KITTELSON & ASSOCIATES

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

TECHNICAL MEMORANDUM

Balboa Reservoir Subsequent EIR

Responses to Comments Supplementary Memorandum

Transit Delay Analysis and Capital Improvements

Date: March 18, 2020 ~~Project #:22126.003~~
To: Wade Wietgrefe, Liz White
From: Mike Alston
cc: Jeanie Poling

PURPOSE OF MEMORANDUM

This technical memorandum (memo) ~~supplements the Balboa Reservoir Draft Subsequent Environmental Impact Report (DSEIR) Section 3.B, Transportation and Circulation and the Response to Comments Section 4.C, Transportation and Circulation. Specifically, this memo~~ identifies and analyzes existing sources of transit delay to the 29 Sunset, ~~K/~~T K Ingleside/T Third Street~~/Ingleside~~, and 43 Masonic Muni lines in the Balboa Reservoir project study area, and then recommends ~~the feasibility and effect of~~ offsite capital improvements to reduce transit travel times ~~and relates them to transit travel times~~. The results of this analysis further refine and inform Balboa Reservoir Draft Subsequent Environmental Impact Report (DSEIR)'s **Mitigation Measure M-C-TR-4. Monitor Cumulative Transit Travel Times and Implement Measures To Reduce Transit Delay.** ~~The improvements identified could be implemented as part of **Project Mitigation Measure M-C-TR-4: Monitor Cumulative Transit Travel Times and Implement Measures to Reduce Transit Delay.** The Improvements could be implemented to supersede the requirement in **Mitigation Measure M-C-TR-4** to monitor cumulative transit travel times by preventively addressing the sources of transit delay. Analysis was conducted in coordination with the San Francisco Planning Department and the San Francisco Municipal Transportation Agency (SFMTA) to identify possible infrastructure improvements that could achieve transit travel time delay reductions in the project study area.~~

This memo is organized as follows:

- Background
- Analysis Approach
- Findings
- Recommended Improvements
- Secondary Effects of Implementing Improvements~~of Improvements on Ocean Avenue~~

Commented [w1]: Great job! The document provides substantial evidence for the revisions to mitigation measure M-C-TR-4. Monitoring Cumulative Transit Travel Times and Implement Measures to Reduce Transit Delay. Most of our edits and comments are editorial to clarify language and to shorten this memo up. Please reach out to Liz to clarify comments and edits.

Few globals:
-address the 43.
-Liz attempted to delete 49 references, but double-check.
-please avoid terms that may be misconstrued as CEQA impact determinations (e.g., substantial).
-please use consistent terms as that used in the EIR and then if new terms here, use consistent terms throughout.
- Instead of infrastructure, let's call them capital improvements.
- Several parts of the analysis keep referring to cumulative delay. Please keep it as delay. Under +project conditions, our mark is 4 minutes, under +cumulative conditions, our mark is 2 minutes. The point is that we are trying to erase the project's delay before it begins, cumulative and project conditions.
-some minor other stylistic items

Commented [HT2]: Global On our website, it is stylized as: KT: K Ingleside/T Third Street.

LWhite: Kittelson, please make this a global.

Commented [w3R2]: Unless the draft SEIR said something else, then fine to leave as is.

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BACKGROUND

The DSEIR presented an analysis of transit delay under existing plus project conditions and under 2040 cumulative conditions. The impacts were determined to be less than significant under existing plus project conditions and significant and unavoidable under 2040 cumulative conditions, with the proposed project contributing considerably. ~~Discussion of cumulative analysis approach is provided in "2040 Cumulative Conditions" starting on DSEIR p. 3.B-56, and cumulative impacts analysis and findings are presented in "Impact C-TR-4" starting on DSEIR p. 3.B-96.~~

~~The proposed project's contribution to delays along these lines could be cumulatively considerable with two or more minutes of delay added.~~ The project would make a considerable contribution[1,2], defined as two or more minutes, to cumulative transit delay to the ~~The Muni lines identified as potentially cumulatively impacted include the following:~~

- K/T Third/Ingleside;
- 29 Sunset; and the 43 Masonic Muni lines.
- ~~43 Masonic; and~~
- ~~49 Van Ness/Mission.~~

~~The proposed project's contribution to delays along these lines could be cumulatively considerable with two or more minutes of delay added.~~ ~~The 8 series buses also travel through the area but were not found to be significantly impacted.~~

~~This memo identifies and analyzes potential capital improvements that can be provided to further define the following component of **Mitigation Measure M-C-TR-4: Monitor Cumulative Transit Travel Times and Implement Measures to Reduce Transit Delay** (excerpted below from DSEIR p. 3.B-97 through 3.B-100):~~

> ~~**Mitigation Measure M-C-TR-4: Monitor Cumulative Transit Travel Times and Implement Measures to Reduce Transit Delay.** The project sponsor, under either project option, shall monitor cumulative transit travel times for the identified route segments of the K/T Third/Ingleside, 29 Sunset, 43 Masonic, and 49 Van Ness/Mission lines to determine if a route~~

[1] The 8 Bayshore and 8BX Bayshore B Express ~~series buses~~ series buses also travel through the study area; however, as identified in the DSEIR, the proposed project would not considerably contribute to cumulative transit delay on these routes. The 91 Third ~~3rd~~ Street/19th Avenue Owl and K Owl also travels through the corridor, but is an overnight only route and is ~~therefore~~ not included in the analysis.

[2] The Responses to Comments (RTC) document revised the draft SEIR analysis and Mitigation Measure M-C-TR-4, which incorrectly identified that the proposed project would have a considerable contribution to cumulative transit delay on the 49 Van Ness/Mission line.

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~~does not meet its performance standard. If applicable, the project sponsor shall implement feasible measures (as developed in consultation with SFMTA) to reduce transit delay and meet the transit travel time performance standard.~~

ANALYSIS APPROACH

This analysis consists of both quantitative and qualitative approaches to identify and analyze sources of transit delay and quantify how implementation of capital improvements would reduce transit travel times. ~~This section describes the analysis conducted to identify capital improvements and provide an estimate of associated transit delay savings along Muni lines K/T Third/Ingleside, 29 Sunset, and 49 Van Ness/Mission. The 43 Masonic was studied separately and is not addressed in this memo.~~ Figure 1 presents the ~~project~~ study area as it relates to these approaches.

Figure 1: ~~Project~~ Memo Approaches Study Area

Commented [w4]: Please use draft SEIR figure 3.B-3 as your base and update the figure accordingly to articulate the items you are attempting to highlight. Please provide a symbol in the legend for new items in this figure.

Please rethink boundary of memo approach study area to reflect what is described in this memo and to track the streets more closely (e.g., instead of going into Westwood Park).

Analysis Approach for K/T Third/Ingleside, and 29 Sunset

The analysis approach compares transit travel times during the peak period and nighttime off-peak period. Transit travel times are typically slowest during the p.m. peak period, greatly influenced by vehicle congestion. Off-peak nighttime travel times represent the conditions in which transit vehicles do not experience the typical delays related to vehicle congestion in the p.m. peak period. As a result, the off-peak nighttime travel times are a comparison to the p.m. peak period travel times to calculate the differences between individual segments of delay within the study area, and to identify the delay sources for those segments.

Identifying the specific locations, causes, and amount of delay along a transit route provide the ability to estimate delay reductions from improvements. In contrast, the data collected for the DSEIR analysis includes existing K/T travel times for the full segment along Ocean Avenue between Jules Avenue and Balboa Park BART, but not for points and subdivided segments along the corridor.

The ~~The~~ analysis was conducted for the routes along the following segments:

- K/T Third/Ingleside:~~,~~ Jules Avenue/Ocean Avenue to Balboa Park Bay Area Rapid Transit (BART);
- K/T Third/Ingleside:~~,~~ San Jose Avenue/Geneva Avenue to Dorado Terrace/Ocean Avenue;
- 29 Sunset:~~,~~ Plymouth Avenue/Ocean Avenue to Mission St/Persia Avenue; and
- 29 Sunset:~~,~~ Mission St/Persia Avenue to Plymouth Avenue/Ocean Avenue~~;~~
- ~~49 Van Ness/Mission, Frida Kahlo Way/CCSF South Entrance to Mission St/Persia Avenue; and~~
- ~~49 Van Ness/Mission, Mission St/Ocean Avenue to Frida Kahlo Way/CCSF South Entrance~~.

~~Capital improvements would be targeted to improve transit operations at a fixed point along a service segment (i.e., an intersection and approach direction), with benefits accruing to the segment's travel time.~~Field data collection ~~was conducted to~~ identified ~~y~~ the following:

- Sources of transit delay along the corridor (~~i.e.,~~ location and descriptive cause);
- Delay values associated with given locations and bus actions (corridor delay, transit reentry delay, or passenger boarding delay); and
- Qualitative observations of conditions at potential improvement locations.

Based on the data and observations, ca~~C~~apital improvements are then recommended to ~~would be targeted to~~ improve transit operations at a fixed point along a service segment (i.e., an intersection and approach direction), with benefits accruing to the segment's travel time.

Analysis Approach for 43 Masonic

The analysis for the 43 Masonic supplements the Synchro corridor analysis from the DSEIR and utilizes the traffic counts and future traffic volumes from the DSEIR to calculate delay to the line ~~43 Masonic~~ at the Ocean Avenue/Frida Kahlo Way/Geneva Avenue intersection. The delay associated with the inbound 43 Masonic (i.e., going towards Balboa Park BART station) primarily comes from the signal at Frida Kahlo/Ocean Avenue. The delay experienced at this intersection is primarily associated

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Commented [EW5]: Kittelson, I know we worked on this addition together but just realized this is the first time this is introduced in the memo so please define this in a footnote.

with vehicle congestion. This is different than the delay on Ocean Avenue, which can be attributed to other factors, such as left or right turning vehicles.

As a result, nNo additional data collection was needed to calculate transit delay because thehis supplemental Synchro analysis allows the disaggregation of corridor travel time to identify the amount of delay attributable to the specific transit movement at the intersection versus along the segment as a whole.

~~Furthermore, the delay associated with the inbound 43 Masonic (i.e., going towards Balboa Park BART station) primarily comes from the signal at Frida Kahlo/Ocean Avenue. The delay experienced at this intersection is primarily associated with vehicle congestion. This is different than the delay on Ocean Avenue, which can be attributed to other factors, such as left or right turning vehicles.~~

Data Collection

The field data collection occurred ~~was conducted~~ in two phases to achieve a disaggregate analysis of travel times and delays. The pP.mM. peak period data collection and observation yielded travel times along and through fixed segments of the transit routes, along with descriptions of operational events at each location. The pP.mM. peak period data collection was conducted from 5-7 p.m. on Tuesday, December 17, 2019; Wednesday, December 18, 2019; and Thursday, January 16, 2020. The off-peak travel time runs occurred ~~were conducted~~ between 8 p.m. and 11:59 p.m. on Thursday, January 9, 2020, and Thursday, January 23, 2020.[3] ~~.[4] The p.m. peak period data were compared to off-peak travel time runs, which provided travel times through the same locations during off-peak conditions. A comparison gives the travel time delay between peak and off-peak conditions.~~

~~Without disaggregating corridor travel time to identify the specific locations, causes, and amount of delay along a transit route, delay reduction from improvements cannot be estimated. For example, data available from DSEIR analysis include existing K/T travel times for the full segment along Ocean Avenue between Jules Avenue and Balboa Park BART but not for points and subdivided segments along the corridor.~~

[3] City College was in regular session during all p.m. peak period data collection (December 17, December 18, January 16). City College was in regular session during January 23, 2020, off-peak (8-11 p.m.) data collection but not during January 9 off-peak data collection. As explained, off-peak travel time runs were compared to historical data to check that they were representative.

[4] Field data were collected during typical conditions (i.e., no events, disruptions, or inclement weather).

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P.M. Peak Period Delay Collection and Observation

Travel time data were collected and qualitative observations recorded ~~during the p.m. peak period (5-7 p.m.)~~ at the following locations from a fixed vantage point[5]:

- Ocean Avenue and Brighton Avenue (eastbound and westbound);
- Ocean Avenue and Plymouth Avenue (eastbound and westbound); and
- Ocean Avenue and Frida Kahlo Avenue (eastbound and westbound).

~~The observations yielded the following:~~

~~Based on discussions with SFMTA, these are locations where improvements were identified to be feasible. Field data were collected during typical conditions (i.e., no events, disruptions, or inclement weather).~~

~~The relevant travel time for approaching bus or light rail vehicles from the previous intersection. These travel times were then averaged and compared to baseline travel times (see next section) to obtain average travel time delay associated with a location.~~

- ~~Qualitative descriptions of what can be said to account for travel time delay. Examples include:~~
  - ~~Waiting behind a left-turning vehicle;~~
  - ~~Waiting behind a right-turning vehicle;~~
  - ~~Queue spillback (from intersection ahead);~~
  - ~~General traffic congestion;~~
  - ~~Stopped at a red light;~~
  - ~~Boarding/alighting delay; and/or~~
  - ~~Stopped from cross traffic blocking the box.~~

At each intersection, both segment travel time and node travel time were ~~the following variables were~~ calculated, both of which are defined below.

~~:~~

- Segment travel time is defined as ~~:~~ ~~t~~The time required for the transit vehicle to travel from the previous intersection to the subject intersection. The recorded time began when the front of the vehicle cleared the previous intersection and ended when ~~the vehicle either came to a stop when~~:
  - The vehicle stopped at a red light; or
  - The front of the vehicle entered the intersection during a green light; or
  - The vehicle was within a car length of the back of a queue at the intersection.

[5] These data collection locations were identified in coordination with the SFMTA.

Commented [EW6]: I have the following questions on this section:
- With the exception of the days, aren't the methods for collection and observation the same under the p.m. peak period and also during the nighttime runs? Should we group them both in the same heading?
- How many observations comprise the p.m. peak period v. the nighttime runs? We should disclose the number of data sets that we averaged to get the nighttime v. peak period data?

Commented [EW7]: Define the vantage points in the footnotes or reference where the reader can find them in the memo.

Commented [EW8]: I deleted this sentence; I'm thinking first we explain that we evaluated the delay, looked at the sources of delay and then, in consultation with SFMTA, looked proposed improvements that would address the delays identified.

Commented [EW9]: Baseline usage seems out of place here without an explanation. Let's just keep it as off peak here and then we can explain the baseline concept in the off peak heading.

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Node travel time is defined as: tThe time required for the transit vehicle to pass through an intersection.

- The recorded time began when:
  - The vehicle stopped at a red light; or
  - The front of the vehicle entered the intersection during a green light; or
  - The vehicle was within a car length of the back of a queue at the intersection.
  - The recorded time ended when the front of the transit vehicle cleared the intersection.

Off-Peak Travel Nighttime Time Runs

~~In order to compare the p.m. peak period travel times at and through the locations listed above, off-peak travel time runs were also conducted to establish baseline disaggregate transit travel times. These baseline travel times were then compared to p.m. peak travel times to establish delay at locations along the corridor.~~

~~The off-peak travel time runs were conducted between 8 p.m. and 11:59 p.m. Field data were collected during typical conditions (i.e., no events, disruptions, or inclement weather).~~ Kittelson conducted four~~Repeated~~ observations of the studied segments and ~~were conducted, and the average corridor travel times were~~ compared these average corridor travel times to SFMTA historical travel times. The comparison of the observed data to the historical travel times served as a cross-check to ~~to~~ ensure that the observations appropriately represented ~~were representative for~~ the studied segments.[6] These segments included:

- K/T Third/Ingleside
  - Eastbound, Ocean Avenue/Miramar Avenue to Balboa Park BART
  - Westbound, Balboa Park BART to Ocean Avenue/Miramar Avenue
- 29 Sunset
  - Eastbound, Plymouth Avenue/Ocean Avenue to Ocean Avenue/Howth Street
  - Westbound, Ocean Avenue/I-280 onramp to Plymouth Avenue/ Ocean Avenue
- ~~49 Van Ness/Mission~~
  - ~~Westbound, Ocean Avenue/I-280 onramp to City College Terminal~~

[6] The SFMTA maintains an internal database of historical travel times; those data points are limited to historical travel time between stops. SFMTA provided historical weeknight travel times as a point of reference. The SFMTA data provided includes median and 90th percentile historical travel times between stops. The average off-peak travel time runs for the selected segments were compared against the median historical travel times to ensure they were representative.

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Commented [HT10]: Don't understand this one so much and how it differs from the first bullet. Does the first bullet only apply when the transit vehicle is the first one in the queue?

Obviously we're not changing the methodology now, but I think it could be worded more clearly.

LWhite: Kittelson, please clarify.

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Commented [EW11]: Maybe we just state here that the observations collected were then compared to SFMTA's historical travel times as a cross check?

Comment from T. Henderson: Maybe a new sub-section that just talks about the comparison to historical data? Right now the topics blend and I had to read several times to understand.

LWhite: Kittelson, please revise. Tony and I had similar comments about this.

Commented [HT12]: Clarify that this is the SFMTA provided data below. On first read, it can appear that these were the segments for the off-peak data collection.

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~~Analysis Assumptions~~

~~This analysis is intended to identify delay sources and quantify potential cumulative conditions delay savings based on infrastructure solutions. As explained in "Impact C-TR-4" starting on DSEIR p. 3.B-96, the cumulative conditions are uncertain and are estimated conservatively in the DSEIR analysis. This analysis compared p.m. peak period conditions (5-7 p.m.) to off-peak nighttime conditions (8 p.m. – 12 a.m.) to quantify existing levels of delay and potential future delay savings from capital improvements. The comparison between peak and off-peak periods is suitable to estimate cumulative delay for the following reasons:~~

- ~~**Increased vehicle traffic:** The difference in p.m. peak period and off-peak nighttime conditions is explained by increased vehicle traffic levels in the p.m. peak period and thus slower operating speeds, more conflicting turning movements, more pedestrian activity and a higher level of congestion. The nature of cumulative analysis is an assumption of traffic volume growth in p.m. peak period compared to existing conditions. Because increased level of vehicle traffic accounts for the difference in both cases, the comparison is apt and the delay findings are translatable.~~
- ~~**Exponential nature of delay:** Traffic delay is not linear but compounding in nature. In congested conditions, every additional vehicle adds extra delay to any other vehicles behind that additional vehicle. Therefore, cumulative conditions delay in the p.m. peak period relative to existing conditions would be expected to be greater than the observed difference in existing off-peak and p.m. peak period conditions (i.e., adding vehicles to a higher baseline level of traffic). The difference in travel time delays noted in field data likely underestimates the cumulative delay difference.~~

Commented [EW13]: I don't understand this statement, can we remove this?

FINDINGS

~~The delay and observational findings are presented below for the three observed locations:~~

- ~~Ocean Avenue/Brighton Avenue, eastbound and westbound;~~
- ~~Ocean Avenue/Plymouth Avenue, westbound; and~~
- ~~Ocean Avenue/Frida Kahlo Way, eastbound and westbound.~~

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Ocean Avenue/Brighton Avenue

Eastbound

Table 1 provides average observed travel times at Ocean and Brighton avenues in the eastbound direction for the K/T Third/Ingleside and the 29 Sunset.

Table 1:Transit Travel Time Delays Eastbound at Ocean Avenue/Brighton Avenue

Route/Location	Off-Peak Nighttime Average Travel Time	Peak Average Travel Time (seconds)	~~Delay (~~Difference (in seconds~~)~~

	(seconds)		
K/T Third/Ingleside			
Link travel time: Plymouth to Brighton	14	14	0
Node travel time: through Brighton	4	29	26
29 Sunset			
Link travel time: Plymouth to Brighton	13	17	4
Node travel time: through Brighton	12	28	16

Source: Kittelson, 2020.

MThe most substantial differences in delay at this location were associated with the intersection rather than the approaching segmentnode: an average of 26 and 16 seconds for the K/T Third/Ingleside and 29 Sunset, respectively. The following observations provide context for peak period travel times at this location in the eastbound direction:

- The segment/link travel times were relatively similar between peak and off-peak periods, indicating that delay is mostly associated with the intersection rather than propagating queues that slow the corridor down.
- The K/T travels in the center-running track lane and is thus more sensitive tosometimes delayed associated withby left-turning vehicles. The line train was frequently observed to be stuck behind left-turning vehicles, at times resulting in missing a green light and incurring additional delay from the red signal.
- The K/T routinely stopped at red lights in the p.m. peak period. In the off-peak period, the line did was not observed to not experience any travel time delay due to red lights.
- The 29 has the flexibility to operates in either lane and was generally observed in the far right travel lane and does not wait directly behind left-turning vehicles (it must be in the right lane traveling through the intersection to be aligned to serve the next passenger stop). However, one observation noted that queueingqueuing from a left-turning vehicle affected both lanes and contributed to delay for the 29.
- The 29 was frequently stopped at red lights during the peak period.
- With the center-running track lane serving left-turning vehicles, the rightmost lane serves the 29, a majority of through vehicles, and right-turning vehicles. Drivers turning right must yield to pedestrian movements at the parallel crosswalk, delaying through vehicles behind right-turning vehicles.

In the eastbound direction, a substantial portion of the delay to the K/T Line and a portion of the delay to the 29 can be attributed to left-turning vehicle delay. This, includesing frequently waiting behind left-turning vehicles searching for a gap in oncoming traffic. In the westbound direction, observations did not include transit vehicles waiting behind left-turning vehicles, but delay from waiting at a red light was substantial.

Commented [HT14]: Global – use "intersection" instead of "node"?

LWhite: Agree, please make a global edit.

Commented [w15R14]: I'm ok with node or intersection, if the term is defined earlier and used consistently.

Global: please use consistent terms throughout. For example, this table uses link where earlier the term is segment.

Commented [EW16]: Does this mean the signal timing? If not, what does this mean?

Commented [HT17]: Want to confirm my understanding of the methodology. It sounded like that once the train entered the queue, that it ended their "link" travel time and started their "node" travel time. If that understanding is correct, I don't think we can make this statement based on the information we have. Instead, the queue could be part of the node/intersection delay.

LWhite: Kittelson, please address

Commented [HT18]: Westbound has not yet been discussed.

LWhite: Kittelson, I have removed this statement from the eastbound section.

Westbound

Table 2 provides average observed travel times ~~at~~ on Ocean Avenue approaching and through ~~and~~ Brighton ~~avenues~~ Avenue in the westbound direction for the K/T Third/Ingleside and the 29 Sunset.

Table 2:Transit Travel Time Delays Westbound at Ocean Avenue/Brighton Avenue

Route/Location	Off-Peak ~~Nighttime~~ Average Travel Time (seconds)	Peak Average Travel Time (seconds)	~~Delay (~~Difference in seconds~~)~~
K/T Third/Ingleside			
Link travel time: Lee to Brighton	8	14	6
Node travel time: through Brighton	3	40	37
29 Sunset			
Link travel time: Lee to Brighton	8	17	9
Node travel time: through Brighton	2	25	23

Source: Kittelson, 2020.

M~~The m~~ost ~~substantial~~ differences in delay were associated with the ~~intersection rather than the approaching segment~~node: an average of 37 and 23 seconds for the K/T Third/Ingleside and 29 Sunset, respectively. The following observations provide context for the peak period travel times at this location in the westbound direction:

- The segment travel times almost doubled for the K/T and ~~did~~ doubled for the 29 but represent small portion of each line's travel time compared to the time through the intersection. The differences ~~do~~ indicate that p.m. peak period congestion levels affect operating speed through the corridor in the westbound direction.
- The K/T travels in the center-running track lane and is ~~thus more sensitive to~~sometimes delayed ~~associated with~~by left-turning vehicles. The train was not observed to be stuck behind left-turning vehicles such that the train would miss a green light and incur additional delay from the red signal,~~The K/T was not observed to miss any green lights indications and wait for an extra signal cycle from waiting behind left-turning vehicles,~~ as was observed in the eastbound direction. However, left turns do contribute to approach delay in this direction, and the K/T was frequently observed to experience delay at red lights in this direction. The p~~P~~.m~~M~~. peak hour turning movement counts collected for the project show 122 left-turning vehicles in the p.m. peak hour (see Appendix A)~~;, and~~ observations indicate that most left-turning drivers must wait until the end of the permissive green phase to turn left.
- The 29 operates in the ~~far~~ right travel lane and does not wait directly behind left-turning vehicles. The left-turning delay has less direct influence on 29 operations.
- The 29 was frequently stopped at red lights during the peak period.

- With the center-running track lane serving left-turning vehicles, the right~~most~~ lane serves the 29~~, a majority of through vehicles~~, and right-turning vehicles, as well as observed to serve the majority of through vehicles. Drivers turning right must yield to pedestrian movements at the parallel crosswalk, potentially delaying through vehicles behind right-turning vehicles.

Ocean Avenue/Brighton Avenue Findings

Commented [w19]: Please delete all the findings for each of the intersection sections. It summarizes what's already been said and I would prefer to leave this memo as short as possible. Please let me know if you disagree.

In the eastbound direction and westbound directions in the p.m. peak period, left-turning vehicles share the center-running track lane with the K/T, which must wait for vehicles to turn and clear the intersection to proceed straight. To travel through the intersection in the p.m. peak hour, the K/T experiences 26 seconds of travel time delay in the eastbound direction and 37 seconds of travel time delay in the westbound direction compared to off-peak conditions. In both directions, the left turns are served by permissive phasing, requiring drivers to yield to oncoming traffic and to pedestrians crossing to their left. As a result, these drivers typically wait through the green phase and turn at the end of the phase.

The 29 does not share the track lane and is less ~~sensitive to the propagation of~~delayed by left-turning ~~delay~~vehicles. However, with the center-running track lane effectively serving one or two vehicles per green phase, the ~~far~~ right lane in each direction serves the majority of the vehicles (~~both~~ the 29 bus, the majority of through vehicles, and right-turning vehicles yielding to crossing pedestrians). The 29 experiences an average of 16 seconds of travel time delay in the eastbound direction and 23 seconds of travel time.

To travel through the intersection in the p.m. peak hour, the 29 experiences 16 seconds of travel time delay in the eastbound direction and 23 seconds of travel time delay in the westbound direction compared to off-peak nighttime conditions. In the westbound direction, the 29 also experiences nine seconds of travel time between Lee and Brighton avenues, doubling its off-peak travel time.

Ocean Avenue/Plymouth Avenue

Eastbound

Table 3 provides average observed travel times at Ocean and Plymouth avenues in the eastbound direction for the K/T Third/Ingleside.

Table 3:Transit Travel Time Delays Eastbound at Ocean Avenue/Plymouth Avenue

Location	Off-Peak ~~Nighttime~~ Average Travel Time (seconds)	Peak Average Travel Time (seconds)	~~Delay (~~Difference in seconds~~)~~
K/T Third/Ingleside			
Link travel time:	16	-1	-

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Miramar to Plymouth			
Node travel time: through Plymouth	13	27	14

[1]Observed p.m. peak period link travel time was for the segment between Granada Avenue and Plymouth Avenue, not from Miramar. Comparison would not be commensurate.

Source: Kittelson, 2020.

Commented [w20]: Table note missing from table and please clarify second sentence.

The average p.m. peak hour travel time delay through the intersection was 14 seconds compared to off-peak nighttime conditions. The following observations provide context for peak period travel times:

- The K/T was observed to sit at a red light in almost all p.m. peak hour observations, including as a result of waiting behind a left-turning vehicle and subsequently missing a green phase. Like at the Brighton location, the K/T travels in the center-running track lane and is ~~sensitive to~~sometimes delayed ~~associated with~~by left-turning vehicles.
- The 29 turns right from Plymouth Avenue onto Ocean Avenue at this intersection and does not travel eastbound through the intersection.

Westbound

Table 4 provides average observed travel times at Ocean and Plymouth avenues in the westbound direction for the K/T Third/Ingleside and the 29 Sunset.

Table 4:Transit Travel Time Delays Westbound at Ocean Avenue/Plymouth Avenue

Location	Off-Peak Nighttime Average Travel Time (seconds)	Peak Average Travel Time (seconds)	~~D~~ ~~elay (~~Difference in seconds)
K/T Third/Ingleside			
Link travel time: Brighton to Plymouth	7	11	4
Node travel time: through Plymouth	4	29	25
29 Sunset			
Link travel time: Brighton to Plymouth	5	9	4
Node travel time: through Plymouth	3	33	30

Source: Kittelson, 2020.

The average p.m. peak hour travel time delay through the intersection was 14 seconds compared to off-peak nighttime conditions. The following observations provide context for peak period travel times:

- The travel time difference in segment/link travel times for each line ~~was not substantial,~~ indicates~~ing~~ that the ~~significant~~ sources of delay are at the intersection rather than due to overall travel speeds on the segment.
- The K/T was observed to sit at a red light in most all p.m. peak hour observations, including as a result of waiting behind a left-turning vehicle and subsequently missing a green phase on multiple occasions. The average delay experienced is largely a result of delay behind left-turning vehicles and subsequent red-light delay. Although the p.m. peak hour average among observations is 30 seconds, the maximum observed node travel time was 57 seconds, indicating wide variability. Like at the Brighton location, the K/T travels in the center-running track lane and is ~~sensitive to~~sometimes delayed ~~associated with~~by left-turning vehicles.
- The 29 turns left onto Plymouth Avenue at this intersection, so it is subject to the same operational delay and issues as the K/T. During the p.m. peak hour, the 29 was observed to miss its green phase multiple times, with a maximum node travel time of 99 seconds resulting from waiting for left-turning drivers (sitting through two red phases).

Ocean Avenue/Plymouth Avenue Findings

In the eastbound direction and westbound directions in the p.m. peak period, left-turning vehicles share the center-running track lane with the K/T, which must wait for vehicles to turn and clear the intersection to proceed straight. To travel through the intersection in the p.m. peak hour, the K/T experiences 14 seconds of travel time delay in the eastbound direction and 25 seconds of travel time delay in the westbound direction compared to off-peak conditions. In both directions, the left turns are served by permissive phasing, requiring drivers to yield to oncoming traffic and to pedestrians crossing to their left. As a result, these drivers typically wait through the green phase and turn at the end of the phase.

In the eastbound direction the 29 does not travel through the intersection on Ocean Avenue. In the westbound direction the 29 turns left from the center-running track lane and is ~~sensitive to the~~sometimes delayed by ~~propagation of~~ left-turning ~~delay~~vehicles. The 29 was observed to miss green phases on multiple occasions due to waiting behind left-turning vehicles, including missing two green phases on one occasion. To travel westbound through the intersection in the p.m. peak hour, the 29 experiences an average of 30 seconds of travel time delay compared to during off-peak conditions.

Ocean Avenue and Geneva Avenue/Frida Kahlo Way

Eastbound

Table 5 provides average observed travel times in the eastbound direction for the K/T Third/Ingleside and the 29 Sunset.

Table 5: Transit Travel Time Delays Eastbound at Ocean Avenue/Frida Kahlo Way/Geneva Avenue

Location	Off-Peak Nighttime Average Travel Time (seconds)	Peak Average Travel Time (seconds)	Delay (Difference in seconds)
K/T Third/Ingleside			
Link travel time: Lee to Frida Kahlo	19	18	-
Node travel time: through Frida Kahlo*	39	53	14
29 Sunset			
Link travel time: Lee to Frida Kahlo	10	15	5
Node travel time: through Frida Kahlo	57	54	-

*Includes dwell time
Source: Kittelson, 2020.

As Table 5 provides, the p.m. peak period travel time delays were not substantial based on the observations and data collection. The following observations provide context for travel times:

- During peak and off-peak periods, the K/T
- The 29 includes a near side bus stop between Harold and Genevae avenues. Following this stop, the bus driver must reenter the traffic stream to continue along Ocean Avenue. A combination of red lights, associated re-entry delay (with a green or red indication), and slow operating speeds through the intersection resulted in similar peak hour and off-peak average travel times for the 29. Observed p.m. peak hour node travel times were widely variable, ranging from 21 seconds to 82 seconds.
- The K/T line shares a travel lane with left-turning vehicles. The intersection provides a protected left-turn phase, so left-turning drivers do not share a conflicting phase with crossing pedestrians and do not need to yield to oncoming traffic. However, the K/T may still wait behind a vehicle left-turning vehicle if the adjacent through traffic has a green indication but the protected left-turn phase has a red indication.

Commented [EW21]: Missing statement here.

Commented [HT22]: I think more explanation can be provided about how this is different than the other locations. It could sound like a better situation because it is phase separated, but could go into more detail about how the train gets stuck because of the phase separation.

LWhite: Kittelson, please address but succinctly

Westbound

Table 6 provides average observed travel times in the ~~eastbound~~ westbound direction for the K/T Third/Ingleside and, the 29 Sunset~~, and the 49 Van Ness/Mission~~.

Table 6: Transit Travel Time Delays Westbound at Ocean Avenue/Frida Kahlo Way/Geneva Avenue

Location	Off-Peak Nighttime Average Travel Time (seconds)	Peak Average Travel Time (seconds)	Delay (Difference in seconds)

K/T Third/Ingleside			
Link travel time: Howth to Frida Kahlo	12	17	5
Node travel time: through Frida Kahlo	11	49	38
29 Sunset			
Link travel time: Howth to Frida Kahlo	15	20	5
Node travel time: through Frida Kahlo	8	66	58
~~49 Van Ness/Mission~~			
~~Link travel time: Howth to Frida Kahlo~~	~~14~~	~~38~~	~~24~~
~~Node travel time: through Frida Kahlo~~	~~17~~	~~49~~	~~32~~

Source: Kittelson, 2020.

The following observations provide context for travel times:

- In the p.m. peak hour, the K/T experienced an average of 38 seconds of travel time delay compared to off-peak conditions. This delay was mostly a result of red-light delay and of ~~queueing~~queuing once the K/T left the separated track lane to the east of the intersection. No left turns are allowed from the center-running track lane, so the K/T was not observed to be waiting behind turning vehicles. Rather, the limited green time and the ~~queueing~~queuing present contributed to higher p.m. peak hour travel times.
- The 29 ~~and 49~~ experienced 58 ~~and 32~~ seconds of relative delay to travel through the intersection in p.m. peak hour conditions compared to in off-peak conditions. Observations noted that the 29 ~~both lines were~~ frequently queued in advance of the intersection, in some cases back to Howth Street. As a result of queueing, ~~many~~ buses missed green signal phases and waitED~~ing~~ for an extra signal cycle..
- T~~Both t~~he 29 was ~~and 49 were~~ observed to use the center-running track lane to bypass ~~queueing~~queuing on at least one occasion. ~~Those instances resulted in lower travel times.~~
- ~~Both the 29 and 49 were observed to use the center-running track lane to bypass queueingqueuing on at least one occasion. Those instances resulted in lower travel times.~~
- This intersection serves multiple approaches with higher volumes than the Brighton and Plymouth intersections. Much of the delay recorded was observed to be a result of ~~queueing~~queuing, likely as a result of the allocation of green time to competing intersection approaches.

Ocean Avenue/Frida Kahlo Way/Geneva Avenue Findings

In the eastbound direction, the K/T and the 29 were ~~not~~ observed to experience ~~substantial~~ less than 15 seconds of p.m. peak hour delay compared to off-peak conditions. In the westbound direction, the

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Commented [HT23]: What was the max travel time? Might be helpful context to show variability.

LWhite: Kittelson, please address.

Commented [HT24]: This can be broadened. Yes, it has the highest side street volumes, but I believe it is also the highest volume Ocean Ave approaches within the study area (confirm). Also, it has some of the longest ped crossings, affecting min green times.

LWhite: Kittelson, let's discuss this one with Tony.

Commented [HT25]: What about the left-turn impacts?

LWhite: Kittelson, please address.

Commented [w26R25]: If this section is left in, that is.

K/T, and the 29 ~~, and 49~~ experience substantial delay in traveling through the intersection—38 ad ~~,~~ 58 ~~, and 32~~ seconds, respectively. ~~However, the signal currently includes a protected eastbound left-turn phases, prohibits westbound left turns, and provides a separated track lane for westbound K/T vehicles.~~ The delays were observed to be a result of queueing and competing demands at the intersection.

Commented [HT27]: This statement seems out of place.

LWhite: Removed. Kittelson, please advise if we should keep.

Combined Delay

Table 7 provides the recorded travel time delays presented above by line, direction, and location.

Table 7: P.M. Peak Hour Transit Travel Time Delays by Line

Location	Eastbound	Westbound
K/T Third/Ingleside		
Node travel time: through Plymouth Avenue	14	25
Node travel time: through Brighton Avenue	26	37
Node travel time: through Frida Kahlo Way	14	38
Total Combined Delay	**54**	**100**
29 Sunset		
Link Travel Time: Lee to Brighton	n/a	9
Node travel time: through Brighton Avenue	16	23
Node travel time: through Plymouth	-	30
Node travel time: through Frida Kahlo Way	-	58
Total Combined Delay	**16**	**120**
~~49 Van Ness/Mission~~		
~~Link travel time: Howth to Frida Kahlo Way~~	~~-~~	~~24~~
~~Node travel time: through Frida Kahlo Way~~	~~-~~	~~32~~
~~**Total Combined Delay**~~	~~**-**~~	~~**56**~~

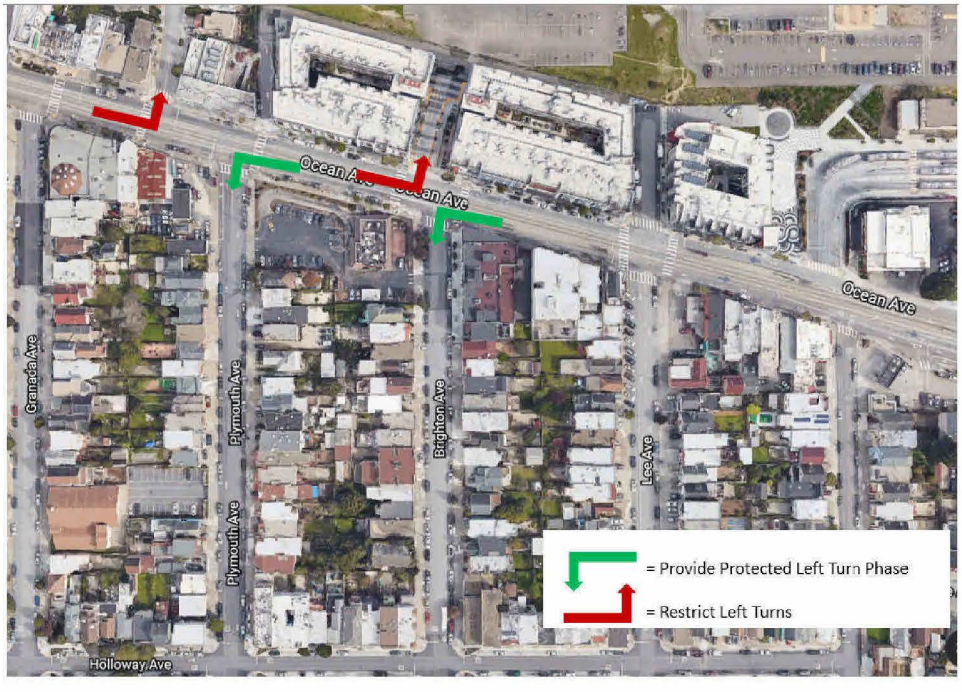
Source: Kittelson, 2020.

RECOMMENDED IMPROVEMENTS

The following improvements are recommended to reduce transit travel times in the study area and are displayed in ~~A number of proposed improvements have been agreed upon based on the data collection and observations, and in consultation with SFMTA.~~ Figure 2 ~~provides an overview of the proposed mitigations, which are discussed in the subsequent sections~~. These proposed improvements require approval by the SFMTA and subject to review by relevant rail oversight authorities.

- Providing a protected green arrow~~/permissive~~ signal phase for westbound left turns at Ocean Avenue/Brighton Avenue;
- Prohibit eastbound left turns at Ocean Avenue/Brighton Avenue;
- Providing a protected green arrow~~/permissive~~ signal phase for westbound left turns at Ocean Avenue/Plymouth Avenue; and
- Prohibit eastbound left turns at Ocean Avenue/Plymouth Avenue.
- Construct a bus boarding island on southbound Frida Kahlo.

Figure 2: Recommended Improvements to Reduce Transit Travel Times~~Proposed Mitigations~~



Source: Google Earth

Ocean Avenue/Brighton Avenue

Eastbound: Prohibit Left Turns

At Ocean and Brighton avenues, prohibiting eastbound left turns would provide dual benefit to transit operations. It would eliminate transit delay for the K/T associated with waiting behind left-turning vehicles, which was observed to ~~be considerable and to~~ result in missing green phases. A left turn prohibition would also provide more through volume capacity and would give through drivers the ability to choose a lane rather than to proceed in the right~~most~~ lane. This would benefit the 29 as well, whose drivers would either travel in a right~~most~~ lane with fewer vehicles or could also use the left~~most~~ lane to travel through the intersection if right-turning vehicles are yielding to crossing pedestrians.

Implementing this improvement would improve reliability for the K/T and 29 and could reduce p.m. peak hour travel time delay compared to off-peak travel times by up to 26 and 16 seconds, respectively.

Westbound: Provide Protected/Permissive Left Turn Phasing

At Ocean and Brighton avenues, providing a protected green arrow/~~permissive~~ left turn phase would allow left-turning vehicles a dedicated portion of the signal phase and would reduce delay for the K/T associated with waiting behind those left-turning vehicles. This improvement would improve reliability for the K/T and could reduce delay by up to 37 seconds.

Ocean Avenue/Plymouth Avenue

Eastbound: Prohibit Left Turns

At Ocean and Plymouth avenues, prohibiting eastbound left turns would provide dual benefit to transit operations. It would eliminate transit delay for the K/T associated with waiting behind left-turning vehicles, which was observed to ~~be considerable and to~~ result in missing green phases. A left turn prohibition would also provide more through volume capacity and would give through drivers the ability to choose a lane rather than to proceed in the right~~most~~ lane. This improvement would improve reliability for both lines and could reduce delay for the K/T by up to 14 seconds.

Westbound: Provide Protected/Permissive Left Turn Phasing

At Ocean and Brighton avenues, providing a protected/permissive left turn phase would allow left-turning vehicles a dedicated portion of the signal phase and would reduce delay for the K/T associated with waiting behind those left-turning vehicles. This improvement would improve reliability for the K/T. This benefit would also accrue to the 29, which turns left at the intersection and is subject to the same travel delays. This improvement would improve reliability for both lines and could reduce delay for the K/T by up to 25 seconds and for the 29 by up to 30 seconds.

Commented [HT28]: Don't know if I fully agree with this statement. The concept would be a lagging phase, so the queuing could still exist during the permissive phase, so it may not change lane choice much.

LWhite: Kittelson, let's discuss with Tony.

Commented [HT29]: This is the maximum observed difference in travel time, but does not necessarily mean that it could be fully mitigated by the signal phase change. A following transit vehicle would still need to wait for a turning vehicle to clear, while this would hopefully be less than today, it would not be a complete elimination of that delay. Also, there's still potential for other sources of delay.

LWhite: Kittelson, please acknowledge this in the statement but then still end with the point that this improvement would reduce p.m. peak period travel times by 26 and 16 seconds.

Commented [HT30]: Similar to earlier comments. Although left-turn delay would be eliminated, there could be other sources of delay still.

LWhite: See my response to earlier comment and address as well.

Ocean Avenue/Geneva Avenue/Frida Kahlo Way

Feasible capital improvement recommendations to improve transit operations were not identified. Improvements that privilege operations along Ocean Avenue (e.g., more green time for Ocean Avenue approaches) would bring disbenefit to the 43 and 49 lines traveling along Frida Kahlo Way at the same intersection. Constrained right-of-way limits quick-build improvement options, as well.

Conclusion

The recommended improvements further refine the capital measures identified as part of **Project Mitigation Measure M-C-TR-4: Monitor Cumulative Transit Travel Times and Implement Measures to Reduce Transit Delay.**

Secondary Effects of Implementing Improvements ~~on Ocean Avenue~~

The following describes the secondary construction and operational effects of implementing the improvements identified above.

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General Effect to Vehicle Traffic

The reliability and delay reduction benefits described for transit vehicles along Ocean Avenue as a result of the proposed changes would also accrue to general traffic along Ocean Avenue. Anticipated effects are discussed below:

- For westbound left-turning drivers at Plymouth and Brighton avenues, a protected/permissive phase provides dedicated time to make the left turn ~~without yielding~~ separated from~~to~~ oncoming traffic or pedestrians. It would also provide a safety benefit with the provision of the protected movement.
- The westbound protected left-turn phase would occupy a share of green time and would result in a decrease in green time of a few seconds to other phases~~, likely the side-street approaches~~.
- For eastbound through drivers along Ocean Avenue, the prohibition of left turns at Plymouth and Brighton avenues would improve travel times and reliability, eliminating instances of delay from waiting behind a left-turning vehicle.

Effects on left-turning drivers at Plymouth or Brighton avenues are discussed in the Circulation section below.

Pedestrian Benefits

The Ocean Avenue/Plymouth Avenue intersection serves many ~~a considerable number of~~ pedestrians in the p.m. peak hour. These pedestrians share a signal phase with the parallel Ocean Avenue movements, including ~~through,~~ the right-turn~~ing~~, and left-turn~~ing~~ movements~~drivers along Ocean Avenue~~. The shared vehicle turning movements and pedestrian crossings create a conflict~~s~~ between road users and contributes travel time delay for turning drivers yielding to pedestrians. The two intersections with recommended improvements serve the following number of pedestrians ~~(refer to Tables 3.B-3 and 3.B-4 on DSEIR p. 3.B-12 and 3.B-13)~~:

- **Ocean Avenue/Brighton Avenue:** 442 pedestrians across north leg, 278 pedestrians across south leg in the weekday p.m. peak hour (5-7 p.m.; see Appendix A)
- **Ocean Avenue/Plymouth Avenue:** 349 pedestrians across north leg, 152 pedestrians across south leg in the weekday p.m. peak hour (5-7 p.m.; see Appendix A)

For pedestrians crossing the north legs of these intersections, conflicting left-turning vehicles would be eliminated. For pedestrians crossing the south legs of these intersections, conflicts with left-turning drivers would be reduced ~~separated into different signal phases~~. Separating the left-turning conflicts provides a safety benefit to pedestrians crossing Plymouth and Brighton avenues.

General Effect on Circulation

The identified improvements will have the following anticipated effect on circulation within the study area:

- **The prohibition of eastbound left turns at Ocean and Plymouth avenues.** Prohibiting this movement will redistribute the 11 left-turning drivers currently making this movement in the p.m. peak hour. These drivers would have the following ~~a few~~ options (see Figure 2):
  - Turn left at Faxon, Miramar, or Granada avenues in advance of the Plymouth Avenue intersection; or
  - Turn right at Granada Avenue, left to Holloway Avenue, and then left at Plymouth Avenue, left at Ocean Avenue, and right at Plymouth Avenue, adding approximately 1,700 feet of diversion to their trip.
- **The prohibition of eastbound left turns at Ocean and Brighton avenues.** Prohibiting this movement will redistribute the 39 left-turning drivers currently making this movement in the p.m. peak hour. These drivers would have the following ~~a few~~ options (see Figure 2):
  - Turn right at Plymouth, Granada, or Miramar avenues, left at Brighton Avenue, and through at Ocean Avenue, adding approximately 1,700 feet of diversion to their trip. Transit travel time and reliability benefits accrue to general traffic.

  Note that Brighton Avenue provides vehicular access to the Whole Foods parking deck and to Avalon Ocean Avenue residential parking.

Both prohibitions would redistribute these left-turning trips and increase the traffic on the relevant local streets by an amount commensurate to the existing eastbound left-turn volumes.

~~Status of Mitigation Measures~~

~~Subject to SFMTA approval, these mitigation measures are recommended.~~

Commented [HT31]: Are we saying something more about impacts to side streets, even in a qualitative point of view.

LWhite: Kittelson, let's discuss this comment with Tony

Commented [w32R31]: Yes, please provide more here – what that means to transit and safety in particular. It can be a short summary.

APPENDIX A: MULTIMODAL TURNING MOVEMENT COUNTS

APPENDIX B: PEAK HOUR DATA COLLECTION

Commented [EW33]: Please remove the 22188 from the top of the sheets.

Commented [w34R33]: It would be helpful if appendix B and C looked the same format too, but don't prioritize this if challenging.

APPENDIX C: OFF-PEAK (NIGHTTIME) DATA COLLECTION

Commented [EW35]: Appendix C should remove references to the historical travel times. Those are included in Appendix D and it's confusing to introduce them and make a comparison in Appendix C when they haven't been included yet.

APPENDIX D: HISTORICAL SFMTA MUNI TRAVEL TIMES