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TECHNICAL MEMORANDUM

Date:	August 1, 2019
To:	Reservoir Community Partners, LLC
From:	Kittelson & Associates, Inc.
Subject:	Balboa Reservoir – Non-CEQA Analysis, Overview and Executive Summary

INTRODUCTION

This memorandum summarizes the supplemental transportation analyses for the Balboa Reservoir development (proposed project). The supplemental transportation analyses covers topics not analyzed under California Environmental Quality Act (CEQA) that were identified in the scoping and project development process to support project development efforts and address community concerns. The analysis was conducted for informational purposes and is not intended to identify or develop recommendations for implementation. The following topics were analyzed:

- **Parking supply and demand.** The purpose of this analysis is to present parking supply and occupancy counts, present a methodology and framework for ongoing monitoring and reporting of parking utilization rates, and assess the effect of the proposed development on existing off-street and on-street parking.
- **Vehicle operations.** The objective of the analysis is to evaluate existing and existing plus project corridor operations along Ocean Avenue and Ridgewood Avenue-Frida Kahlo Way and intersection operations at select study intersections to estimate the changes in travel time attributable to the project and to evaluate potential modifications to improve traffic flow and vehicle progression at intersections along Ocean Avenue. Data on existing transit operations is used to inform the evaluation.
- **Shuttle feasibility.** The purpose of this analysis is to assess the feasibility of a shuttle operating between the Balboa Reservoir site, the City College of San Francisco (CCSF) campus, and the Balboa Park BART/Muni station.

The key findings of the parking analysis, operations analysis, and shuttle study are presented in this memorandum. The technical memorandums are included as attachments.

PARKING ANALYSIS

The key findings of the parking supply and utilization data collection and the parking demand analysis are summarized in this section.

Off-Street Parking Supply and Utilization

The project site is located west of City College of San Francisco's (CCSF) Ocean Campus, east of the Balboa Park neighborhood, and south of Archbishop Riordan High School. The project site is currently occupied by a 1,007-space surface parking lot ("Lower Lot" or west basin) accessed by two driveways on Frida Kahlo Way. The Lower Lot serves as overflow parking for the CCSF's 1,167-space Upper Lot (or east basin), which is accessed from the same two driveways on Frida Kahlo Way.

Parking inventory and occupancy data was collected at both the Upper and Lower Lots on Thursday, December 7, 2017, Wednesday, January 31, 2018, and Wednesday, April 18, 2018 when CCSF was in session. The peak hourly utilization of both the Lower Lot and Upper Lot was observed to occur between 10 a.m. and 1 p.m. The observed maximum combined occupancy rate of 73% (1,596 cars parked and 578 spaces available) occurred on Wednesday, January 31, 2018 between 11 a.m. and 12 p.m.

The Upper Lot can accommodate the existing combined parking demand (the total demand observed at both the Lower Lot and Upper Lot) during the a.m. and p.m. periods (7 to 9 a.m. and 5 to 7 p.m.) but would not meet the combined parking demand during the weekday midday period (10 a.m. to 12 p.m.). During the weekday midday peak hour of parking demand, assuming parking was available only at the Upper Lot, there would be a shortfall of up to 239 parking spaces.

Neighborhood (On-Street) Parking Supply and Utilization

On-street parking utilization data were collected by IDAX Data Solutions[1] in the site vicinity on two weekdays in February 2019. Each block face within the neighborhood on-street parking study area was observed three times a day for two days: at 9:00 a.m. (a.m.), 2:00 p.m. (midday), and 8:00 p.m. (p.m.). Days with street cleaning or abnormal parking behavior were avoided. Parking supply data in the form of number of available parking spaces per block were provided by San Francisco Municipal Transportation Agency (SFMTA).

Based on this data, there are a total of 906 parking spaces within the parking study area and between approximately 200 and 300 on-street spaces are available on weekdays during any given time period (a.m., midday, and p.m.). The highest levels of occupancy were generally observed to occur during the weekday p.m. period.

Parking Demand Analysis

Parking demand was calculated for residential, short-term retail and daycare visitors, and long-term employee parking for both the retail and childcare uses. This parking demand estimation focuses on the midday time period when the retail and childcare are active and existing CCSF parking demand would exceed capacity of the Upper Lot. While adjustments were made to account for the proposed

[1] IDAX Data Solutions is a multimodal data solutions company providing transportation data with an office in San Francisco, CA.

transportation demand management (TDM) plan and affordable housing on site, the estimated project-generated parking demand can be considered conservative and likely overstates demand based on the site context and travel characteristics, transit proximity and quality, and existing and expected travel characteristics.

The Developer's Proposed Option would generate a total midday parking demand for 455 vehicle parking spaces (426 residential, 29 retail and childcare visitor, 18 retail and childcare employee). The Additional Housing Option would generate a total midday parking demand for 631 vehicle parking spaces (602 residential, 29 retail and childcare visitor, 18 retail and childcare employee).

The vehicle parking supply proposed under each development scenario was evaluated against the estimated parking demand generated by the project and the existing CCSF overflow demand. Based on this analysis, the projected residential parking demand can be met on-site with the currently proposed 0.5:1 parking ratio under the Developer's Proposed Option during the midday and overnight periods and the Additional Housing Option during the midday period. There would be a 101 space residential parking space shortfall during the overnight period with the Additional House Option.

The parking demand associated with the retail and child care visitor and employee demand (29 spaces) and CCSF overflow demand (239 spaces) could be met by available on-street parking spaces within the neighborhood parking study area (316 spaces during the midday period, 217 spaces during the overnight period). The analysis of the Developer's Proposed Option does not include the 750-space parking garage that is analyzed in the EIR. Some or all of these parking spaces could be included in the final project to meet projected demand. Alternatively, the parking demand from the retail and daycare visitors and employees and overflow CCSF vehicles could be accommodated by a combination of reducing CCSF parking demand through planned TDM measures and/or a shared parking agreement with the Balboa Reservoir project.

The Balboa Reservoir development intends to monitor and manage its parking efficiently while working to encourage the use of transportation modes other than the single occupancy vehicle. Shared or flexible parking designations between residential, retail, and CCSF uses would help to minimize the total number of parking spaces needed to meet project-generated parking demand and overflow CCSF parking demand resulting from the redevelopment of the Lower Lot. Implementation of TDM measures and a shared parking agreement with CCSF would reduce any secondary effects of parking shortfalls on the neighborhood parking supply.

OPERATIONS ANALYSIS

Analysis was conducted for existing and existing plus project conditions. Existing plus project conditions reflects the existing transportation network with the inclusion of vehicle trips generated by the Additional Housing Option. For the purposes of a more conservative analysis, the Additional Housing Option was evaluated, as it would generate more vehicle trips and would therefore have a greater effect on corridor delay and intersection operations. The Developer's Proposed Option would generate about 25 percent fewer vehicle trips and as a result, would be expected to result in less delay compared to the Additional Housing Option.

Corridor Analysis

The corridor delay analysis considers the change in vehicle delay with the addition of project-generated vehicle trips during the weekday a.m. and p.m. peak hours along the following two corridors:

- Ocean Avenue, from Plymouth Avenue to San Jose Avenue
- Ridgewood Avenue-Frida Kahlo Way, from Ridgewood Avenue/Monterey Boulevard to Frida Kahlo Way/Geneva Avenue/Ocean Avenue

The Additional Housing Option would increase delay along the Ocean Avenue study segment by one second in the eastbound direction during the weekday a.m. peak hour and by two seconds and eight seconds in the eastbound and westbound directions, respectively during the weekday p.m. peak hour.

The Additional Housing Option would increase delay along the Frida Kahlo Way study segment by one second in the northbound and southbound directions during the weekday a.m. peak hour and by three seconds in the southbound direction during the weekday p.m. peak hour.

Intersection Operations Analysis

A detailed intersection operations analysis was conducted to identify more specifically how operations may change with the addition of project-generated vehicle trips from the Additional Housing Option during the weekday a.m. and p.m. peak hours at the following three study intersections:

- Brighton Avenue/Ocean Avenue
- Lee Avenue/Ocean Avenue
- Frida Kahlo Way/Geneva Avenue/Ocean Avenue

These three study intersections were selected for analysis to address concerns raised by the community regarding operations at these locations.

The analysis considers the delay, queue length, and level of service for each approach and for the intersection overall. Intersection volumes were adjusted to reflect the peak hour and lane utilization factors[2]. Overall, vehicle trips generated by the Additional Housing Option are not anticipated to substantially increase delays at study intersections during the weekday a.m. and p.m. peak hours. The

[2] Peak hour factor is defined as the hourly volume divided by the peak (fifteen) minute flow rate within that same hour. The lane utilization factor indicates the "uniform" use of available lanes. It is the ratio of the average volume per lane to the heaviest volume in one lane.

key findings of the intersection operations analysis comparing existing with existing plus project conditions are summarized in this section.

Brighton Avenue/Ocean Avenue

- There would not be a substantial change to the delay, queue lengths, and level of service with the addition of project-generated vehicle trips.
- With the addition of project trips, the overall intersection delay may be slightly reduced (by less than one second per vehicle and by 1.3 seconds per vehicle during the weekday a.m. and p.m. peak hours, respectively), as a larger proportion of trips travelling through the intersection are doing so on the coordinated phase, thereby increasing the efficiency of the signal and reducing average vehicle delay.

Lee Avenue/Ocean Avenue

- With the addition of project-generated vehicle trips, the overall intersection delay is projected to slightly increase (by 2.0 and 4.2 seconds per vehicle during the weekday a.m. and p.m. peak hours, respectively).
- The southbound approach is projected to experience the greatest change in delay, queues, and level of service with the addition of project-generated vehicle trips. The delay is estimated to increase by 11.6 seconds per vehicle during the weekday a.m. and p.m. peak hours. The queue length is estimated to increase by 87 feet during the weekday a.m. peak hour and by 81 feet during the weekday p.m. peak hour. The level of service is estimated to change from LOS C to LOS D during the weekday a.m. and p.m. peak hours.

Frida Kahlo Way/Geneva Avenue/Ocean Avenue

- The overall intersection delay is anticipated to increase by 18.4 seconds per vehicle during the weekday a.m. peak hour and by 37.2 seconds per vehicle during the weekday p.m. peak hour with the addition of project-generated vehicle trips.
- The westbound approach is projected to experience the greatest change in delay, queues, and level of service with the addition of project-generated vehicle trips during the weekday a.m. and p.m. peak hours. The delay is estimated to increase by 28.1 and 70.5 seconds per vehicle, respectively. The queue length is estimated to increase by 38.6 and 115 feet, respectively. The level of service is estimated to worsen from a LOS E to a LOS F during the weekday p.m. peak hour.

Potential Intersection Modifications

Intersection modifications can be made to increase safety and capacity, improve vehicle progression, and reduce congestion on the road. The most common strategies include optimizing or modifying signal timing and implementing physical changes or turn movement restrictions at intersections to increase efficiency of intersection or corridor operations. Potential intersection modifications were described and analyzed in the Operations Analysis technical memorandum. Key findings are presented in this section.

Signal Timing Modifications

One of the major objectives of traffic signal optimization is to increase the capacity of at-grade intersections. For this analysis, at each study intersection, five seconds of green time was reallocated from the north/south approaches to the east/west approaches. In other words, green time on Ocean Avenue was increased by five seconds for each phase while the overall cycle length remained fixed. Increasing green time on Ocean Avenue would:

- Decrease overall intersection delays at Brighton Avenue/Ocean Avenue and Frida Kahlo Way/Geneva Avenue/Ocean Avenue by between 1 and 5 seconds and between 45 and 51 seconds, respectively. However, Synchro may overestimate the change in delay and queue lengths reported at Frida Kahlo Way/Geneva Avenue/Ocean Avenue, which operates at, or near, capacity.
- Increase overall intersection delay at Ocean Avenue/Lee Avenue by between 1 and 5 seconds.
- Reduce delay and queue lengths on the eastbound and westbound approaches and increase delay and queue lengths on the northbound and southbound movements at all study intersections.

Signalized intersections along Ocean Avenue operate as actuated-coordinated signals[3] with maximum recall[4] that operate on a fixed cycle length. Signal timing modifications implemented at these three intersections in isolation may adversely affect vehicle progression and have unintended consequences for operations along the corridor. Any adjustments to signal timing would need to be reviewed and approved by SFMTA.

Other Modifications

In addition to signal timing modifications, other intersection modifications and treatments along the corridor may be implemented to increase efficiency of operations and reduce vehicle delay and queue lengths along the corridor. These include installation of left-turn lanes, installation of right-turn lanes, implementation of turn restrictions, and intersection redesign. These treatments can be costly if

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[3] Actuated signals prioritize the through movement of the major street and use sensors to respond to the traffic present at actuated approach, so that the pattern of the signal (the length and order of each phase) depends on the traffic and can be different at every cycle. Sensors report to the signal computer and green is provided for those actuated lanes only when traffic is present and only until the traffic has vacated those lanes or the maximum time set for that phase has been reached.

[4] Each phase in a signalized intersection is given a recall mode of either no call, minimum, maximum, or pedestrian. No recall implies that a phase can be skipped if no vehicles are present/detected. Minimum recall indicates that a phase is being called for its minimum green time, independent of a vehicle's presence. Maximum recall specifies that a phase is being called for its maximum green time. Pedestrian recall means that a phase will always service the pedestrian walk and clearance interval times independent of a pedestrian's presence.

additional right-of-way is needed and there may be other tradeoffs to consider, such as potential adverse effects on conditions for bicyclists and pedestrians. Modifications that would require roadway widening, additional right-of-way, rail reconfiguration, or signal relocation would be major infrastructure projects and may not be feasible or appropriate within the context of the corridor.

Planned projects that are intended to improve safety, access, and comfort for people traveling along Ocean Avenue include the Ocean Avenue Safety Project and I-280 Interchange Modifications at Balboa Park Project.

SHUTTLE STUDY

A shuttle feasibility assessment was conducted to evaluate the potential for shuttle service operating between the Balboa Reservoir Site, CCSF Ocean Avenue campus, and the Balboa Park BART/Muni station. The analysis includes a ridership assessment, service concept, and feasibility analysis. Key findings from the assessment are summarized in this section.

The Balboa Reservoir development is expected to generate up to 2,700 transit trips[6] each day, many to/from the Balboa Park BART/Muni station, approximately 0.6 mile east of the project site. While the total travel demand between these destinations is high, and the shuttle would have convenient stop locations, the shuttle's indirect loop route would have to compete with the high frequency and direct travel of the existing transit service and the flexibility and speed of walking.

The conceptual shuttle route is approximately 2.25 miles long with an estimated peak hour travel time of approximately 31.5 minutes, with variability based on congestion, signal delay, passenger boarding/alighting, final routing, and layover scheduling. The shuttle system route would have stops within the Balboa Reservoir site, on CCSF campus, at City College Terminal, and at the Balboa Park BART/Muni station.

Muni currently offers convenient connections to the Balboa Park BART/Muni station. The K/T Third/Ingleside light rail and Muni bus routes 8, 29, 49, and 91 have stops on Ocean Avenue or the City College Terminal near the project site. Muni route 43 operates on Frida Kahlo Way adjacent to CCSF and on Geneva Avenue to the Balboa Park BART/Muni station. Typical wait times are under five minutes during the weekday a.m. and p.m. peak periods.

The Balboa Reservoir shuttle demand model is calibrated to high shuttle use estimates to serve as a proof of concept. The convenience of a free shuttle was estimated to be more appealing than, and capture the majority of, the BART riders that may otherwise walk, take other transit options, drive alone/carpool, or be dropped off in a taxi or transportation network company vehicle (e.g,. Uber, Lyft). With the shuttle

[6] Source: Balboa Reservoir Transit Assessment Memorandum, June 25, 2019.

operating with at least two vehicles in service, approximately half of the walk trips and the majority of transit, drive alone, and kiss and ride modes would be expected to switch modes and use the shuttle.

However, given that multiple Muni lines serve stops near Balboa Reservoir and CCSF operating on 8-10 minute headways during weekday a.m. and p.m. periods and typical waiting times are under five minutes, the shuttle would have to operate at high frequencies throughout the day to effectively compete with the existing transit service and walking trips. With three shuttle buses in operation, vehicle headways and average waiting time would match that of existing peak hour service. This level of shuttle service is forecast to have an estimated cost of $762,500 to over $1 million per year without considering factors, such as regulatory requirements and operator staffing and scheduling, which would increase costs and may present substantial hurdles to implementation. If a lower frequency and less costly service were provided as an alternative, it would not be competitive with the existing transit and walking alternatives and would see less use. Overall, the shuttle system route would be duplicative with existing transit connection to the Balboa Park BART/Muni station for passengers able to walk to nearby bus and light rail stops. The costs and convenience associated with providing shuttle service should be weighed against alternatives, such as subsidized first mile/last mile taxi or transportation network company rides for those with mobility needs.

ATTACHMENTS

A. Parking Analysis Technical Memorandum
B. Operations Analysis Technical Memorandum
C. Shuttle Study Technical Memorandum

ATTACHMENT A: PARKING ANALYSIS TECHNICAL MEMORANDUM

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TECHNICAL MEMORANDUM

Date:	August 1, 2019
To:	Reservoir Community Partners, LLC
From:	Kittelson & Associates, Inc.
Subject:	Balboa Reservoir – Parking Analysis Memorandum

This memorandum summarizes the results of a parking study conducted for the Balboa Reservoir development (proposed project). The project site is located west of City College of San Francisco's (CCSF) Ocean Campus, east of the Balboa Park neighborhood, and south of Archbishop Riordan High School. The project site is currently occupied by a 1,007-space surface parking lot ("Lower Lot" or west basin) accessed by two driveways on Frida Kahlo Way. The Lower Lot serves as overflow parking for the CCSF's 1,167-space Upper Lot (or east basin), which is accessed from the same two driveways on Frida Kahlo Way.

The purpose of this analysis is to present parking supply and occupancy counts, present a methodology and framework for ongoing monitoring and reporting of parking utilization rates, and assess the impact of the proposed development on existing off-street and on-street parking under several development scenarios. The memorandum is organized as follows:

- Data collection summary
- Parking demand analysis
- Parking monitoring plan
- Conclusion

DATA COLLECTION SUMMARY

Off-Street Parking

Parking inventory and occupancy data was collected at both the Upper and Lower Lots on Thursday, December 7, 2017, Wednesday, January 31, 2018, and Wednesday, April 18, 2018 on a typical non-holiday, non-registration period day when CCSF was in session. Parking data was collected on an hourly basis between 7:00 a.m. and 9:00 p.m. The number of spaces in the Upper and Lower Lots were counted with the use of aerial photography and then verified in the field. Parking occupancy was collected manually by field technicians. The parking lots were divided into areas with a field technician responsible for collecting data in each. Technicians walked the lots every hour, manually counting the number of full and empty stalls in each area. Data was marked by hand in the field and transferred to spreadsheets. The spreadsheet data entries were then checked against the manual entries.

Parking supply and occupancy data are summarized in Exhibit 1 and Exhibit 2. Exhibit 3 illustrates the average utilization from all three dates.

Exhibit 1: Existing CCSF Upper/Lower Lot Parking Supply and Occupancy

	Lower Lot (1,007 Spaces)			Upper Lot (1,167 Spaces)			Combined (2,174 Spaces)		
Time	Parked	Available	Utilization	Parked	Available	Utilization	Parked	Available	Utilization
Thursday, December 7, 2017									
7	0	1007	0%	39	1128	3%	39	2135	2%
8	3	1004	0%	181	986	16%	184	1990	8%
9	11	996	1%	614	553	53%	625	1549	29%
10	133	874	13%	1078	89	92%	1211	963	56%
11	235	772	23%	1071	96	92%	1306	868	60%
12	253	754	25%	1083	84	93%	1336	838	61%
13	167	840	17%	1058	109	91%	1225	949	56%
14	101	906	10%	813	354	70%	914	1260	42%
15	87	920	9%	693	474	59%	780	1394	36%
16	40	967	4%	476	691	41%	516	1658	24%
17	26	981	3%	361	806	31%	387	1787	18%
18	9	998	1%	429	738	37%	438	1736	20%
19	6	1001	1%	537	630	46%	543	1631	25%
20	2	1005	0%	445	722	38%	447	1727	21%
21	1	1006	0%	184	983	16%	185	1989	9%
Wednesday, January 31, 2017									
7	1	1006	0%	79	1088	7%	80	2094	4%
8	4	1003	0%	298	869	26%	302	1872	14%
9	139	868	14%	958	209	82%	1097	1077	50%
10	407	600	40%	1094	73	94%	1501	673	69%
11	533	474	53%	1063	104	91%	1596	578	73%
12	483	524	48%	1046	121	90%	1529	645	70%
13	297	710	29%	963	204	83%	1260	914	58%
14	186	821	18%	876	291	75%	1062	1112	49%
15	135	872	13%	726	441	62%	861	1313	40%
16	76	931	8%	555	612	48%	631	1543	29%
17	55	952	5%	482	685	41%	537	1637	25%
18	17	990	2%	621	546	53%	638	1536	29%
19	12	995	1%	745	422	64%	757	1417	35%
20	8	999	1%	612	555	52%	620	1554	29%
21	4	1003	0%	251	916	22%	255	1919	12%
Wednesday, April 18, 2018									
7	3	1004	0%	56	1111	5%	59	2115	3%
8	4	1003	0%	265	902	23%	269	1905	12%
9	9	998	1%	706	461	60%	715	1459	33%
10	126	881	13%	847	320	73%	973	1201	45%
11	238	769	24%	1078	89	92%	1316	858	61%
12	181	826	18%	1009	158	86%	1190	984	55%
13	187	820	19%	939	228	80%	1126	1048	52%
14	85	922	8%	792	375	68%	877	1297	40%
15	67	940	7%	633	534	54%	700	1474	32%
16	39	968	4%	536	631	46%	575	1599	26%
17	22	985	2%	449	718	38%	471	1703	22%
18	17	990	2%	489	678	42%	506	1668	23%
19	10	997	1%	563	604	48%	573	1601	26%
20	5	1002	0%	510	657	44%	515	1659	24%
21	5	1002	0%	141	1026	12%	146	2028	7%

Sources: Kittelson & Associates, Inc. 2019; Quality Counts, 2017 & 2018.
Note: Parking utilization was rounded.

Exhibit 2: Existing CCSF Upper/Lower Lot Parking Supply and Occupancy – Thursday, December 7, 2017

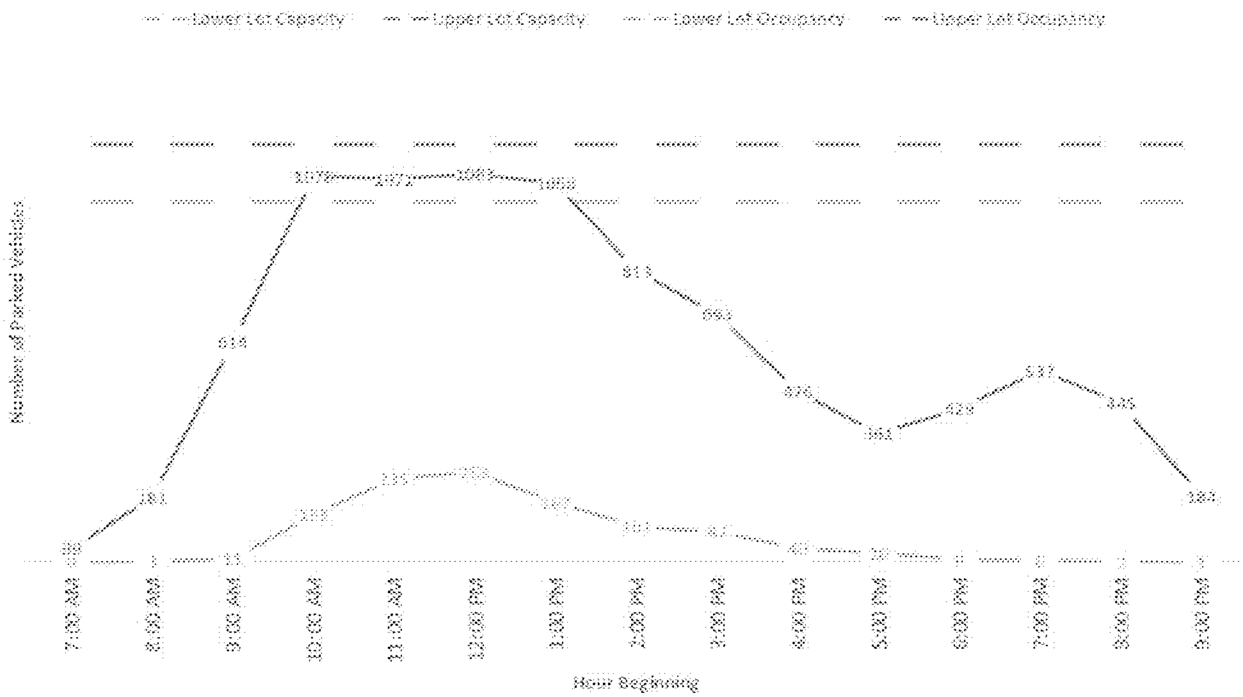


Exhibit 3: Existing CCSF Upper/Lower Lot Parking Supply and Occupancy – Wednesday, January 31, 2018

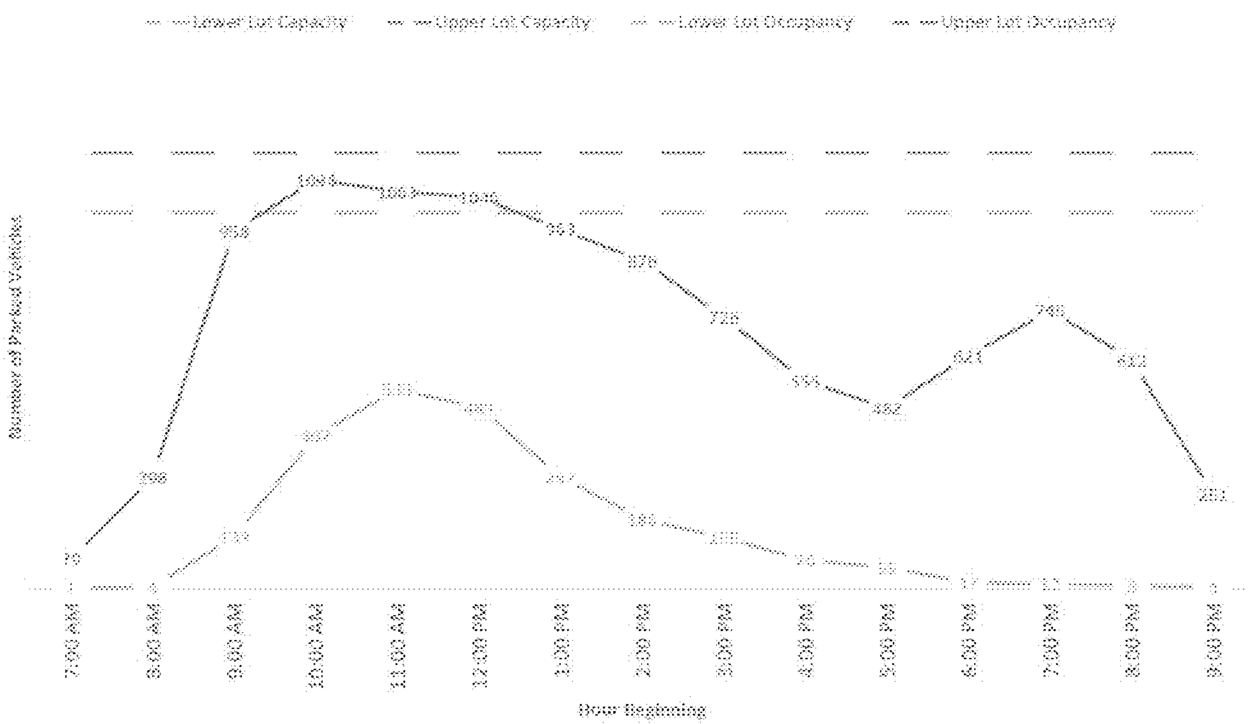
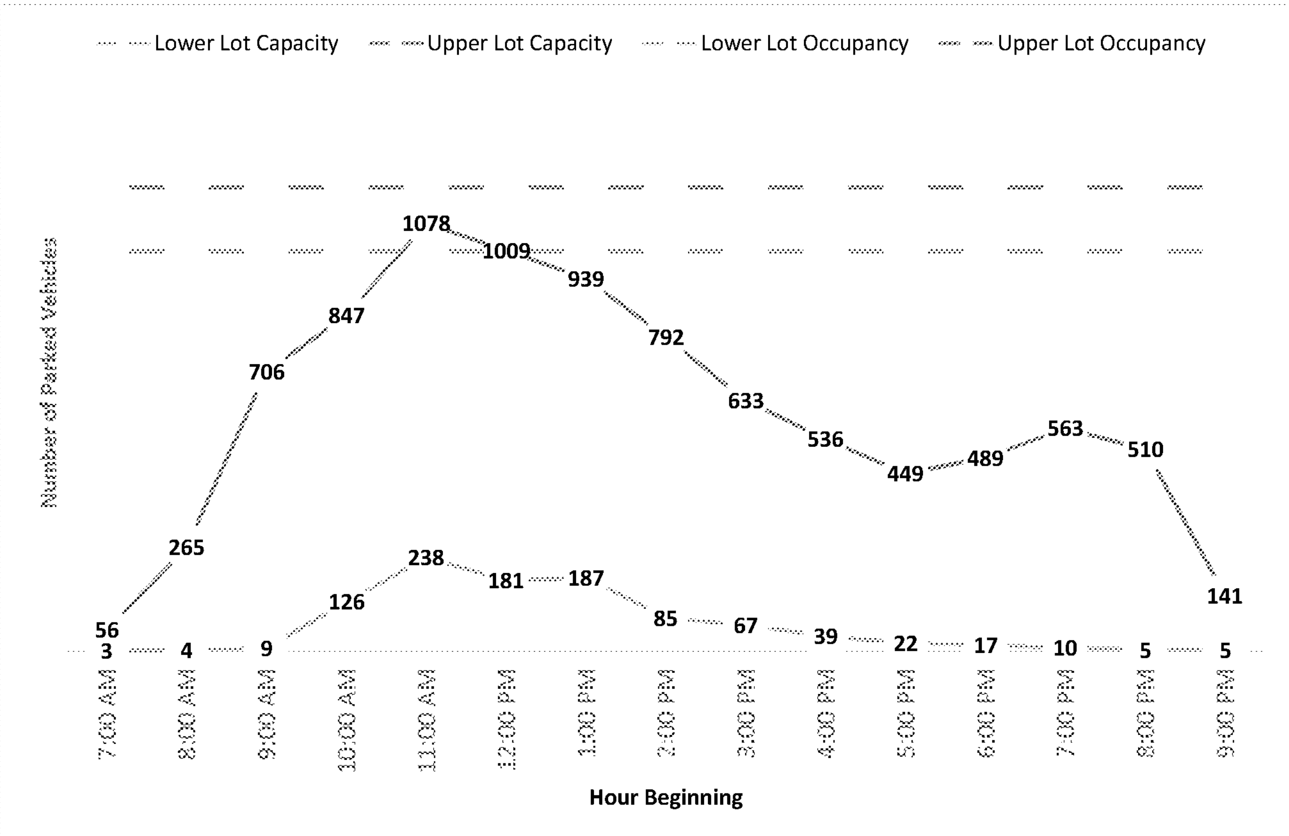


Exhibit 4: Existing CCSF Upper/Lower Lot Parking Supply and Occupancy – Wednesday, April 18, 2018



As shown in Exhibit 1 through Exhibit 4, the peak hourly utilization of both the Lower Lot and Upper Lot occurs between 10:00 a.m. and 1:00 p.m. during all three days of observation.

- On Thursday, December 7, 2017, the peak hour of occupancy occurred between 12:00 p.m. and 1:00 p.m. in both the Lower Lot and Upper Lot; at this time, there were 253 cars parked (754 spaces available) in the Lower Lot and 1,083 cars parked (84 spaces available) in the Upper Lot. This represents a utilization rate of 25% in the Lower Lot and 93% in the Upper Lot and a combined occupancy rate of 61%.
- On Wednesday, January 31, 2018, the peak hour of occupancy occurred between 11:00 a.m. and 12:00 p.m. in the Lower Lot and between 10:00 a.m. and 11:00 a.m. in the Upper Lot; during these times, there were 533 cars parked (474 spaces available) in the Lower Lot and 1,094 cars parked (73 spaces available) in the Upper Lot during the peak hours. This represents a utilization rate of 53% in the Lower Lot and 94% in the Upper Lot.
- On Wednesday, April 18, 2018, the peak hour of occupancy occurred between 11:00 a.m. and 12:00 p.m. in both the Lower Lot and Upper Lot; at this time, there were 238 cars parked (769 spaces available) in the Lower Lot and 1,078 cars parked (89 spaces available) in the Upper Lot. This represents a utilization rate of 24% in the Lower Lot and 92% in the Upper Lot and a combined utilization rate of 61%.

- The maximum combined occupancy rate of 73% (1,596 cars parked and 578 spaces available overall) occurred on Wednesday, January 31, 2018 between 11:00 a.m. and 12:00 p.m.

Neighborhood (On-Street) Parking

On-street parking utilization data were collected by IDAX Data Solutions[1] traffic data collection staff in the site vicinity on weekdays in February 2019 for the block faces shown in Exhibit 5. Each block face was observed three times a day for two days: at 9:00 a.m. (a.m.), 2:00 p.m. (midday), and 8:00 p.m. (p.m.). Days with street cleaning, holidays, events, or other abnormal parking behavior were avoided.

Each observation included the number of parked cars and for each vehicle:

- License plate numbers
- Parking regulation for parking space
- If legally parked
- If parked in a curb cut

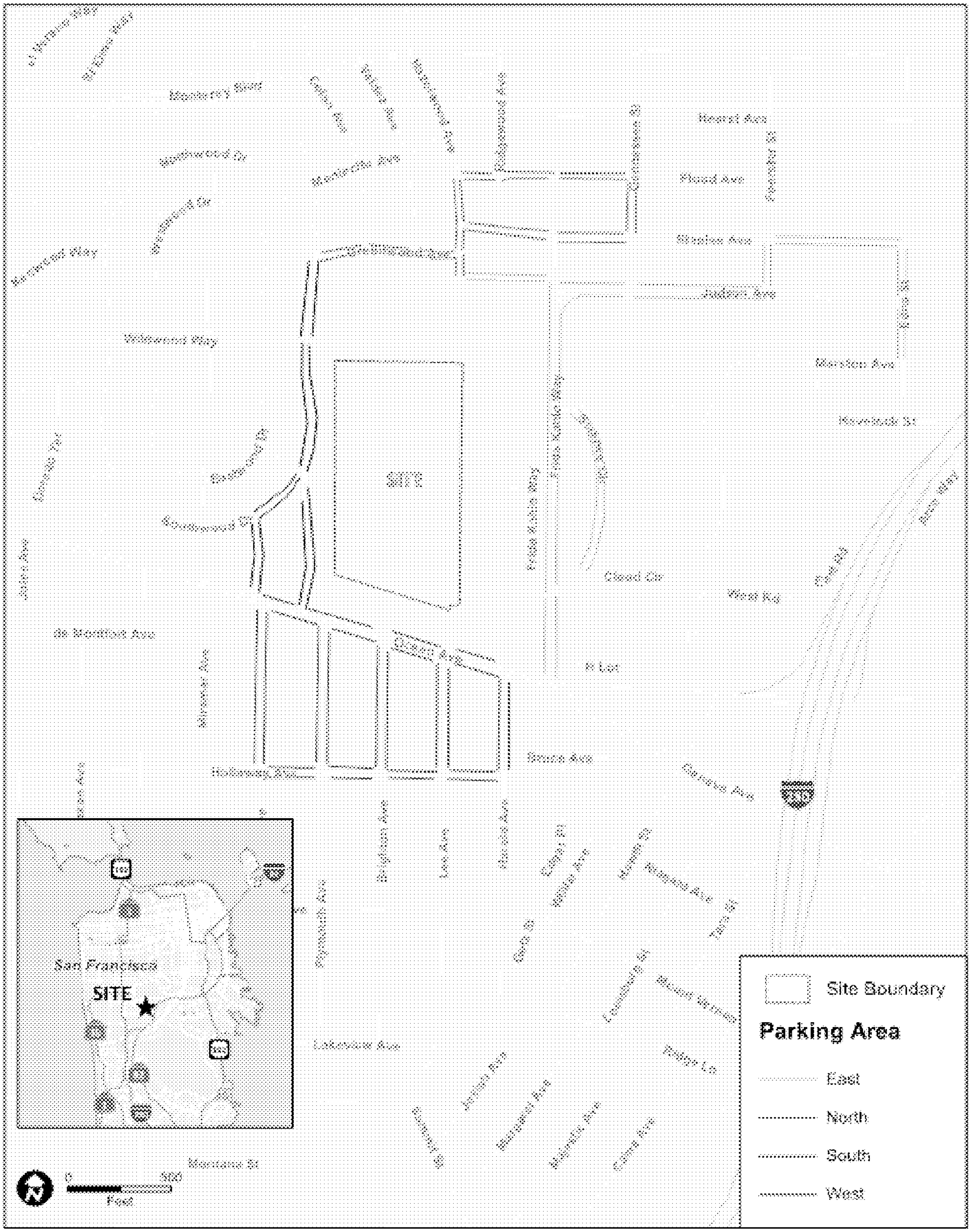
Vehicles parked illegally or across driveways/curb cuts were disregarded as the parking supply consists of only legal parking spaces. While these vehicles constitute parking demand, the spaces these vehicles occupy are not included in the parking supply, so they have no impact on the total available spaces, defined by remaining legal spaces. Each observation period averaged 4.8 illegally parked vehicles and 28.3 vehicles parked in curb cuts, primarily in residential blocks south of Ocean Avenue and north of CCSF.

Parking supply data in the form of number of remaining legal parking spaces per block were provided by San Francisco Municipal Transportation Agency (SFMTA). For blocks where the number of observed legally parked vehicles exceed the SFMTA provided supply, the maximum observed occupancy count was used as the parking supply.

Existing Parking Utilization

The parking utilization and supply data was grouped into four parking areas (north, east, south, and west) shown in Exhibit 5. Percent occupancy and number of available spaces were determined for each observation period for each area as shown in Exhibits 6 and 7. The parking supply and availability by area is presented in Exhibit 8.

[1] IDAX Data Solutions is a multimodal data solutions company providing transportation data with an office in San Francisco, CA.



Source: Kittelson & Associates, Inc., 2019

Case No.2018-007883ENV: Balboa Reservoir Project

Exhibit 5: Neighborhood (On-Street) Parking Study Area

Exhibit 6: Parking Occupancy by Area

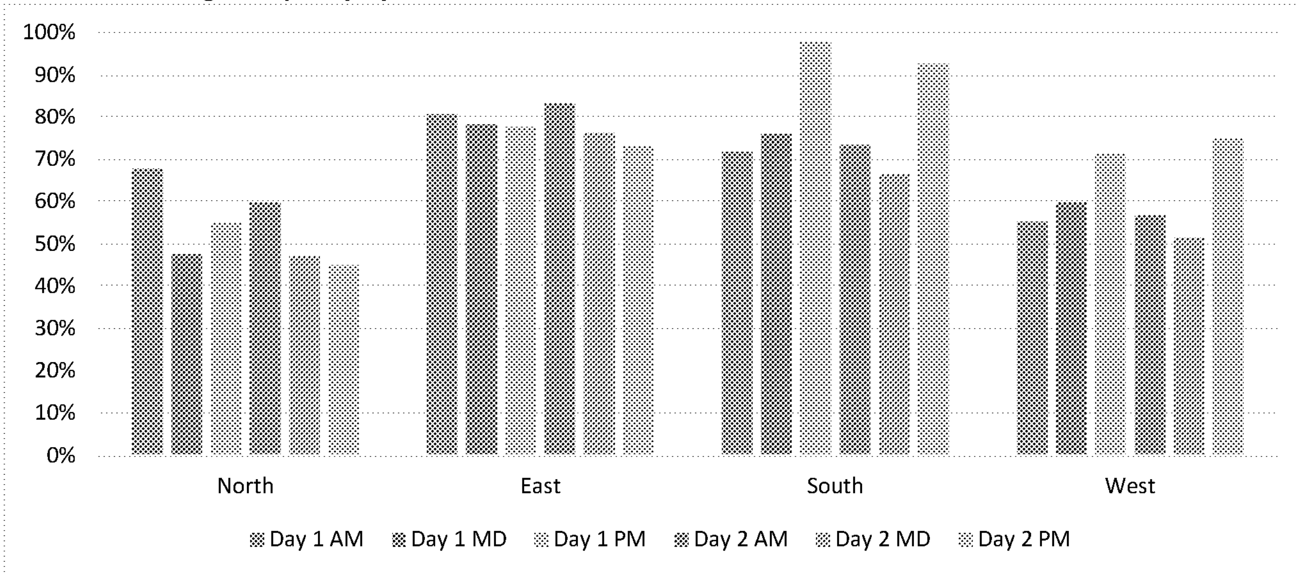


Exhibit 7: Parking Availability by Area

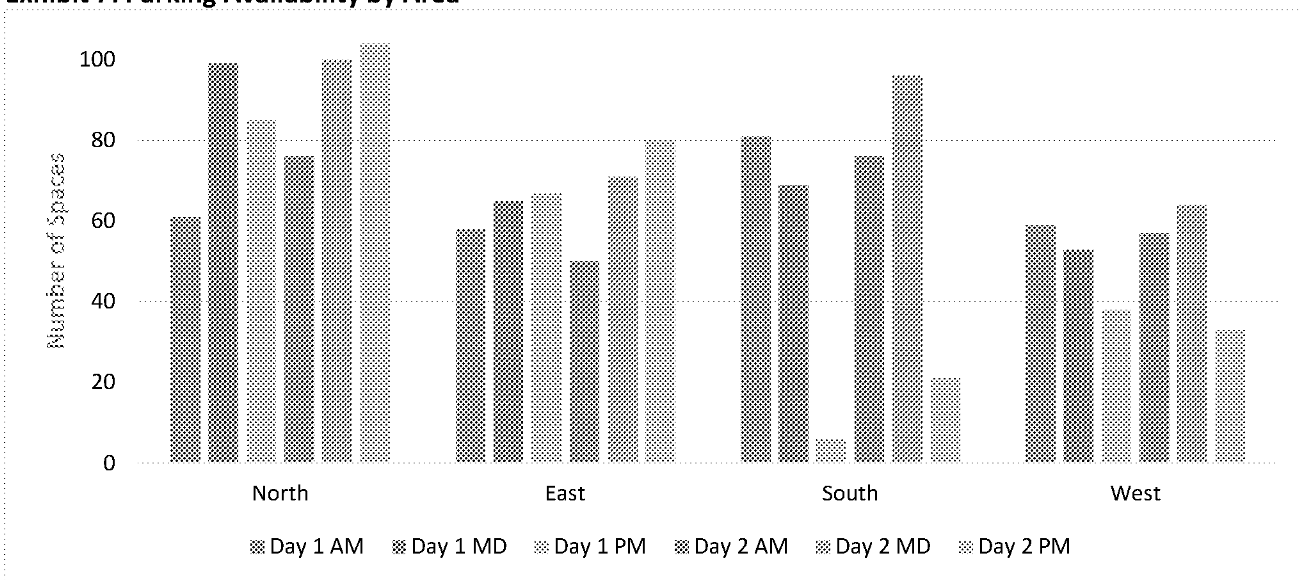


Exhibit 8: Available Street Parking Spaces by Area and Time Period

Parking Area	Supply	Available Street Parking Spaces by Time Period						Average
		Day 1 AM	Day 1 MD	Day 1 PM	Day 2 AM	Day 2 MD	Day 2 PM	
North	189	61	99	85	76	100	104	**88**
East	299	58	65	67	50	71	80	**65**
South	286	81	69	6	76	96	21	**58**
West	132	59	53	38	57	64	33	**51**
Total	**906**	**259**	**286**	**196**	**259**	**331**	**238**	**262**

Sources: Kittelson & Associates, Inc. 2019; IDAX 2019; SFMTA 2019.
Notes: AM = weekday a.m. (9 a.m.); MD = weekday midday (2 p.m.); PM = weekday p.m. (8 p.m.)
Data presented represents the total available parking spaces by area and time period for each parking area as calculated by subtracting the observed legally parked vehicles from the maximum of the SFMTA parking supply and greatest legally parked vehicle observation.

Exhibit 8 indicates that there are a total of 906 parking spaces within the parking study area and between approximately 200 and 300 on-street spaces are available on streets within the parking study area on weekdays during any given time period. The North and West parking areas have the highest proportion of available street parking with average occupancy of less than 60% (equivalent to 88 and 51 available spaces, respectively). The South area has the highest average occupancy at 80% (equivalent to about 58 available spaces) with the weekday p.m. period approaching 100% utilization. The weekday p.m. period was generally observed to have the highest occupancy.

Parking in the site vicinity is controlled by a combination of the following types of regulation:

- Parking meters
- Residential Permit Parking (RPP): 2-hour time-limited parking between 8:00 a.m. and 6 p.m. weekdays, except with residential permit
- Time Limit: 2-hour time-limited parking without exception
- Unregulated: no apparent parking regulations outside of street sweeping hours

The supply and average number of available parking spaces distributed by parking regulation type is presented in Exhibit 9. As shown in Exhibit 8, over 300 on-street parking spaces are available in the on-street parking study area during the midday period (2 p.m.). As shown in Exhibit 9, the parking demand from overflow CCSF vehicles can be accommodated by the available on-street parking supply, though parking regulations may hinder use.

Exhibits 1 through 4 summarize the parking utilization in the Upper Lot and Lower Lot (project site). Exhibit 10 presents the combined occupancy for the Upper Lot and Lower Lot and assumes that no parking spaces would be provided on the Lower Lot. The number of parked vehicles is calculated as the sum of the number of vehicles parked in the Lower Lot and the number of vehicles parked in the Upper Lot. The available spaces and utilization rate are calculated based on the Upper Lot supply of 1,167 parking spaces assuming the Lower Lot has a parking supply of zero spaces. A utilization rate less than 100% indicates that the Upper Lot could accommodate the existing combined parking demand.

As shown in Exhibit 10, the Upper Lot can accommodate the existing combined parking demand during the a.m. and p.m. periods (7 to 9 a.m. and 5 to 7 p.m.) but would not meet the combined parking demand during the weekday midday period (10 a.m. to 12 p.m.). During the weekday midday peak hour of parking demand there would be a shortfall of up to 239 spaces. A similar analysis in the March 2019 CCSF Ocean Campus TDM Plan and Parking Analysis reported a shortfall of 91 spaces without the Lower Lot. The CCSF Ocean Campus TDM Plan and Parking Analysis was prepared by Fehr & Peers and commissioned by CCSF.

Exhibit 9: Average Available Street Parking Spaces by Area and Parking Regulation

Parking Area	Parking Count Type	Parking Regulation				Total
		Parking Meters	Residential Parking Permit	Time Limit	Unregulated	
North	Supply	0	0	70	119	**189**
	Available	0	0	53	35	**88**
East	Supply	0	0	45	254	**299**
	Available	0	0	9	56	**65**
South	Supply	42	244	0	0	**286**
	Available	16	42	0	0	**58**
West	Supply	0	79	0	53	**132**
	Available	0	35	0	16	**51**
Total	**Supply**	**42**	**323**	**115**	**426**	**906**
	Available	**16**	**77**	**62**	**107**	**262**

Sources: Kittelson & Associates, Inc. 2019; IDAX 2019; SFMTA 2019.
Notes: Data presented represents average available parking spaces by block attributed to the predominate parking regulation for that block.

Exhibit 10: Existing City College Upper/Lower Lot Parking Occupancy and Upper Lot Supply

Time Period	Time (Hour Beginning)	Combined Occupancy[1]		
		Parked Vehicles	Available Spaces, Upper Lot	% Utilization, Upper Lot
Weekday a.m. Peak Period	7 a.m.	59	1,108	5%
	8 a.m.	252	915	22%
Weekday Midday Peak Period	10 a.m.	1,228	-61	105%
	11 a.m.	1,406	-239	120%
	12 p.m.	1,352	-185	116%
Weekday p.m. Peak Period	5 p.m.	465	702	40%
	6 p.m.	527	640	45%

Sources: Kittelson & Associates, Inc. 2019; Quality Counts, 2017 & 2018.
Notes: Data presented represents the average across three days of data collection: Thursday, December 7, 2017, Wednesday, January 31, 2018, and Wednesday, April 18, 2018.
[1] Parked vehicles calculated as the sum of the number of vehicles parked in both the Lower Lot and Upper Lot. Available spaces and utilization rate calculated based on the Upper Lot supply of 1,167 parking spaces, assuming zero parking spaces provided in the Lower Lot.

The City College of San Francisco March 2019 Facilities Master Plan Final Draft recommends a new West Parking Garage with up to 1,200 spaces to be constructed on the Upper Lot in conjunction with additional buildings. However, the plan states "the size of the structure does not include specific consideration for the potential loss of parking in the lower Balboa Reservoir." The plan also calls for transportation demand management measures to reduce vehicle and parking demand on campus.

PARKING DEMAND ANALYSIS

The project site is the 17.4-acre parcel located across Frida Kahlo Way from the City College of San Francisco campus and adjacent to a City College parking lot that fronts onto Frida Kahlo Way. The project site is currently used as an approximately 1,000-space surface parking lot (known as the "Lower Lot") for City College, supplementing the 1,167 vehicle parking spaces in the Upper Lot.

Proposed development scenarios are shown in Exhibit 11 including 0.5:1 residential unit parking ratio. The proposed development, both options, is assumed to be comprised of 40% one-bedroom, 30% two-bedroom, 30% three-bedroom units with 50% of the units being affordable housing. The unit mix is a conservative estimate used for analysis purposes. The actual unit mix may differ.

Exhibit 11: Proposed Land Use Program

Land Use	Unit of measurement	Options	
		Developer's Proposed Option	Additional Housing Option
Residential[1]	Total Dwelling Units	1,100	1,550
	Total Square Feet	1,283,000	1,547,000
General Retail	Gross Square Feet	7,500	7,500
Childcare & Community Room	Gross Square Feet	10,000	10,000
Residential Vehicle Parking[2]	Spaces	Up to 550	Up to 650

Source: Reservoir Community Partners, LLC
[1] Based on information provided by Reservoir Partners LLC, the analysis assumes the following bedroom unit mix: 40% one-bedroom, 30% two-bedroom, 30% three-bedroom units. The unit mix is a conservative estimate used for analysis purposes and the actual unit mix may differ.
[2] Under the Developer's Proposed Option, up to 750 additional public parking spaces are being considered.

Parking demand for the proposed development, both options, was estimated based on the methodology in Appendix G of the *2002 Transportation Impact Analysis Guidelines*[2] (2002 Guidelines) with adjustments to account for the proposed affordable housing and transportation demand management (TDM) measures. The parking demand formulas and parameters from the 2002 Guidelines were used directly to estimate the parking demand associated with the residential units and the retail and daycare space. Affordable housing units were assumed to have a reduced parking demand relative to market rate units to reflect the lower rates of auto ownership, price of unbundled parking, and quality of transit service near the project site.

Transportation Demand Management

The development will implement transportation demand management (TDM) measures to encourage the use of non-auto modes and reduce vehicle trips. Proposed TDM measures are identified in Exhibit 12, along with the estimated vehicle trip reduction rate associated with implementation.

[2] An update to the 2002 Guidelines was published in February 2019. However, the parking demand methodology presented in the 2019 Guidelines is based on the neighborhood parking rate for non-residential uses only. The 2002 Guidelines methodology was determined to be more appropriate for the proposed development.

Exhibit 12: TDM Measures and Estimated Vehicle Trip Reduction

TDM Measure	Range of Vehicle Trip Reduction Rate	Estimated Vehicle Trip Reduction Rate for Developer's Proposed Option and Additional Housing Option[1]
Improve Biking/Walking Network	0% to 2%	1.0%
Provide Bicycle Parking	0.625%	0.6%
Implement Car Share Program	5% to 15%	5.0%
Unbundle Parking	2.6% to 13%	4.3%
Limit On-Site Parking Supply	5% to 12.5%	8.8%
Improved Design of Development[2]	3% to 21.3%	10.7%
TDM Program Total		**30.4%**

Source: California Air Pollution Control Officers Association, Quantifying Greenhouse Gas Mitigation Measures, August 2010.
Notes:
[1] Vehicle trip reduction rate estimated based on the estimated level of adoption and aggressiveness of implementation of a given strategy and account for the implementation of other TDM program elements so as not to overestimate vehicle trip reduction for the overall program.
[2] Design elements include: multimodal wayfinding, real-time information displays, on-site bikeshare, bicycle repair station, showers and lockers, delivery supportive amenities, and tailored transportation marketing.

The range of effectiveness for vehicle trip reductions (VTR) identified for each measure is based on information included in the California Air Pollution Control Officers Association, Quantifying Greenhouse Gas Mitigation Measures, August 2010 (CAPCOA Report). The quantification methods provided in the CAPCOA Report are based on an extensive literature review and are appropriate for use in this project-level analysis. The estimated vehicle trip reduction rate is based on the anticipated level of adoption and aggressiveness of implementation of a given strategy. Vehicle trip reduction is estimated by applying the vehicle trip reduction rate to the vehicle trips generated by the target user group, which would include residents, employees, and visitors to the site.

As shown in Exhibit 12, the selected TDM measures would reduce vehicle trips generated by the project. Similar to how these treatments would facilitate non-auto trips, these amenities would reduce parking demand. Reduced auto demand reduces parking demand for visitors and employees. Actions such as unbundling parking from residential units and limiting parking supply directly impact residential parking demand. Therefore, the TDM measures were estimated to reduce residential parking demand by 30.4%.

Project Parking Demand

Parking demand was calculated for residential, short-term retail and daycare visitors, and long-term employee parking for both the retail and childcare uses, as shown in Exhibit 13. This parking demand estimation focuses on the midday time period when the retail and childcare are active and existing CCSF parking demand would exceed capacity of the Upper Lot. While adjustments were made to account for the TDM plan and affordable housing, this parking estimate is conservative and likely overstates demand based on the site context and travel characteristics, transit proximity and quality, and existing and expected travel characteristics. Additionally, this parking analysis reflects 2019 parking costs and regulations; future parking policies may influence parking demand for CCSF and the Balboa Reservior.

Exhibit 13: Estimated Midday Site Parking Demand with Travel Demand Management

Land Use	Project Options	
	Developer's Proposed Option	Additional Housing Option
Residential (Midday 80% of Overnight)[1]	426	602
Retail & Childcare Short-Term	11	11
Retail Employee[2]	9	9
Childcare Employee[3]	9	9
Total Development Midday Parking Demand	**455**	**631**

Notes:
[1] Based on distribution of unit sizes and affordable housing; 20% midday reduction based on page G-2 of 2002 Transportation Analysis Guidelines. Overnight parking demand is 514 vehicles for the Developer's Proposed Option and 724 for the Additional Housing Option.
[2] Daily non-work automobile trips calculated by adjusting Table 6 of the Travel Demand Memorandum trips by Table C-2 values of 2002 Transportation Analysis Guidelines; vehicle occupancy based on SD-3 retail trips per 2002 Transportation Analysis Guidelines.
[3] Number of employees based on Table C-1 of 2002 Transportation Analysis Guidelines; Mode split per Table 4 of Travel Demand Memorandum.

As shown in Exhibit 13, the Developer's Proposed Option would generate a total midday parking demand for 455 vehicle parking spaces (426 residential, 29 retail and childcare visitor, 18 retail and childcare employee). The Additional Housing Option would generate a total midday parking demand for 631 vehicle parking spaces (602 residential, 29 retail and childcare visitor, 18 retail and childcare employee).

The vehicle parking supply proposed under each development scenario was evaluated against the estimated parking demand generated by the project and the existing CCSF overflow demand. The summary results are shown in Exhibit 14.

Exhibit 14: Total Parking Analysis Summary (0.5:1 Parking Ratio [currently proposed])

Time Period	Parking Scenario	Developer's Proposed Option (0.5:1)				Additional Housing Option (0.5:1)			
			Supply				Supply		
		Demand	On-Site[1]	Neighborhood[2]	Total	Demand	On-Site	Neighborhood[2]	Total
Midday	Residential	426	550	0	550	602	650	0	650
	Public/CCSF[3]	268	0	316	316	268	0	316	316
	Total	694	550	316	866	870	650	316	966
Overnight	Residential	533	550	0	550	751	650	0	650
	Public/CCSF[3]	0	0	217	217	0	0	217	217
	Total	533	550	217	767	751	650	217	867

Notes: (0.5:1) denotes a parking ratio of 0.5 residential parking spaces for 1 residential unit; green-shaded cells have excess parking supply while red-shaded cells have parking deficits
[1] Developer's Proposed Option supply does not include the 750-space parking garage that is analyzed in the EIR. Some or all of these parking spaces could be included in the final project to meet projected demand.
[2] Neighborhood supply includes available street parking spaces within the parking study area during the given time period (Midday and Evening/Overnight).
[3] Includes 29 retail and child care visitor and employee demand and 239 overflow CCSF vehicles.

As shown in Exhibit 14, the currently proposed 0.5:1 parking ratio meets residential parking demand under the Developer's Proposed Option during the midday and overnight periods and the Additional

Housing Option during the midday period. There would be a 101 space residential parking space shortfall during the overnight period with the Additional House Option. The parking demand associated with the retail and child care visitor and employee demand (29 spaces) and CCSF overflow demand (239 spaces) could be met by available on-street parking spaces within the study area (316 spaces during the midday period, 217 spaces during the overnight period).

Alternatively, the parking demand from the retail and daycare visitors and employees and overflow CCSF vehicles could be accommodated by a combination of reducing CCSF parking demand through planned TDM measures and/or a shared parking agreement with the Balboa Reservoir project. Additionally, under the Developer's Proposed Option, the supply shown in Exhibit 14 does not include the 750-space parking garage that is analyzed in the EIR. Some or all of these parking spaces could be included in the final project to meet projected demand.

PARKING MONITORING PLAN

Goal of the Monitoring Plan

The goal of the monitoring plan is to conduct ongoing monitoring and evaluation of vehicle parking supply and utilization on the Balboa Reservoir project site and nearby City College of San Francisco parking facility. Data will be collected and reviewed to help inform the construction of parking facilities and to determine if parking and transportation demand management strategies are needed.

Background

The Balboa Reservoir Parking Utilization Study (2017-2018) presented above, is an analysis of the parking conditions on the proposed project site ("Lower Lot") and the adjacent Upper Lot. Data was collected at three time periods when school was in session to gauge when parking utilization would be at its highest levels of the year.

The Parking Utilization Study (2017-2018) was intended to monitor and evaluate parking supply and usage to understand the potential effects of the proposed Balboa Reservoir development on the Lower Lot and the resulting loss of parking on City College of San Francisco staff and students. This initial study will be used to develop the framework and methodology for ongoing monitoring and evaluation of parking supply and utilization on the Balboa Reservoir site and the Upper Lot to guide management of Balboa Reservoir and City College of San Francisco parking facilities. Proposed methodology and implementation of the parking monitoring plan is discussed in the following sections.

Methodology

Balboa Reservoir Parking Utilization Study (2017-2018) Methodology

For the Balboa Reservoir Parking Utilization Study (2017-2018), parking data was collected on an hourly basis over a 14-hour time period, between 7:00 a.m. and 9:00 p.m. Data was collected on three separate mid-week days (Tuesday, Wednesday, or Thursday) when CCSF was in session. The number of spaces in the Upper and Lower Lots were counted with the use of aerial photography and then verified in the field. Parking occupancy was collected manually by field technicians. The parking lots were divided into areas with a field technician responsible for collecting data in each area. Technicians walked the lots every hour, manually counting the number of full and empty stalls in each area. Data was marked by hand in the field and transferred to spreadsheets. The spreadsheet data entries were then checked against the manual entries. The cost of data collection was $560 for each of the Upper Lot and Lower Lot, or $1,120 total, for each 14-hour observation period.

Ongoing Monitoring and Evaluation

The following methodology for ongoing monitoring is recommended to provide efficient and accurate data collection, to align reported space types with parking management categories, and to make the utilization report simple and accessible to all audiences.

- **Survey Study Area.** Collect data within the Lower Lot and Upper Lot. When construction of the Balboa Reservoir project begins, collect data within the Upper Lot only. After construction of the Balboa Reservoir project, if public parking is provided on the Balboa Reservoir site, collect data at the public parking facility and the Upper Lot.
- **Survey Time Period.** Conduct the survey over a four-week period, during the third, fourth, fifth, and sixth weeks of the fall academic term, alternating weekly between Wednesday and Thursday in order to capture daily variations in class schedules and allow for two surveys on each day to get a broader representation of parking demand. This survey period is intended to be inclusive of the period of peak CCSF enrollment.
- **Survey Duration.** Conduct data collection between the hours of 7 a.m. and 9 p.m. to capture hourly variation and peak periods of parking demand.
- **Parking Space Classification.** Classify vehicle parking spaces into the following categories to align with existing parking types provided by CCSF[3] and the Balboa Reservoir project: student; faculty/staff; Americans with Disabilities Act (ADA); reserved; short-term/metered; public (free); public (paid); and private (residents only). Additional categories that could be considered depending on applicability, include electric vehicle charging spaces and dedicated carpool spaces. The Balboa Reservoir Parking Utilization Study (2017-2018) collected and reported

[3] City College of San Francisco 2019 Facilities Master Plan, March 2019. P. 2-32. https://www.ccsf.edu/en/about-city-college/administration/vcfa/facilities_planning/facilities-master-plan.html, accessed April 5, 2019.

utilization data for each facility but did not classify the parking spaces into categories. This approach made data collection and reporting simple and easy to understand, however, it offers limited utility to match space types with parking management categories and patterns of parking demand.

- **Parking Capacity.** Parking capacity is a measure of the number of parking spaces available within the surveyed locations at the time of the survey. Year-to-year changes in capacity are influenced by the physical addition or removal of parking lots and spaces as well as by changes in the management of individual spaces and lots.
- **Parking Utilization.** The overall parking utilization rate is calculated as the ratio of occupied spaces to the total number of parking spaces in the surveyed lots. The percent utilization reported would be an average of the four survey days. Parking utilization should be reported overall (for both facilities combined), by location (for each individual facility), and by parking space category.
- **Reporting.** The parking utilization study should be conducted on an annual basis and build on prior year's data to allow for a longitudinal/historical evaluation.

Future Management of Parking Facilities

Balboa Reservoir development intends to manage its parking efficiently while working to encourage the use of transportation modes other than the single occupancy vehicle. These efforts are being pursued concurrently and in partnership with City College of San Francisco, Public Utilities Commission, and the City of San Francisco to address the future parking needs for CCSF Ocean Campus.

City College of San Francisco approved its Facilities Master Plan in March 2019. The document outlines a vision for the future of the campus that directs cars to routes at the perimeter of campus, emphasizes a more pedestrian atmosphere on Frida Kahlo Way, and limits on-campus circulation to ADA and service vehicles. City College of San Francisco is developing a transportation demand management program aimed at actively reducing single occupancy vehicle trips to the campus through strategies including designated carpool and carshare vehicle parking and provision of passenger loading and short-term parking spaces. According to information included in the Facilities Master Plan, the West Parking Structure could replace surface parking in the Upper Lot due to the construction of the Performing Arts Education Center. The structure may include up to 1,200 vehicle parking spaces on six floors. Additional vehicle parking would be provided in the East Surface Parking lot located on the east side of the east campus.

With regular monitoring of parking utilization and careful management, Balboa Reservoir and CCSF can support efficient use of the facilities by implementing transportation demand management measures and parking strategies that could include, but are not limited to:

- **Private parking partnerships**. Shared parking arrangement between Balboa Reservoir and City College of San Francisco.

- **Parking policies**. Implement changes to policies and practices that optimize parking occupancy and turnover, such as adding time limits or paid parking, including variable demand-based pricing.
- **Physical improvements**. Make physical improvements, including sidewalk widening, installation of bike facilities and amenities, and wayfinding to increase use of non-auto modes.
- **Shuttle service**. Provide fixed-route or on-demand shuttle service between the project site and key destinations to increase use of non-auto modes.
- **Valet parking**. Implement centralized valet service, thereby increasing capacity of existing parking facilities by enabling tandem parking.
- **Increase parking supply**. Construct a new garage or expand the existing facility.

SUMMARY OF FINDINGS

The key findings of the parking supply and utilization data collection and the parking demand analysis are summarized below:

- The peak hourly utilization of both the Lower Lot and Upper Lot occurs between 10 a.m. and 1 p.m. The observed maximum combined occupancy rate of 73% (1,596 cars parked and 578 spaces available) occurred between 11 a.m. and 12 p.m.
- Under existing parking pricing policy, the Upper Lot can accommodate the existing combined parking demand (the total demand observed at both the Lower Lot and Upper Lot) during the a.m. and p.m. periods (7 to 9 a.m. and 5 to 7 p.m.) but would not meet the combined parking demand during the weekday midday period (10 a.m. to 12 p.m.). During the weekday midday peak hour of parking demand, assuming parking was available only at the Upper Lot, there would be a shortfall of up to 239 parking spaces.
- There are a total of 906 parking spaces within the neighborhood on-street parking study area and between approximately 200 and 300 on-street spaces are available on weekdays during any given time period (a.m., midday, and p.m.).
- Projected residential parking demand can be met at a 0.5:1 parking ratio except during the overnight period for the Additional Housing Option, which would have a 101 space shortfall.
- Projected parking demand from the retail and daycare visitors and employees and overflow CCSF vehicles could be accommodated by available on-street parking spaces, reduced Balboa Reservoir and CCSF parking demand through planned TDM measures, and/or a shared parking agreement with the Balboa Reservoir project.
- The Balboa Reservoir development intends to monitor and manage its parking efficiently while working to encourage the use of transportation modes other than the single occupancy vehicle. Shared or flexible parking designations between residential, retail, and CCSF uses would help to minimize the total number of parking spaces needed to meet project-generated parking demand and overflow CCSF parking demand resulting from the redevelopment of the Lower Lot. Implementation of TDM measures and a shared parking agreement with CCSF would reduce the impacts of parking shortfalls on the neighborhood parking supply.

ATTACHMENT B: OPERATIONS ANALYSIS TECHNICAL MEMORANDUM

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TECHNICAL MEMORANDUM

Date:	August 1, 2019
To:	Reservoir Community Partners, LLC
From:	Kittelson & Associates, Inc.
Project:	Balboa Reservoir – Operations Analysis Memorandum

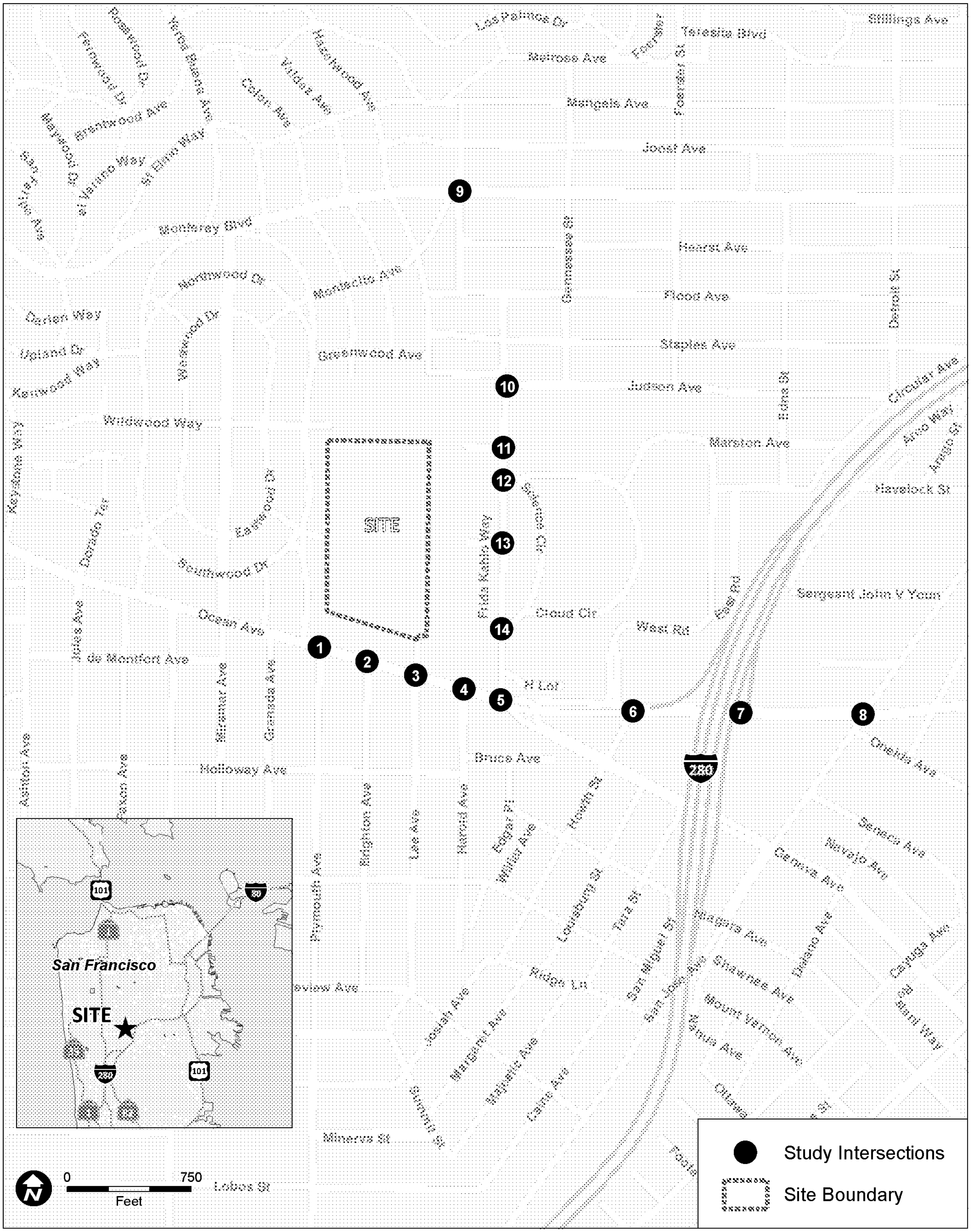
This memorandum summarizes the corridor delay and intersection operations analyses conducted for the Balboa Reservoir development (proposed project). The objective of the analysis is to evaluate existing and existing plus project corridor operations along Ocean Avenue and Ridgewood Avenue-Frida Kahlo Way and intersection operations at select study intersections to estimate the changes in travel time attributable to the project and to evaluate potential modifications to improve traffic flow and vehicle progression at intersections along Ocean Avenue. Data on existing transit operations is used to inform the evaluation. This memorandum is organized as follows:

- Data collection summary
- Analysis methodology
- Corridor delay analysis
- Intersection operations analysis
- Potential intersection modifications
- Summary of findings

DATA COLLECTION SUMMARY

Intersection Turning Movement Counts

Weekday a.m. (7 to 9 a.m.) and p.m. (4 to 6 p.m.) period multimodal turning movement counts were collected at 14 locations along Ocean Avenue, Ridgewood Avenue, and Frida Kahlo Way. Turning movement counts were collected on a weekday (Tuesday, Wednesday, or Thursday) when City College of San Francisco was in session. The study intersection locations are shown in Figure 1 and listed in Table 1.



Source: Kittelson & Associates, Inc., 2019

Balboa Reservoir Project

Figure 1
Study Intersections

Table 1: Study Intersections

#	Intersection
1	Plymouth Avenue/Ocean Avenue
2	Brighton Avenue/Ocean Avenue
3	Lee Avenue/Ocean Avenue
4	Harold Avenue/Ocean Avenue
5	Frida Kahlo Way/Geneva Avenue/Ocean Avenue
6	I-280 SB Off-Ramp/Ocean Avenue
7	I-280 NB On-Ramp/Ocean Avenue
8	San Jose Avenue/Ocean Avenue
9	Ridgewood Avenue/Monterey Boulevard
10	Frida Kahlo Way/Judson Avenue
11	Frida Kahlo Way/City College Upper Reservoir Lot (N)
12	Frida Kahlo Way/Cloud Circle (N)
13	Frida Kahlo Way/City College Upper Reservoir Lot (S)
14	Frida Kahlo Way/Cloud Circle (S)

SFMTA General Transit Feed Specification (GTFS) Data

The SFMTA provided General Transit Feed Specification data for two inbound/outbound routes operating on streets adjacent to the project, 29 Sunset and 43 Masonic, for the weekday a.m. and p.m. peak periods (7 to 9 a.m. and 4. to 6 p.m.). SFMTA provided GTFS data for the segment of line 29 on Ocean Avenue between Mission Street/Persia Avenue and Plymouth Avenue and for the segment of line 43 extending from Gennessee Street/Monterey Boulevard to the City College Bookstore for inbound (southbound) operations and from the City College Bookstore to Foerster Street/Monterey Boulevard for outbound (northbound) operations. Historical travel time data was provided for dates between August 27, 2018 and March 8, 2019. Table 2 displays an average of the data for weekday a.m. and p.m. peak periods.

Table 2: SFMTA Transit Data

Transit Line	Study Segment	Transit Travel Time (minutes:seconds)	
		a.m.	p.m.
29	Mission Street/Persia Avenue to Plymouth Avenue/Ocean Avenue	10:55	12:00
	Plymouth Avenue/Ocean Avenue to Mission Street/Persia Avenue	9:53	10:10
43	Gennessee Street/Monterey Boulevard to City College Bookstore	4:25	4:05
	City College Bookstore to Foerster Street/Monterey Boulevard	4:37	4:35

Sources: SFMTA, 2019.
Notes: a.m. refers to 7 to 9 a.m. and p.m. refers to 4 to 6 p.m. Travel time is reported in minutes and seconds.

Transit Travel Time Runs

Supplemental transit time data was collected along study segments via onboard surveys. Transit travel times were collected on Tuesday, April 2, 2019, during the weekday a.m. peak period (7 to 9 a.m.) and the weekday p.m. peak period (4 to 6 p.m.). Two staff boarded each transit vehicle at the route start point and recorded the travel time between each stop and the dwell time at each stop. Data was gathered for the following Muni lines and study segments:

- K/T Third/Ingleside – from Jules Avenue/Ocean Avenue to the Balboa Park BART Station (eastbound) and from San Jose Avenue/Geneva Avenue to Dorado Terrace/Ocean Avenue (westbound)
- 29 Sunset – from Mission Street/Persia Avenue to Plymouth Avenue/Ocean Avenue (westbound) and from Plymouth Avenue/Ocean Avenue to Mission Street/Persia Avenue (eastbound)
- 43 Masonic – from Frida Kahlo Way/CCSF South Entrance to Foerster Street/Monterey Boulevard (northbound) and from Gennessee Street/Monterey Boulevard to Frida Kahlo Way/CCSF South Entrance (southbound)
- 49 Van Ness/Mission – from Frida Kahlo Way/CCSF South Entrance to Mission Street/Persia Avenue (eastbound) and from Mission Street/Ocean Avenue to Frida Kahlo Way/CCSF South Entrance (westbound)

Table 3 shows observed transit travel times for each study segment. Multiple travel time runs were conducted on each segment in each direction. The value in the table reflects the average of those runs.

Table 3: Supplemental Transit Travel Time Runs

Transit Line	Transit Route	Transit Travel Time (minutes:seconds)	
		a.m.	p.m.
K	Jules Avenue/Ocean Avenue to Balboa Park BART Station	3:30	8:42
	San Jose Avenue/Geneva Avenue to Dorado Terrace/Ocean Avenue	3:28	10:03
29	Mission Street/Persia Avenue to Plymouth Avenue/Ocean Avenue	7:10	9:55
	Plymouth Avenue/Ocean Avenue to Mission Street/Persia Avenue	8:01	12:09
43	Frida Kahlo Way/CCSF South Entrance to Foerster Street/Monterey Boulevard	4:20	4:37
	Gennessee Street/Monterey Boulevard to Frida Kahlo Way/CCSF South Entrance	4:16	4:23
49	Frida Kahlo Way/CCSF South Entrance to Mission Street/Persia Avenue	5:39	10:04
	Mission Street/Ocean Avenue to Frida Kahlo Way/CCSF South Entrance	7:18	11:25

Sources: Kittelson & Associates, Inc. 2019.
Notes: CCSF stands for Community College of San Francisco. a.m. refers to 7 to 9 a.m. and p.m. refers to 4 to 6 p.m. Travel time is reported in minutes and seconds. Multiple transit runs were recorded, and the value in the table reflects an average of those runs.

The supplemental transit travel time data displayed in Table 3 is relatively consistent with the average historical travel time data for both peak periods on 43 Masonic and the evening peak period on 29 Sunset. While the transit travel time runs collected for 29 Sunset during the weekday a.m. peak hour were within the overall range of historic travel time data provided by SFMTA, they were about 3 minutes less than the average historic travel times reported by SFMTA during the weekday a.m. peak period (7-8 minutes as compared to 10-11 minutes). Variation between the average transit travel times observed on Tuesday, April 2, 2019 and the average of historic transit travel time data collected between August 27, 2018 and March 8, 2019 could be related to differences in the volume of vehicles traveling along the corridor and differences in dwell time and the number of passengers boarding/alighting along the corridor, among other factors. Additionally, the supplemental transit travel time data relies on two to three data points on a single day of observation compared to multiple data points collected over a 193 day period.

ANALYSIS METHODOLOGY

All corridor delay analyses described in this memorandum were performed using Trafficware's Synchro modeling software. This software helps provide a macroscopic evaluation of traffic conditions. The transportation network, consisting of the study intersections outlined in Table 1, was constructed utilizing San Francisco (SF) Planning Department's *Guidelines for Synchro Intersection LOS Analysis* (2012), as well as signal timing information provided by the San Francisco Municipal Transportation Agency (SFMTA).

Corridor Delay Analysis

Corridor delay analysis was conducted along the following two corridors:

- Ocean Avenue, from Plymouth Avenue to San Jose Avenue
- Ridgewood Avenue-Frida Kahlo Way, from Ridgewood Avenue/Monterey Boulevard to Frida Kahlo Way/Geneva Avenue/Ocean Avenue

Synchro summarizes corridor delay for approaches along the arterial and includes through and turning lane groups[1]. The specific performance measure that is documented is total delay along the corridor by direction[2]. This performance measure is used to provide information about existing travel times through the study corridors and evaluate travel time increases associated with vehicle traffic generated by the proposed project options.

Intersection Operations Analysis

Detailed intersection operations analysis was conducted at the following three locations:

- Brighton Avenue/Ocean Avenue
- Lee Avenue/Ocean Avenue
- Frida Kahlo Way/Geneva Avenue/Ocean Avenue

These three study intersections were selected for analysis to address concerns raised by the community regarding operations at these locations.

Intersection level of service (LOS) analyses were performed in accordance with the procedures stated in the 2000 *Highway Capacity Manual*. Intersection level of service is dependent on control delay[3] and is analogous to letter grades in a school report card, ranging from LOS A to LOS F. Motorists using an intersection that operates at a LOS A experience very little delay and usually do not stop, while those using an intersection that operates at a LOS F will experience long delays typically greater than 80 seconds per vehicle.

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[1] The corridor delay is calculated by utilizing weighted volumes for approaches on the arterial. These volumes are not adjusted for the peak hour factor (PHF) or lane utilization factor. Peak hour factor is defined as the hourly volume divided by the peak (fifteen) minute flow rate within that same hour. The lane utilization factor indicates the "uniform" use of available lanes. It is the ratio of the average volume per lane to the heaviest volume in one lane.

[2] Total corridor delay is calculated by summing the control delay and queue delay and is presented in seconds per vehicle.

[3] Control delay is defined to include initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. This variable is measured in seconds per vehicle during a specific time period (for example, the p.m. peak hour).

All queue length analyses were performed in accordance with Synchro methodologies and represent the 95th percentile maximum queue lengths. The 95th percentile queue is the queue length that would not be exceeded 95 percent of the time.

All three signalized intersections operate as actuated-coordinated[4] signals with maximum recall[5] on the coordinated phase. This control type is defined as having the major movements (i.e., Ocean Avenue) as coordinated and set to a maximum recall, while the minor streets (Brighton Avenue, Lee Avenue, and Frida Kahlo Way/Geneva Avenue) are actuated and typically have no recall. The signals also operate on a fixed cycle length, so if there is any unused time in a cycle, it is added to the designated coordinated phases.

Analysis Scenarios

Analysis was conducted for existing and existing plus project conditions. Existing plus project conditions reflects the existing transportation network with the inclusion of vehicle trips generated by the Additional Housing Option.

The Balboa Reservoir development has two proposed project options:

- Developer's Proposed Option. 1,100 dwelling units, 10,000 square feet of childcare use and 7,500 square feet of retail and is estimated to add 249 vehicle trips and 318 vehicle trips during the a.m. and p.m. peak hours, respectively.
- Additional Housing Option. 1,550 dwelling units, 10,000 square feet of childcare use and 7,500 square feet of retail and is forecasted to add 329 vehicle trips and 423 vehicle trips during the a.m. and p.m. peak hours, respectively.

For the purposes of a more conservative analysis, the Additional Housing Option was evaluated, as it would generate more vehicle trips and would therefore have a greater effect on corridor delay and intersection operations. The Developer's Proposed Option would generate about 25 percent fewer vehicle trips and as a result, would be expected to result in less delay compared to the Additional Housing Option.

[4] Actuated signals prioritize the through movement of the major street and use sensors to respond to the traffic present on the actuated approach, so that the pattern of the signal (the length and order of each phase) depends on the traffic and can be different at every cycle. Sensors report to the signal computer and green is provided for those actuated lanes only when traffic is present and only until the traffic has vacated those lanes or the maximum time set for that phase has been reached.

[5] Each phase in a signalized intersection is given a recall mode of either no call, minimum, maximum, or pedestrian. No recall implies that a phase can be skipped if no vehicles are present/detected. Minimum recall indicates that a phase is being called for its minimum green time, independent of a vehicle's presence. Maximum recall specifies that a phase is being called for its maximum green time. Pedestrian recall means that a phase will always service the pedestrian walk and clearance interval times independent of a pedestrian's presence.

CORRIDOR DELAY ANALYSIS

The corridor delay analysis considers the change in vehicle delay with the addition of project-generated vehicle trips along Ocean Avenue, from Plymouth Avenue to San Jose Avenue, and along Ridgewood and Frida Kahlo Way, from Ridgewood Avenue/Monterey Boulevard to Frida Kahlo Way/Geneva Avenue/Ocean Avenue. Table 4 and Table 5 display the total corridor delay for existing conditions and existing plus project conditions for the weekday a.m. and p.m. peak hours.

Table 4: Corridor Delay – Ocean Avenue

Scenario	Weekday a.m. Peak Hour (seconds/vehicle)		Weekday p.m. Peak Hour (seconds/vehicle)	
	Eastbound	Westbound	Eastbound	Westbound
Existing Conditions	11	32	13	33
Existing Plus Additional Housing Option Conditions	12	32	15	41
Project-Related Change	**+1**	**0**	**+2**	**+8**

Sources: Kittelson & Associates, Inc. 2019.

Table 5: Corridor Delay – Frida Kahlo Way

Scenario	Weekday a.m. Peak Hour (seconds/vehicle)		Weekday p.m. Peak Hour (seconds/vehicle)	
	Northbound	Southbound	Northbound	Southbound
Existing Conditions	3	11	4	19
Existing Plus Additional Housing Option Conditions	4	12	4	22
Project-Related Change	**+1**	**+1**	**0**	**+3**

Sources: Kittelson & Associates, Inc. 2019.

As shown in Table 4, the Additional Housing Option would increase delay along the Ocean Avenue study segment by one second in the eastbound direction during the weekday a.m. peak hour and by two seconds and eight seconds in the eastbound and westbound directions, respectively during the weekday p.m. peak hour. As shown in Table 5, the Additional Housing Option would increase delay along the Frida Kahlo Way study segment by one second in the northbound and southbound directions during the weekday a.m. peak hour and by three seconds in the southbound direction during the weekday p.m. peak hour.

INTERSECTION OPERATIONS ANALYSIS

A detailed intersection operations analysis was conducted to identify more specifically how operations at the three study intersections (Brighton Avenue/Ocean Avenue, Lee Avenue/Ocean Avenue, and Frida Kahlo Way/Geneva Avenue/Ocean Avenue) may change with the addition of project-generated vehicle trips from the Additional Housing Option during the weekday a.m. and p.m. peak hours.

The analysis considers the delay, queue length, and LOS for each approach and for the intersection overall. Intersection volumes were adjusted to reflect the peak hour and lane utilization factors. Based on observations along Ocean Avenue, there were twice as many vehicles in the outside lanes, compared to the center lanes, as to avoid the light rail tracks and to avoid being delayed behind transit. Therefore, a lane utilization factor[6] of 0.75 was applied to eastbound and westbound through movements at each study intersection. Table 6 summarizes the weekday a.m. peak hour results, and Table 7 displays the weekday p.m. peak hour results.

Table 6: Intersection Operations – Weekday a.m. Peak Hour

Intersection/ Scenario	Eastbound			Westbound			Northbound			Southbound			Int. Delay
	Delay	Queue	LOS	Delay	Queue	LOS	Delay	Queue	LOS	Delay	Queue	LOS	
Existing Conditions													
Brighton Avenue	7.9	136.0	A	6.4	374.0	A	36.2	52.0	D	64.4	25.0	E	9.2
Lee Avenue	8.6	55.0	A	16.6	263.0	B	31.6	94.0	C	23.6	30.0	C	14.3
Frida Kahlo Way/Geneva Avenue	39.0	427.0	D	**136.4**	**485.0**	**F**	30.4	210.0	C	21.4	87.0	C	84.3
Existing Plus Additional Housing Option													
Brighton Avenue	7.9	136.0	A	6.2	398.0	A	36.2	52.0	D	64.4	25.0	E	9.0
Lee Avenue	8.6	55.0	A	17.4	265.0	B	33.4	107.0	C	35.2	117.0	D	16.3
Frida Kahlo Way/Geneva Avenue	51.9	487.0	D	**164.5**	**521.0**	**F**	31.3	218.0	C	21.4	87.0	C	102.7
Project Change													
Brighton Avenue	-	-	-	-0.2	+24.0	-	-	-	-	-	-	-	-0.2
Lee Avenue	-	-	-	+0.8	+2.0	-	+1.8	+13.0	-	+11.6	+87.0	C to D	+2.0
Frida Kahlo Way/Geneva Avenue	+12.9	+60.0	-	+28.1	+36.0	-	+0.9	+8.0	-	-	-	-	+18.4

Sources: Kittelson & Associates, Inc. 2019.
Notes: LOS = Level of Service. Int. = Intersection. Approach delay is measured in average seconds delay experienced per vehicle on the approach during the specified time period. Intersection delay is the average total vehicle delay of all movements through an intersection during the specified time period. Queue length is measured in feet and represents the queue for through or left-turn lane movements on each approach. Analysis results presented in **bold** represents an approach exceeding capacity, with a volume-to-capacity ratio greater than 1.0[7]. Synchro may overestimate the delay and queue lengths reported at intersections or approaches operating at, or near, capacity.

[6] A lane utilization factor can be applied in Synchro as to indicate a specific distribution across lanes. The factor is estimated by dividing the total approach volume by the number of lanes and the highest lane volume.
[7] According to the *Highway Capacity Manual*, capacity is defined as the maximum flow rate for a roadway under specific geometric, traffic, environmental, and control conditions. When a volume-to-capacity ratio (v/c) is greater than one, then there is typically high delay and long queues.

Table 7: Intersection Operations – Weekday p.m. Peak Hour

Intersection/ Scenario	Eastbound			Westbound			Northbound			Southbound			Int. Delay
	Delay	Queue	LOS	Delay	Queue	LOS	Delay	Queue	LOS	Delay	Queue	LOS	
Existing Conditions													
Brighton Avenue	9.6	140.0	A	**78.2**	**570.0**	**E**	36.8	62.0	D	42.5	16.0	D	**45.6**
Lee Avenue	9.4	64.0	A	18.0	314.0	B	32.5	98.0	C	27.7	70.0	C	15.7
Frida Kahlo Way/Geneva Avenue	46.9	471.0	D	**75.1**	**393.0**	**E**	29.6	203.0	C	23.3	141.0	C	53.7
Existing Plus Additional Housing Option													
Brighton Avenue	9.6	142.0	A	**75.1**	**492.0**	**E**	36.8	62.0	D	42.5	16.0	D	**44.3**
Lee Avenue	9.4	64.0	A	22.2	323.0	C	35.4	130.0	D	39.3	151.0	D	19.9
Frida Kahlo Way/Geneva Avenue	**60.4**	**516.0**	**E**	**145.6**	**508.0**	**F**	31.9	223.0	C	23.3	141.0	C	90.9
Project Change													
Brighton Avenue	-	+2.0	-	-3.1	-78.0	-	-	-	-	-	-	-	-1.3
Lee Avenue	-	-	-	+4.2	+9.0	B to C	+2.9	+32.0	C to D	+11.6	+81.0	C to D	+4.2
Frida Kahlo Way/Geneva Avenue	+13.5	+45.0	D to E	+70.5	+115.0	E to F	+2.3	+20.0	-	-	-	-	37.2

Sources: Kittelson & Associates, Inc. 2019.
Notes: LOS = Level of Service. Int. = Intersection. Approach delay is measured in average seconds delay experienced per vehicle on the approach during the specified time period. Intersection delay is the average total vehicle delay of all movements through an intersection during the specified time period. Queue length is measured in feet and represents the queue for through or left-turn lane movements on each approach. Analysis results presented in **bold** represents an approach exceeding capacity, with a volume-to-capacity ratio greater than 1.0. Synchro may overestimate the delay and queue lengths reported at intersections or approaches operating at, or near, capacity.

Brighton Avenue/Ocean Avenue

The intersection of Brighton Avenue/Ocean Avenue is a four-legged, offset, signalized intersection. The eastbound and westbound approaches have two through lanes each, where the inside lanes serve transit buses and light rail and general vehicles. Left-turns onto Brighton Avenue are permitted for these approaches. The northbound and southbound approaches consist of one lane in each direction that serves through, right, and left-turn movements.

Traffic signals along Ocean Avenue, west of Geneva Avenue, are coordinated to provide east-west progression during the weekday a.m. and p.m. peak periods. Traffic signal control at Brighton Avenue/Ocean Avenue operates with three phases. The cycle length during both peak periods is 80 seconds. Phases on Ocean Avenue are always being called to their maximum green time, whereas any green time not utilized on Brighton Avenue is added to the through movements on Ocean Avenue. Brighton Avenue operates with split phasing, with southbound movements following northbound movements

As shown in Table 6 and Table 7, there would not be a substantial change to the delay, queue lengths, and level of service for all approaches at the intersection of Brighton Avenue/Ocean Avenue with the addition of project-generated vehicle trips. The following is a summary of the analysis results:

- The westbound approach would operate above capacity, with a volume-to-capacity ratio greater than 1, during the weekday p.m. peak hour for existing and existing plus project conditions.
- With the addition of project trips, the overall intersection delay may be slightly reduced (by less than one second per vehicle and by 1.3 seconds per vehicle during the weekday a.m. and p.m. peak hours, respectively), as a larger proportion of trips travelling through the intersection are doing so on the coordinated phase, thereby increasing the efficiency of the signal and reducing average vehicle delay.
- The westbound approach is projected to experience the greatest amounts of change with the buildout of the Additional Housing Option.
    - With the project, delays on this approach may be slightly reduced (by 0.2 and 3.1 seconds per vehicle during the weekday a.m. and p.m. peak hours, respectively), as a larger proportion of intersection traffic is on the coordinated phase.
    - With the project, the queue length may increase slightly (by 24 feet) during the weekday a.m. peak hour and decrease slightly (by 78 feet) during the weekday p.m. peak hour. This decrease is due to better utilization of the coordinated phase.
    - The level of service is estimated to remain the same during the weekday a.m. and p.m. peak hours.
- The project would not add trips to Brighton Avenue and the delay, queue length, and level of service on the northbound and southbound approaches are forecast to remain the same during the weekday a.m. and p.m. peak periods.

Lee Avenue/Ocean Avenue

The intersection of Lee Avenue/Ocean Avenue is a four-legged signalized intersection. The eastbound and westbound approaches have two through lanes each, where the inside lanes serve transit and vehicles. Left-turns onto Lee Avenue are prohibited for these approaches. The northbound and southbound approaches consist of one lane in each direction that serves through, right, and left-turn movements. Lee Avenue is anticipated to be an access route to the project, and to accommodate additional traffic entering and exiting the project, Lee Avenue will be restriped to include an additional lane on the southbound approach. Therefore, for the purposes of this memorandum, the southbound approach was analyzed using a different lane configuration than what is existing. The lane configuration analyzed for existing and existing plus project conditions is comprised of a southbound left-turn lane and a southbound through/right-turn lane.

Traffic signals along Ocean Avenue, west of Geneva Avenue, are coordinated to provide east-west progression during the weekday a.m. and p.m. peak periods. Traffic signal control at Lee Avenue operates with two phases. The cycle length during both peak periods is 80 seconds. Phases on Ocean Avenue are always being called to their maximum green time, whereas any green time not utilized on Lee Avenue is added to through movements on Ocean Avenue. For pedestrians utilizing the eastbound and westbound crosswalks, there is a four second leading pedestrian interval. This means that pedestrians are given a head start when entering an intersection before vehicles are given a green indication.

The data in Table 6 and Table 7 summarizes the quantitative measures for the quality of traffic at the intersection. The following outlines the results of the intersection operations analysis comparing existing traffic conditions and existing plus project traffic conditions:

- With the addition of project-generated vehicle trips, the overall intersection delay may slightly increase (by 2.0 and 4.2 seconds per vehicle during the weekday a.m. and p.m. peak hours, respectively).
- The southbound approach is projected to experience the greatest change in delay, queues, and level of service with the addition of project-generated vehicle trips.
    - The delay is estimated to increase by 11.6 seconds per vehicle during the weekday a.m. and p.m. peak hours.
    - The queue length is estimated to increase by 87 feet during the weekday a.m. peak hour and by 81 feet during the weekday p.m. peak hour.
    - The level of service is estimated to change from LOS C to LOS D during the weekday a.m. and p.m. peak hours.
- There would be a slight increase in delay on the northbound approach (1.8 and 2.9 seconds during the weekday a.m. and p.m. peak hours, respectively) with the addition of project-generated vehicle trips. Queue lengths would increase by less than two vehicle lengths.
- There would be a slight increase in delay on the westbound approach (0.8 and 4.2 seconds during the weekday a.m. and p.m. peak hours, respectively) with the addition of project-generated vehicle trips. Queue lengths would increase by less than one vehicle length.
- The eastbound approach is projected to experience little to no change in delay, queues, or level of service during the weekday a.m. and p.m. peak hours with the addition of project-generated vehicle trips.

Frida Kahlo Way/Geneva Avenue/Ocean Avenue

The intersection of Frida Kahlo Way/Geneva Avenue/Ocean Avenue is a four-legged signalized intersection. The eastbound approach has one left-turn lane, one through lane, and a through/right-turn lane. The westbound approach has two through lanes and one through/right-turn lane. The northbound approach has one left-turn lane and one shared left/right-turn lane. The southbound approach has one right-turn lane, one through lane, and one through/left-turn lane. Both general vehicles and transit vehicles utilize the eastbound left-turn lane and westbound inside through lane.

Traffic signals along Ocean Avenue, west of Geneva Avenue, are coordinated to provide east-west progression during the weekday a.m. and p.m. peak periods. The cycle length during both peak periods is 80 seconds. Northbound/southbound approaches and eastbound/westbound approaches run concurrently. Left-turning movements on the eastbound approach and the westbound approach are protected and are given a left-turn green arrow.

Referencing the data outlined in Table 6 and Table 7 project generated trips are predicted to result in changes to delay, queues, and level of service at Frida Kahlo Way/Geneva Avenue/Ocean Avenue. The following describes the changes between existing conditions and existing plus project conditions:

- The eastbound approach is estimated to operate over capacity with the addition of project-generated trips during the weekday p.m. peak hour. The westbound approach is estimated to operate over capacity during the weekday a.m. and p.m. peak hours for existing and existing plus project conditions.
- The overall intersection delay is anticipated to increase by 18.4 seconds per vehicle during the weekday a.m. peak hour and by 37.2 seconds per vehicle during the weekday p.m. peak hour with the addition of project-generated vehicle trips.
- The addition of project-generated vehicle trips is forecast to result in changes to delay and queue length on the eastbound approach during the weekday a.m. and p.m. peak hours, as follows:
    - The delay is estimated to increase by 12.9 and 13.5 seconds per vehicle, respectively.
    - The queue length is estimated to increase by 60 and 45 feet, respectively.
- The addition of project-generated vehicle trips is forecast result in changes to delay, queue length, and level of service on the westbound approach during the weekday a.m. and p.m. peak hour, as follows:
    - The delay is estimated to increase by 28.1 and 70.5 seconds per vehicle, respectively.
    - The queue length is estimated to increase by 38.6 and 115 feet, respectively.
    - The level of service is estimated to worsen from a LOS E to a LOS F during the weekday p.m. peak hour.
- The addition of project-generated vehicle trips are estimated to result in minimal changes to the delay, queue length on the northbound and southbound approaches during the weekday a.m. and p.m. peak hours.

Corridor Travel Times

To assess the effect of project-generated vehicle traffic on transit travel time on Muni lines K/T, 29, 43 and 49, the total change in delay across the three intersections for various movements is presented in Table 8.

Table 8: Transit Travel Time Changes

Transit Line	Transit Route	Ocean Avenue Corridor Transit Travel Time (minutes:seconds)					
		Existing Conditions		Project-Related Change		Existing Plus Project Conditions	
		a.m.	p.m.	a.m.	p.m.	a.m.	p.m.
K	Jules Avenue/Ocean Avenue to Balboa Park BART Station	3:30	8:42	0:29	1:12	3:59	9:54
	San Jose Avenue/Geneva Avenue to Dorado Terrace/Ocean Avenue	3:28	10:03	0:13	0:14	3:41	10:17
29	Mission Street/Persia Avenue to Plymouth Avenue/Ocean Avenue	10:55	12:00	0:29	1:12	11:24	13:12
	Plymouth Avenue/Ocean Avenue to Mission Street/Persia Avenue	9:53	10:10	0:13	0:14	10:06	10:23
43	Gennessee Street/Monterey Boulevard to City College Bookstore	4:25	4:05	-	-	4:25	4:05
	City College Bookstore to Foerster Street/Monterey Boulevard	4:37	4:35	0:01	0:05	4:38	4:40
49	Frida Kahlo Way/CCSF South Entrance to Mission Street/Persia Avenue	5:39	10:04	0:01	0:05	5:40	10:09
	Mission Street/Ocean Avenue to Frida Kahlo Way/CCSF South Entrance	7:18	11:25	0:01	0:05	7:19	11:30

Sources: SFMTA, 2019 (Existing Conditions). Kittelson & Associates, Inc. 2019 (Project-Related Change).
Notes: Delay is measured in seconds per vehicle. Transit times are presented in minutes and seconds. "-" indicates data not available.

As shown in Table 8, project-related change in transit travel time could not be calculated for the 43 Gennessee Street/Monterey Boulevard to City College Bookstore study segment as no study intersections are located along that segment. The greatest project-related increase in transit travel times of 29 seconds and 1 minute 12 seconds are estimated to affect the westbound operations for Muni lines K and 29 during the weekday a.m. and p.m. peak hours, respectively. This refined and detailed analysis considers the effect of imbalanced lane utilization along Ocean Avenue. As a result, the analysis results presented herein may differ from those presented within the corridor delay analysis and transit assessment memorandums.

POTENTIAL INTERSECTION MODIFICATIONS

Intersection modifications can be made to increase safety and capacity, improve vehicle progression, and reduce congestion on the road. The most common strategies include optimizing or modifying signal timing and implementing physical changes or turn movement restrictions at intersections to increase efficiency of intersection or corridor operations. This section presents a discussion and quantitative analysis of potential signal timing modifications and a discussion and qualitative assessment of other potential modifications.

Signal Timing Modifications

One of the major objectives of traffic signal optimization is to increase the capacity of at-grade intersections. This section discusses increasing green time on Ocean Avenue and evaluates the potential of this modification to reduce vehicle delay at study intersections along Ocean Avenue. For this analysis, at each study intersection, five seconds of green time was reallocated from the north/south approaches to the east/west approaches. In other words, green time on Ocean Avenue was increased by five seconds for each phase while the overall cycle length remained fixed. Table 9 and Table 10 summarize the delay, queue length, and level of service for each approach comparing existing plus project conditions and existing plus project conditions with the green time modifications for weekday a.m. and p.m. peak hours.

As shown in Table 9 and Table 10, the green time extension would reduce delay on eastbound and westbound movements and increase delay on northbound and southbound movements at study intersections along Ocean Avenue. Increasing, or reallocating, green time to Ocean Avenue would result in longer wait times for people crossing Ocean Avenue.

Table 9: Intersection Operations – Weekday a.m. Peak Hour with Green Time Reallocation to Ocean Avenue

Intersection/Scenario	Eastbound			Westbound			Northbound			Southbound			Int. Delay
	Delay	Queue	LOS	Delay	Queue	LOS	Delay	Queue	LOS	Delay	Queue	LOS	
Existing Plus Additional Housing Option													
Brighton Avenue	7.9	136.0	A	6.2	398.0	A	36.2	52.0	D	64.4	25.0	E	9.0
Lee Avenue	8.6	55.0	A	17.4	265.0	B	33.4	107.0	C	35.2	117.0	D	16.3
Frida Kahlo Way/Geneva Avenue	51.9	487.0	D	**164.5**	**521.0**	**F**	31.3	218.0	C	21.4	87.0	C	102.7
Existing Plus Additional Housing Option with Green Time Reallocation to Ocean Avenue													
Brighton Avenue	6.5	80.0	A	5.1	44.0	A	37.6	67.0	D	73.8	25.0	E	8.1
Lee Avenue	5.4	54.0	A	15.6	301.0	B	42.3	129.0	D	68.0	150.0	E	17.4
Frida Kahlo Way/Geneva Avenue	32.2	426.0	C	**73.7**	**390.0**	**E**	54.9	280.0	D	25.9	95.0	C	51.6
Change with Green Time Reallocation to Ocean Avenue													
Brighton Avenue	-1.4	-56.0	-	-1.1	-354.0	-	+1.4	+15.0	-	+9.4	-	-	-0.9
Lee Avenue	-3.2	-1.0	-	-1.8	+36.0	-	+8.9	+22.0	C to D	+32.8	+33.0	D to E	+1.1
Frida Kahlo Way/Geneva Avenue	-19.7	-61.0	D to C	-90.8	-131.0	F to E	+23.6	+62.0	C to D	+4.5	+8.0	-	-51.1

Sources: Kittelson & Associates, Inc. 2019.

Notes: LOS = level of service. Int. = Intersection. Approach delay is measured in average seconds delay experienced per vehicle on the approach during the specified time period. Intersection delay is the average total vehicle delay of all movements through an intersection during the specified time period. Queue length is measured in feet and represents the queue for through or left-turn lane movements on each approach. Analysis results presented in **bold** represents an approach exceeding capacity, with a v/c>1.0. Synchro may overestimate the delay and queue lengths reported at intersections or approaches operating at, or near, capacity.

Table 10: Intersection Operations – Weekday p.m. Peak Hour with Green Time Reallocation to Ocean Avenue

Intersection/ Scenario	Eastbound			Westbound			Northbound			Southbound			Int. Delay
	Delay	Queue	LOS	Delay	Queue	LOS	Delay	Queue	LOS	Delay	Queue	LOS	
Existing Plus Additional Housing Option													
Brighton Avenue	9.6	142.0	A	**75.1**	**492.0**	**E**	36.8	62.0	D	42.5	16.0	D	**44.3**
Lee Avenue	9.4	64.0	A	22.2	323.0	C	35.4	130.0	D	39.3	151.0	D	19.9
Frida Kahlo Way/Geneva Avenue	**60.4**	**516.0**	**E**	**145.6**	**508.0**	**F**	31.9	223.0	C	23.3	141.0	C	90.9
Existing Plus Additional Housing Option with Green Time Reallocation to Ocean Avenue													
Brighton Avenue	8.5	115.0	A	**66.4**	**542.0**	**E**	38.2	85.0	D	42.5	16.0	D	**39.5**
Lee Avenue	5.9	58.0	A	20.2	368.0	C	56.9	175.0	E	**90.3**	**184.0**	**F**	24.1
Frida Kahlo Way/Geneva Avenue	33.2	442.0	C	**63.3**	**362.0**	**E**	28.7	288.0	E	28.9	155.0	C	45.7
Change with Green Time Reallocation to Ocean Avenue													
Brighton Avenue	-1.1	-27.0	-	-8.7	+50.0	-	+1.4	+23.0	-	-	-	-	-4.8
Lee Avenue	-3.5	-6.0	-	-2.0	+45.0	-	+21.5	+45.0	D to E	+51.0	+33.0	D to F	+4.2
Frida Kahlo Way/Geneva Avenue	-27.2	-74.0	E to C	-82.3	-146.0	F to E	-3.2	+65.0	C to E	+5.6	+14.0	-	-45.2

Sources: Kittelson & Associates, Inc. 2019.

Notes: LOS = level of service. Int. = Intersection. Approach delay is measured in average seconds delay experienced per vehicle on the approach during the specified time period. Intersection delay is the average total vehicle delay of all movements through an intersection during the specified time period. Queue length is measured in feet and represents the queue for through or left-turn lane movements on each approach. Analysis results presented in **bold** represents an approach exceeding capacity, with a v/c>1.0. Synchro may overestimate the delay and queue lengths reported at intersections or approaches operating at, or near, capacity.

The following section describes the changes between existing plus project conditions with and without the signal timing adjustment at each study intersection:

- Brighton Avenue/Ocean Avenue
    - The overall average intersection delay would decrease by 0.9 seconds per vehicle during the weekday a.m. peak hour and by 4.8 seconds per vehicle during the weekday p.m. peak hour, with the green time adjustment.
    - The greatest reductions in delay and queue lengths are estimated to occur on the westbound movements on Ocean Avenue. During the weekday a.m. peak hour, the delay is estimated to decrease by 1.1 seconds per vehicle, while the queue length is estimated to decrease by 354 feet, with the green time adjustment. During the weekday p.m. peak hour, the delay is estimated to decrease by 8.7 seconds per vehicle, though the queue length is estimated to increase by 50 feet, with the green time adjustment.
- Lee Avenue/Ocean Avenue
    - The overall average intersection delay is projected to increase by 1.1 seconds per vehicle during the weekday a.m. peak hour and by 4.2 seconds per vehicle during the weekday p.m. peak hour, with the green time adjustment.
    - During the weekday a.m. peak hour, the delay on the southbound approach is estimated to increase by 32.8 seconds per vehicle, the queue length is estimated to increase by 33 feet, and the level of service is estimated to worsen from a LOS D to LOS E, with the adjustment to the green time. During the weekday p.m. peak hour, the delay is estimated to increase by 51 seconds per vehicle, the queue length is estimated to increase by 33 feet, and the level of service is estimated to worsen from a LOS D to LOS F, with the green time adjustment.
    - The delay on the eastbound approach is estimated to decrease by 3.2 and 3.5 seconds per vehicle during the weekday a.m. and p.m. peak hours, respectively, with the adjustment to the green time.
- Frida Kahlo Way/Geneva Avenue/Ocean Avenue
    - During the weekday a.m. and p.m. peak periods, the delays on the eastbound and westbound movements are anticipated to decrease with the green time adjustment.
    - The overall average intersection delay is forecast to decrease by 45.2 seconds per vehicle during the weekday a.m. peak hour and by 51.1 seconds per vehicle during the weekday p.m. peak hour, with the green time adjustment. Synchro may overestimate delay and queue lengths reported at intersections and approaches operating at, or near, capacity.
    - With the addition of the green time adjustment, the westbound approach is anticipated to experience the greatest changes. During the weekday a.m. peak hour, the delay would decrease by 90.8 seconds per vehicle, the queue length would decrease by 131 feet, and the level of service would improve from LOS F to LOS E. During the weekday p.m. peak hour, the delay would decrease by 82.3 seconds per vehicle, the queue

length would decrease by 146 feet, and the level of service would improve from LOS F to LOS E.

Overall, the intersection delay is anticipated to decrease at Brighton Avenue/Ocean Avenue (by between 1 and 5 seconds) and Frida Kahlo Way/Geneva Avenue/Ocean Avenue (by between 45 and 51 seconds)[8] and is anticipated to increase at Ocean Avenue/Lee Avenue (by between 1 and 5 seconds) with the green time adjustments. Generally, the reallocation of green time to Ocean Avenue would reduce delay and queues on the eastbound and westbound approaches and increase delay and queue lengths on the northbound and southbound movements.

As previously discussed, signalized intersections along Ocean Avenue operate as actuated-coordinated signals with maximum recall[9] that operate on a fixed cycle length. Signal timing modifications implemented at these three intersections in isolation may adversely affect vehicle progression and have unintended consequences for operations along the corridor. Any adjustments to signal timing would need to be reviewed and approved by SFMTA.

Other Modifications

In addition to signal timing modifications, other intersection modifications and treatments along the corridor may be implemented to increase efficiency of operations and reduce vehicle delay and queue lengths along the corridor. The following types of modifications may be considered:

- **Install left-turn lanes**. Left-turn lanes remove stopped or slow-moving left-turning motor vehicles from the stream of through traffic and reduce the potential for rear-end crashes at intersections. The safety and capacity benefits of left-turn lanes apply to all vehicular traffic, motorized as well as non-motorized. However, left-turn lanes add to the pedestrian crossing distance and pedestrian crossing time. The additional street width needed for left-turn lanes may require land taking or removal of on-street parking. These treatments can be costly if additional right-of-way is needed. Intersection reconfiguration that would require roadway widening or additional right-of-way may not be feasible or appropriate within the context of the corridor.
- **Install right-turn lanes.** Right turn lanes are used to remove decelerating right-turning motor vehicles from the traffic stream, and also to provide an additional lane for the storage of right-turning motor vehicles. Where the right-turn volume is heavy, this removal of the turning motor vehicle from the traffic stream can also reduce a primary cause of rear-end crashes at

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[8] Synchro may overestimate delay and queue lengths reported at intersections and approaches operating at, or near, capacity.

[9] Actuated signals prioritize the through movement of the major street and use sensors to respond to the traffic present at actuated approach, so that the pattern of the signal (the length and order of each phase) depends on the traffic and can be different at every cycle. Sensors report to the signal computer and green is provided for those actuated lanes only when traffic is present and only until the traffic has vacated those lanes or the maximum time set for that phase has been reached.

intersections. The safety and capacity benefits of right-turn lanes apply to all vehicular traffic, motorized as well as non-motorized. However, right-turn lanes add to the pedestrian crossing distance and pedestrian crossing time. The additional street width needed for right-turn lanes may require land taking or removal of on-street parking. These treatments can be costly if additional right-of-way is needed. Intersection reconfiguration that would require roadway widening or additional right-of-way may not be feasible or appropriate within the context of the corridor.

- **Implement turn restrictions**. Left turns take a large amount of space and signal time and right turns can be problematic for transit and through vehicle operations in the right lane. Prohibiting turns and shifting turn volume to intersections where they can be best accommodated – with signal phases and turn lanes – can improve general traffic and transit performance, and walking and bicycling safety at the same time. On two-way streets, left-turn restrictions can substantially increase the capacity of general traffic lanes.
- **Redesign intersections**. Unconventional intersection designs can be used to increase the capacity of intersections at high volume locations. Examples of unconventional designs include median U-turns, jug handles, superstreets, quadrant roadway intersections, continuous flow intersections, and synchronized-split phasing intersections. In these designs, one or more traffic movements are prohibited and re-routed at the intersection, so that fewer signal phases are needed at the intersection signal, thereby increasing the capacity of the intersection. These designs typically require extra land space and re-routed traffic movements often need to go through the intersection multiple times, which limits travel time and congestion reduction benefits. Other examples of unconventional designs include tandem intersections with separate left-turn phases and intersections with dynamic use of exit lanes for left-turns. These designs can increase the utilization of the intersection cross-section without removing or re-routing turning movements. These designs are not intuitive for drivers and can be challenging to navigate. Intersection reconfiguration that would require roadway widening, additional right-of-way, rail reconfiguration, or signal relocation would be major infrastructure projects and may not be feasible or appropriate within the context of the corridor.

Other planned projects that are intended to enhance safety and may reduce vehicle delay along the corridor include the Ocean Avenue Safety Project[10] and the I-280 Interchange Modifications at Balboa Park Project[11].

The Ocean Avenue Safety Project is aimed at improving safety, accessibility, and comfort for people traveling on Ocean Avenue and Geneva Avenue between Ocean Avenue/Geneva Avenue/Frida Kahlo Way and San Jose Avenue. The goals of this project are to develop of a set of near-term improvements, cost-effective measures that can be installed quickly (near-term project construction planned for

[10] SFMTA, Ocean Avenue Safety Project website, https://www.sfmta.com/projects/ocean-avenue-safety-project
[11] SFCTA, I-280 Interchange Modifications at Balboa Park Project website, https://www.sfcta.org/I-280-interchange-modifications-balboa-park-project

Summer 2020) to improve safety on Ocean Avenue and to create a long-term vision for the Ocean Avenue corridor that can be coordinated with other on-going projects or a future Muni re-rail project.

The I-280 Interchange Modifications at Balboa Park Project is aimed at reducing multimodal conflicts at the I-280 freeway ramps while maintaining vehicle operations in the area, providing safe, accessible, and convenient connections, and developing cost-effective solutions that can be implemented within the next decade. The recommended modifications include I-280/Geneva Avenue northbound on-ramp closure and southbound I-280/Ocean Avenue off-ramp realignment and construction of a new signalized intersection.

City College of San Francisco Facilities Master Plan[12] identifies several recommendations that would enhance transportation in the area, including developing site improvements to provide direct access between transit stops and campus gateways and coordinating efforts to support local “Transit First” policies, encourage use of non-auto modes, and implement transportation demand management measures to reduce driving to the campus.

SUMMARY OF FINDINGS

For the purposes of a more conservative analysis, the Additional Housing Option was evaluated, as it would generate more vehicle trips and would have a greater effect on corridor delay and intersection operations. The Developer’s Proposed Option would generate about 25 percent fewer vehicle trips and as a result, would be expected to result in less delay compared to the Additional Housing Option.

Corridor Delay Analysis

Overall, vehicle trips generated by the Additional Housing Option are not anticipated to substantially increase delays along Ocean Avenue and Ridgewood Avenue/Frida Kahlo Way during the weekday a.m. and p.m. peak hours. The results of the corridor delay analysis comparing existing with existing plus project conditions are summarized in this section.

Ocean Avenue

- Under existing and existing plus project conditions, vehicles travelling westbound experience greater delay compared to vehicles travelling eastbound, during the weekday a.m. and p.m. peak hours. Specifically, westbound vehicles experience 32 and 33 seconds of delay per vehicle during the weekday a.m. and p.m. peak hours, while eastbound vehicles experience 11 and 13 seconds of delay per vehicle during the weekday a.m. and p.m. peak hours, respectively.
- Vehicle trips generated by the Additional Housing Option increase the delay by one second per vehicle for eastbound movements, while westbound movements experience no change in delay

[12] City College of San Francisco, City College Facilities Master Plan, approved by the Board of Trustees in March 2019, https://www.ccsf.edu/en/about-city-college/administration/vcfa/facilities_planning/facilities-master-plan.html

during the weekday a.m. peak hour. Vehicle trips generated by the Additional Housing Option increase the delay by two seconds per vehicle for eastbound movements and eight seconds per vehicle for westbound movements during the weekday p.m. peak hour.

Ridgewood Avenue-Frida Kahlo Way

- Under existing and existing plus project conditions, vehicles travelling southbound experience greater delay compared to vehicles travelling northbound, during the weekday a.m. and p.m. peak hours. Specifically, southbound movements endure 11 and 19 seconds of delay per vehicle during the weekday a.m. and p.m. peak hours, while northbound movements experience 3 and 4 seconds of delay per vehicle during the weekday a.m. and p.m. peak hours, respectively.
- Vehicle trips generated by the Additional Housing Option increase the delay by one second per vehicle for northbound and southbound movements during the weekday a.m. peak hour. Vehicle trips generated by the Additional Housing Option do not affect the delay for northbound movements, though southbound movements experience and increase in delay by three seconds per vehicle during the weekday p.m. peak hour.

Intersection Operations Analysis

Overall, vehicle trips generated by the Additional Housing Option are not anticipated to substantially increase delays at study intersections during the weekday a.m. and p.m. peak hours. The results of the intersection operations analysis comparing existing with existing plus project conditions are summarized in this section.

Brighton Avenue/Ocean Avenue

- There would not be a substantial change to the delay, queue lengths, and level of service with the addition of project-generated vehicle trips.
- With the addition of project trips, the overall intersection delay may be slightly reduced (by less than one second per vehicle and by 1.3 seconds per vehicle during the weekday a.m. and p.m. peak hours, respectively), as a larger proportion of trips travelling through the intersection are doing so on the coordinated phase, thereby increasing the efficiency of the signal and reducing average vehicle delay.
- The westbound approach is projected to experience the greatest amounts of change with the addition of project-generated vehicle trips:
  - Delays on this approach may be slightly reduced (by 0.2 and 3.1 seconds per vehicle during the weekday a.m. and p.m. peak hours, respectively), as a larger proportion of intersection traffic is on the coordinated phase.
  - Queue length may increase slightly (by 24 feet) during the weekday a.m. peak hour and decrease slightly (by 78 feet) during the weekday p.m. peak hour. This decrease is due to better utilization of the coordinated phase.

  - The level of service is estimated to remain the same during the weekday a.m. and p.m. peak hours.

Lee Avenue/Ocean Avenue

- With the addition of project-generated vehicle trips, the overall intersection delay is projected to slightly increase (by 2.0 and 4.2 seconds per vehicle during the weekday a.m. and p.m. peak hours, respectively).
- The southbound approach is projected to experience the greatest change in delay, queues, and level of service with the addition of project-generated vehicle trips.
  - The delay is estimated to increase by 11.6 seconds per vehicle during the weekday a.m. and p.m. peak hours.
  - The queue length is estimated to increase by 87 feet during the weekday a.m. peak hour and by 81 feet during the weekday p.m. peak hour.
  - The level of service is estimated to change from LOS C to LOS D during the weekday a.m. and p.m. peak hours.

Frida Kahlo Way/Geneva Avenue/Ocean Avenue

- The overall intersection delay is anticipated to increase by 18.4 seconds per vehicle during the weekday a.m. peak hour and by 37.2 seconds per vehicle during the weekday p.m. peak hour with the addition of project-generated vehicle trips.
- The addition of project-generated vehicle trips is forecast to result in changes to delay and queue length on the eastbound approach during the weekday a.m. and p.m. peak hours, as follows:
  - The delay is estimated to increase by 12.9 and 13.5 seconds per vehicle, respectively.
  - The queue length is estimated to increase by 60 and 45 feet, respectively.
- The addition of project-generated vehicle trips is forecast to result in changes to delay, queue length, and level of service on the westbound approach during the weekday a.m. and p.m. peak hour, as follows:
  - The delay is estimated to increase by 28.1 and 70.5 seconds per vehicle, respectively.
  - The queue length is estimated to increase by 38.6 and 115 feet, respectively.
  - The level of service is estimated to worsen from a LOS E to a LOS F during the weekday p.m. peak hour.

Corridor Transit Travel Times

Overall, vehicle trips generated by the Additional Housing Option are anticipated to increase transit travel times by a maximum of 1 minute 12 seconds on Muni lines K and 29 in the eastbound direction during the weekday p.m. peak hour. The addition of project-generated vehicle trips is projected to increase delays by a maximum of 15 seconds for other lines/directions.

Signal Timing Modifications

Reallocating five seconds of green time from north/south phases to east/west phases on Ocean Avenue would have the following effect on study intersections during the weekday a.m. and p.m. peak hours:

- Decrease overall intersection delays at Brighton Avenue/Ocean Avenue and Frida Kahlo Way/Geneva Avenue/Ocean Avenue by between 1 and 5 seconds and between 45 and 51 seconds, respectively. However, Synchro may overestimate the change in delay and queue lengths reported at Frida Kahlo Way/Geneva Avenue/Ocean Avenue, which operates at, or near, capacity.
- Increase overall intersection delays at Ocean Avenue/Lee Avenue by between 1 and 5 seconds.
- Generally, signal timing modifications would reduce delay and queues on the eastbound and westbound approaches and increase delay and queue lengths on the northbound and southbound movements.

Signalized intersections along Ocean Avenue operate as actuated-coordinated signals with maximum recall[13] that operate on a fixed cycle length. Signal timing modifications implemented at these three intersections in isolation may adversely affect vehicle progression and have unintended consequences for operations along the corridor. Any adjustments to signal timing would need to be reviewed and approved by SFMTA.

Other Modifications

In addition to signal timing modifications, other intersection modifications and treatments along the corridor may be implemented to increase efficiency of operations and reduce vehicle delay and queue lengths along the corridor. These include installation of left-turn lanes, installation of right-turn lanes, implementation of turn restrictions, and intersection redesign. These treatments can be costly if additional right-of-way is needed and there may be other tradeoffs to consider, such as potential adverse effects on conditions for bicyclists and pedestrians. Intersection reconfiguration that would require roadway widening, additional right-of-way, rail reconfiguration, or signal relocation would be major infrastructure projects and may not be feasible or appropriate within the context of the corridor.

Planned projects that are intended to improve safety, access, and comfort for people traveling along Ocean Avenue include the Ocean Avenue Safety Project and I-280 Interchange Modifications at Balboa Park Project.

[13] Actuated signals with maximum recall prioritize the through movement of the major street and use sensors to respond to the traffic present at actuated approach. Sensors report to the signal computer and green is provided for those actuated lanes only when traffic is present and only until the traffic has vacated those lanes or the maximum time set for that phase has been reached.

ATTACHMENT C: SHUTTLE STUDY TECHNICAL MEMORANDUM

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TECHNICAL MEMORANDUM

Date:	August 1, 2019
To:	Reservoir Community Partners, LLC
From:	Kittelson & Associates, Inc.
Subject:	Balboa Reservoir – Shuttle Study Memorandum

Kittelson & Associates, Inc. (Kittelson) has prepared this memorandum to present the results of a shuttle assessment analysis for the proposed Balboa Reservoir project (Case No. 2018-007883ENV) in San Francisco, California. The purpose of this analysis is to assess the feasibility of a shuttle operating between the Balboa Reservoir site, the City College of San Francisco (CCSF) campus, and the Balboa Park BART/Muni station. The memorandum is organized as follows:

- Ridership Assessment
- Service Concept
- Feasibility Analysis
- Conclusion

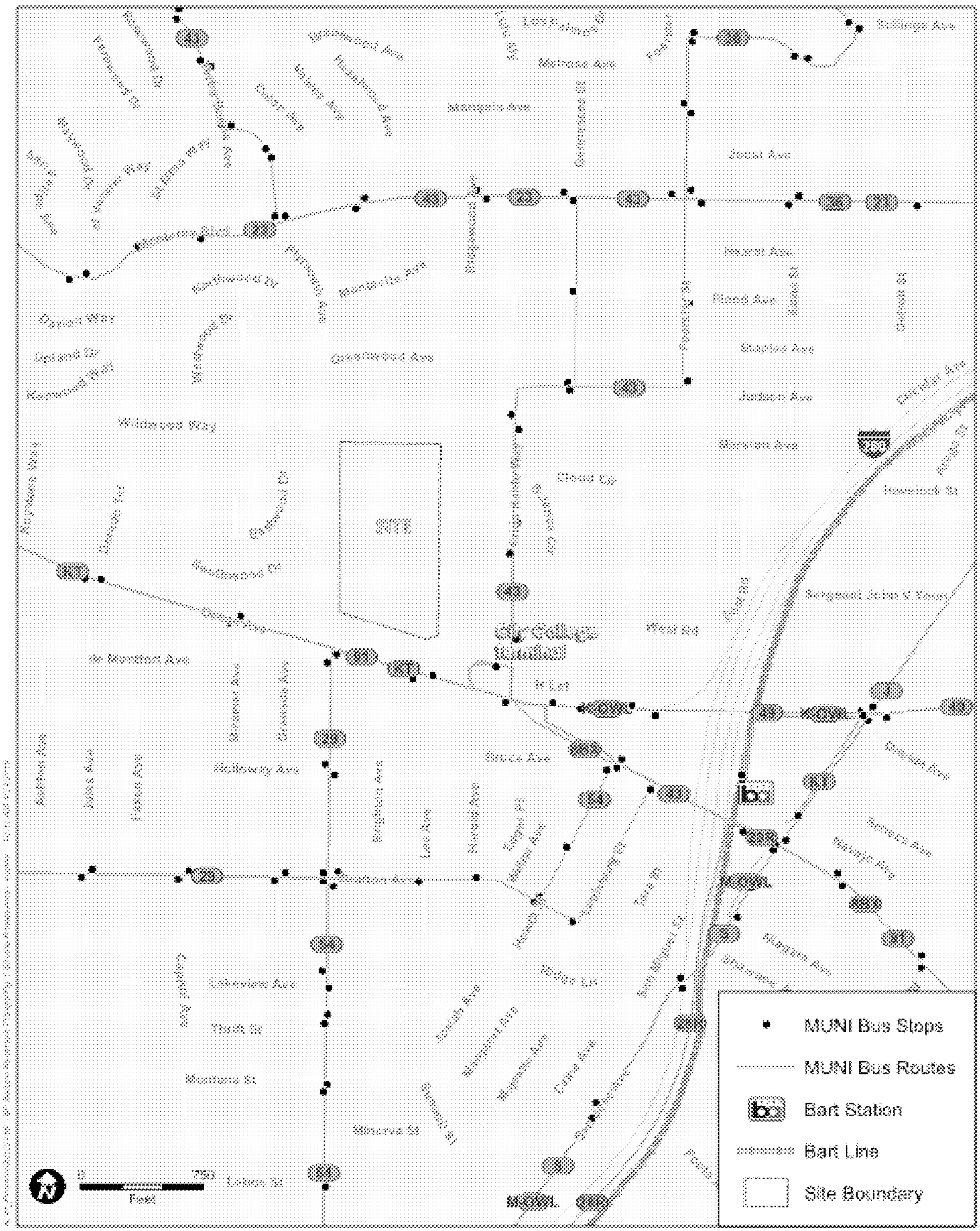
EXECUTIVE SUMMARY

The Balboa Reservoir development is expected to generate up to 2,700 transit trips[1] each day, many to/from the Balboa Park BART/Muni station, approximately 0.6 miles east of the project site. While a direct shuttle connecting the site to transit hubs and CCSF would potentially attract a high ridership, the shuttle must operate at high frequencies to effectively compete with the existing transit service and walking trips. A free, high-frequency shuttle service is forecast to be well-utilized with an estimated cost well over $750,000 per year. If a lower frequency and less costly service were provided as an alternative, it would not be competitive with the existing transit and walking alternatives and would see less use.

RIDERSHIP ASSESSMENT

The proposed Balboa Reservoir development is well served by existing transit, as documented by the April 19, 2019 *Transit Assessment Memorandum*, which projects a 38% transit mode share for project-generated trips and up to 2,700 daily transit trips. Existing transit routes and stops are presented in Figure 1.

[1] Source: Balboa Reservoir Transit Assessment Memorandum, January 14, 2019



Source: Kittelson & Associates, Inc., 2019

Case No.2018-007883ENV: Balboa Reservoir Project

Figure 1
Existing Transit Service

A shuttle service to connect the Balboa Reservoir development with the City College Terminal, the Balboa Park BART/Muni Station, and CCSF is under consideration. While the total travel demand between these destinations is high, the forecast shuttle demand would take into consideration walking times versus shuttle wait and travel times when considering the desirability of shuttle use. This ridership choice is based heavily on the quality of proposed shuttle service, which is described in greater detail in the next section. This shuttle analysis assumes the shuttle service would be more appealing than existing transit service when the travel times are similar.

Existing Transit Service

Muni currently offers convenient connections to the Balboa Park BART/Muni station as shown in Figure 1. The K Ingleside light rail and Muni bus routes 8, 29, 49, and 91 have stops on Ocean Avenue or the City College Terminal near the project site. Muni route 43 operates on Frida Kahlo Way adjacent to CCSF and on Geneva Avenue to the Balboa Park BART/Muni station. Each line operates on 8- to 10-minute headways during daytime periods and 15- to 20- minute headways after 7 p.m[2]. Given that multiple lines serve most nearby stops, typical waiting times are under five minutes during the weekday a.m. and p.m. peak periods. The shuttle system route would be duplicative with existing transit connection to the Balboa Park BART/Muni station for passengers able to walk to nearby bus and light rail stops.

Walking Travel Time

The Balboa Park BART/Muni station is approximately 0.6 mile from the Balboa Reservoir development, a trip of 14 minutes at a typical walking pace of 4 feet per second[3]. A similar walking trip to the City College Terminal and the adjacent K Ingleside light rail is less than 0.3 miles, or about a 6 minute walk. To be appealing to passengers, the shuttle must offer time savings and convenience on par or better than these walking trips.

Kittelson prepared a spreadsheet model to estimate weekday a.m. and p.m. peak hour shuttle demand between the four shuttle stops based on walking versus shuttle waiting time plus travel time. This iterative process, illustrated in Exhibit 1, results in the needed number and size of shuttles to serve the corresponding demand.

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[2] Source: San Francisco Municipal Transit Agency, 2019. *https://www.sfmta.com/getting-around/muni/routes-stops*

[3] This walking pace is similar to estimated walk times from Google Maps.

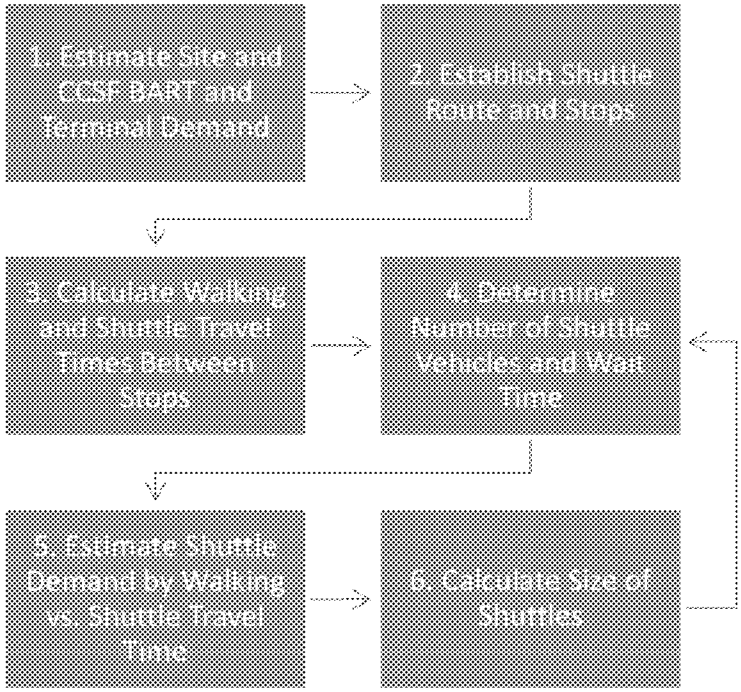


Exhibit 1 Peak Hour Shuttle Demand Estimation Process

The steps in the spreadsheet model are as follows:

1. **Estimate Site and CCSF BART and Terminal Demand**[4]
   a. Peak hour transit demand between the project site and the Balboa Park BART/Muni Station and the City College Terminal were calculated from the *Transit Assessment Memorandum*
   b. CCSF demand to/from BART was calculated from:
      i. Estimate of the percentage of peak hour Balboa Park BART/Muni station riders to/from CCSF
      ii. Estimate of CCSF students and faculty using BART during peak hours
   c. CCSF demand to/from the City College Terminal was assumed to equal the CCSF demand to/from BART
2. **Establish Shuttle Route and Stops**
   a. Stops established at Balboa Reservoir, City College Terminal, Balboa Park BART/Muni Station, and CCSF
3. **Calculate Walking and Shuttle Travel Times Between Stops**

[4] CCSF transit ridership data is not available. In lieu of specific CCSF transit ridership data, BART Station Survey data and CCSF enrollment data were used as they represent the best/most relevant data available for this analysis. The analysis relies on informed assumptions regarding mode share to determine CCSF transit ridership. Actual CCSF transit ridership may vary. However, it is expected to be within a reasonable range of the assumed ridership and would not substantially affect the analysis.

   a. Walking time between stops calculated by distance and intersection crossings
   b. Shuttle travel times estimated from distance, route, and Google Maps peak hour travel time estimates
4. **Determine Number of Shuttle Vehicles and Wait Time**
   a. Total shuttle route travel time determines the number of trips per hour per shuttle
   b. Number of shuttles determines headway (time between shuttles at a given stop)
   c. Average wait time is one-half the headway
5. **Estimate Shuttle Demand by Walking vs. Shuttle Travel Time**
   a. Calculate ratio of shuttle waiting plus travel time and walking travel time between each stop
   b. Assign proportion of demand between each stop pair to the shuttle: if the shuttle is comparable to walking, shuttle usage is high; if the shuttle travel time is several times that of walking, shuttle usage is low.
6. **Calculate Size of Shuttles**
   a. Determine the size of shuttles needed to serve the maximum number of riders on any link of the shuttle route.

Step 5 includes estimating the proportion of trips between stops that would use the shuttle. As the number of shuttles operating the peak hour increase, the headway and associated average wait time decrease, which increase the attractiveness of the shuttle compared to walking, increasing projected ridership. Kittelson developed a shuttle demand model informed by BART mode access research shown in Table 1 and Exhibit 2. Walking travel times compared to shuttle travel times determine the proportion of total demand uses the shuttle for each stop pair.

Table 1 Balboa Park BART Station Access Mode from Home to BART

Station	Walk	Bicycle	Bus, Train, or Other Transit	Motorcycle / Motorized Scooter	Drive Alone / Carpool	Drop Off / Taxi / Other
Balboa Park	56%	6%	13%	0%	6%	20%

Sources: 2015 BART Station Profile Study
Notes: Drop Off/Taxi/Other category does not include TNCs given the data is from 2015, before TNCs were available.

Per the 2015 Station Profile Study, 56% of current Balboa Park riders walk to the station, with a median walking distance of 0.52 miles. Additionally, 13% of existing Balboa Park BART Station riders use transit (median distance of 1.15 miles) and 20% are dropped off; likely due to a lack of vehicle parking at the station, there are only 6% drive alone/carpool trips to the station. Combining the Balboa Park BART Station specific data in Table 1 with the general distance-based data in Exhibit 2, walking is expected to comprise about 30% of the 0.6-mile trips between the Balboa Reservoir development and the Balboa Park BART Station, depending on the frequency of the shuttle. The Balboa Reservoir shuttle demand model is calibrated to high shuttle use estimates to serve as a proof of concept. The convenience of a free shuttle was estimated to be more appealing than and capture the majority of the BART riders that may otherwise walk, take other transit options, drive alone/carpool, or be dropped off in a taxi or TNC. Given the Balboa Reservoir development is proposed to include limited, unbundled parking; residents are expected to have low rates of auto ownership; and given that the Balboa Park BART Station does not include station parking, driving the 0.6 miles to the station is expected to be particularly unappealing compared to the distribution of travel mode shown in Table 1 and Exhibit 2.

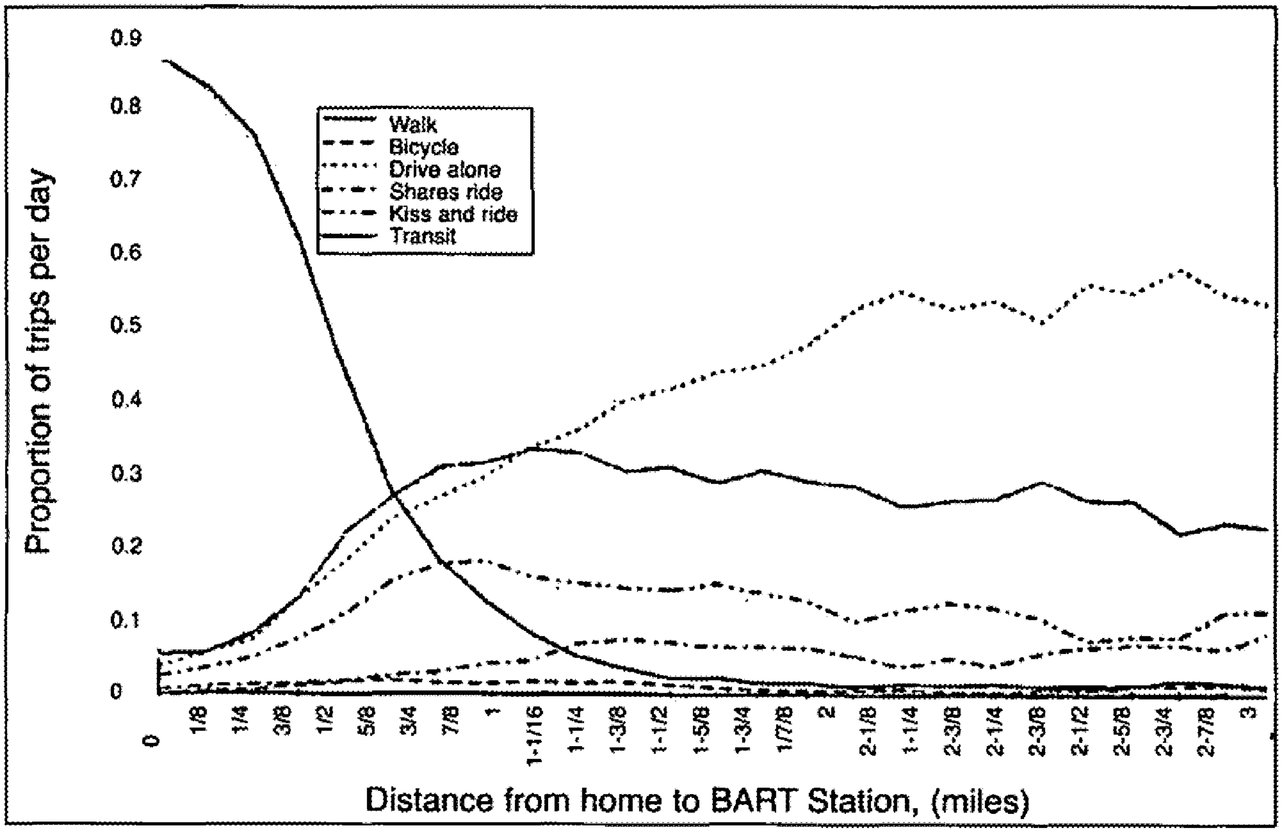


Exhibit 2 Distribution of Travel Mode to BART Stations by Distance[5]

The model is flexible to be responsive to a range of projections and assumptions and can be used as tool to forecast a range of demand scenarios. Key assumptions include the shuttle would be free for Balboa Reservoir residents and visitors and CCSF students, staff, and faculty and the shuttle would use Muni bus stops. An example of the model results is shown in Table 2 for the one-way site trips to the Balboa Park BART/Muni station. Table 2 presents the results of the shuttle model for one to four shuttles operating in the peak hour.

[5] Source: Cervero, R. *Walk-and-Ride: Factors Influencing Pedestrian Access to Transit, 2001.*

Table 2: Weekday Peak Hour Ridership Estimate: Site to BART

Shuttle Operations					Average Walking Time (minutes)	Average Transit Time (minutes)[1]	Percent Use Shuttle
Number of Shuttles	Headway (minutes)	Average Wait Time (minutes)	Travel Time (minutes)	Average Total Shuttle Time (minutes)			
1	31.5	15.8	7.5	23.3	14	15	53%
2	15.8	7.9		15.4			73%
3	10.5	5.3		12.8			82%
4	7.9	3.9		11.4			87%

Sources: Kittelson & Associates, Inc. 2019; Google Maps 2019.
Notes: [1] Consists of typical walking time, average wait time, and transit travel time.
All times rounded to nearest tenth.

As shown in Table 2, for this 0.6-mile walking route, the average walking time and transit travel time are approximately equal to the average total shuttle time (average wait plus travel time) when two shuttles are operating. With the shuttle in operation, approximately half of the walk trips and the majority of transit, drive alone, and kiss and ride modes shown in Exhibit 2 would be expected to switch modes and use the shuttle. The shuttle use is estimated to range from 53 to 87 percent of BART riders traveling to/from Balboa Reservoir and CCSF.

Table 3 demonstrates the shuttle vehicles can be smaller when more shuttles are in operation, even as total demand increases. The forecast shuttle ridership roughly doubles as service improves from one to four shuttles in peak hour operation.

Table 3: Weekday Peak Hour Ridership Estimate and Shuttle Needs

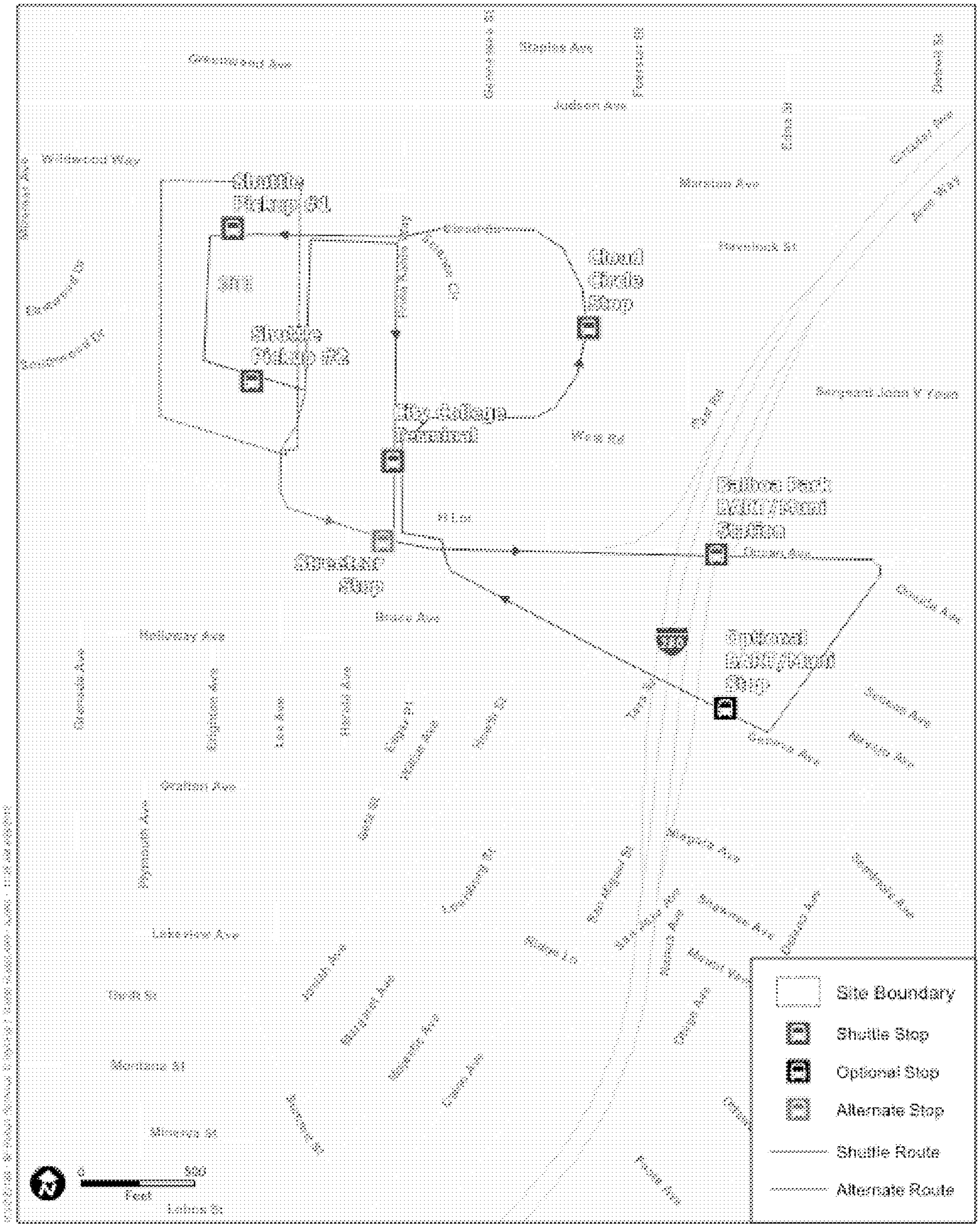
Number of Shuttles	Headway (minutes)	Peak Hour Ridership		Peak Passenger Load	Shuttle Vehicle
		AM	PM		
1	31.5	142	87	41	40-Foot Bus
2	15.8	236	169	35	35-Foot Bus
3	10.5	281	203	27	Cutaway Minibus
4	7.9	304	222	22	Cutaway Minibus

Sources: Kittelson & Associates, Inc. 2019; BART 2019; CCSF 2019.
Notes: AM = weekday a.m.; PM = weekday p.m.

SERVICE CONCEPT

Shuttle Route

The conceptual shuttle route and stop location concept is presented in Figure 2. This route would operate in one direction, clockwise, to allow loading/unloading on the most convenient side of the street at each stop to minimize the need for street crossings. The route is approximately 2.25 miles long with an estimated peak hour one-way travel time of approximately 20 minutes, not including loading/unloading and dwell time.



Source: Kittelson & Associates, Inc., 2019

Case No. 2018-007883ENV: Balboa Reservoir Project

Figure 2
Proposed Shuttle Service

This concept represents one potential route and additional analysis would be needed in later stages of the shuttle planning process to further refine the alignment and ensure feasibility, including stops and facilities to serve shuttle vehicles within and outside of the Balboa Reservoir site.

Shuttle Stops

The proposed stops are:

- Balboa Reservoir: one or two stops pending final street layout and locations suitable for shuttle stops
- City College Terminal: served by the existing Muni bus stop on Frida Kahlo Way, or via the alternate Lee Avenue route to the Ocean Avenue Muni bus stop.
- Balboa Park BART/Muni Station: the assumed stop is at the Ocean Avenue Muni bus stop but could be served alternatively or in addition at the Geneva Avenue Muni bus stop. The Geneva Avenue Muni bus stop location is currently constrained and shuttle of this stop may not be feasible. An alternative stop location would need to be found.
- CCSF: the assumed stop is a central and convenient location on Cloud Circle.

Shuttle buses loading and unloading passengers in Muni bus stops at Balboa Park BART/Muni Station and near the City College Terminal is essential to the feasibility of the service. This access would require SFMTA approval. SFMTA regulations would not currently permit shuttle service at these bus stops.

Service Headways

The proposed route is expected to be approximately 31.5 minutes long during peak hours, with variability based on congestion, signal delay, passenger boarding/alighting, final stops/routing, layover scheduling, and the site circulation network. The associated headways based on the number of shuttles in operation and the corresponding vehicle needs are shown in Table 3.

Vehicle dwell times while loading/unloading vary by ridership and vehicle type, such as if two-door boarding is feasible. For this analysis, dwell time was assumed to be 30 seconds for the City College Terminal, CCSF stops, and the Balboa Park BART/Muni station stop, and 10 minutes at the site to account for up to two stops, a timepoint, and a 10 minute layover once per hour. Shuttle dwell times in this study are intended to be conservative and are estimated based on several factors specific to the shuttle service including time points and/or coordination with BART arrival and potential higher proportion of riders needing assistance.

Hours of Operation

Hourly demand projections are beyond the scope of this study. Midday and evening shuttle demand is expected to be less than peak hour demand for the primarily residential Balboa Reservoir development while CCSF demand is forecast to respond to class schedule, remaining steady throughout much of the weekday. Suggested initial service span for scheduled service is 6 a.m. to 8 p.m. on weekdays and 10 a.m. to 6 p.m. on weekends. More shuttles should be in operation during the weekday a.m. and p.m. peaks and during midday. The shuttles can run either on a fixed schedule (where buses may wait to keep on schedule) or run continuously.

During periods of lower demand, such as early morning, late evening, and weekends, the shuttle can be run as demand responsive service instead of fixed route/schedule. This would require a request and dispatching mechanism. Alternatively, a reduced schedule could be provided to serve CCSF night classes or late-night BART train arrivals. As is typical with transit service, the shuttle's initial hours, schedule, and frequency should be revised based on actual ridership needs.

Vehicle Requirements

As shown in Table 3, vehicle capacity varies with the number of vehicles in operation. A fleet of three accessible "cutaway" minibuses with 24-28 passenger capacity would be optimal for high-frequency peak hour service and flexible off-peak service.

SHUTTLE COST ANALYSIS

Shuttle costs primarily comprise of two main elements:

- Shuttle vehicles (rolling stock)
- Operational costs
    - Driver's wages and benefits
    - Insurance
    - Vehicle maintenance
    - Fuel

"Cutaway" minibuses cost between $42,000 and $58,000[6] and have an average lifespan of 5.6 years[7]. Operational costs for shuttles operating in San Mateo county indicate typical shuttle operations costs of $60 to $80 per hour. The weekday peak period shuttles typically cost between $150,000 and $200,000 annually[8]. Based on San Francisco Consumer Price Index data, there has been an annual average escalation of about three percent over the last nine years. This escalation would be expected to continue in the future.

The shuttle concept analyzed in this memorandum assumes three "cutaway" minibus shuttles operating during weekday a.m. and p.m. peak period with reduced service during off peak and weekend periods. This analysis assumes a weekday service of five hours with three buses, eight hours with two buses, and two hours

[6] Source: Colorado Department of Transportation, *Overview of Transit Vehicles*

[7] Source: Federal Transit Administration, *Useful Life of Buses and Vans, 2007*

[8] Source: San Mateo County Transportation Authority, *San Mateo County Shuttle Inventory and Analysis*, 2010. San Mateo County data assumed to be similar to San Francisco.

with one bus. Weekend service is assumed to be nine hours with one bus in operation. Based on this operational profile, low and high estimates of the vehicle and operational costs of the shuttle concept is shown in Table 4.

Table 4: Shuttle Concept Estimated Annual Costs (2019 $)[9]

Estimate	Number of Vehicles	Annualized Vehicle Costs[1]	Weekday Service Shuttle-Hours[2]	Weekend Service Shuttle-Hours[2]	Annual Operations Cost[3]	Total Annual Cost
Low	3	$22,500	33	9	$740,000	$762,500
High		$31,000			$980,000	$1,011,00

Sources: Kittelson & Associates, Inc. 2019; CODOT, FTA 2007, San Mateo CTA, 2010
Notes:
[1] Based on three shuttle vehicles to be replaced every 5.6 years.
[2] Sum of number of hours each shuttle is assumed to operate
[3] Annual hours of shuttle service times hourly operational cost; escalated to 2019 costs and rounded.

The vehicle and operations costs can be reduced by owning and operating fewer vehicles and/or reducing service hours, which in turn would reduce the usefulness and appeal of the shuttle and result in fewer riders, as shown in Table 3.

ADDITIONAL CONSIDERATIONS

This feasibility analysis focuses on the attractiveness and potential ridership of a potential shuttle based on various levels of service. The feasibility analysis does not consider regulatory, facility, or operational concerns, such as:

- Shuttle operator labor requirements
- Operator rest facility locations
- Balboa Reservoir shuttle stop locations or supporting amenities
- SFMTA regulatory provisions and permitting requirements
- Muni bus stop operations and feasibility of shared bus zones
- Operator staffing and scheduling
- Dispatch and operations management
- Shuttle maintenance facilities and staffing

These items require further study and are likely to increase the cost of shuttle operations.

[9] Year 2010 costs escalated by 29% based on San Francisco CPI growth per Bureau of Labor Statistics, to reflect Year 2019 costs.

CONCLUSION

The high level of transit ridership forecast for Balboa Reservoir residents, employees, and visitors and CCSF students, staff, and faculty indicate a high frequency shuttle service with buses every nine minutes may be well utilized during peak periods to reduce travel time, provide convenience, enhance mobility particularly for seniors and people with disabilities, and/or increase personal security/sense of safety. The shuttle provides an opportunity for collaboration between Balboa Reservoir and CCSF for mutual benefit as approximately 40 percent of peak hour demand is associated with CCSF.

However, the Balboa Reservoir site and CCSF are within walking distance of high frequency transit with service to/from the Balboa Park BART/Muni station. The costs associated with operating a shuttle must be weighed against alternatives, such as subsidized first mile/last mile taxi or TNC rides for those with mobility needs. While the shuttle, as presented, would connect several destinations, the shuttle's indirect one-way loop route would have to compete with the high frequency and direct travel of the existing transit service and the flexibility and speed of walking. With three shuttle buses in operation, vehicle headways and average waiting time would match that of existing peak hour service. However, with one operating shuttle, off-peak periods would have headways of up to 31.5 minutes, making taking the shuttle slower than walking or using existing transit. Given the estimated cost of high-quality service of $762,500 to over $1 million per year (see Table 4), the shuttle concept would not be competitive with existing transit service and walking at a reasonable level of service. Additional considerations, including regulatory requirements and operator staffing and scheduling would increase costs and may present substantial hurdles to implementation.