MUNI FORWARD

Church Street Pilot Transit Lanes

SFMTA
Municipal Transportation Agency

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Contents

About the SFMTA iv

Church Street Pilot Report 6

Executive Summary 7

Muni Service Reliability 7

Church Street Operations 7

Recommendations 7

Pilot Corridor Background 8

Muni Operations Under Pilot 8

Pilot Evaluation Criteria 8

1 - Muni Service 9

2 - Local Circulation 10

3 - Transit-Only Lane Violations 10

4 - Red Paint Durability 11

Conclusion 13

About the SFMTA

Vision

San Francisco: great city, excellent transportation choices.

Mission Statement

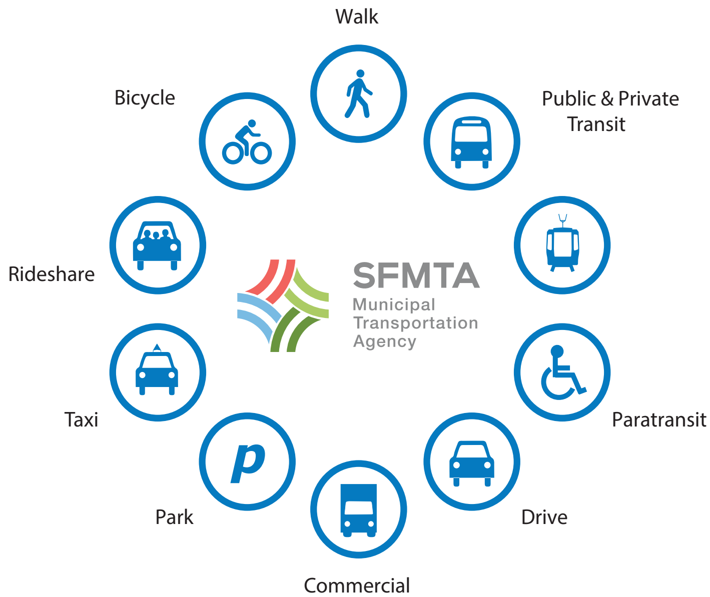
We work together to plan, build, operate, regulate, and maintain the transportation network, with our partners, to connect communities.

Who We Are

The San Francisco Municipal Transportation Agency, a department of the City and County of San Francisco, is responsible for the management of all ground transportation in the city. The SFMTA keeps people connected through the San Francisco Municipal Railway (Muni), the nation's seventh largest public transit system. The agency's additional responsibilities include managing parking and traffic, bicycling, walking and the regulation of taxis. With a staff of more than 4,700, the SFMTA's diverse team of employees is one of the city's largest with representation by 18 labor organizations.

About the SFMTA

What We Do



The SFMTA plans, designs, builds, operates, regulates and maintains one of the most comprehensive transportation networks in the world. The agency directly manages five types of public transit in San Francisco (motor coach, trolley coach, light rail, historic streetcar and cable car) and promotes other forms of transportation including walking, bicycling, taxi and auto use. In addition to overseeing paratransit service for those unable to use fixed-route transit service, the agency also regulates the taxi industry and oversees on- and off-street public parking spaces.

With more than 3,500 transit stops, Muni keeps people connected, delivering more than 700,000 passenger boardings on an average weekday and offering unmatched accessible transit service to San Francisco's 800,000 residents and a workday population of approximately 1.2 million.

The SFMTA also manages 450,000 on and off-street parking spaces, 19 public parking garages and lots, more than 28,000 meters, nearly 282,000 street signs and 1,200 traffic signals on 946 miles of city streets. The agency is responsible for traffic calming, pedestrian and bicycle safety, traffic enforcement and the painting and striping of roads, including those that define 217 miles of the city's growing bicycle network. As a part of the SFMTA's pedestrian safety initiatives, the agency also manages the School Crossing Guard Program to keep children safe when crossing city streets.

Church Street Pilot Report

Executive Summary

SFMTA launched the Church Street Transit Lanes Pilot on March 23, 2013 to evaluate the effectiveness red transit-only lanes to improve Muni service reliability and reduced travel times. The pilot was implemented as part of the Agency's larger Transit Effectiveness Project (TEP) planning process. The TEP planning process concluded in March 2014 with the approval of the TEP environmental document (EIR). The projects approved in the TEP continue today under the agency's Muni Forward program.

The pilot established center-running, dedicated transit-and-taxi-only lanes along three blocks of Church Street, in both directions, between 16th Street and Duboce Avenue. The pilot also included left turn restrictions, parking changes, and a red paint treatment to provide a clear visual indication of the lanes' transit-only designation.

A comprehensive data collection and analysis effort was undertaken to understand the Pilot's impact on transit service, local circulation, driver compliance, and the durability of the red paint treatment. The summary findings from this analysis are below.

Muni Service Reliability

1. Total travel time through the pilot area has dropped by up to 14% or 1 minute on average.
2. Travel time *variability* has dropped by up to 27% on average.
3. The red paint has been an effective passive enforcement strategy.
4. The red paint material has held up well, with the majority of the painted lanes retaining over 90% coverage after 18 months.

Church Street Operations

1. The pilot has not significantly increased delay for drivers through the corridor (~800 drivers per peak hour), except at the northbound approach to Duboce Avenue, where multiple factors have combined to add up to a minute of additional delay.
2. The pilot has not reduced parking supply, and has in fact expanded it by truncating commercial loading hours to better meet local merchants' needs.

Recommendations

Based on field observations and data analyzed in the pilot, it is recommend that a future capital project adjust the overhead wires serving the 22 Fillmore so that it can safely operate in the dedicated lane north of Market Street. This change is expected to further improve the Muni travel time in the corridor and also improve automobile movement throughout the area.

Pilot Corridor Background
The J Church and 22 Fillmore combined send 24 vehicles per hour through the study corridor, but carry more than twice as many passengers (1500 riders per hour during the AM and PM peaks). The study corridor also serves approximately 700 personal vehicles per hour, during the AM and PM commute period, which extend from 7:45 - 8:45 AM, and 5:00 - 6:00 PM, respectively. Roughly 150 of these vehicles are making a left turn at either 15th Street or 16th Street.

Muni Operations Under Pilot
The pilot established center-running, dedicated transit-and-taxi-only lanes along three blocks of Church Street, in both directions, between 16th Street and Duboce Avenue. During the pilot and presently, the 22 Fillmore and the J Church operate in the red transit-only lane using the existing boarding islands for passenger loading. Due to constraints in the overhead wiring infrastructure, the 22 Fillmore must merge into the curbside travel lane north of Market Street (this lane is shared with other automobiles). To increase the effective capacity in the remaining mixed-flow lane, the pilot also introduced signal timing changes at 16th Street and 15th Street that prioritized north/south movements along Church Street by transferring green times from the corresponding east/west signal phases.

Pilot Evaluation Criteria
Before starting the Church Street Pilot, the following evaluation criteria were established to provide a framework for determining success. Each metric has 3 possible outcomes: Ideal, Meets Standard, and Substandard. The remainder of the document will discuss and evaluate the data collected during the pilot for each of the four metrics.

Metric	Ideal	Meets Standards	Substandard
1 - Muni Service	Peak period travel times and reliability improve	peak period travel times and reliability improve or stay the same	peak period travel times and reliability do not improve
2 - Local Circulation	Level of service (LOS) on Church Street, Sanchez Street, and Dolores Street do not degrade	Church Street, Sanchez Street, and Dolores Street operate at LOS E or better	Church Street, Sanchez Street, and Dolores Street operate at LOS F or worse
3 - Transit-Only Lane Violations	percentage of compliant vehicles is greater than baseline driver compliance rate on comparable corridors	percentage of compliant vehicles is the same as the baseline driver compliance rate on comparable corridors	percentage of compliant vehicles is lower than the baseline driver compliance rate on comparable corridors
4 - Red Paint Durability	measured deterioration rate exceeds the manufacturer's expected product life	measured deterioration rate matches the manufacturer's expected product life	measured deterioration rate exceeds the manufacturer's expected product life

1 - Muni Service

The study used Automatic Vehicle Locator (AVL, GPS data generated by each Muni Vehicle) data to compare travel time and travel time reliability on each Muni route before and after the Pilot. Weekday travel times through the study corridor for the month of September 2013 (six months after the pilot went into effect) were calculated and summarized using a variety of statistical measures to estimate travel times and travel time reliability, and compared to results for September 2012. The change in the interquartile range (the difference between the 75th percentile and the 25th percentile of travel times) was used to gauge the pilot's effect on reliability, where smaller interquartile ranges translate into greater schedule adherence, and vice versa.

Expected travel time savings were calculated based on how much longer it took to traverse the corridor at a given time relative to the late evening (7-10 PM), which is assumed to be free of congestion-related delay. Similarly, expected reliability improvements were estimated based on the interquartile range observed during the late evening (7-10 PM). As the pilot is designed to address only congestion-related delay and unreliability, these estimates serve as a meaningful reference for evaluating the findings.

The pilot has largely eliminated congestion-related delay on the J Church. The average peak period travel time is lower by up to 12% (40 seconds) in the outbound direction, and up to 13% lower (60 seconds) in the inbound direction. The travel time savings generally match or exceed estimates of travel time delay, which generally ranged from 20-30 seconds during the AM peak and 60 seconds during the PM peak. All results were statistically significant.

The pilot has eliminated congestion-related delay on the 22 Fillmore inside the pilot corridor, although this delay has been offset by new pilot-related congestion outside the corridor. The pilot has reduced average peak period travel times up to 12% (50 seconds) in the outbound direction, which generally match or exceed estimates of travel time delay through the corridor. These travel time savings, however, exclude the eastbound Hermann St "jog" from Fillmore Street to Church Street, which appears to have increased significantly during the AM and mid-day periods. When we include these segments, the total corridor travel time savings during the AM peak is reduced by about half, from 45 seconds to 20 seconds, and the mid-day travel time savings disappears entirely.

While no statistically significant change in travel times was observed for the inbound 22 Fillmore through the corridor, a block-by-block analysis reveals a different picture. There are consistent decreases in inbound travel times south of Market St, especially during the PM peak when delay appears to be most problematic. However, these decreases appear to be offset by significant increases in travel times north of Market St, where the 22 Fillmore is forced to merge out of the dedicated lanes and back into heavily congested mixed-flow traffic.

The pilot has improved travel time reliability through the corridor. The reduction in travel time interquartile ranges met or exceeded expectations, except for the inbound 22 Fillmore during the AM peak, and the outbound J Church during the PM Peak. The inbound 22 Fillmore exception is probably due to the bus contending with additional congestion merging back into the mixed flow lane north of Market Street. A block-by-block analysis of the outbound J Church suggests the problem is localized to the single block between Duboce Ave and 14th Street / Market. This could be the result of (1) queuing at the left-turn pocket onto Reservoir St that the outbound 22 Fillmore can bypass, but that the J Church cannot; or (2) modal conflicts at the intersection of Duboce Ave / Church St that interfere with the left-turn movement.

The travel time and reliability improvements have remained consistent through the 18-month

pilot.
The analysis was repeated again 12-months and 18-months into the pilot. Results from both were generally consistent with the 6-month findings, within a statistical margin of error (95% confidence interval).

2 - Local Circulation

To test the pilot's effect on local circulation along Church Street, and potential diversion of traffic to parallel streets, SFMTA compared average traffic volumes along the Corridor and parallel streets before and after implementation. Counts were generally conducted on clear weekdays in November 2012 and November 2013.

Pilot-related delay along signalized Church Street intersections was estimated using the Synchro 8.0 software package, while VisSim simulation software was used to estimate delay at the more complex, unsignalized Duboce Avenue intersection. The change in automobile delay before and after the Pilot was compared to significance criteria established by the San Francisco Planning Department. When measuring traffic diversion to parallel streets, peak hour traffic volumes needed to (1) change by at least 30 vehicles, and (2) amount to at least a 10% change to be considered significant.

The pilot has not led to a significant increase in delay to personal vehicles along the Church Street corridor, except at the northbound approach to Duboce Avenue. With the exception of Duboce Ave, the corridor was operating well within design capacity before the pilot. All intersections along the corridor operated at LOS C or better. Market Street generally contributed the most delay, which makes sense given the number of competing movements at that intersection and long cycle lengths. After the pilot, the corridor generally continued to operate well within design capacity.

While level of service at intersections south of Market largely remained unchanged, delay at Market Street does appear to have increased noticeably, falling from about LOS C to LOS D. This increase is due in part to the reduction in capacity along Church Street, but also in part to additional traffic generated by the new mixed-use development at Dolores and Market. The increase in delay was not, however, large enough to qualify as significant under San Francisco Planning Department guidelines.

Delay along the northbound approach to Duboce Avenue has appreciably worsened. The average peak period control delay at the northbound approach to Duboce Avenue has increased about one minute. This increase is due in part to (1) the reduction in capacity as a result of the pilot, (2) bus blockages from the 22 Fillmore loading at the curbside lane, and (3) additional traffic generated by the new mixed-use development. This impact can potentially be mitigated by moving the overhead wires for the 22 Fillmore so that it can safely operate in the center lane north of Market Street.

The pilot has not led to significant traffic diversion to parallel streets. No significant increases in traffic volumes were observed along Sanchez Street or Hermann Street during either peak period. While a significant increase in volumes was observed along southbound Dolores Street during the PM peak, these changes appear to be primarily driven by the new mixed-use development at Market Street and Dolores Street, and not the pilot.

3 - Transit-Only Lane Violations

To test the effectiveness of the red paint treatments at reducing violation rates, we compared violation rates along Church Street to violation rates along Judah Street, between 22nd Ave and 25th Ave. This stretch of Judah Street is a 4-lane facility (2 lanes in each direction) that features fixed rail guideways along center-running transit lanes, along with left-turn restrictions and on-street parking, making it functionally comparable to the transit lanes on Church Street.

No special transit lane enforcement efforts were scheduled along either Church Street or Judah Street during November 2013 when the counts were collected, nor had any taken place for at least seven months since the launch of the pilot in March 2013. As the pilot established entirely new transit lanes along Church Street where none existed before, the corridor received special enforcement attention for the first few weeks following implementation. For the first two weeks, the San Francisco Police Department (SFPD) issued advisements to motorists observed traveling within the transit lanes during peak periods. After the two week grace period, SFPD began issuing citations. This special enforcement effort continued for another two weeks. Since then, the Church Street transit lanes have been largely unenforced.

Traffic counts on Church Street and Judah Street were collected on two days in November 2013. For Church Street, each incidence of a private vehicle (excluding official medallioned taxis) traveling in the dedicated-lane was noted as a violation, whether they were traveling through or performing an illegal left turn. For Judah Street, each incidence of a private vehicle (excluding official medallioned taxis) traveling in the dedicated-lane during the peak period was noted as a violation, whether they were traveling through or performing an illegal left turn; during the off-peak period, when left turns from the dedicated lanes are allowed, only those vehicles traveling through were noted as violations.

Given that violation rates are very sensitive to congestion (i.e. appear to increase exponentially with congestion), and Judah Street generally does not experience the congestion levels observed on Church Street; in comparing average violation rates, we include only those observations along Church Street where approach volumes are less than or equal to 300 vehicles per hour. This threshold is roughly half the design capacity of an urban roadway, and corresponds to when congestion generally becomes much more noticeable. This theoretical threshold is supported by the count data, which shows exponential growth in violation rates along Church Street at volumes above 300 vehicles per hour.

The red paint treatment reduces transit lane violations by roughly half. The violation rate along the Church Street transit lanes is a little less than half (42%) the violation rate observed along the Judah Street transit lanes, even though average traffic volumes along Church Street are almost twice as high. The average violation rate observed along the Church Street corridor during uncongested conditions was about 7 percent, versus a violation rate of about 12 percent along Judah Street. The difference was statistically significant. Even at the northbound approach to Market Street and Duboce Avenue, where congestion and delay can be quite significant, the observed violation rates are lower than expected given the relatively high volumes. Ranging between 10% and 15%, the violation rates observed north of Market Street are on par with the rates observed on Judah Street, where congestion and delay are not a problem.

4 - Red Paint Durability

While red paint treatments have generally proven to be effective at protecting the integrity of transit only lanes, whether this solution is more efficient than simply increasing enforcement efforts depends in large part on their long-term durability. The StreetBond150 coating product developed by Quest Construction Products was selected for this Pilot based on its performance in New York City's red transit lane experiment, and SFMTA's past experience using the product to paint green bike lanes throughout San Francisco. The product was applied in March 2013 in accordance with the training guide supplied by Quest, and is expected to last at least 3-5 years.

To test the durability of the red paint treatments, SFMTA selected nine locations along the corridor, and tracked the rate of deterioration of the paint over time. Three different location types were selected:

1. Immediately adjacent to a transit stop
2. Midblock
3. Intersection without a transit stop

Site visits were conducted every three months, beginning September 2013 and ending September 2014. During each visit, several photos were taken at each of the nine locations, on a sunny day, at a time with no shadows on the red paint. The photos were taken parallel to the street surface, approximately 3.5 feet overhead, on sunny days, with the same camera and exposure settings to ensure uniform digital imaging conditions. The photos were then processed using the digital image processing software ImageJ to determine the percentage of the surface area in each photograph that was still covered by red paint. Two photos were analyzed at each location in order to get an average paint coverage value for the location.

The results of the analysis show that the red paint treatment has deteriorated the most at transit stop locations (70-80% of coverage remaining), followed by intersection approaches, where about 80-90% of coverage remains. Midblock locations—representative of the vast majority of the painted surface area—have fared well, with over 90% of coverage remaining at all locations tested.

This wear pattern makes sense, as transit stops and intersection approaches are generally subject to higher frictional (accelerating, braking, and turning movements) and heat stress (undercarriage of idling vehicles) than midblock locations. Deterioration rates also appear to be affected by pavement quality.

The StreetBond150 coating product is performing as expected. Extrapolating the observed deterioration rates forward, we can expect more than 85% red-paint coverage along most of the corridor after 3 years, falling to 80% coverage after 5 years. Transit stop and intersection approach locations will likely need touchups at the 5-year mark, where coverage will dip below 50%.

Conclusion

The Church Street Pilot has exceeded the evaluation criteria established in 3 of the 4 metrics. Based on these results from data analyzed at 6 months, 12 months, and 18 months, the Pilot can be declared a success. The data combined with observations and feedback from customers, indicate the pilot changes should be made permanent. The pilot also indicates that other transit-only lanes in San Francisco should be painted red to increase those lanes' effectiveness.

Metric	Ideal	Meets Standards	Substandard
1 - Muni Service	X		
2 - Local Circulation	X		
3 - Transit-Only Lane Violations	X		
4 - Red Paint Durability		X	

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