KITTELSON & ASSOCIATES

1161 MISSION STREET, OFFICE #563
SAN FRANCISCO, CA 94103
P 415.579.1778

# TECHNICAL MEMORANDUM

Date: June 27, 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 $500,000 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

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 door-to-door shuttles service would be more appealing than existing transit service when the travel times are similar.

## Existing Transit Service

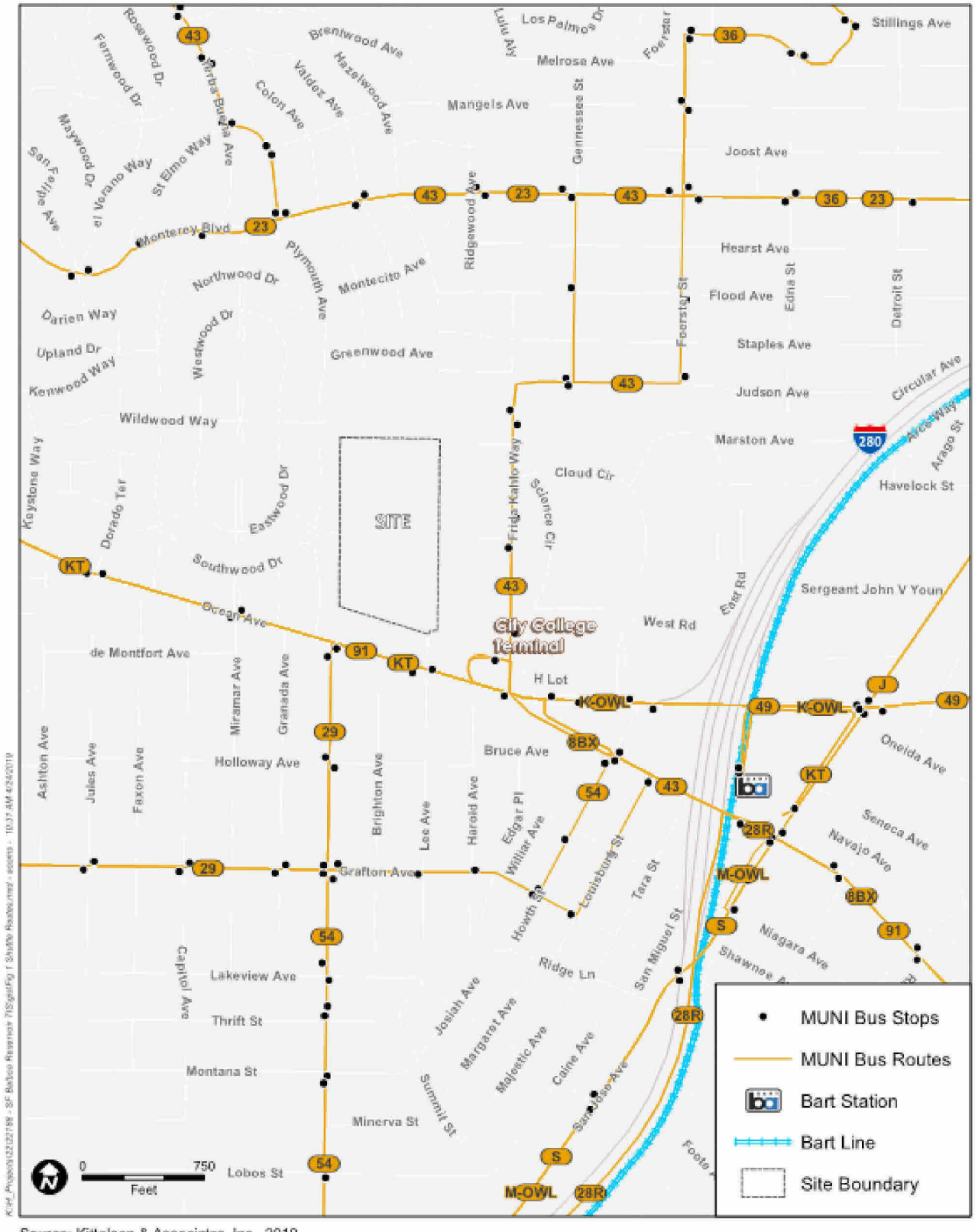
Muni currently offers convenient connections to the Balboa Park BART/Muni station as shown in Figure 1. The K Ingleside light rail and Muni bus routes 8, 29, 49, and 91 have stops on Ocean Avenue or the City College Terminal near the project site. Muni route 43 operates on Frida Kahlo Way adjacent to 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. 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.

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




Source: Kittelson & Associates, Inc., 2019

Case No.2018-007883ENV: Balboa Reservoir Project

**Figure 1**
**Existing Transit Service**

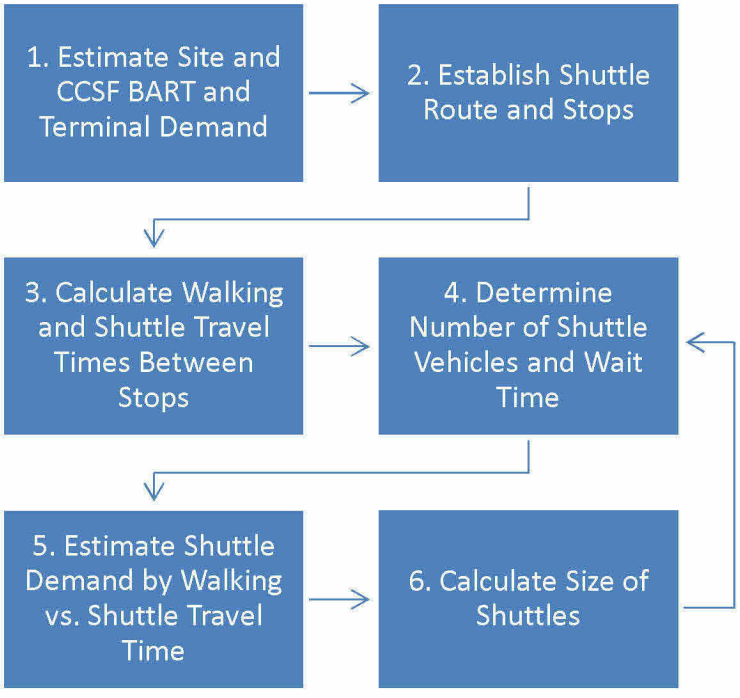



**Exhibit 1 Peak Hour Shuttle Demand Estimation Process**

The steps in the spreadsheet model are as follows:

1. **Estimate Site and CCSF BART and Terminal Demand**
    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 BART demand
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**
    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 routes 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 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

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, door-to-door 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). 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.

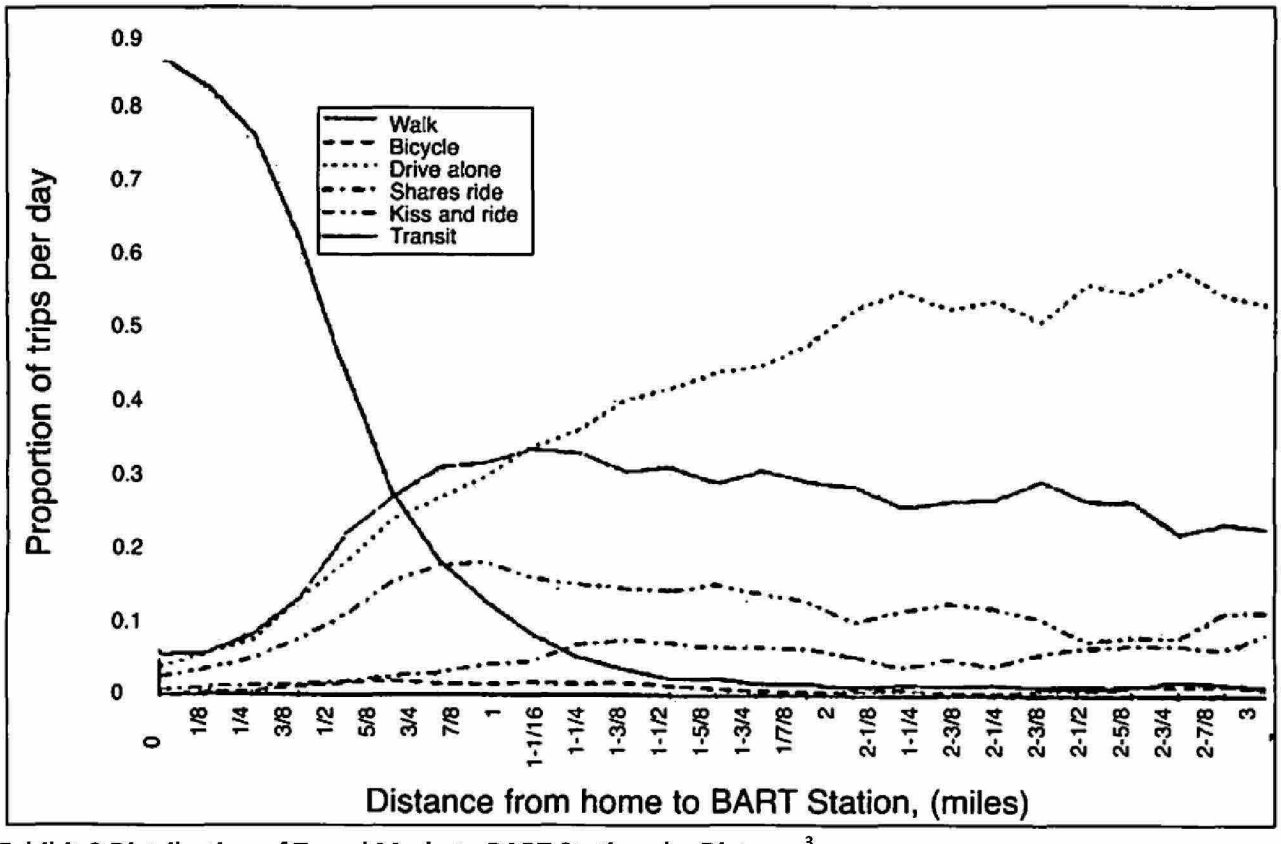



**Exhibit 2 Distribution of Travel Mode to BART Stations by Distance**[3]

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 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.

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

| Shuttle Operations | | | | | Average Walking Time (minutes) | Percent Use Shuttle |
|---|---|---|---|---|---|---|
| Number of Shuttles | Headway (minutes) | Average Wait Time (minutes) | Travel Time (minutes) | Average Total Shuttle Time (minutes) | | |
| 1 | 26 | 13 | 7.5 | 20.5 | 14 | 59% |
| 2 | 13 | 6.5 | | 14 | | 77% |
| 3 | 8.7 | 4.3 | | 11.8 | | 85% |
| 4 | 6.5 | 3.3 | | 10.8 | | 90% |

Sources: Kittelson & Associates, Inc. 2019; Google Maps 2019.

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

As shown in Table 2, for this 0.6-mile walking route, the average walking time is 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 59 to 90 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 | 26 | 176 | 137 | 43 | 40-Foot Bus |
| 2 | 13 | 260 | 216 | 35 | 35-Foot Bus |
| 3 | 8.7 | 296 | 249 | 27 | Cutaway Minibus |
| 4 | 6.5 | 316 | 257 | 21 | 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 travel time of approximately 20 minutes, not including loading/unloading and dwell time. 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.

## 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.
- CCSF: the assumed stop is a central and convenient location on Cloud Circle.


Source: Kittelson & Associates, Inc., 2019

Case No.2018-007883ENV: Balboa Reservoir Project

**Figure 2**
**Proposed Shuttle Service**

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.

## Service Headways

The proposed route is expected to be approximately 26 minutes long during peak hours, with variability based on congestion, signal delay, loadings/unloadings, 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 and CCSF stops, 1 minute for the Balboa Park BART/Muni station stop, and 4 minutes at the site to account for up to two stops and a layover/timepoint.

## 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[4] and have an average lifespan of 5.6 years[5]. 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[6]. 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 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**

| 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 | $570,000 | $592,000 |
| High | | $31,000 | | | $760,000 | $791,000 |

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.

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.

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

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

[6] Source: San Mateo County Transportation Authority, *San Mateo County Shuttle Inventory and Analysis*, 2010

## EXTERNALITIES

Shuttle operation would include externalities not considered in the operational costs:

- Vehicle miles traveled: the assumed shuttle service traveling a 2.25-mile route every 26 minutes would travel nearly 50,000 miles annually, including through pedestrian-oriented areas of CCSF and the Balboa Reservoir development.
- Increased congestion due to added vehicles along the route at intersections and bus stops.
- The shuttle would increase greenhouse gas emissions in the project area as walking and existing transit trips are replaced by shuttle rides. The Balboa Reservoir project is committed to sustainability and reducing greenhouse gas emissions by facilities multimodal transportation.
- The shuttle's additional vehicle miles and emissions need to be considered against its reduction in private vehicle demand associated with the reduced drive alone and passenger drop off/kiss-and-ride usage from Table 1 and Exhibit 2. Peak hour BART ridership demand between the Balboa Reservoir development and the Balboa Park BART Station is estimated at 80 total person trips, including16 private vehicle trips, which could be replaced by two shuttle runs.

## 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 9 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 Transportation Network Company rides for those with mobility needs. While the shuttle would provide almost door-to-door service, 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. 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 26 minutes, making taking the shuttle slower than walking or using existing transit. Given the estimated cost of high-quality service of $592,000 to $791,000 per year (see Table 4), the shuttle concept would not be competitive with existing transit service and walking at a reasonable level of service.