safety hazards (i.e., disease transmission, traffic hazards when geese cross roads).

The majority of complaints with Canada Goose involve accumulations of feces on lawns and walkways at homes, schools, and public parks, compromising the overall quality of life, and having the potential to pose serious health threats due to the presence of disease-causing organisms.

Due to their inefficient digestive systems, grazing habits and molting patterns, geese do pose a risk to human health and safety. Canada Goose and their fecal matter can cause a deterioration in water quality in the City's surrounding water bodies (i.e., lagoon and beaches).

1.1 General Health and Avian Influenza Risks

Potential health risks posed by the abundant droppings of the Canada goose are a relatively untouched area of study as the urban goose concentrations are a relatively new phenomenon. Locally, high bacteria levels partly attributed to goose droppings have been identified in the Foster City lagoon and beach areas. Since 2017, these findings have resulted in mandatory beach closures after analysis of water samples for beaches at Erckenbrack Park, Marlin Park, and Gull Park.

Due to the fact that it is possible to contract disease from goose fecal matter, there are general recommendations for areas where these droppings may be present.

1. Wash hands, clothes and sports equipment immediately after exposure
2. Small children, pregnant women or immune-compromised individuals should avoid areas with high concentrations of droppings
3. Small children who may put hands in their mouths should not be placed in contact with these areas

Currently there is also concern with a potential pandemic threat of avian influenza (otherwise known as bird flu or the H5N1 virus). At present, there appears to be three likely scenarios for bird flu. From best to worst they are:

1. The virus will loose its virulence and while still spreading be less of a threat to humans and birds. This is hypothetical, based on changes between influenza strains found in the past and current flu outbreaks.
2. The virus will remain as it is and be spread widely by migratory birds. Management of bird/bird and bird/human contacts is and will continue to be required to follow the spread of the virus.
3. The virus will mutate and be transmitted human to human. This could produce a worldwide pandemic and would need to be addressed by the development of effective rapid quarantine methods and production of a vaccine.

1.2 Addressing Water Quality Impacts and Sampling

The City of Foster City, as a component of its Lagoon Management Plan, will contract with a lagoon water management company to help understand the best methods to reduce the bacteria levels in the lagoon. This can be achieved by several different methods including: chemical, mechanical, outreach programs, and wildlife population control. Additionally, lagoon water testing otherwise known as the "Fecal Indicator Bacteria (FIB) Monitoring Program" will continue (at least through March 2022) to provide a baseline data set that will assist in investigating sources of bacteria to Foster City Lagoon and the seasonal variability in such sources. Sampling will also help confirm data collected by County Environmental Health Services (EHS.)

Recommendations

The most effective strategy for alleviating resident Canada goose conflicts is an integrated mitigation plan to reduce the overall local population of geese. This involves curtailing reproduction, site aversion, and habitat modification to discourage and/or limit the number of birds in certain areas. Throughout the year an integrated goose program may include a combination of tactics.

2.1 Goals and Measures

The *Foster City Canada Goose Population Management Plan* is meant to target specific areas, where public health, safety, and property damage are at risk due to increased populations. The City's goal is to systematically work on these aspects to help address these issues.

Staff has identified three goals for implementing a Canada goose management program.

1. The primary goal is to focus annually on the open, green space and water areas in the City of Foster City to reduce the Canada goose population and address community concerns.
2. The second goal is to evaluate and develop strategies annually that employ both short-term and long-term methods, such as creating physical barriers that deter geese from loafing on property and addling eggs to curtail reproduction.
3. The final goal will be to support other community public and private property owners to develop plans and implement processes of their own to reduce the number of Canada Goose on property not owned by the City of Foster City.

Effective geese management plans generally follow a seasonal timeline, and therefore, the City of Foster City will generally implement this plan during the spring, summer, and fall seasons.

2.2 Management Techniques

The options for Canada goose management are varied in type and meeting the goals as outlined will require the implementation of a broad set of techniques. Any one management strategy used alone will likely be ineffective for any significant length of time, since tolerance and habituation will likely occur. As a result, City staff will implement the use of an integrated management approach, where a number of techniques are applied in varying ways at unique times and locations. Staff understands that future reduction plans may require new management strategies that require adjustments or improvements.

2.3 Population Reduction

Nesting Management

Annual nest search and treatment will be conducted in localized areas. The areas to be searched and treated include suitable nesting habitat immediately adjacent to water body areas. Nest searches and treatment protocol will follow methods prescribed by the required U.S. Department of Agriculture and U.S. Fish & Wildlife Service permits. Permit conditions will be followed and reporting will be conducted on an annual basis. To facilitate future nest searches, the City of Foster City will continue to collaborate with the neighboring cities in an egg-addling effort. Over the years, a regional contractor has addled thousands of eggs located at Bair Island, which generally won't make a noticeable impact in the population until a span of 20 years.

Removal and Disposition

Capture and removal of flightless, mixed age groups of geese during the spring/summer flightless period is an effective way to reduce localized population of geese during the peak golf course and park use time (May-September). The use of contractors to capture and remove for the disposition of geese is a management option for

consideration. Goose removal and disposition would need to be conducted according to the regulatory permit conditions.

Selective and occasional lethal removal of geese are also an effective complement to other nonlethal measures. Lethal removal of geese by means of euthanization is a management option. Such removal and disposition would also need to be detailed and conducted according to the regulatory permit conditions. Conditions would include the number of geese and the specific information about the methods to be used in their harvest and disposition.

Habitat Modification and Site Aversion

Site Modifications may include but are not limited to: no mowing areas, increase height of vegetation around ponds and creek banks, planting or promoting shrubs by natural willow colonization, landscape plantings, or added temporary or permanent barriers. The use of temporary snow fence, woven wire, fishing line, etc. that limits Canada goose access to the water areas during the spring, summer, and fall season may be considered. Any fencing that is installed would need to be removed prior to the winter season, and should be established in a manner that prevents geese from entering the fenced off area from the water or from the adjacent property areas. Staff may also expand use of strobe lights in and around water areas as well as stay up to date on all new technologies for goose reduction strategies.

Other techniques that may help with site aversion include liquid deterrents applied to lawn areas or fogging of the geese with a non-harmful chemical that will cause irritation and make the treated areas uninviting. The chemicals are not harmful to pets or other wildlife.

2.4 Public Information and Communication Plan

Informing the public about Canada Goose population management activities is an integral part of a successful goose management plan. Information will be shared through community publications, electronic tools, and public meetings. Signage or posted notices may also be developed for certain areas and activities if needed. All persons performing management activities will provide City staff with accurate and thorough information about goose management objectives, strategies, and schedules.

To incorporate early, open and ongoing communication, community engagement efforts may include, but is not limited to, the following means:

- City Webpage: A dedicated webpage on the City's website that will provide information regarding geese, past mitigation efforts, frequently asked questions, and a contact/comment form
- Factsheet: An informational handout summarizing the public health & safety issue, goals of the *Canada Goose Population Management Plan*, and where to learn more
- Brochure/Signage: Brochure for Parks Maintenance staff to hand out, as well as posted signage throughout parks to discourage members of the public from feeding birds
- Educational Video: An informational video that provides perspectives from different community stakeholders on the public health & safety issue
- Clean-Up Event: A community event that encourages public involvement and provides an educational opportunity for participants; related to Earth Day and sustainability efforts
- Press Releases: Periodic press releases advising the community of the public health & safety issues, providing notice and progress updates as different mitigation efforts are employed
- City's e-Newsletter: Sharing of relevant updates through the City's e-Newsletter (as needed)
- Social Media: Frequent posts through the City's social media platforms, including Facebook, Nextdoor, and Twitter (as needed)

2.5 Partner Relationships and Permit Requirements

Under the Migratory Bird Treaty Act (MBTA), Canada Goose are protected and are subject to the regulations of the Code of Federal Regulations, Title 50 - Wildlife and Fisheries. In general, state regulations follow federal regulations for the control of Canada Goose. The MBTA prohibits the "take" of protected migratory bird species without prior authorization (through a depredation permit) by the Department of Interior U.S. Fish and Wildlife Service. A depredation permit is required to control migratory birds that are causing, or if there exists the potential to cause serious damage. Depredation permits should only be sought after other deterrents have proved unsuccessful. They are intended to provide short-term relief for bird damage until long-term, non-lethal measures can be implemented to eliminate or significantly reduce the problem.

Coordination of all Canada geese population management activities will be communicated with the appropriate regulatory agencies, Parks & Recreation Department, Public Works Department, and the City Manager's Office. Population monitoring, permitting, annual reporting for egg addling and/or any other depredation permit, dates/conditions for permits, permit in possession while conducting activities, etc. will be the responsibility of City staff and all contractors employed to implement such services.

Lastly, City staff will explore opportunities for regional collaboration with other jurisdictions along the Peninsula that, too, experience persistent and increasing Canada Goose challenges as the population continues to rise. Foster City and its regional partners are engaged in an ongoing effort to elevate the goose population issue to the San Mateo County Health Department to determine whether the effects of the goose presence in the region constitutes a health emergency, which would expand the mitigation options available.

2.6 Staff Contact Information

Any questions regarding the *Foster City Canada Goose Population Management Plan* can be directed to: geese@fostercity.org.

ADOPTED: November 1, 2021 (via Minute Order No. 1816)

UPDATED: June 3, 2022 (non-substantive changes)