

**San Francisco PedSafe Phase II
FINAL IMPLEMENTATION REPORT AND EXECUTIVE
SUMMARY**

Prepared for

**US Department of Transportation
Federal Highway Administration**



Prepared by

**San Francisco Municipal Transportation Agency
Pedestrian Program
and
University of California Traffic Safety Center
University of California**

February 25, 2008

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Pedestrian Safety Engineering and Intelligent Transportation System-Based Countermeasures
Program for Reduced Pedestrian Fatalities, Injuries,
Conflicts and Other Surrogate Measures

Prepared for

**US Department of Transportation
Federal Highway Administration**

**Cooperative Agreement
DTFH61-02-X-00017**

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TABLE OF CONTENTS

1	EXECUTIVE SUMMARY AND INTRODUCTION.....	1
1.1.	Purpose and Scope	1
1.1.1.	Purpose.....	1
1.1.2.	Key Work Products.....	1
1.2.	San Francisco’s Setting.....	2
1.3.	Project Overview and Schedule.....	5
1.4.	Countermeasure Overview.....	6
1.5.	Deployment.....	7
1.5.1.	Deployment Steps.....	7
1.5.2.	Comparison of Countermeasures: Cost	7
1.5.3.	Comparison of Countermeasures: Availability and Standard Use	8
1.5.4.	Comparison of Countermeasures: Installation Complexity.....	9
1.6.	Devices Not Deployed.....	9
1.6.1.	Smart Lighting and Other Roadway Lighting Improvements	9
1.6.2.	Upgrade of In-Pavement Crosswalk Lights.....	9
1.6.3.	Pedestrian Scramble (Exclusive Pedestrian Phase)	10
1.6.4.	Animated Eyes Signals	10
1.7.	Data Collection and Analysis Methods for PedSafe Countermeasures.....	10
1.8.	Summary of Results for PedSafe Countermeasures	10
1.9.	Summary of Results for Non-PedSafe Countermeasures	14
1.9.1.	Pedestrian Scramble (Exclusive Pedestrian Phase)	14
1.9.2.	Pedestrian Countdown Signals	15
1.9.3.	In-Pavement Crosswalk Lights.....	15
1.9.4.	Accessible (Audible) Pedestrian Signals	16
1.10.	Education and Outreach.....	16
1.11.	Phase II Conclusions.....	17
1.11.1.	Lessons Learned: overall project success and Countermeasures.....	17
1.11.2.	Lessons Learned: Outreach.....	18
1.11.3.	Lessons Learned: Implementation	19
1.11.4.	Lessons Learned: Data Collection and Analysis	19
1.11.5.	Comparison with Other Cities	19
1.11.6.	Next Steps and Further Research.....	20
2.	COUNTERMEASURE IMPLEMENTATION	21
2.1.	Overview of Installation Challenges.....	21
2.2.	Comparison of Countermeasures: Ease of Implementation.....	22
2.3.	Comparison of Countermeasures: Costs.....	23
2.4.	Comparison of Countermeasures: Availability and Standard Use	27
3.	DEPLOYMENT OF INDIVIDUAL COUNTERMEASURES	29
3.1.	In-Street Pedestrian Signs.....	29
3.2.	“TURNING TRAFFIC MUST YIELD TO PEDESTRIANS” Signs.....	31
3.3.	“LOOK” Pavement Stencils	33
3.4.	Modify Signal Timing.....	36
3.5.	Pedestrian Head Start.....	38

3.6.	Advanced Stop Lines and Red Visibility Curb Zones	39
3.7.	Flashing Beacons	43
3.8.	Portable Changeable Message Speed Limit Sign	48
3.9.	Americans With Disabilities (ADA) Curb Ramps.....	51
3.10.	Median Refuge Islands	52
3.11.	Automated Video Detection of Pedestrians to Adjust Signal Timing	54
3.12.	Changeable Message Speed Limit Sign.....	56
3.13.	Retro-Reflective Materials.....	59
3.14.	Education	60
3.15.	Devices Not Deployed.....	62
3.15.1.	Smart Lighting and Other Lighting Improvements	62
3.15.2.	Upgrade of In-Pavement Crosswalk Lights.....	62
3.15.3.	Pedestrian Scramble (Exclusive Pedestrian Phase)	63
3.15.4.	Animated Eyes Signals	63
4.	DATA ANALYSIS OF COUNTERMEASURES	65
4.1.	Data Analysis Report (By Reference).....	65
4.2.	Pedestrian Detector Performance.....	65
4.2.1.	Pedestrian Detector Overview	65
4.2.2.	Video Detection: Data Collection Methods.....	67
4.2.3.	Video Detection: Manual Data Collection Results.....	67
4.2.4.	Video Detection: Automated Data Collection Results	68
4.3.	Analysis of Non-pedsafe countermeasures.....	69
4.3.1.	Pedestrian Scramble.....	69
4.3.2.	Pedestrian Countdown Signals	72
4.3.3.	In-Pavement Crosswalk Lights.....	74
4.3.4.	Accessible (Audible) Pedestrian Signals	76
5.	OUTREACH AND EDUCATION	77
6.	PHASE II CONCLUSIONS.....	79
6.1.	Lessons Learned.....	79
6.1.1.	Lessons Learned: overall project success and Countermeasures.....	79
6.1.2.	Lessons Learned: Outreach.....	81
6.1.3.	Lessons Learned: Implementation	81
6.1.4.	Lessons Learned: Data Collection and Analysis	82
6.2.	Comparison With Other Cities.....	83
6.3.	Next Steps and Further Research.....	83
	APPENDIX A: OUTREACH ASSEMBLY SUMMARY AND EVALUATION	85

INDEX OF FIGURES

Figure 1.2-1	San Francisco Pedestrian Injury Collisions: 1996-2005	4
Figure 1.2-2	San Francisco Pedestrian Injury Locations and PedSafe Zones	4
Figure 4.2-1	9th & Howard Intersection with Video Camera at Top of Streetlight Pole.....	66
Figure 4.2-2	Northeast Crosswalk with Video Detection Zones at 9th & Howard	66
Figure 4.2-3	Econolite Autoscope Pedestrian Detection Zones and Display	67
Figure 4.2-4	Pattern of Cycle Lengths.....	68

INDEX OF TABLES

Table 1.8-1 San Francisco FHWA PedSafe Project: Data Highlights.....	11
Table 3.1-1 In-Street Pedestrian Signs: Characteristics Of Intersections.....	29
Table 3.2-1 “TURNING TRAFFIC MUST YIELD TO PEDESTRIANS” Signs: Characteristics Of Intersections.....	31
Table 3.3-1 “LOOK” Pavement Stencils: Characteristics Of Intersections	34
Table 3.4-1 Modify Signal Timing: Characteristics Of Intersections.....	36
Table 3.5-1 Pedestrian Head Start: Characteristics Of Intersections.....	38
Table 3.6-1 Advanced Stop and Red Visibility Curb Zone Lines: Characteristics Of Intersections	41
Table 3.7-1 Push Button Activated Flashing Beacon: Characteristics Of Intersection	44
Table 3.7-2 Infrared Activated Flashing Beacons: Characteristics Of Intersection	46
Table 3.8-1 Portable Changeable Message Speed Limit Sign: Characteristics Of Intersections .	49
Table 3.9-1 ADA Curb Ramps: Characteristics Of Intersection	51
Table 3.10-1 Median Refuge Islands: Characteristics Of Intersections	53
Table 3.11-1 Automated Video Detection of Pedestrians to Adjust Signal Timing: Characteristics Of Intersections	54
Table 3.12-1 Changeable Message Speed Limit Signs : Characteristics Of Intersections	56
Table 4.3-1 Impact of Pedestrian Scrambles on Pedestrian Safety and Convenience.....	70
Table 4.3-2 Impact of Pedestrian Scrambles on Through Vehicle Speeds on Stockton Street ...	70
Table 4.3-3 Pedestrian Countdown Signals Pilot Project: Impacts on Behavior and Attitudes ...	74

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1 EXECUTIVE SUMMARY AND INTRODUCTION

1.1. PURPOSE AND SCOPE

1.1.1. PURPOSE

This report presents the methods and key findings from San Francisco PedSafe, a comprehensive pedestrian safety planning and engineering project. It is one of three such projects in the nation funded by the Federal Highway Administration (FHWA) to evaluate:

In Phase I: The effectiveness of a pedestrian safety plan targeted to higher-injury areas;

In Phase II: The implementation of a range of mostly low-to-moderate-cost, innovative safety improvements.

This report concentrates on the Phase II countermeasure implementation efforts, minimizing duplication with earlier reports, and focusing primarily on the implementation experience and overall lessons learned.

1.1.2. KEY WORK PRODUCTS

The San Francisco Municipal Transportation Agency (SFMTA) and the University of California, Berkeley Traffic Safety Center (TSC) proposed and conducted the project from planning through implementation. A separate *Phase I (Planning) Final Report*, finalized October 29, 2003, covered:

- **Problem Identification:** a comprehensive picture of pedestrian injury collisions in San Francisco.
- **Countermeasure Selection Plan:** a conceptual blueprint, describing proposed countermeasures for PedSafe implementation, countermeasures already committed for implementation outside of PedSafe, and descriptions of countermeasures selected for inclusion in the PedSafe study.
- **Evaluation Plan:** a conceptual plan for assessing the impacts of the countermeasures.
- **Outreach and Awareness Plan:** a conceptual plan for educating the public about countermeasures to be implemented, in addition to promoting safer driver and pedestrian behavior.

The February 28, 2005 *Phase II Implementation Plan and Preliminary Engineering Report* clarified the countermeasure plan, including cost estimates and, where appropriate, conceptual layout plans. It also presented refined outreach and data collection/evaluation plans. Due to engineering and institutional challenges, some of the proposed countermeasures could not be implemented. These challenges are described in this report.

The January 2008 *Phase II Data Analysis Report* presented detailed findings from observations of video recordings of pedestrian and driver behavior, and from intercept surveys of pedestrians at countermeasure sites. This *Data Analysis Report* is briefly summarized here, but readers

interested in the safety effectiveness of the countermeasures should refer to the full *Data Analysis Report*. In addition, data findings are presented for several countermeasures (e.g., accessible/audible pedestrian signals) that were installed outside of the formal PedSafe project. These treatments were neither funded by the FHWA grant nor covered by the Evaluation Plan, and were therefore not evaluated in the same standardized manner.

1.2. SAN FRANCISCO'S SETTING

San Francisco's unique physical and sociopolitical characteristics influenced the conduct and impacts of the PedSafe project. This setting and its pedestrian injury patterns were described in detail in the *Phase I (Planning) Final Report*. Among the most significant characteristics of the city are the following:

- Compact, high density, hilly urban terrain with many six-leg intersections;
- Very high reliance on public transit and walking as basic transportation modes, as compared to other major western U.S. cities;
- Commitment to public transit, walking, and bicycling as priorities in the City Charter;
- A combined city/county jurisdiction; and
- Engineering, planning, and public health staff dedicated exclusively to pedestrian safety, with a record of implementing innovative measures, pre-dating the FHWA PedSafe project.

San Francisco is a relatively compact, high-density city of 47 square miles with extensive public transit. Although the famous hills can be challenging, most residents and businesses are within a quarter-mile of a bus or rail line—and the weather is fairly mild most days. The street system and traffic signal hardware are older than those of most other major western U.S. cities. Along the “diagonal” arterial streets of Market Street and Columbus Avenue, there are five- and six-leg intersections.

In 2000 in the San Francisco metro area, 9.5% of the workforce commuted by public transit and 3.6% walked, while 68.3% drove alone. (Walking and transit use are higher in the more urbanized study area.) By comparison, in the Miami metro area, 4.2% commuted by public transit, only 2.3% walked, and 75.3% drove alone. In the Las Vegas metro area, 1.8% commuted by public transit, 3.7% walked, and 74.3% drove alone.¹

The City Charter declares San Francisco to be a “transit first city,” which includes walking and bicycling as higher-priority modes. The SFMTA is unusual nationally, although not unique, in holding responsibility for both public transit and traffic engineering functions. Substantial funding has been allocated to pedestrian safety improvements. For example, a local transportation sales tax devotes over \$800,000 annually to “pedestrian circulation and safety” improvements, and more than twice that level to “traffic calming.”

As a combined city and county, the local government has a streamlined governing structure. However, numerous agencies are involved in pedestrian safety. In recent years, pedestrian safety

¹ FHWA website on 2000 Census, <http://www.fhwa.dot.gov/ctpp/jtw/jtw4.htm>.

plans and outreach efforts have been carried out by two different sections of the Public Health Department, the Department of the Environment, the Police Department, the Public Works Department, the County Transportation Authority, and the SFMTA. Walk San Francisco, a citywide non-profit advocacy group, is joined by several other community organizations heavily involved in this area, as well as an official Pedestrian Safety Advisory Committee.

Major pedestrian safety efforts completed outside of this PedSafe project included:

- Conversion of standard pedestrian signals to the countdown version at over 800 intersections [described in more detail in Chapter 4, Section 4.3-2].
- Conversion to the more prominent ladder-style striping of more than 2,000 crosswalks at over 900 locations.
- Conversion of hundreds of pedestrian crossing warning signs to the more visible fluorescent yellow-green version.
- Use of pedestrian scramble phasing (exclusive pedestrian phase) at about a dozen intersections [described in more detail in Chapter 4, Section 4.3-1].

San Francisco has one of the higher per-capita pedestrian fatality rates in the nation. However, when the estimated amount of walking (the level of exposure) is taken into account, the actual risk to the pedestrian stepping off the curb is lower than in many other cities.² The level of pedestrian injuries has been steadily dropping over the last decade. Total pedestrian injury collisions fell 31.3% between 1996 and 2005.³

Figure 1.2-1 shows the general declining trend in pedestrian injuries since 1996. The annual number of pedestrian injuries at higher-injury locations has also decreased substantially. Figure 1.2-2 shows the PedSafe zones and the geographic distribution of pedestrian injuries. Higher-injury intersections and blocks are clustered in several areas and along major arterial corridors.

² Surface Transportation Policy Project, *Pedestrian Safety in California: Five Years of Progress & Pitfalls*, August 2002. http://www.transact.org/ca/ped_safety_report_2002.htm

³ More details on San Francisco traffic-related injuries and fatalities are available from the San Francisco Department of Parking and Traffic, *2005 Traffic Collision Report*. http://www.sfmta.com/cms/rtraffic/documents/Collision_report_2005.pdf

Figure 1.2-1
San Francisco Pedestrian Injury Collisions: 1996-2005

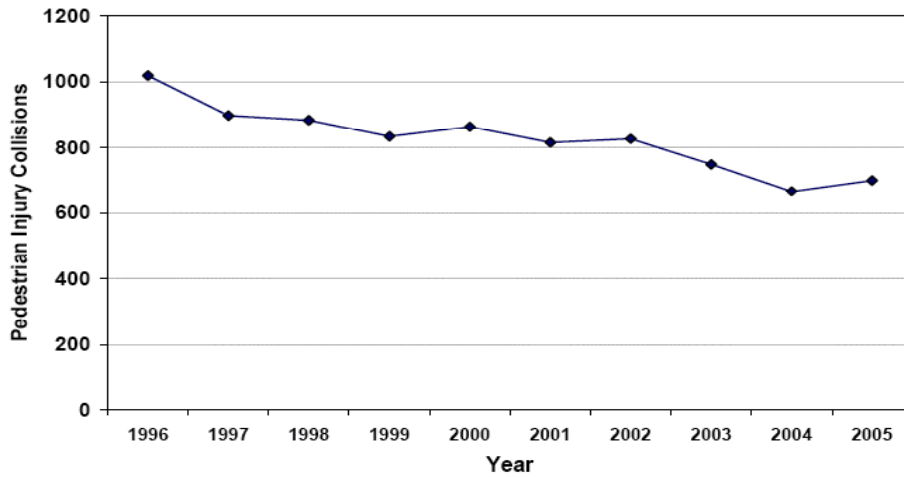
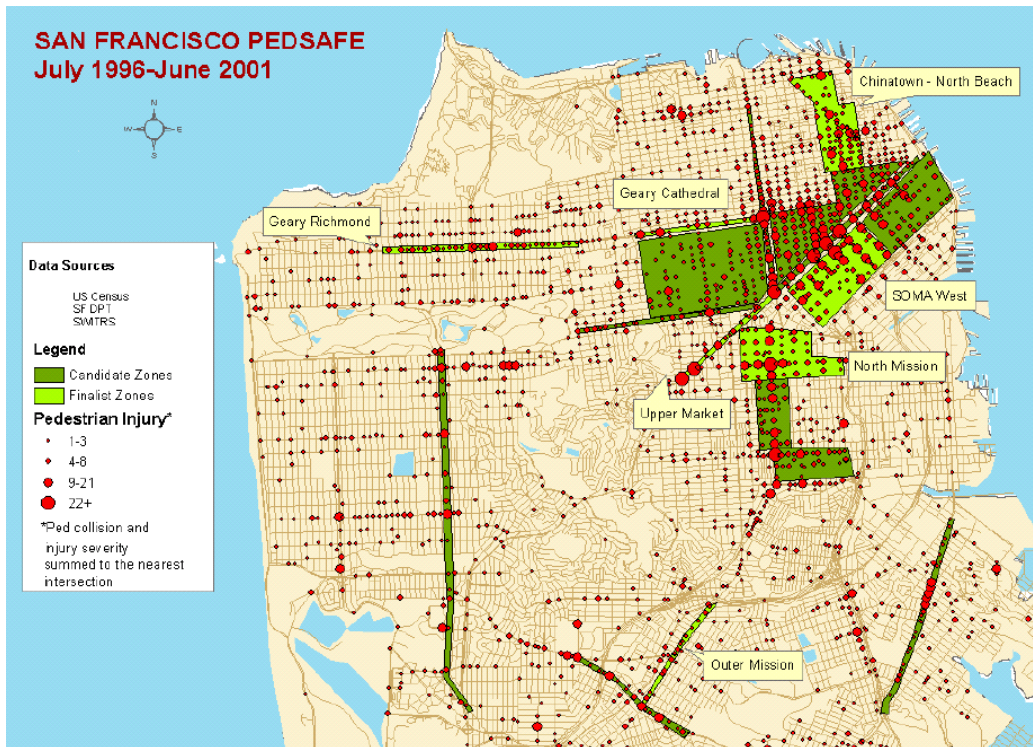


Figure 1.2-2
San Francisco Pedestrian Injury Locations and PedSafe Zones



1.3. PROJECT OVERVIEW AND SCHEDULE

The Phase I planning analysis and recommendations were developed in 2002. In addition to extensive technical analysis, 10 meetings were held with internal and external stakeholders between March and December 2002.

In 2003, the Phase I Concept Plan was developed and revised, and arrangements made for implementation. The San Francisco Phase I concept plan and preliminary final report that is the basis for this implementation plan was approved by the San Francisco Municipal Transportation Agency (SFMTA) Board of Directors in April 2003. The SFMTA Board is the policymaking entity for traffic engineering functions previously managed by the Department of Parking and Traffic (DPT), now the Division of Parking and Traffic.

The Phase I problem analysis was conducted on three different levels: (1) citywide, (2) within selected corridors and zones with higher levels of pedestrian injuries, and (3) at specific intersections within the study zones. Extensive collision analysis was conducted using the Pedestrian Bicycle Crash Analysis Tool (PBCAT) and statistical software. This analysis was useful both in defining study zones and in assessing potential countermeasures for implementation at specific locations.

Some 68 potential countermeasures were assessed based on criteria including: relative cost, presumed safety effectiveness, and ease of implementation. Nine general engineering countermeasures and 10 intelligent transportation systems (ITS) countermeasures were selected for consideration for specific locations. No conceptual engineering was possible in Phase I.

The accompanying data collection/evaluation plan proposed assessment of the individual impacts of each countermeasure and a broader evaluation of its cumulative impact within study areas. Measures of effectiveness (MOEs) included both collisions and surrogate measures of pedestrian and driver behavior. However, it was not possible to conduct meaningful collision analysis within the Phase II timeframe, considering the additional time needed to design and implement the countermeasures and the typical delay in receiving collision tabulations.

The outreach plan proposed integrating PedSafe countermeasure outreach and awareness into ongoing efforts, as well as working with agencies responsible for pedestrian safety (e.g., Police and Public Health departments) and working with grassroots community groups committed to pedestrian safety projects. For the most part, pedestrians did not need education about countermeasures because their meaning was intuitively clear (e.g., countdown signals and “LOOK” pavement stencils). The plan outlined a media campaign, which was later supplemented by educational presentations about pedestrian safety, including distribution of retro-reflective items (e.g., armbands) at elementary/middle schools and senior centers.

In a Summer 2003 funding application, the San Francisco team proposed to move into Phase II implementation. The funding application schedule did not allow for thorough feasibility analysis prior to the deadline for submission of a detailed budget and implementation schedule for specific countermeasures. A two-day site visit in November 2003 included a detailed review of the initial countermeasure plan by FHWA staff and consultants.

Extensive engineering efforts began in 2004, including additional feasibility research and design layouts for a broad range of innovative devices and interventions. An *Implementation Plan and Preliminary Engineering Report* (February 28, 2005) provided a detailed blueprint for conducting Phase II.

Implementation of the countermeasures took place from Spring 2005 through Fall 2006, with final refinement of several devices in early 2007. The actual implementation was largely consistent with the Phase I report and the Phase II implementation plan, although some modifications were made in response to practical difficulties or changing circumstances. Some countermeasures were not feasible for implementation, as described in more detail in Chapter 4.

1.4. COUNTERMEASURE OVERVIEW

A total of thirteen countermeasures (nine general engineering countermeasures and four intelligent transportation systems [ITS] countermeasures) were implemented by the SFMTA and evaluated by the Traffic Safety Center during this Phase II investigation:

GENERAL ENGINEERING COUNTERMEASURES

- In-Street Pedestrian Crossing (Impactable “Yield To Pedestrians”) Signs
- TURNING TRAFFIC MUST YIELD TO PEDESTRIANS Signs
- “LOOK” Pavement Stencils
- Modified Signal Timing
- “Pedestrian Head Start”
- Advanced Stop Lines and Red Visibility Curb Zones
- ADA Curb Ramps
- Median Refuge Islands
- Distribution of Retro-Reflective Materials

INTELLIGENT TRANSPORTATION SYSTEMS (ITS) COUNTERMEASURES

- Flashing Beacons (both automated detection and push button-actuated)
- Portable Changeable Message Speed Limit Sign
- Automated (Video) Detection of Pedestrians to Extend Crossing Time
- Changeable Message Speed Limit Sign (fixed)

In addition, an outreach program was implemented. This outreach effort included distribution of a video public service announcement (PSA) to cable and small/ethnic local TV stations, and presentations at schools and senior centers (including distribution of retro-reflective items). It was not possible to evaluate each of the outreach efforts separately.

1.5. DEPLOYMENT

1.5.1. DEPLOYMENT STEPS

The following steps were required for the implementation of each countermeasure:

1. Conceptual Engineering
2. Feasibility Study
3. Preliminary and Final Engineering
4. Approvals (when necessary)
5. Procurement
6. Coordination with Data Collection Schedule
7. Installation
8. Monitoring
9. Maintenance and Refinement

1.5.2. COMPARISON OF COUNTERMEASURES: COST

The overall cost of this project was slightly greater than \$1.1 million, including \$681,000 in federal funding. The federal funding averaged roughly \$120,000 per year.

The total costs of the nearly six-year-long project included the following rough estimates:

PLANNING PHASE I: \$215,000

IMPLEMENTATION PHASE II: \$920,000

Including:

Design of Countermeasures: \$145,000

Installation/Deployment Labor: \$125,000

Materials and Equipment: \$ 95,000

Data Collection & Evaluation: \$225,000

Other Program Management \$330,000

(including planning and design of countermeasures
not installed)

It should be noted that San Francisco construction and labor costs are substantially higher than the national average. On an annual basis, the project cost was actually a relatively small share of the total San Francisco public expenditures for pedestrian safety planning, design, enforcement, and outreach/education. The federal funding was limited in comparison to the unit cost of higher-cost pedestrian safety countermeasures. This influenced the selection of countermeasures.

Both the Portable Changeable Message Speed Limit Sign and the outreach program carried substantial operating personnel costs. The other countermeasures, once installed, did not require personnel for operation, although modification and specific maintenance were required by many of the devices. In general, the labor costs far exceeded the equipment and materials costs. Overall, the engineering/administrative costs were quite substantial, largely due to the need for specialized training, mobilization, and approvals for new devices. These engineering/administrative costs often exceeded the material/equipment costs and the installation labor.

The least expensive countermeasures in total per-unit costs were the “LOOK” pavement stencils and the roadside TURNING TRAFFIC MUST YIELD TO PEDESTRIANS signs (\$800 and \$300 per intersection respectively). The most expensive countermeasures were the video detection system to adjust signal timing (\$17,300 out-of-pocket costs) and the flashing beacon with automated detection (\$62,600). Although the listed project costs of other countermeasures exceeded those of the video detection system, the full video detection costs are significantly understated by the out-of-pocket figure above as the PedSafe project was not charged for the video detection camera equipment or its initial installation, and substantial technical assistance was provided free of charge by Econolite, the manufacturer of the equipment.

1.5.3. COMPARISON OF COUNTERMEASURES: AVAILABILITY AND STANDARD USE

All countermeasures were explicitly or implicitly compliant with the Manual on Uniform Traffic Control Devices (MUTCD) and the California MUTCD State Supplement. It was not necessary to obtain special approval to experiment with any of the countermeasures from FHWA or the California Department of Transportation (Caltrans). Several countermeasures that were considered experimental when initially proposed by the San Francisco team were added to the MUTCD in the 2003 revision. Formal local approvals were needed for red visibility curb zones (from the Municipal Transportation Agency Board of Directors and the County Board of Supervisors).

The following countermeasures are in very limited use as “off the shelf” products, but are not considered experimental:

- “LOOK” Pavement Stencils⁴;
- Flashing Beacons (push button-actuated);
- Portable Radar Portable Changeable Message Speed Limit Signs;
- Changeable Message Speed Limit Signs;
- Distribution of Retro-Reflective Materials; and
- Video Public Service Announcements.

⁴ The LOOK pavement stencils included a Chinese-English stencil that was custom designed by SFMTA staff, working with the vendor.

The following countermeasures were “custom-made” and involved innovative technologies, although they did not require approval as formal experiments:

- Automated (Video) Detection of Pedestrians to Extend Crossing Time, and
- Flashing Beacons (Automated Detection with Infrared Bollards).

The other countermeasures were considered innovative at the time they were proposed, but were generally easily available “off the shelf.”

1.5.4. COMPARISON OF COUNTERMEASURES: INSTALLATION COMPLEXITY

The countermeasures requiring the most effort to install or use were:

- Portable Radar Portable Changeable Message Speed Limit Signs;
- Changeable Message Speed Limit Signs;
- Automated (Video) Detection of Pedestrians to Extend Crossing Time; and
- Flashing Beacons (Automated Detection with Infrared Bollards) .

These were more complicated to install because they involved procurement of specialized equipment and/or customized design. They all required intensive adjustments or fine tuning (usually by electricians). In the case of the radar Portable Changeable Message Speed Limit Sign, complex logistical and scheduling arrangements needed to be made with the Police Department.

1.6. DEVICES NOT DEPLOYED

Several countermeasures originally proposed in the Phase I Concept Plan were not implemented. The reasons are explained below.

1.6.1. SMART LIGHTING AND OTHER ROADWAY LIGHTING IMPROVEMENTS

“Smart lighting” is a promising concept of supplemental street corner and crosswalk lighting triggered by detection of pedestrians. The Phase I Concept Plan proposed this countermeasure for several intersections that had higher numbers of nighttime pedestrian injuries. More detailed research early in Phase II could not find a major U.S. city that had experimented with this technology, although it was proposed for use in Miami and Las Vegas. SFMTA management was concerned about the possible liability exposure from the use of such a device. Street lighting is not managed by that agency’s Division of Parking and Traffic in San Francisco, and the other two departments that operate street lights (Public Utilities Commission) and design lighting improvements (Public Works) were not interested in cooperating on street lighting improvements considering the funding available.

1.6.2. UPGRADE OF IN-PAVEMENT CROSSWALK LIGHTS

In the Phase I Concept Plan, DPT proposed repairing and upgrading the crosswalk pavement lights, then installed at the intersection of Mission and Santa Rosa, with a more visible

configuration of lights. The Mission & Santa Rosa installation had proven unreliable and had been turned off indefinitely, primarily due to water collecting in the cans below the lights (despite waterproofing efforts by electricians), and secondarily due to detection problems with the microwave pedestrian detection units. Pressure from policy makers and the news media convinced DPT that it was unacceptable to allow the lights to remain. DPT removed the lights and committed to replacing them with flashing beacons. Data were already collected at all four in-pavement crosswalk light locations.

1.6.3. PEDESTRIAN SCRAMBLE (EXCLUSIVE PEDESTRIAN PHASE)

While exclusive pedestrian phases were installed prior to Phase II (and at local expense) at four intersections on Stockton Street, installation at a fifth adjacent intersection was deferred indefinitely due to concerns about impacts on Muni public transit schedule adherence. This improvement is still planned for the future after transit signal priority can be provided and other signal timing adjustments made to satisfy Muni management.

1.6.4. ANIMATED EYES SIGNALS

The animated eyes countdown signals were not installed as originally planned, because the vendor, Relume, lost interest in supporting experimentation with the device, apparently after assessing the market potential for the devices.

1.7. DATA COLLECTION AND ANALYSIS METHODS FOR PEDSAFE COUNTERMEASURES

Because insufficient time had elapsed since installation of the countermeasures to analyze their long-term impacts on pedestrian injuries, surrogate evaluation measures were used. Two primary methods were employed to assess the impacts of the countermeasures:

- Video recorded observations of pedestrian and driver behavior (e.g., pedestrian/vehicle conflicts and pedestrian crossing time)
- Intercept (interview) surveys of pedestrians at countermeasure intersections (regarding knowledge of and support for countermeasures).

The pedestrian/driver observations were generally completed before and after installation. In some cases, multiple baseline and follow-up observations were conducted to ascertain the effects of the passage of time and novelty fading. Statistical tests (generally chi-square for contingency tables and t-test for difference of means/proportions) were performed.

1.8. SUMMARY OF RESULTS FOR PEDSAFE COUNTERMEASURES

Following is a summary of results. Results for individual countermeasures and intersections are described in detail in the separate January 2008 *Data Analysis Report*. Generally, video recorded observation results are only reported in this table if they are statistically significant ($p < 0.05$).

**Table 1.8-1
San Francisco FHWA PedSafe Project: Data Highlights**

NOTE: All countermeasures are considered standard devices (in federal traffic engineering manual, *Manual on Uniform Traffic Control Devices, MUTCD*), unless otherwise noted. "Low cost" typically is under \$5,000 per installation, "medium" is \$5,000 to \$20,000.

COUNTER-MEASURE	PURPOSE	DATA COLLECTION/ ANALYSIS METHODS	OBSERVATION HIGHLIGHTS	RELATIVE COST	COMMENTS
1. In-Street Pedestrian Signs	Used in median of uncontrolled crosswalks to encourage drivers to yield to pedestrians and to help delineate the crosswalk. Designed to be safe and visible next to moving traffic.	Video recorded pedestrian/driver behavior at 4 crosswalks (including marked and unmarked crosswalks at same intersection). Interviewed pedestrians at 1 intersection.	Very substantial increases in drivers yielding at all 4 crosswalks (53% pre vs. 68% post overall). About 27% of respondents felt signs made them feel safer, but only 18% of respondents correctly identified the recent safety change.	Low	High rate of damage to signs unless they are placed on a raised island or are completely out of turn path.
2. "TURNING TRAFFIC MUST YIELD TO PEDESTRIANS" Signs	Mounted at street corners of intersections to encourage turning drivers to yield to peds. Usually used at signalized intersections	Video recorded pedestrian/driver behavior at 4 crosswalks, 3 of them 4-leg, and 1 a 3-leg. 3 of 4 were signalized. Focused on turning drivers who would see signs.	Small, but significant impact on drivers yielding at all 4 corners. About 28% of respondents felt signs made them feel safer, but almost none correctly identified the recent safety change initially.	Low	Standard MUTCD sign used, although more prominent versions have been used by other cities.
3. "LOOK" Pavement Stencils	Thermoplastic "LOOK" stencils applied on pavement in crosswalks (within 4 feet of curb) to encourage pedestrians to look for conflicting vehicles. Tested at signalized intersections only, but could be used at unsignalized.	Video recorded pedestrian/driver behavior at 3 intersections. Interviewed pedestrians at 1 intersection.	Mixed impacts on pedestrians looking, increased at 1 intersection and decreased at 2. No significant change in vehicle/pedestrian conflicts. About 29% of respondents felt safer, but only about 8% correctly identified the recent safety change.	Low	Stencils are highly susceptible to fading and blemishes. Used Chinese/English at 1 location. MUTCD compliant, but not explicitly included.

San Francisco PedSafe:
Final Report and Executive Summary

COUNTER-MEASURE	PURPOSE	DATA COLLECTION/ ANALYSIS METHODS	OBSERVATION HIGHLIGHTS	RELATIVE COST	COMMENTS
4. Modified Signal Timing	All-red phase extensions at 3 intersections intended to reduce conflicts for pedestrians who are late crossing. (At 1 intersection, accompanied by installation of pedestrian signals for crossing minor street, and at another, pedestrian clearance increased, but Walk shortened (due to area wide cycle change).) Also, longer cycle and longer pedestrian crossing time at 4th intersection.	Video recorded 2 all-red intersections. Manual observations for 2 other intersections. Interview survey at 1 all-red intersection.	Findings too complicated and generally minor to summarize. About 60% of respondents felt the signal timing change made them "extremely safe" or "more safe." However, virtually none realized initially that there had been a timing change.	Low	Not possible to isolate simple timing changes. Substantial difference in the changes tested at different intersections.
5. Pedestrian Head Start	4-second leading pedestrian interval added at 3 intersections with heavy left turns from one-way streets, and also at 1 2-way intersection with more balanced turning movements. Intended to allow pedestrians to start crossing and establish right-of-way before heavy turn movements block them.	Video recorded 4 intersections. Interview survey at 1 intersection.	Significant reduction in vehicles turning in front of pedestrians at 3 intersections (6.2% pre vs. 4.0% post overall). About 56% of respondents felt the signal timing change made them feel "extremely safe" or "more safe." However, only 9% correctly identified the recent safety change.	Low	Impact of pedestrian head start could possibly be enhanced with red turn arrow.
6. Advanced Stop Lines and Red Visibility Curb Zones	Line typically 4-10 feet before crosswalk (controlled or uncontrolled) to discourage intrusion into crosswalk and to provide better visibility, reduce multiple threat problem. In some cases accompanied by red visibility curb zones	Video recorded 2 intersections. Both had relatively small samples for some variables. Interviewed pedestrians at 1 intersection.	Generally inconclusive results for pedestrian/driver behavior. About 37% said change made them feel safer, however none correctly identified the change initially.	Low	

COUNTER-MEASURE	PURPOSE	DATA COLLECTION/ ANALYSIS METHODS	OBSERVATION HIGHLIGHTS	RELATIVE COST	COMMENTS
7A. Flashing Beacons – Push Button Actuated	Used at uncontrolled crosswalk to warn drivers to yield to pedestrians	Video recorded 1 intersection. No interview survey.	Substantial reduction in vehicle/pedestrian conflicts (6.7% pre vs. 1.9% post), substantial increase in vehicle yielding (70% to 80%). Only 17% used push button, although another 27% crossed while beacon was on.	Medium	
7B. Flashing Beacons – Automated Detection	Used at uncontrolled crosswalk to warn drivers to yield to pedestrians. Automated (infrared) detection useful because substantial share of pedestrians typically do not push button.	Video recorded 1 intersection. No pedestrian interview survey.	Substantial reduction in vehicle/pedestrian conflicts (6.1% pre vs. 2.9% post) and pedestrians trapped (4.1% to 0%), substantial increase in vehicle yielding (82% to 94%).	High (higher than push button type)	
8. Portable Changeable Message Speed Limit Sign	Used mid-block to notify drivers they are speeding, displaying speed. Trailer typically moved daily, so duration of impacts may be limited, but drivers are less likely “tune it out.”	Video recorded pedestrian/driver behavior at 4 intersections. Collected pre/post vehicle speed data. No interview survey because trailer only deployed for a day per location.	Inconclusive impacts on driver behavior at crosswalks. Should have no impacts on pedestrian behavior. Significant speed reductions (by 1- 6 MPH).	Medium capital cost, but can have major operating costs for towing, storage, setup.	More a general speed control measure than pedestrian-specific measure.
9. Median Refuge Island	Raised islands used at controlled and uncontrolled crossings to provide a safer median refuge to encourage pedestrians to stop and defer crossing until safer. Also, may slow turns.	Video recorded pedestrian/driver behavior at 2 intersections. Interviewed pedestrians at 1 intersection.	Inconclusive impacts on driver and pedestrian behavior. Only 3% of pedestrians stayed on island 8+ seconds. However, 70% felt safer and 36% recognized the improvement.	Medium	New islands were in “shadow” of existing long median islands, so impact may have been reduced.
10. Automated Video Detection of Pedestrians to Adjust Signal Timing	Used to extend crossing time when pedestrians are detected as likely to finish on the red. Extension in SF is for maximum 3 seconds and shows solid Red Hand and green ball to pedestrian.	Video recorded pedestrian/driver behavior at 1 intersection. Also collected data on extension frequency and duration. No interview survey since counter-measure is virtually invisible to pedestrians.	Reduction in pedestrians finishing crossing on solid red hand (14 to 12%). Device also successfully extended crossing time for late pedestrians.	High, both capital and labor to set up.	Vendor believes this is the only such video application in the US. Ideally, detection logic should be changed so vehicles encroaching on crosswalk don't trigger extension.

COUNTER-MEASURE	PURPOSE	DATA COLLECTION/ ANALYSIS METHODS	OBSERVATION HIGHLIGHTS	RELATIVE COST	COMMENTS
11. Fixed Changeable Message Speed Limit Sign	Used mid-block to notify drivers they are speeding and display speeds. As a permanent sign, effects at one location more likely to endure, but drivers may "tune out."	Video recorded pedestrian/driver behavior at 3 intersections. Also measured pre/post vehicle speeds, but results do not appear to be useful. Interviewed pedestrians at 1 intersection.	Inconclusive pedestrian/driver behavior impacts. No significant speed reduction on arterial streets. About 42% of pedestrians felt countermeasure made them feel safer, but none identified the change correctly initially (hardly visible from intersection).	Medium	Signs were installed on arterial streets where it may be difficult to know if sign speed applies to them or others in platoon, although in some cities they are used only on neighborhood collector streets, often near schools.
12. ADA Curb Ramps	Used for safer, easier crosswalk entry by those in wheelchairs, with strollers, etc. The SF installation separated curb ramp from gas station driveway at 1 corner to reduce potential for conflicts between gas station traffic and pedestrians, along with other curb ramp improvements.	No driver/pedestrian behavior analysis because curb ramps not expected to make observable change on measures of effectiveness. Interviewed pedestrians at 1 intersection, but results not considered reliable.	The primary safety benefit was to separate gas station traffic from pedestrians at one corner.	Medium	

1.9. SUMMARY OF RESULTS FOR NON-PEDSAFE COUNTERMEASURES

1.9.1. PEDESTRIAN SCRAMBLE (EXCLUSIVE PEDESTRIAN PHASE)

The raw number of pedestrian injury crashes before and after installation at the four existing Stockton Street scramble intersections increased (comparing equal 2.5-year periods) from 2 to 4. However, several factors suggested that this result should not imply a continuing negative impact:

- Relatively low pre-installation numbers.
- Injuries sustained by elderly only.
- Two of four collisions could not be related to the pedestrian scramble, even indirectly.

The impact of pedestrian scramble phasing on collision rates at other San Francisco intersections has been positive. Three other intersections outside of Chinatown experienced substantial reductions in pedestrian-involved collisions after the scramble phasing was introduced.

The total number of vehicle/pedestrian conflicts observed at the Stockton Street pedestrian scramble intersections decreased from 7.0% to 1.1%. However, the proportion of pedestrians running or aborting their crossing increased at each intersection, in total from 5.3% to 11.2%.

1.9.2. PEDESTRIAN COUNTDOWN SIGNALS

San Francisco has been a national leader in the use of pedestrian countdown signals, converting virtually all of the pedestrian signals citywide (over 800 intersections) to the countdown version. This was completed outside of the FHWA PedSafe project, and the results of the conversion were reported separately and in greater detail.⁵

During the 14-intersection pilot installation, there were statistically significant improvements in pedestrian behavior and attitudes. The number of pedestrians who finished crossing during the red phase decreased from 14% to 9%. The proportion of pedestrians who ran or aborted their crossing decreased from 13% to 8%. The proportion of pedestrians who reported the pedestrian signals to be “very helpful” increased from 34% to 76%.

At 579 intersections converted from conventional to countdown pedestrian signals, the number of pedestrian injury collisions decreased by 22%. During the same period, at 204 other intersections without countdown signals, the decline was only 2%. The proportion of all traffic collisions attributed to running a red light decreased from 45% to 34%. While there were numerous factors affecting the decline in the number of drivers running red lights, it is likely that the countdown devices played a major role by providing warning to drivers approaching a “stale green” (a green light about to change).

Pedestrian countdown signals have been proposed as the standard device for pedestrian signals for revisions of the *Manual on Uniform Traffic Control Devices* expected in 2009.

1.9.3. IN-PAVEMENT CROSSWALK LIGHTS

In-pavement crosswalk lights were installed at four locations in San Francisco: three by the city and county (DPT) in 2001, and the first by a private school (in Spring 2000). At the two infrared bollard locations, 91-94% of pedestrians were detected correctly, and only 2-9% of activations were false. By contrast, at one microwave pedestrian detection location, only 71-86% of pedestrians were detected correctly, and 24% of activations were false.

For the combined microwave pedestrian detection data (at the two installations), the proportion of drivers stopping for pedestrians increased from 53% before installation to 72% after

⁵ Markowitz, F., Sciortino, S, Fleck, J. and B. Yee. “Pedestrian Countdown Signals: Experience with an Extensive Pilot Installation.” *ITE Journal*, vol. 76, no. 1 (January 2006): 43-48. Fielding, S. *Pedestrian Countdown Signals: Evaluation of Citywide Installation in San Francisco*. Pro Walk Pro Bike Presentation, Madison, WI, September 5, 2006.

installation. The percentage of pedestrians running to complete or aborting crossings actually increased from 2% to 5%.

At the City Hall infrared bollard installation, the number of drivers stopping increased from 67% to 82%. The percentage of pedestrians running to complete or aborting crossings was reduced from 6% to 3%. At the same location, pedestrian intercept interviews were conducted. Of those aware of the lights, 50% believed they were “very helpful” in crossing safely. Also, 73% believed drivers were yielding more frequently.

1.9.4. ACCESSIBLE (AUDIBLE) PEDESTRIAN SIGNALS

Modern accessible pedestrian signals (APS) provide an audible and vibrotactile indication of the Walk signal to the blind and visually impaired. They also can provide audible and Braille information about the intersection name and crosswalk orientation. San Francisco has installed APS devices at 52 intersections. This installation was funded and implemented separately from the PedSafe project.

While primarily intended to serve visually impaired pedestrians, the devices also appear to benefit sighted pedestrians. The proportion of sighted pedestrians finishing on the solid Red Hand phase at five pilot intersections decreased from 27% to 17%, while the proportion starting on the Walk phase increased from 59% to 70%.

1.10. EDUCATION AND OUTREACH

The education and outreach program consisted of three tracks: (1) development/distribution of video public service announcements (PSAs) to cable and small/ethnic local TV stations, (2) presentations to schools and senior citizen facilities, and (3) distribution of retro-reflective materials at the presentations and through organizations such as the YMCA.

The video PSAs were included initially in the FHWA Pedestrian Safety Campaign Planner. SFMTA staff arranged for Spanish, Russian, Chinese/Cantonese, and Chinese/Mandarin voice-over versions.

The direct outreach program was presented at five senior centers and six public elementary and middle schools in or near study zones (see Appendix A). The presentations included general safety tips and information about the PedSafe project and other related projects. Retro-reflective items, such as armbands, were distributed at the presentations, and to other schools and senior centers in the study area.

1.11. PHASE II CONCLUSIONS

1.11.1. LESSONS LEARNED: OVERALL PROJECT SUCCESS AND COUNTERMEASURES

The project was successful in demonstrating the ability of a local government/university team to develop a data-based plan to improve pedestrian safety, focusing on higher-injury areas, and then to implement and evaluate this plan. The project catalyzed San Francisco's consideration and use of a number of innovative, generally lower-cost countermeasures. It also provided an opportunity for the San Francisco team to learn more about best practices in pedestrian safety from FHWA and other grantees. There are numerous off-the-shelf materials and references that are directly useful (much of it FHWA-produced, such as the Pedestrian Safety Campaign Planner, the *Walkable Community* brochure, and numerous research reports).

Because San Francisco had such a extensive pedestrian safety program even before PedSafe was initiated, there was limited room for the project to catalyze major citywide changes or to achieve high visibility, especially considering the project budget. The federal funding (about \$680,000 or \$120,000 per year) was extremely helpful and appreciated. However, on a per-year or per-intersection basis it was fairly limited, even compared to some other funding sources used for pedestrian and traffic safety.

The primary lessons learned from the project about the countermeasures include the following:

- A wide range of pedestrian safety countermeasures is available and can be tailored to specific location characteristics. A package of such measures can reduce vehicle/pedestrian conflicts, increase driver yielding, and make other changes in driver and pedestrian behavior that should over the long term decrease pedestrian injuries.
- It was not feasible to analyze the actual impacts of the countermeasures on pedestrian injuries due to the short time after device installation and the lag in receiving crash data. Of course, pedestrian safety is heavily affected by a wide range of factors beyond the control of a project such as PedSafe. The ability of a project with the budget the size of this PedSafe effort to have a major citywide impact is limited, although it can certainly catalyze significant changes
- Particularly cost-effective countermeasures appeared to be in-street pedestrian crossing ("Yield To Pedestrians") signs and pedestrian countdown signals. The pedestrian countdown signals, installed citywide in San Francisco, not only appear effective in aiding pedestrians in safer crossing, but also have some value in warning drivers of approach on a "stale green." The In-Street Pedestrian signs were effective and relatively inexpensive, but susceptible to damage when not installed on a raised island.
- By contrast, the "LOOK" pavement stencils appeared to have negligible value.

- Low-cost but effective measures have the advantages of quick implementation and the potential to draw support and funding for further improvements.
- Flashing beacons and in-pavement crosswalk lights both appeared effective at inducing drivers to yield to pedestrians at uncontrolled crosswalks. However, the flashing beacons at Mission & Santa Rosa are considered insufficient at this location by the Traffic Engineering Division, and will be replaced by a conventional traffic/pedestrian signal
- The Portable Changeable Message Speed Limit Sign was more effective than the fixed speed display sign at reducing driver speeds.
- Pedestrian Scramble phasing is potentially quite effective for certain situations (e.g., smaller intersections with heavy volumes of turning vehicles and pedestrians), but can be difficult to use in some situations (e.g., wide intersections with heavy through traffic volumes).
- Pedestrian Head Starts had mixed results. There were significant reductions in the number of vehicles turning in front of pedestrians at three of four intersections. However, these changes did not lead to a significant reduction in vehicle/pedestrian conflicts.
- Video detection of pedestrians to extend crossing time appeared to be a promising technology, but needs further testing and refinement.
- Infrared detection of pedestrians to trigger beacons or in-pavement lights has been more effective in San Francisco than overhead microwave detection.
- Accessible (Audible) Pedestrian Signals (APS) were helpful to sighted pedestrians as well as visually impaired pedestrians.
- Pedestrians appeared to appreciate most countermeasures, but showed minimal awareness of which devices had been installed. Among pedestrians surveyed about improving intersection safety, comments varied widely and there were essentially no common suggestions.
- It was not possible to make conclusions about how the overall effectiveness of the countermeasures varied by neighborhood or pedestrian characteristics (e.g., age group). This was primarily because the number of installations for each countermeasure was limited.

1.11.2. LESSONS LEARNED: OUTREACH

- Device-specific safety instruction was typically not necessary, as most devices were intuitive or even invisible to pedestrians.
- To reach the maximum audience, translate outreach messages into multiple languages.

1.11.3. LESSONS LEARNED: IMPLEMENTATION

- Coordinating improvements with other agencies, especially those involved in street construction, is critical.
- Developing and implementing a comprehensive pedestrian safety plan requires a time frame of several years or more.
- It is advantageous to have full-time, dedicated pedestrian safety planning and engineering staff.
- Institutional issues proved challenging, especially dealing with other departments regarding public transit and street lighting issues.

1.11.4. LESSONS LEARNED: DATA COLLECTION AND ANALYSIS

- Video data collection had the advantage of allowing repeated viewings and precise time stamping of events (such as pedestrian wait time duration). However, the labor requirements for tabulating video recorded events were several times greater than for manual data collection. In addition, the video field of vision was often restricted.
- Clear, consistent definitions of measures of effectiveness (MOEs) are helpful, but difficult to achieve. In particular, there is no universal, accepted definition of “vehicle/pedestrian conflict.”
- The earlier Version 1 of PBCAT (Pedestrian/Bicycle Collision Analysis Tool) used for Phase I analysis proved difficult to use. Statistical software and Crossroads™ software proved more flexible and helpful. Often, the actual police collision reports had to be reviewed to understand the problems specific to an intersection (such as precise vehicle movements involved prior to collisions).
- While analysis of crash patterns is quite helpful in selecting the proper treatment, several years of crash data are needed, and even then, patterns at the same intersection may vary significantly year-to-year. Site visits are therefore essential.
- Crash analysis should consider the pedestrian and/or vehicle volumes as a measure of exposure, rather than using only the absolute number of injuries or crashes.

1.11.5. COMPARISON WITH OTHER CITIES

Similar projects were carried out in the Las Vegas and Miami metropolitan areas. A preliminary final report was available for Miami, but not for Las Vegas as of publication time. The Miami findings were consistent with San Francisco’s for the In-Street Pedestrian signs and Pedestrian Head Starts (leading pedestrian interval.)

1.11.6. NEXT STEPS AND FURTHER RESEARCH

The primary opportunity for additional research would be an evaluation of actual pedestrian injury impacts of the countermeasures. This would require follow up observations 3-6 years after device installation. SFMTA participated in a proposal by the San Francisco Injury Center (affiliated with the University of California, San Francisco) to the federal Centers for Disease Control for funding to perform this analysis, but the application was turned down due to limited funding.

2. COUNTERMEASURE IMPLEMENTATION

This chapter discusses the deployment of the countermeasures. It first presents an overview of the countermeasures and the installation challenges. Also presented is a comparison of the countermeasures in terms of cost and device availability. A description of each individual countermeasure, its purpose, the setting for each San Francisco installation, device availability and approval status, cost information, and key issues are presented in Chapter 3.

2.1. OVERVIEW OF INSTALLATION CHALLENGES

Phase II involved the installation and evaluation of a broad range of pedestrian safety measures, from nearly routine signal timing changes to customized infrared and video detection equipment. However, there were several common challenges that the San Francisco team faced:

- **Selection and Confirmation of Countermeasures:** The initial process of selecting countermeasures and assigning them to specific locations was described in the *Phase I Final Report* and the *Phase II Implementation Plan and Preliminary Engineering Report*. This involved development of a comprehensive list of candidate countermeasures, which were then rated on several criteria, such as cost, presumed effectiveness, ease of implementation, and ability to attract additional funding. These were matched to particular study intersections by careful analysis of the pedestrian safety problem at each intersection and the physical characteristics of the intersection. (For example, if a high number of pedestrian injuries were attributed to vehicles failing to yield to pedestrians while turning left, the TURNING VEHICLES MUST YIELD TO PEDESTRIANS sign and median refuge islands were considered. The median refuge islands required sufficient median space, so were not useful at most locations.)

This effort had to balance the desire (for both safety and research reasons) to spread deployment to a large number of sites with the limited project budget. The initial countermeasure plan was also modified during Phase II conceptual engineering. This step included intensive research on other installations nationally and preliminary design. Local conditions could affect the feasibility of countermeasures significantly. (For example, installing video detection cameras at a location with trolley wires could be complicated by potential camera blockages.)

While SFMTA staff proposed and finally decided on the selection of countermeasures, FHWA and SAIC staff (and other stakeholders) were actively involved. The preliminary countermeasure plan was reviewed by an External Stakeholder Advisory Group, comprised primarily of the existing Pedestrian Safety Advisory Council, and by the Pedestrian Safety Interdepartmental Working Group. The plan was also approved by the San Francisco Municipal Transportation Agency Board (effectively the “transportation commission” for the City and County of San Francisco). This was followed by a two-day site visit in November 2004 with FHWA and SAIC, including extensive field work and follow-up communications.

- **Scheduling of Countermeasures:** A complex, phased installation schedule was established for each pedestrian safety measure at specific intersections. This was intended to accommodate the evaluation plan, as designed by the University of California at Berkeley Traffic Safety Center (TSC). This phased installation was implemented to facilitate data collection with limited field crew staffing over a wide geographic area of the city, and to conduct video recording for analysis of pedestrian/driver behavior. It was intended that at some locations two or more countermeasures would be installed, but at separate times to allow for separate evaluation. It was also intended that multiple baseline observations would be made to allow for statistical controls. This phased installation schedule had to be coordinated with San Francisco DPT sign, paint and signal shops, which process dozens of work order requests on a monthly basis. Typically the shops prioritize work orders, but do not schedule work tasks for specific days weeks ahead.
- **Internal and Inter-Agency Coordination:** The signal timing changes for All Red phases, increased Walk phase time, and Pedestrian Head Starts required coordination with the DPT signal shop’s high priority signal upgrade projects and other signal timing changes. Installation of fixed radar speed signs and flashing beacons required prior determination of whether electrical power was available in the field, requiring notification and permission of utility agencies. Installation of median refuge islands involved planning and design coordination with the Department of Public Works for construction of the islands. The Department of Telecommunications and Information Services installed flashing beacons, but needed to work closely with the DPT Signal Shop. The video detection installation required close coordination with Econolite (the manufacturer of the video camera and detection system), the developer of the D4 customized signal controller software, the DPT Signal Shop, and SFgo (citywide integrated traffic management system) engineers. In general, any pedestrian safety measure that touched the street pavement required checking with street repaving and construction project schedules so that installation would not be scheduled before a major repaving or construction project on the street.
- **Public Hearing Process:** Some pedestrian safety measures such as red visibility curbs, and construction of median refuge islands required a public hearing. Parking changes related to the red visibility curbs also required City and County Board of Supervisor approval.
- **Weather:** Heavy, continual rains during the winter months caused delays in installation of several of the pedestrian safety measures that involved painting of surface pavement such as red visibility curb zones, advanced limit lines, “LOOK” stencils and painted islands for installation of “Yield to Pedestrians” signs.

2.2. COMPARISON OF COUNTERMEASURES: EASE OF IMPLEMENTATION

Four countermeasures proved especially challenging to deploy:

- Portable Radar Portable Changeable Message Speed Limit Signs;
- Changeable Message Speed Limit Signs;
- Video Detection Of Pedestrians to Extend Crossing Time; and
- Flashing Beacons With Infrared Bollards.

All involved procurement or deployment of sophisticated electronic equipment that engineering staff and electricians were not highly familiar with. All required customized design layouts.

The portable radar Portable Changeable Message Speed Limit Sign required extensive staff support for several reasons. First, comprehensive testing and adjustment were necessary after delivery to ensure that the device worked properly. Second, it required a formal Memorandum of Understanding (MOU) between the SFMTA and the San Francisco Police Department (SFPD), as the latter stored, maintained, transported, and set up the device. Third, it required continuing coordination between SFMTA and the SFPD, including scheduling deployment to coincide with data collection. Finally, to avoid vandalism and to heighten the novelty impact of the device, it was moved to different sites on a daily basis, requiring extensive labor.

The primary challenge with the Changeable Message Speed Limit signs was to locate them on poles where they could both utilize existing electrical power and also be effective and visible. Additionally, the devices required extensive fine-tuning by SFMTA electricians, primarily to adjust the detection zone.

The video detection of pedestrians to extend crossing time was a completely innovative use of the technology, which Econolite believes is the only U.S. application of this type. A customized detection zone scheme and logic for adjusting the signal timing had to be developed, tested, and refined, and the Econolite Autoscope detection software needed to be coordinated with the D4 traffic signal controller software.

The flashing beacons with infrared bollards required the most substantial construction of any countermeasure, and included installation of conduit and wiring the device across a four-lane arterial street. This required investigation of possible conflicts with high-risk utilities (including contacting numerous utility providers). While individual components (the detection bollards and the beacons themselves) were commercially available, the combination was custom-designed. The detection bollards included an in-surface activation device (ISAD), which was not widely in use. The detection bollards' effectiveness was highly sensitive to their location and placement.

2.3. COMPARISON OF COUNTERMEASURES: COSTS

The overall cost of this project was slightly greater than \$1.1 million, including \$681,000 in federal funding. The federal funding averaged roughly \$120,000 per year.

The total costs of the nearly six-year-long project included the following rough estimates:

PLANNING PHASE I:	\$215,000
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San Francisco PedSafe:
Final Report and Executive Summary

IMPLEMENTATION PHASE II: \$920,000

Including:

Design of Countermeasures:	\$145,000
Installation/Deployment Labor:	\$125,000
Materials and Equipment:	\$ 95,000
Data Collection & Evaluation:	\$225,000
Other Program Management Costs (including planning and design of countermeasures not installed)	\$330,000

It should be noted that San Francisco construction and labor costs are substantially higher than the national average. On an annual basis, the project cost was actually a relatively small share of the total San Francisco public expenditures for pedestrian safety planning, design, enforcement, and outreach/education.

The federal funding was limited in comparison to the unit cost of higher-cost pedestrian safety countermeasures. This influenced the selection of countermeasures.

If this project were replicated with a focus strictly on improving pedestrian safety cost-effectively, the data collection/evaluation and other program management costs could be substantially lower than the above rough estimates. These costs were driven partly by an extensive data collection and analysis effort using extremely labor-intensive video observations and a major intercept survey of over 1,000 pedestrians. “Other Program Management Costs” include primarily SFMTA costs for such items as: preparation of major technical reports, progress reports, and contract documents; planning and design work on countermeasures that were never implemented; meetings and tele-conferences with FHWA and SAIC (including several site visits); preparation of invoices and financial reports; internal progress reporting; work planning meetings and memos; coordination with other projects and departments; and background research activities directly related to the project.

Cost estimates provided in the body of this report include: materials/equipment, installation labor, and engineering/administration labor. This includes shop and engineering/planning labor from conceptual design through fine-tuning and initial operations/maintenance. (See Table 2.3-1 for a summary of estimated capital costs. Additional detail is provided in Chapter 3, including a breakdown of estimated costs into materials, installation labor, and engineering/administrative labor. San Francisco construction costs tend to be significantly higher than national averages.)

It was not possible to track costs precisely due to the accounting system limitations. Material/equipment costs are precise figures, whereas labor costs are based on careful estimates by key project staff. Labor costs also include overhead and fringe benefits.

The Portable Changeable Message Speed Limit Sign and the outreach program carried significant operating costs for operating personnel but, once installed, other countermeasures did not require personnel for operation except for small modifications and maintenance for many of the devices. In general, the labor costs far exceeded the equipment and materials costs.

The least expensive countermeasures in total per-unit costs were the “LOOK” pavement stencils (\$300 per stencil) and the “TURNING TRAFFIC MUST YIELD TO PEDESTRIANS” signs (\$800/sign). The retroreflective materials averaged less than \$3 per item, but several thousand were distributed. The most expensive countermeasures were the video detection system to adjust signal timing (out of pocket costs of \$17,300) and the flashing beacon with automated (infrared) detection (\$62,600). Although several other countermeasures appear to be higher, the video detection costs as listed are significantly understated since the PedSafe project did not pay for the video detection camera equipment or its initial installation, and substantial technical assistance was provided free of charge by Econolite, the manufacturer of the equipment.

Table 2.3-1
Summary of Estimated Capital Costs
(including installation labor, materials/equipment, and engineering/administrative costs)

Countermeasure	Estimated Total Cost Per Unit	Unit	Operations/Maintenance Needs and Other Notes
In-Street Pedestrian Sign	\$1,800	Sign	High level of damage if not on raised island
“TURNING TRAFFIC MUST YIELD TO PEDESTRIANS” Sign	\$800	Sign	Low level of maintenance
LOOK Pavement Stencils	\$300	Stencil	Significant level of fading.
Modified Signal Timing	\$2,600	Intersection	Negligible maintenance costs (beyond fine tuning)
Pedestrian Head Start Signal Timing (“leading pedestrian interval”)	\$2,600	Intersection	Negligible maintenance costs (beyond fine tuning)
Red Curb Zone/Advance Limit Lines	\$2,000	Intersection	Average for intersections, some with and new red curb zones. Engineering/Admin. Costs increased by need for legislative approval of red curb zones
Flashing Beacons: Push Button Activated	\$21,000	Crosswalk	Moderate level of maintenance needed
Flashing Beacons: Infrared Activation	\$62,600	Crosswalk	Moderate to high level of maintenance needed
Portable Changeable Message Speed Limit Sign	\$40,200	Sign with Trailer	Includes estimated one-year of operation, as the operating costs can easily exceed equipment costs
Fixed Radar Speed Sign	\$12,000	Sign	Moderate level of maintenance needed.
Automated (Video) Detection of Pedestrians to Adjust Crossing Time	\$17,300	Intersection	Out-of-pocket costs much lower than for new installation, since project “borrowed” existing camera and vendor donated design and installation time. Moderate to high level of maintenance needed.
Median Refuge Island	\$8,600	Island	Low level of maintenance needed.
ADA Curb Ramps	\$27,000	Intersection	Low level of maintenance needed.
Retroreflective Clothing Accessories	\$2.69	Item	Cost heavily dependent on specific item.
Video PSA Production	\$1,200	Contract	Only includes contract cost for vendor to record voices and produce copies

In general, the engineering/administrative costs were quite substantial, and often exceeded the material/equipment costs and the installation labor. The engineering/administrative costs for the first-time use of a technology are often much higher than continuing costs. Therefore, the listed costs, especially for the most innovative or complicated countermeasures, would not be good predictors of future costs for new installations.

2.4. COMPARISON OF COUNTERMEASURES: AVAILABILITY AND STANDARD USE

All countermeasures were explicitly or implicitly consistent with the Federal Manual on Uniform Traffic Control Devices (MUTCD) and the California MUTCD. It was not necessary to obtain special approval to experiment with any of the countermeasures from FHWA or the California Department of Transportation. Several countermeasures considered experimental when initially proposed by the San Francisco team were added to the MUTCD in the 2003 revision. Formal local approval from the Municipal Transportation Agency Board of Directors and the County Board of Supervisors were required for visibility red curb zones.

The following countermeasures are considered approved or standard devices or treatments and are now widely used in California, although they were regarded as innovative when they were initially proposed:

- In-Street Pedestrian Signs
- “TURNING TRAFFIC MUST YIELD TO PEDESTRIANS” Signs
- Modified Signal Timing
- “Pedestrian Head Start”
- Advanced Stop Lines and Red Visibility Curb Zones
- ADA Curb Ramps
- Median Refuge Islands

The following countermeasures are in limited use as “off the shelf” products, but not considered experimental:

- “LOOK” Pavement Stencils⁶
- Flashing Beacons (Push Button-Actuated)
- Portable Changeable Message Speed Limit Signs
- Changeable Message Speed Limit Signs
- Distribution of Retro-Reflective Materials

⁶ The LOOK pavement stencils included a Chinese-English stencil that was custom designed by SFMTA staff, working with the vendor.

- Video Public Service Announcements

The following countermeasures were “custom-made” and involved innovative technologies, although they did not require approval as formal experiments:

- Automated (Video) Detection of Pedestrians to Extend Crossing Time
- Flashing Beacons (Automated Detection with Infrared Bollards)

3. DEPLOYMENT OF INDIVIDUAL COUNTERMEASURES

This chapter discusses the full deployment of countermeasures. Data collection and evaluation were conducted at selected intersections.

3.1. IN-STREET PEDESTRIAN CROSSING SIGNS

Purpose and Description:

MUTCD R1-6 In-Street Pedestrian Crossing Signs (also known as impactable “Yield To Pedestrians” (YTP) signs) are intended for use at uncontrolled (unsignalized) crosswalks to remind drivers of laws regarding pedestrians’ right-of-way. They are more noticeable than roadside signs and may also exert a minor traffic-calming effect by effectively narrowing the inside lanes slightly. Dimensions and color: 12” x 44”, fluorescent yellow green diamond sheeting with 10” x 24” white high intensity sheeting insert. Overall height is 47 inches. The signs can be installed with either a portable or fixed base.



The signs were installed at four intersections, typically with two signs per intersection. (More detailed notes on observation intersections are provided in the separate *Data Analysis Report*.)

**Table 3.1-1
In-Street Pedestrian Crossing Signs: Characteristics of Intersections**

Intersections	Street 1: No. of Lanes	Street 2: No. of Lanes	Adjacent Land Uses	Posted Speed Limit	Notes
16th & Capp	4	2	BART Station, Elementary School, Commercial and Residential	25	1 sign on marked crosswalk, 1 on unmarked crosswalk. Staggered 4-leg intersection.
Mission & France	4	2	Neighborhood Commercial	25	T intersection.
Mission & Admiral	4	2	Institutional, Residential	25	Staggered 4-leg intersection.
Mission & Santa Rosa	4	2	Neighborhood Commercial	25	T intersection. Installed prior to PedSafe and replaced. Also, installed flashing beacons here.

Federal/State Approval Status (MUTCD):

This pedestrian safety measure has federal approval status according to the Manual on Uniform Traffic Control Devices (MUTCD) Section 2B.12, In-Street Pedestrian Crossing Signs (R1-6, R16a). The legend "State Law" may be shown at the top of the sign if applicable. The legends "Stop For" or "Yield To" may be used in conjunction with the appropriate symbol. If a median island is available, the in-street pedestrian crossing sign, if used, should be placed on the island.

National Use:

In-Street Pedestrian signs have been tested and used by many cities in the U.S. including: Cedar Rapids, Salt Lake City, Madison, Las Vegas, Miami, at the Michigan State University Campus, and in states such as New Hampshire, New York, Minnesota, and the District of Columbia. The City of Madison, Wisconsin utilized these signs and found that the number of drivers yielding to pedestrians increased by 6 to 15 percent.⁷ An informal study of the signs' use by traffic planners for Michigan State University Campus indicated a substantial increase in the number of drivers who stopped at the signed crosswalks.⁸

Cost:

Item	Total Cost	Sign Cost
Materials/Supplies/Equipment	\$7,600	\$950
Installation Labor	\$2,600	\$325
Engineering/Administration	\$4,400	\$550
Total Cost	\$14,600	\$1,825

Availability:

This product can be purchased off-the-shelf.

Vendors:

Hawkins Traffic Safety Supply, Berkeley California, email: hawkins48@aol.com

Impact Recovery Systems, San Antonio, Texas (manufacturer), <http://www.impactrecovery.com/>

How/Who Installed:

The In-Street Pedestrian signs were installed on a painted median island or raised median island where feasible, by bolting them into the street surface pavement. The signs were installed by the San Francisco Municipal Transportation Agency (MTA) sign shop staff.

Utility/Environmental Issues:

Installation should be coordinated with repaving and other street project schedules.

⁷ City of Madison, "Year 2 Field Evaluation of Experimental 'In-Street' YIELD TO PEDESTRIAN Signs" (submitted to FHWA), 1999.

⁸ *In-Street Yield To Pedestrian Sign Application in Cedar Rapids, Iowa*. Iowa Department of Transportation, Final Report, 2003.

Installation Challenges:

Careful consideration of turning movements, lane width and bus routes are important in determining the location for sign installation. Installation on a raised median island is preferable to installation directly on the roadway with only a double yellow split or painted island. Signs were often knocked down and/or damaged by cars, trucks and buses hitting them. The signs must be placed carefully, taking into account car and truck turning movements and lane widths, in order to reduce damage to the signs. San Francisco experienced high damage rates to signs located near left turn paths of intersections.

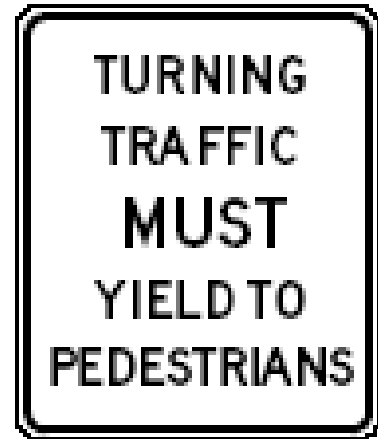
Maintenance Needs:

It is preferable to install the signs on raised medians if possible. Maintenance time and costs will increase if the installation location is susceptible to knockdowns.

3.2. “TURNING TRAFFIC MUST YIELD TO PEDESTRIANS” SIGNS

Purpose and Description:

To remind drivers who are making turns to yield to pedestrians, particularly at signalized intersections where right turn on red (RTOR) is permitted and pedestrian crosswalks are marked, a “Turning Traffic Must Yield To Pedestrians” (R10-15) sign may be used. For application of these signs San Francisco selected intersections with higher levels of conflicts between turning vehicles and pedestrians and higher pedestrian collision rates from left-turning vehicles. Dimensions and color: standard size is 30” x 36” with black legend on white retro-reflective background. Some cities, such as San Ramon (CA) and San Francisco have used their own versions of these signs in the past. San Ramon’s sign was more distinctive than the MUTCD and included red and black text. In San Francisco the MUTCD-compliant signs were installed at eight intersections.



**Table 3.2-1
“TURNING TRAFFIC MUST YIELD TO PEDESTRIANS” Signs: Characteristics Of Intersections**

Intersections	Street 1: No. of Through Lanes	Street 2: No. of Through Lanes	Primary Adjacent Land Uses	Posted Speed Limit	Notes
Mission Street & Ocean Ave.	4	4	Neighborhood Commercial	25	Angled T intersection.
Mission Street & Avalon Ave.	4	2	Neighborhood Commercial and Institutional	25	Unsignalized intersection. Others all signalized.
Mission & Persia Streets	4	2	Neighborhood Commercial	25	5-leg intersection, with 2 Persia approaches at odd angles.

San Francisco PedSafe:
Final Report and Executive Summary

Intersections	Street 1: No. of Through Lanes	Street 2: No. of Through Lanes	Primary Adjacent Land Uses	Posted Speed Limit	Notes
6th & Harrison Streets	4	5	Commercial	25 on 6th, 30 on Harrison	
10th & Harrison Streets	4	5 (typical along Harrison)	Commercial	25 on 10th, 30 on Harrison	Unusual geometry for Harrison, with eastbound approach right turn only.
6th & Mission Streets	4	4	Commercial and Residential	25	Area has high level of pedestrian violations, substance abusers, etc.
Geary Street & Van Ness Ave.	4	6	Commercial and Residential	25	Van Ness is state highway.
16th & Guerrero Streets	3	4	Commercial and Residential	25	

Federal/State Approval Status (MUTCD):

This pedestrian safety measure has federal approval status according to the Manual on Uniform Traffic Control Devices (MUTCD) Section 2B.45, Traffic Signal Signs (R10-1 through R10-21).

National Use:

Also known as “Roadside Yield to Pedestrians (YTP)” signs, these are used in many cities throughout the United States. A more common application of R10-15 signage is to remind vehicles turning right on red to yield to pedestrians crossing in the crosswalk.

Cost:

Item	Total Cost	Sign Cost
Materials/Supplies/Equipment	\$1,000	\$167
Installation Labor	\$1,100	\$183
Engineering/Administration	\$2,900	\$483
Total Cost	\$5,000	\$833

Availability:

This product is available off the shelf.

Vendors:

Multiple vendors, such as:

Safety Sign, a Division of Brimar Industries, Garfield, New Jersey, <http://www.safetysign.com/>

How/Who Installed:

The roadside YTP signs are tied onto signal or streetlight poles at a height sufficient for good visibility by turning vehicles. They should be installed at a 45-degree angle to face turning traffic throughout more of the turn. The signs were installed by the SFMTA sign shop staff.

Utility/Environmental Issues:

Field visits need to be conducted to determine whether there is room on the signal or utility pole for installation of the sign, and whether the sign can be angled 45 degrees without blocking the signal heads. Permission must be secured from the appropriate agency responsible for streetlights prior to installing signs on the streetlight poles.

Installation Challenges:

Some signs were not installed on the correct signal/streetlight poles or were not angled 45 degrees to turning traffic. Also several of the signs appeared to have been struck by turning trucks as they were loosened from their fasteners.

Maintenance Needs:

The signs must be installed securely and at the correct angle so that they will not block traffic signal heads or be knocked down by turning trucks. Maintenance time and costs will increase if the installation location is susceptible to knockdowns.

3.3. “LOOK” PAVEMENT STENCILS

Purpose and Description:

Pavement stencils are an inexpensive alternative to the electronic “animated eyes” signals countermeasure that was eliminated from the PedSafe study due to the lack of an available vendor to provide a combined animated eyes/countdown signal. The “LOOK” stencils remind pedestrians to look for cross and turning traffic before leaving the curb and entering the roadway. The stenciled images consist of opposing left- and right-pointing arrows with the word “LOOK” centered between them. These stencils are applied to the roadbed facing the sidewalk along the gutter line.



The word “LOOK,” in twelve-inch letters with left- and right-pointing arrows, is dye-cut into solid black and solid white pavement marking material. The two "O"s have small eyeballs on the inside of the letters to help advertise the intended message. The letters and arrows are interchanged with the background material to provide black-on-white and white-on-black messages, resulting in no wasted material. San Francisco also used bilingual, custom-made “LOOK” signs with both English words and Chinese characters.

These were initially installed at seven intersections. After the data collection was completed, they were added at five other intersections, by agreement with FHWA. These installations were too late for evaluation.

**Table 3.3-1
“LOOK” Pavement Stencils: Characteristics Of Intersections**

Intersections	Street 1: No. of Through Lanes	Street 2: No. of Through Lanes	Primary Adjacent Land Uses	Posted Speed Limit	Notes
4th & Harrison Streets	4	5	Commercial	25/30	Signalized. 5-leg intersection with freeway on-ramp.
17th & Mission Streets	2	4	Commercial	25	Signalized.
Broadway & Columbus Ave.	4	4	Commercial, Major Tourist Center	25	Signalized. Damaged by restaurant dumping dirty water in gutter. Chinese/English customized stencils.
6th Ave. & Geary Blvd.	2	6	Commercial	25	Signalized. Also, median islands added here.
6th & Mission Streets	4	4	Commercial, High Density Residential	25	Signalized. Initially damaged by unrelated construction.
7th & Mission Streets	4	4	Commercial, Government	25	Signalized. Initially damaged by unrelated construction.
17th/Market/Castro Streets	2	4 on Market/4 on Castro	Commercial & Muni Metro Station	25/30/25	Signalized.
16th/Market/Noe Streets	2	4 on Market/2 on Noe	Commercial	25/30/25	Signalized.
Broadway/Stockton Streets	4	2	Commercial & High Density Residential	25	Signalized. Chinese/English customized stencils.
16th & Capp Sts.	3	2	BART station, School, Commercial, High Density Residential	25	Minor street stop. Also, impactable Yield sign and flashing beacon site.
Mission St. & Ocean Ave.	4	3	Neighborhood Commercial	25	Signalized. Odd angled T intersection, immediately adjacent to another T intersection.
11th Ave. & Geary Blvd.	2	6	Neighborhood Commercial and Residential.	25	Minor street stop, planned for signal.

Federal/State Approval Status (MUTCD):

The California and Federal MUTCD address pavement markings in Section 3B.19, Pavement Word and Symbol Markings. *“Word and symbol markings on the pavement are used for the purpose of guiding, warning, or regulating traffic. Symbol messages are preferable to word messages.”* The guidelines do not specifically mention “LOOK” pavement markings, but allow for choice in the selection of messages. The “LOOK” pavement markings have been deemed to conform to MUTCD standards for word messages by the Markings Technical Committee at the Texas Transportation Institute (part of the National Committee on Uniform Traffic Control Devices).

National Use:

“LOOK” pavement stencils are used in several European countries and have been tested in the United States in Salt Lake City, Miami, and Las Vegas.

Cost:

Item	Total Cost	Unit Cost
Materials/Supplies/Equipment	\$7,400	\$110
Installation Labor	\$8,400	\$125
Engineering/Administration	\$4,400	\$65
Total Cost	\$20,200	\$300

Availability: This product is available off the shelf.

Vendors:

Flint Trading Inc., Thomasville, North Carolina, <http://www.flintrtrading.com/> (manufacturer)

Pervo Paint Company, San Diego, California, <http://www.pervo.com/>

Time Striping Inc. Van Buren, Arkansas, <http://www.timestriping.com/>

How/Who Installed:

The “LOOK” stencils are made of thermoplastic and installed by heat from a torch onto the surface of the pavement at crosswalk entryways and were installed by SFMTA paint shop staff.

Utility/Environmental Issues:

Coordination with street repaving and construction project schedules is necessary.

Installation Challenges:

The “LOOK” stencils must be applied to a clean, dry street pavement surface and care must be taken to avoid over-application of the heat torch, as this may prevent the thermoplastic from setting properly, resulting in the stenciled message appearing blurry. There was a delay in production and an increase in cost for the bilingual English/Chinese language version stencils, and due to their increased size and the unusual geometry of the intersection, the bilingual stencils were placed in crosswalk entryways in a manner where they almost overlapped.

Maintenance Needs:

At one intersection where the stencil was applied, restaurant owners dumped greasy water into a city catch basin, which flowed over the stencils causing them to become dirty and fade. According to the vendor, the stencils can be cleaned with a soapy solution if they become dirty. Street cleaning can be requested at locations where this is a common occurrence.

3.4. MODIFY SIGNAL TIMING

Purpose and Description:

San Francisco modified the signal timing at five intersections with higher rates of pedestrian collisions. The signal timing was modified to add 0.5-1 second All Red phases, or extending pedestrian crossing time. All Red phases are a useful tool for pedestrian safety at intersections with high traffic and pedestrian volumes. By adding an All Red phase, the intersection is cleared of vehicle cross traffic and pedestrian crossings before the opposing traffic is released. This measure should improve clearance but it is not 100% effective.

**Table 3.4-1
Modify Signal Timing: Characteristics Of Intersections**

Intersections	Street 1: No. of Through Lanes	Street 2: No. of Through Lanes	Primary Adjacent Land Uses	Posted Speed Limit	Notes
9th & Harrison Streets	5	4	Commercial	25/30	Added 1 sec. all-red phases. In an areawide change related to opening of a parallel freeway segment , cycle and total pedestrian crossing time were reduced.
16th & Valencia Streets	2	4	High Density Residential and Commercial	25	New timings introduced along with side street countdown signals. Added all-red phase.
Geary Street & Van Ness Ave.	4	6	Commercial and High Density Residential	25	Van Ness is a state highway. Longer cycle and longer crossing time. "Yield to Pedestrians" signs also installed.
6th & Harrison Streets	4	5	Commercial	25/30	Added pedestrian head start crossing 6th Street.
Geary Blvd. & Laguna Street	6	2	Commercial and High Density Residential	35/25	More crossing time and extended all-red phase.

Federal/State Approval Status (MUTCD):

The addition of All Red phases and extending pedestrian crossing time was implemented following approved guidelines in the Manual on Uniform Traffic Control Devices (MUTCD), Section 4D.10 Yellow Change and Red Clearance Intervals, and Section 4E.10, Pedestrian Intervals and Signal Phases, and according to the Department of Parking and Traffic's (DPT) Guidelines to Common Signal Timing Settings and Conventions, first adopted March 28, 2003 and updated January 28, 2005 by the DPT Signal Review Committee.

National Use:

Modified signal timing is used in major cities throughout the United States.

Cost:

Item	Total Cost	Cost per Intersection
Materials/Supplies/Equipment		
Installation Labor	\$5,500	\$1,400
Engineering/Administration	\$4,800	\$1,200
Total Cost	\$10,300	\$2,600

Note: Cost per intersection for signal timing changes was \$1,200 based on cost estimate from the Phase II Implementation Plan and Preliminary Engineering Report 2/28/05

Availability: Not applicable.

Vendors: Not applicable.

How/Who Installed:

The signal timing changes were developed by traffic engineers and implemented by SFMTA signal shop electricians.

Utility/Environmental Issues:

Signal modification changes should be coordinated with any signal upgrades or installation schedules.

Installation Challenges:

Signal modification must be evaluated by traffic engineers to ascertain its feasibility and to verify that the changes are compatible with the specific signal controller type in use at the location.

Maintenance Needs:

It is necessary to conduct field checks to confirm that signal timing changes have been made correctly, and to update signal timing cards based on traffic/pedestrian volume changes.

3.5. PEDESTRIAN HEAD START

Purpose and Description:

Pedestrian Head Starts were added at five locations to provide an initial four seconds of crossing time to establish pedestrians’ right-of-way before vehicles started turning. The “head start” is particularly useful at intersections with multiple turn lanes, heavy turning volumes, and longer crossing distances. While a red turn arrow would be a useful addition, this was not budgeted in San Francisco.

**Table 3.5-1
 Pedestrian Head Start: Characteristics Of Intersections**

Intersections	Street 1: No. of Through Lanes	Street 2: No. of Through Lanes	Primary Adjacent Land Uses	Posted Speed Limit	Notes
6th & Howard Streets	4	4	Commercial, Hotel	25/30	
8th & Howard Streets	4	4	Commercial and High Density Residential	25/30	
10th & Harrison Streets	4	5 (typical along Harrison)	Commercial	25 on 10th, 30 on Harrison	Unusual geometry for Harrison, with eastbound approach right turn only.
6th & Mission Streets	4	4	Commercial and Residential	25	Area has high level of pedestrian violations, substance abusers, etc.
Mission & Ocean Streets	4	3	Neighborhood Commercial	25	Signalized. Odd angled T intersection, immediately adjacent to another T intersection.

Federal/State Approval Status (MUTCD):

The addition of Pedestrian Head Start was implemented following approved guidelines in the Manual on Uniform Traffic Control Devices (MUTCD) from Section 4E.10, Pedestrian Intervals and Signal Phases, and according to the Department of Parking and Traffic’s (DPT) Guidelines to Common Signal Timing Settings and Conventions, first adopted March 28, 2003 and updated January 28, 2005 by the DPT Signal Review Committee.

National Use:

Pedestrian Head Start is used in major cities throughout the United States

Cost:

Item	Total Cost	Cost per Intersection
Materials/Supplies/Equipment	\$0	\$0
Installation Labor	\$5,400	\$1,400
Engineering/Administration	\$4,800	\$1,200
Total Cost	\$10,200	\$2,600

Note: Cost per intersection for signal timing changes engineering/administration was \$1,200 based on cost estimate from the Phase II Implementation Plan and Preliminary Engineering Report 2/28/05

Availability: Not applicable.

Vendors: Not applicable.

How/Who Installed:

Signal timing changes were evaluated by DPT traffic engineers and implemented by San Francisco DPT signal shop staff.

Utility/Environmental Issues:

Level-of-service impacts checked when potential for adverse impacts. (The City of San Francisco standard holds reduction of LOS from D to E to be a significant adverse impact.)

Installation Challenges:

Coordination with existing planned signal timing changes and signal upgrades at proposed PedSafe intersections was necessary.

Maintenance Needs:

It is necessary to conduct field checks of intersections to make sure signal timing changes have been made correctly, and to update signal timing cards.

3.6. ADVANCED STOP LINES AND RED VISIBILITY CURB ZONES

Purpose and Description:

Vehicles often encroach into crosswalks while waiting either to make a right turn on red, or for the signal to change, hindering the ability of pedestrians to have a clear path to cross the street in the crosswalk. Advanced stop lines remind drivers to stop in advance of pedestrians crossing in a crosswalk and to discourage crosswalk encroachment by drivers. Advanced stop lines can be useful at uncontrolled crosswalks to reduce “multiple threat” collisions where a following vehicle passes a first vehicle stopped for the pedestrian.

Advanced limit lines were installed at 14 intersections. They were installed 6 feet from the crosswalk at signalized intersections and 10 feet from the crosswalk on uncontrolled main (arterial) street approaches.

San Francisco PedSafe:
Final Report and Executive Summary

Large trucks and autos parked at intersection corners often block the visibility of pedestrians standing on corners waiting to cross the street. Red visibility curb zones are installed at intersection corners to improve the visibility of vehicles for crossing pedestrians, and the visibility of pedestrians for drivers. These red curb zones are usually 20 feet long but may be longer or shorter depending on an analysis of visibility at intersection corners.

Red visibility curb zones were installed at nine of the 14 intersections.

**Table 3.6-1
Advanced Stop Lines and Red Visibility Curb Zones: Characteristics of Intersections**

Intersections	Street 1: No. of Through Lanes	Street 2: No. of Through Lanes	Primary Adjacent Land Uses	Posted Speed Limit	Notes
Mission Street & Geneva Ave.	4	4	Neighborhood Commercial	25	Limit lines on all approaches.
Mission/Avalon/Teresa Streets	4	2	Institutional and Neighborhood Commercial	25	Limit lines on Mission. Red zone (20 feet) on Mission. Removed 1 parking meter.
Mission Street & France Ave.	4	2	Neighborhood Commercial	25	Limit lines on Mission. Red zone (28 feet) on Mission. Removed 1 parking meter.
Mission Street & Santa Rosa Ave.	4	2	Neighborhood Commercial	25	Limit lines on Mission approaches. Red zone (20 feet) on Mission. Removed 1 metered white zone space.
Geary Blvd. & 7th Ave.	6	2	Commercial, Medical	25	Signalized. Limit lines on Geary approaches.
Geary Blvd. & 11th Ave.	6	2	Commercial	25	Minor street stop. Limit lines on Geary approaches. 10-foot red zone on Geary. Removed yellow loading space.
Market/Castro/17th Streets	4	4/2	Commercial, Muni Metro Station	30/25/25	Signalized. Limit lines on 5 of 6 approaches.
Market/Noe/16th Streets	4	2/2	Commercial	30/25/25	Signalized. Limit lines on northbound/southbound Noe and westbound Market approaches. Red zones on 16th Street (11 and 20 feet). Removed 2 meter spaces.
4th & Harrison Streets	4	5	Commercial	25/30	Signalized. 5-leg intersection with freeway on-ramp. Limit lines on all approaches. 18-foot red zone on Harrison. Removed 1 meter space.
9th & Harrison Streets	5	4	Commercial	25/30	Signalized. Limit lines on all approaches. Added 22-foot red zone on Harrison. Also added 1 sec. all-red phases.
6th & Minna Streets	4	2	Commercial and High Density Residential	25	Minor street (alley) stop controlled. Replaced limit lines on 6th. Location with high level of pedestrian violations, substance abuse, etc.

San Francisco PedSafe:
Final Report and Executive Summary

Intersections	Street 1: No. of Through Lanes	Street 2: No. of Through Lanes	Primary Adjacent Land Uses	Posted Speed Limit	Notes
17th & Mission Streets	2	4	Commercial	25	Signalized. Limit lines on all approaches.
16th & Capp Streets	3	2	BART Station, Commercial, School	25	Minor street stop-controlled. Limit lines on 16th Street only. 20 ft. red zone on 16th. Removed 1 meter space. Also received impactable Yield sign and flashing beacons.
Columbus Ave. & Union Street	4	2	Commercial. Major tourist center.	25	Signalized. Advanced limit lines on all approaches, and added 15 ft. visibility red zone on Union Street. Removed 1 metered yellow loading zone.

Federal/State Approval Status (MUTCD):

Limit lines four feet in advance of crosswalks may be used at any location with limited crosswalk visibility, for driver compliance, or non-standard geometrics. (Caltrans Supplement to MUTCD). The use of stop lines is approved by MUTCD in Section 3B.16, Stop and Yield Lines. The MUTCD defines a stop line as a solid white pavement marking line extending across approach lanes to indicate the point at which a stop is intended or compulsory.

The use of red visibility curbs is approved by MUTCD in Section 3B.18, Parking Space Markings *“Parking space markings tend to prevent encroachment into fire hydrant zones, bus stops, loading zones, approaches to intersections, curb ramps, and clearance spaces for islands and other zones where parking is restricted.”* The MUTCD diagram shows that the distance of these no parking red visibility zones at intersection approaches are generally 20 feet long. In fact, the California MUTCD optional guidance is that all intersections, parking should be prohibited for one stall length before or after marked crosswalks, and at signalized intersections, it is preferred to prohibit parking for two stall lengths on the near side approach to the crosswalk. (The national MUTCD shows the same recommendation in a diagram, but does not include the explicit text.)

San Francisco’ draft guidelines recommend installing advanced stop lines using the following range of recommended distances: controlled intersection approaches: 4 to 6 feet; uncontrolled intersection approaches up to 35 MPH: 6 to 10 feet; uncontrolled intersection approaches over 35 MPH: 6 to 20 feet; midblock crosswalks, controlled or uncontrolled up to 35 MPH: 10 to 15 feet; and midblock crosswalk with speed limits over 35 MPH: 10 to 25 feet.

National Use: Advanced stop lines and red visibility curbs are used routinely.

Cost:

Item	Total Cost	Cost per Intersection
Materials/Supplies/Equipment	\$600	\$43
Installation Labor	\$19,500	\$1,393
Engineering/Administration	\$7,300	\$521
Total Cost	\$27,400	\$1,957

Availability:

The products for implementation of this measure are available off the shelf.

Vendors: Multiple vendors

How/Who Installed:

Advanced stop lines are installed using thermoplastic road marking material applied with heat, onto the surface of the pavement at crosswalk entryways. Red curb paint was applied at intersection corners after line of sight visibility analysis was completed. Installation was performed by San Francisco DPT paint shop staff.

Utility/Environmental Issues:

Coordinating stop line striping with street repaving and construction is necessary.

Installation Challenges:

Field visits must be conducted to determine the placement distance of the lines from the crosswalk needed to maintain line of sight visibility between vehicles and pedestrians at intersections. If an entire metered or regulated parking space had to be removed, that required legislation, which often delayed installation. A total of nine parking spaces were removed to create red visibility curb zones at the study intersections. The approval of parking space removal required review by the Interdepartmental Staff Committee on Traffic and Transportation and approval at a County Board of Supervisors Public Hearing.

The advanced limit lines can also reduce queuing distance. The striping of the advanced stop lines must be coordinated with the painting of the red curb zones.

Maintenance Needs:

As advanced stop lines and red curb zones become faded they must be repainted.

3.7. FLASHING BEACONS

Two types of flashing beacons were studied at two intersections. At 16th & Capp, the beacon was push button activated and at Mission & Santa Rosa it was activated by infrared automatic detection. Results showed a substantial increase in vehicle yielding at both intersections. The countermeasure also produced a reduction in vehicle/pedestrian conflict and a reduction in pedestrians being diverted and/or trapped.



Push Button Activated Flashing Beacon (16th and Capp)

Purpose and Description:

A solar-powered flashing beacon activated by push button was installed at 16th and Capp Streets to draw attention to the crosswalk and “Ped Xing” warning signs. This pedestrian safety measure is implemented at uncontrolled crossings, generally where there is a pedestrian attractor nearby, in this case a public school and a BART rapid transit station within a half block. No trenching or wiring was required other than wiring from the push button pole to the flashing beacon. The warning plate (R62E: “Push Button For Pedestrian Warning Lights: Cross with Caution”), including Braille text, was intended to remind pedestrians, including the visually-impaired, that the flashing beacon does not provide them the same level of protection as a standard traffic signal.



**Table 3.7-1
Push Button Activated Flashing Beacon: Characteristics of Intersection**

Intersection	Street 1: No. of Lanes	Street 2: No. of Lanes	Adjacent Land Uses	Posted Speed Limit	Notes
16th & Capp	4	2	BART Station, Elementary School, Commercial and Residential	25	1 sign on marked crosswalk, 1 on unmarked crosswalk. Staggered 4-leg intersection.

Federal/State Approval Status (MUTCD):

Push button activated flashing beacons are approved for use by the Manual on Uniform Traffic Control Devices (MUTCD) as cited in Section 4k.103, Flashing Beacons at School Crosswalks.

National Use:

Push button activated beacons have been installed by governmental agencies throughout North America, and are becoming widely adopted by state departments of transportation (DOTs), counties, and cities.

Cost:

Item	Total Cost	Unit Cost
Materials/Supplies/Equipment	\$7,500	\$7,500
Installation Labor	\$6,000	\$6,000
Engineering/Administration	\$7,300	\$7,300
Total Cost	\$20,800	\$20,800

Availability:

The products are available off the shelf.

Vendors:

Multiple vendors, including:

JSF Technologies, Saanichton, British Columbia, <http://www.solarcrosswalk.com/products.htm>

Carmanah Technologies Corp. Santa Cruz, California, <http://www.carmanah.com/>

Traffic Safety Corp., Sacramento, California, <http://www.xwalk.com/index.html>

Western Pacific Signal LLC, San Leandro, California, <http://www.wpsignal.com/>

How/Who Installed:

The flashing beacons were purchased through JSF Technologies and installed by the City's Department of Telecommunication and Information (DTIS). The project involved the installation of two 1A type poles with top-mounted flashing beacons. Because flashing beacons are solar powered no additional power supply was required. Two pedestrian push button devices were installed. The San Francisco DPT traffic signal shop conducted troubleshooting.

Utility/Environmental Issues:

It is necessary to coordinate installation of flashing beacons signal poles with street repaving and utility construction schedules. A letter was sent out to all underground utility agencies informing them of the proposed project and requesting a response if the project location conflicted with any nearby utilities. Because traffic signal equipment is pre-approved by California environmental laws (CEQA) and its federal counterpart (NEPA), no further clearance was needed.

Installation Challenges:

Field visits were needed to determine the location of existing streetlight poles, signs, parking spaces, and street furniture to facilitate installation of MUTCD-consistent "Pedestrian Crossing Ahead" signs and "Pedestrian Crossing" with arrow signs. Also, the installation of a push button pole with "Push Button For Pedestrian Warning Lights" sign was required in a location with no available existing pole. Shortly after installation this sign had to be replaced due to vandalism. Additional time may be needed for a public hearing process for notifying the public about the project.

Maintenance Needs:

Pedestrian crossing signs and push button signs may require replacement due to vandalism or cleaning due to graffiti. The solar powered flashing beacon rechargeable battery may need to be replaced every 3-5 years under normal operating conditions.

Infrared Activated Flashing Beacon (Mission and Santa Rosa)

Purpose and Description:

The Mission Street and Santa Rosa Avenue location is a T-intersection previously used to test in-pavement crosswalk lights prior to the PedSafe project. The crosswalk lights were removed due to malfunctioning caused by water collecting in the light fixtures and poor microwave detector performance. This study location was selected because of the need for a warning device to increase driver yielding to



pedestrians. Costs were reduced by installing conduit for the flashing beacon within the existing saw cut across Mission Street.

Although the detector performance and effectiveness of the countermeasure were quite positive, the Traffic Engineering Division intends to replace this installation with conventional traffic/pedestrian signal. This is considered a stronger method of pedestrian safety, as well as addressing the needs for turning vehicles to have greater protection.

Infrared detectors were used to activate a flashing beacon. For the east crosswalk approach, two above ground bollards were installed. At the west crosswalk approach, one bollard was replaced with an in-surface activation device (ISAD), due to concern that a full-height bollard would be subject to knockdown by turning vehicles.

The Light Guard Services Inc. Activation bollards, In Surface Activation Device (ISAD), controller, and flashing beacon were purchased through JAM Services and installed by the Department of Telecommunication and Information Services (DTIS). Two-inch conduits were installed across Mission Street to house necessary wires connecting the bollards, ISAD and flashing beacons to the controller. DPT's signal shop assisted DTIS to install the controller, and to activate and trouble shoot the system.

**Table 3.7-2
Infrared Activated Flashing Beacons: Characteristics Of Intersection**

Intersection	Street 1: No. of Lanes	Street 2: No. of Lanes	Adjacent Land Uses	Posted Speed Limit	Notes
Mission & Santa Rosa	4	2	Neighborhood Commercial	25	T intersection. In-pavement lights installed prior to PedSafe and replaced. Also, installed flashing beacons here.

Federal/State Approval Status (MUTCD):

The use of automated bollard/ISAD activated flashing beacons is approved by the Manual on Uniform Traffic Control Devices (MUTCD), as cited in Section 4k.01, General Design and Operation of Flashing Beacons. Typical application includes installing flashing beacons at intersections where a more visible warning is needed, as was the case at the intersection of Mission and Santa Rosa.

National Use:

The Cities of Miami and Las Vegas use flashing beacons primarily at school crossings, and the City of Orlando uses a bollard infrared pedestrian detection system between a major hotel and the Performing Arts Center and Orlando Arena. The City of San Jose recently conducted a study to compare in-pavement crosswalk lights with bollard-activated flashing beacon systems. The earlier pedestrian study of in-pavement crosswalk lights was conducted at night, while the PedSafe study of overhead flashing beacons took place during the day. The results indicated that

the in-pavement crosswalk lights were more effective in encouraging drivers to yield to pedestrians crossing in the crosswalk. However, maintenance problems were generated by both the crosswalk lights and bollard activated system including: moisture penetration of the crosswalk light housing, vandalism, and a malfunction of the bollard detection system. The crosswalk lights require more maintenance than the flashing beacons, primarily due to pavement resurfacing and replacement of crosswalk lights.⁹

Cost:

Item	Total Cost	Unit Cost
Materials/Supplies/Equipment	\$19,300	\$19,300
Installation Labor	\$14,100	\$14,100
Engineering/Administration	\$29,200	\$29,200
Total Cost	\$62,600	\$62,600

Availability:

There was no off the shelf device available. The detection bollards and ISAD were purchased from LightGuard but the DPT signal shop worked with JAM Services to install the customized wiring system from the bollards/ISAD to the controller for activation of the flashing beacons. LightGuard manufactured the bollards, ISAD and the controller.

Vendors:

Multiple vendors:

Traffic Safety Corp., Sacramento, California, <http://www.xwalk.com/index.html>

Centennial Distributors Inc., San Francisco, California, <http://www.centennialdistributors.net/>

Dialight Corp., Roxboro, North Carolina, <http://www.dialight.com/index2.html>

LightGuard, Santa Rosa, California, <http://www.lightguardsystems.com/>

JAM Services Inc., Livermore, California, <http://www.jamservicesinc.com/>

Western Pacific Signal LLC., San Leandro, California, <http://www.wpsignal.com/>

How/Who Installed:

DTIS installed the flashing beacon and controller. A sawcut across Mission Street was used to connect, via wires, the bollard and ISAD on the west side of the street to the controller on the east side of the street. The San Francisco DPT signal shop worked with JAM Services to install the customized wiring system from the bollards/ISAD to the controller for activation of the flashing beacons.

Utility/Environmental Issues:

A letter was sent out to all underground utility agencies informing them of the proposed project and requesting a response if the project location conflicted with any nearby utilities. Because traffic signal equipment is pre-approved by California environmental laws (CEQA) and its federal counterpart (NEPA), no further clearance was needed.

⁹ Crosswalk Enhancement Comparison Study, Experimental Embedded Pavement Flashing Light System vs. Standard Overhead Yellow Flashing Beacon, May 7, 2001, City of San Jose, Mansour Malek. <http://www.lightguardsystems.com/pdf/sanjosestudy.pdf> . 10/24/07.

Installation Challenges:

Because this system was a pilot project testing automated detection of pedestrians using a combination of two bollards and one bollard with ISAD, the project was custom designed and installed. Because of this, extensive time was spent with the vendors and signal shop staff troubleshooting wiring connection problems, as well as waiting for arrival of a specialized control box and LED beacon equipment. Depending on local practices, additional time may be required for a public hearing notifying the public about the project.

After installation we received reports of a malfunctioning flashing beacon. After inspection by our signal shop, it was determined that the malfunction was caused by a combination of a bad wire connection and vandalism (graffiti sprayed across the infrared detection signal). The signal shop was able to repair the wire connection and clean the infrared detection area to correct the problem.

Maintenance Needs:

Operation of flashing beacons requires monitoring to verify that they are operating correctly.

3.8. PORTABLE CHANGEABLE MESSAGE SPEED LIMIT SIGN

Purpose and Description:

Portable Changeable Message Speed Limit Signs, also known as “radar speed trailers,” are used to deter speeding. Radar speed trailer signs display the speed of oncoming traffic and flash LEDs when a vehicle exceeds the posted speed limit. A speed limit sign is included on the trailer. Above a user-selected maximum, the sign “blanks out” to avoid enticing drivers into exhibitions of speed. Speed data is recorded using a customized, portable computer located in the trailer and downloaded onto a desktop computer using SmartStat software.



The Portable Changeable Message Speed Limit Sign was deployed at approximately 50 locations spread across seven zones throughout the city of San Francisco with higher rates of pedestrian collisions. Radar Portable Changeable Message Speed Limit Signs are often deployed along major arterials, or near college and school campuses.

In addition to the MTA Portable Changeable Message Speed Limit Sign, the San Francisco Police Department maintains their own fleet of Portable Changeable Message Speed Limit Signs and



deploys them based on citizen requests. The Portable Changeable Message Speed Limit Sign was found to be more successful in reducing vehicle speeds than the fixed sign, perhaps due to the novelty of seeing the trailer in a new location, and its association with police enforcement.

**Table 3.8-1
Portable Changeable Message Speed Limit Sign: Characteristics of Intersections**

Intersections	Street 1: No. of Lanes	Street 2: No. of Lanes	Adjacent Land Uses	Posted Speed Limit	Notes
16th & Capp	4	2	BART Station, Elementary School, Commercial and Residential	25	Staggered 4-leg intersection.
Mission & France	4	2	Neighborhood Commercial	25	T intersection
Mission & Admiral	4	2	Institutional, Residential	25	Staggered 4-leg intersection
11th Ave. & Geary Blvd.	2	6	Neighborhood Commercial and Residential.	25	Minor street stop, planned for signal.

Federal/State Approval Status (MUTCD):

Changeable speed limit signs are approved in MUTCD Section 2B.13, Speed Limit Sign (R2-1): “A changeable message sign that displays to approaching drivers the speed at which they are traveling may be installed in conjunction with a Speed Limit sign.” According to MUTCD guidelines “If a changeable message sign displaying approach speeds is installed, the legend *YOUR SPEED XX km/h (MPH) or such similar legend should be shown. The color of the changeable message legend should be a yellow legend on a black background or the reverse of these colors.*”

For signs typically used on roadways with 45 MPH & greater speed limits the MUTCD specifies sign dimensions of 36 by 48 inch (18 inch high digits).

For neighborhoods and school zones, the MUTCD specifies that the absolute minimum sign size allowed is 24 x 30 inches (12" high digits), and it provides for larger dimensions in increments of six inches "where speed, volume, or other factors result in conditions where increased emphasis, improved recognition, or increased legibility would be desirable" [2003 MUTCD 2B.03].

National Use:

Portable Changeable Message Speed Limit Signs are commonly used in major cities and towns across the United States along corridors where speeding has been. They are also often used near college and school campuses.

Cost:

San Francisco PedSafe:
Final Report and Executive Summary

Item	Total Cost	Unit Cost
Materials/Supplies/Equipment	\$12,500	\$12,500
Installation Labor	\$7,300	\$7,300
Engineering/Administration	\$20,400	\$20,400
Total Cost	\$40,200	\$40,200

Availability:

Device available off the shelf.

Vendors:

Multiple vendors:

Kustom Signals Inc., Lenexa, Kansas, <http://www.kustomsignals.com/>

Traffic Display Monitoring Systems, Dallas, Texas, <http://1-radar-speed-trailer-display.com/>

Ingram Technologies, Price, Utah, <http://www.ingram-tech.com/contact.htm>

RU2 Systems Inc. Apache Jct., Arizona, <http://www.ru2systems.com/thankyou.htm>

MPH Industries Owensboro, Kentucky, http://www.mphindustries.com/products_home/

How/Who Installed:

The Portable Changeable Message Speed Limit Sign was deployed at 51 intersections, generally at the nearside corner of an intersection. The San Francisco Police Department Traffic Company was responsible for operation, maintenance, storage, and transportation of the trailer to deployment locations. MTA staff downloaded the speed data for analysis by TSC researchers.

Utility/Environmental Issues:

No significant issues.

Installation Challenges:

To implement this countermeasure an agreement was negotiated between SFPD Traffic Company and SFMTA to have the SFPD store, deploy, and maintain the Portable Changeable Message Speed Limit Sign for MTA. Extensive coordination was required to provide SFPD with the installation dates and locations and to train SFPD and MTA staff to collect the radar speed data using the specialized NEC computer and SmartStat software.

During the implementation phase the NEC computer had to be returned to the vendor, Kustom Signals, Inc., for repairs. At another stage during trailer deployment the display board was damaged due to vandalism and was again returned to the vendor for repair.

It is recommended that the Portable Changeable Message Speed Limit Sign be deployed early in the morning to ensure the availability of a corner location free of parked cars.

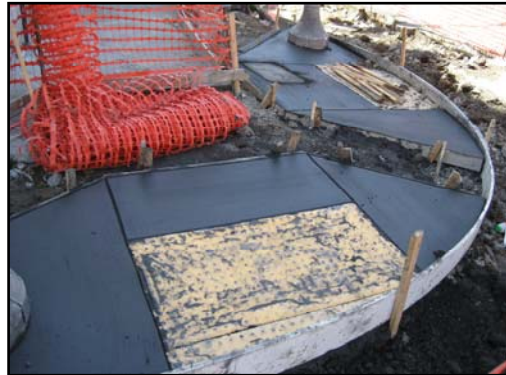
Maintenance Needs:

The Portable Changeable Message Speed Limit Sign battery requires periodic recharging by SFPD staff. The trailer must be stored nightly and is not deployed overnight to protect it from the likely threat of vandalism.

3.9. AMERICANS WITH DISABILITIES (ADA) CURB RAMPS

Purpose and Description:

ADA curb ramps are curb cut outs that facilitate easier crossing, in compliance with the Americans With Disabilities Act of 1990. Deficient curb ramps were replaced and detectable warning strips installed at one intersection for the PedSafe study. These measures included shortening a gas station driveway that intruded into a major crosswalk, replacing it with a curb ramp built to comply with new ADA standards, including the use of truncated or tactile dome mats (colored plastic mats with raised domes on their surface which serve as cues signaling the boundary between the street and sidewalk for the visually impaired). Curb ramp improvements benefit all pedestrians by making street crossing more accessible to elderly pedestrians, children, and pedestrians with strollers, not only pedestrians with physical impairments. The Pedestrian and Bicycle Information Center is a good resource for design guidelines and standards for pedestrian improvements, particularly for designing improvements in compliance with The Americans with Disabilities Act (ADA).



(<http://www.walkinginfo.org/engineering/pedestrians.cfm>)

**Table 3.9-1
ADA Curb Ramps: Characteristics Of Intersection**

Intersection	Street 1: No. of Through Lanes	Street 2: No. of Through Lanes	Primary Adjacent Land Uses	Posted Speed Limit	Notes
17th/Market/Castro Streets	2	4 on Market/ 4 on Castro	Commercial & Muni Metro Station	25/30/25	Signalized.

Federal/State Approval Status (MUTCD):

The Department of Public Works, which is responsible for installing curb ramps, follows state, Caltrans, and ADA design and construction standards when upgrading or installing new curb ramps.

National Use:

Most cities in the United States have a program to upgrade deficient curb ramps to new ADA standards, including the use of truncated or tactile dome mats, which signal the boundary between the street and sidewalk for the visually impaired.

Cost:

Item	Total Cost	Unit Cost
Materials/Supplies/Equipment	\$1,900	\$1,900
Installation Labor	\$16,600	\$16,600
Engineering/Administration	\$8,500	\$8,500
Total Cost	\$27,000	\$27,000

Availability:

San Francisco's Department of Public Works (DPW) was responsible for the design and construction of the ramps. Tactile dome mats are available off the shelf.

Vendors:

Off the shelf tactile dome mats are available from multiple vendors.

How/Who Installed:

Design and construction of curb ramps was completed by San Francisco's DPW, including the installation of tactile dome mats.

Utility/Environmental Issues:

Construction must be coordinated with city repaving and utility construction project schedules. In addition, traffic control plans are required and coordination with city bus service if temporary bus stops or shifts in bus zones are necessary. If construction will occur on a designated state highway route, state highway agencies must be contacted for permits and approvals.

Installation Challenges:

A survey of utilities and sidewalk furniture locations and proposed curb ramp upgrade corners must be conducted to determine whether utilities need to be moved or the ramp design modified.

At one corner, the improvement shortened a gas station driveway that intruded into the crosswalk, and added a to-standard curb ramp. The gas station owner argued over related changes in curb markings.

Maintenance Needs:

Tactile domes require periodic replacement and cement curbs require repair from wear and tear.

3.10. MEDIAN REFUGE ISLANDS

Purpose and Description:

Median refuge islands provide a safe retreat for pedestrians crossing wide, multilane streets with long crossing distances. The islands encourage pedestrians to wait before completing crossing, rather than rushing across traffic. The islands also act as a traffic calming device by forcing left-turning vehicles to reduce their speeds to make shorter



radius turns. Median refuge islands were installed at two signalized intersections, prioritized by curb-to-curb crossing width, multiple lanes, high pedestrian volumes, and history of pedestrian collisions caused by turning vehicles.

**Table 3.10-1
Median Refuge Islands: Characteristics off Intersections**

Intersections	Street 1: No. of Through Lanes	Street 2: No. of Through Lanes	Primary Adjacent Land Uses	Posted Speed Limit	Notes
Geary Blvd. & 6th Ave.	6	2	Commercial, Medical	25	"LOOK" pavement stencils also installed.
Geary Blvd. & Stanyan Street	6	4	Commercial, Residential	25	

Federal/State Approval Status (MUTCD):

The design and construction of median refuge islands followed local, state, and federal guidelines and standards, including recommended minimum size requirements (AASHTO guidance: 50 square feet) and the use of white reflective paint and T-markers at ends of median islands, if necessary, to reduce the likelihood and extent of collision damage to the islands.

National Use:

Median refuge islands are used in major cities nationwide.

Cost:

Item	Total Cost	Cost per island
Materials/Supplies/Equipment	\$4,600	\$1,533
Installation Labor	\$18,200	\$6,067
Engineering/Administration	\$2,900	\$967
Total Cost	\$25,700	\$8,567

Availability:Not applicable.

Vendors: Not applicable.

How/Who Installed:

The median refuge islands were designed and constructed by San Francisco DPW.

Utility/Environmental Issues:

Construction must be coordinated with city repaving and utility construction project schedules.

Installation Challenges:

The installation of median refuge islands required providing adequate lead time for interdepartmental coordination, and careful consideration of bus and truck turning movements to determine refuge island feasibility. Knowledge of vehicle turning movements is necessary in

determining whether the location is feasible, in addition to establishing the precise location and design of the island.

Maintenance Needs:

Median refuge islands located at intersections with heavy vehicle turning traffic are susceptible to curb damage caused by being hit frequently. To reduce the incidence of such damage, white reflective paint and T markers must be well maintained.

3.11. AUTOMATED VIDEO DETECTION OF PEDESTRIANS TO ADJUST SIGNAL TIMING

Purpose and Description:

Automated video detection of pedestrians was installed to provide up to 3 additional seconds of crossing time for pedestrians who were predicted not to reach the curb before traffic was released. Detection zones were grouped into south curb, center, and north curb zones. As a pedestrian crosses the street, a video camera mounted on a utility pole detects the pedestrian crossing into each zone. If a pedestrian is detected at a time and location predicting that the pedestrian will not reach the curb before the light turns red, the signal will extend the solid Red Hand (Don't Walk) and green ball up to 3 seconds. When such an extension is made, a compensating reduction in the Walk phase is made on the next cycle so that the cross street does not lose overall green light time. The video detector was installed at one crosswalk at the intersection of 9th and Howard Streets.



**Table 3.11-1
Automated Video Detection of Pedestrians to Adjust Signal Timing:
Characteristics of Intersections**

Intersections	Street 1: No. of Through Lanes	Street 2: No. of Through Lanes	Primary Adjacent Land Uses	Posted Speed Limit	Notes
9th & Howard Streets	5	4	Gas Station, Commercial	25	Intersection also is red light photo enforcement location.

Federal/State Approval Status (MUTCD):

Because the item is not an actual traffic control device, but only a detection system, it is not addressed by MUTCD.

National Use:

No other use of video detection for this application in the United States is known. The following U.S. cities have installed and are currently operating (ITS) automated detection of pedestrians at

signalized intersections: Portland, Oregon (infrared and microwave detectors), Los Angeles (microwave pedestrian detection sensors). Miami and Las Vegas are testing automated detection on an experimental basis.¹⁰ The system most similar to the San Francisco experiment is the microwave pedestrian detection system in Los Angeles, where curbside microwave detectors activate the pedestrian call while crosswalk detectors extend the clearance interval.

Cost:

Item	Total Cost	Unit Cost
Materials/Supplies/Equipment	previously purchased	
Installation Labor	\$2,700	\$2,700
Engineering/Administration	\$14,600	\$14,600
Total Cost	\$17,300	\$17,300

The out-of-pocket costs shown above were far lower than costs would have been for an entirely new system. Not only was the camera “borrowed” from a previous traffic-related installation, but Econolite provided extensive technical assistance without charge.

Availability:

Automated video detection equipment is available off the shelf. However, the technology requires extensive programming.

Vendors:

There are multiple vendors of the video equipment.

Econolite, Anaheim, California, <http://www.econolite.com/products/autoscope/default.asp>

MS SEDCO Indianapolis, Indiana, <http://www.mssedco.com/traffic.html>

Marlin Controls Inc. Danbury, Connecticut, <http://www.marlin-controls.com/detectors.html>

4th Dimension Traffic of San Francisco provided the signal controller software
<http://www.4dtraffic.com>

How/Who Installed:

An existing video detection camera at 9th and Howard Street, installed prior to the study as part of the existing SFGo Traffic Management System for traffic monitoring purposes, was used to detect pedestrians. This video camera is part of San Francisco’s SFGo system, a real-time traffic management system that includes traffic signal coordination at 100 key intersections.

Utility/Environmental Issues:

Permission from the Public Utilities Commission (PUC) prior to installation on streetlight poles is required.

¹⁰ <http://www.walkinginfo.org/pedsmart/places.htm>

Installation Challenges:

The camera required physical adjustment. Due to the fact that the study intersection was also the site of a red light camera program, issues arose such as the location of the crosswalk lines versus advanced stop bars and where in the intersection the video cameras would be. Ideally, the video detection logic should be adjusted because vehicles encroaching into the crosswalk also activated the extension of pedestrian crossing time.

Maintenance Needs:

It is necessary to monitor the video cameras to ensure that they are operating properly and are angled correctly towards the crosswalks.

3.12. CHANGEABLE MESSAGE SPEED LIMIT SIGN

Purpose and Description:

Fixed Changeable Message Speed Limit signs (also known as driver feedback signs, radar speed display signs, or variable message signs) are interactive signs, generally constructed of a series of LEDs that display vehicle speed as motorists approach. Their purpose is to make drivers aware of their current speed and to encourage those who are speeding to slow down to the legal limit. They are used as a traffic calming device in addition to or instead of physical devices such as speed humps.



Four Changeable Message Speed Limit signs were installed, two at each of two locations; west of Castro on Market Street and near the newly-relocated Bessie Carmichael School in the South of Market neighborhood. The precise installation locations were selected because they had been identified as areas where speeding was a problem, and also because the utility poles to which they were mounted offered convenient electrical service for the signs. Changeable Message Speed Limit signs display the speed of oncoming traffic and flash LEDs when a vehicle exceeds the posted speed limit. Above a certain maximum, the sign “blanks out” to avoid enticing drivers into exhibitions of speed. Speed data were downloaded using a Palm Pilot PDA with Bluetooth software. The signs were installed mid-block near the four locations shown in Table 3.12-1.



**Table 3.12-1
Changeable Message Speed Limit : Characteristics of Intersections**

Locations	Facing Traffic Direction	Street : No. of Through Lanes	Primary Adjacent Land Uses	Posted Speed Limit	Notes
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Locations	Facing Traffic Direction	Street : No. of Through Lanes	Primary Adjacent Land Uses	Posted Speed Limit	Notes
Market Street, west of Castro St.	Southeastbound (outbound)	4	Commercial and Residential	30	On grade near boundary between residential and high-density mixed uses.
Market Street, west of Castro Street, near Douglas Street	Northwestbound (inbound)	4	Residential	30	On grade near boundary between residential and high-density mixed uses.
Harrison Street, east of 7th Street	Westbound	5	Institutional, Industrial	30	On major arterial approach to Bessie Carmichael Elementary
Folsom St. W of 7th St.	Eastbound	5	Institutional, Industrial, Commercial, Residential	30	On major arterial approach to Bessie Carmichael Elementary

Federal/State Approval Status (MUTCD):

Use of fixed radar speed signs is approved by the Manual on Uniform Traffic Control Devices (MUTCD). The MUTCD Expressway specifications dictate that the digits be 18” in height, and 36” by 48” sign dimensions. The signs are typically used on roadways with 45+ MPH speed limits.

For neighborhoods and school zones, the MUTCD specifies that the absolute minimum sign dimensions allowed are 24” by 30” (with digits 12" in height), and provides for larger dimensions in increments of six inches *"where speed, volume, or other factors result in conditions where increased emphasis, improved recognition, or increased legibility would be desirable"* [2003 MUTCD 2B.03].

Many vendors offer a larger, more visible 30” x 42" display sign with digits 15” in height, which vendors claim has become the overwhelming choice for school zones, neighborhoods, and playground areas. The 30” x 42” sign is 75% larger than the MUTCD minimum. It provides improved visibility, but is not inappropriately large for this application, as may be the case with the even larger 36” x 48” sign.

All radar speed signs must be FCC approved, and must display an identification plate with the appropriate FCC information. SpeedCheck radar speed signs meet both of these requirements.¹¹

National Use:

Fixed Changeable Message Speed Limit signs are commonly used in major cities, towns, and near college campuses and schools where speeding along major corridors has been identified. San Francisco has focused their use primarily on key arterial routes and near schools.

¹¹ MUTCD speed radar sign guidelines: <http://www.informationdisplay.com/radar-speed-sign-FAQ.shtml>. 10/19/07.

Cost:

Item	Total Cost	Cost per Sign
Materials/Supplies/Equipment	\$22,900	\$5,700
Installation Labor	\$13,600	\$3,400
Engineering/Administration	\$11,700	\$2,900
Total Cost	\$48,200	\$12,000

Availability:

Changeable Message Speed Limit signs are available off the shelf from multiple vendors.

Vendors:

There are multiple vendors.

SpeedCheck Information Display Products, Indianapolis, Indiana,
<http://enforcementproducts.com/speedmonitoringtrailers.html>

Wattco, State College, Pennsylvania, <http://www.wattco.net/ats.htm>

3M, St. Paul, Minnesota,

[http://solutions.3m.com/wps/portal/3M/en_US/Traffic_Safety/TSS/Offerings/Products/
Permanent_Signing/](http://solutions.3m.com/wps/portal/3M/en_US/Traffic_Safety/TSS/Offerings/Products/Permanent_Signing/)

Fortel Traffic, Inc., Anaheim, California, <http://www.forteltraffic.com/>

Western Pacific, San Leandro, California, <http://www.wpsignal.com/gh/fsmd.htm>

How/Who Installed:

The Changeable Message Speed Limit signs were procured in a competitive bid process but were installed by City forces. The fixed radar speed signs were installed on street light poles with appropriate electrical service points by the San Francisco DPT signal shop.

Utility/Environmental Issues:

Approval is required from the Public Utilities Commission (PUC) to install fixed radar speed signs on existing streetlight poles with appropriate electrical service points.

Installation Challenges:

Street light poles needed to be surveyed to determine whether appropriate electrical wiring and service points were available for connection to the fixed radar speed signs. In addition to being located where electricity was available, the signs also needed to be placed at strategic locations (e.g., not too close to intersections or to visual distractions). Some of the selected locations did not have adequate electrical service points so alternate locations had to be found for the installations. At some of the locations, the growth of nearby trees blocked visibility of the signs, requiring tree branches to be trimmed, and at one location the radar speed sign had to be relocated to a different street light pole location not blocked by foliage.

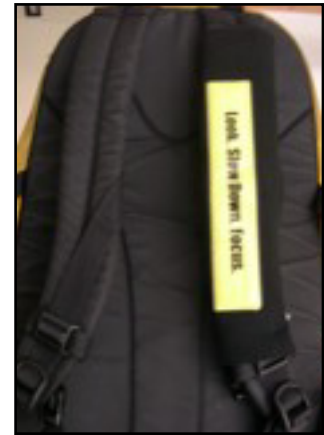
Maintenance Needs:

Radar speed signs must be monitored to verify that they are working properly. Nearby tree branches and other foliage may require regular pruning if they block the visibility of the signs by drivers.

3.13. RETRO-REFLECTIVE MATERIALS

Purpose and Description:

As part of pedestrian safety outreach, several types of retro-reflective materials were chosen for distribution to San Francisco pedestrians, particularly school children and seniors. The retro-reflective items were chosen



based on extensive discussions with educators, public health professionals, and advocates for seniors and children. Zipper pulls, clipsters, and belt wraps were identified as the most useful items for school children, while clipsters, badge clipsters, and armbands were considered most useful for seniors. The items were embellished with retro-reflective material and printed with slogans such as “Be Safe, Be Seen” or “Look, Slow Down, Focus.”

Federal/State Approval Status (MUTCD):

Because the item is not a traffic control device, it is not addressed by MUTCD.

National Use:

Retro-reflective materials are becoming more commonly used in pedestrian safety campaigns nationwide.

Cost:

Item	Total Cost	Unit Cost
Materials/Supplies/Equipment	\$7,300	\$1.39
Installation Labor	n/a	n/a
Engineering/Administration	\$7,200	\$1
Total Cost	\$14,500	\$1.39

Note: There were 5,250 units of retro-reflective materials purchased (mainly zipper pulls and clipsters, some armbands and belt wraps) totaling \$7,300.

Availability:

Information, resources, strategies and products are available off the shelf.

Vendors:

Multiple vendors supply retro-reflective materials for pedestrian safety campaigns.

How/Who Installed:

The retro-reflective materials were distributed primarily by SFMTA staff to middle/elementary schools and senior citizen centers, and then by their staffs to individual students and seniors.

Utility/Environmental Issues: Not applicable.

Installation Challenges:

It was particularly challenging to contact, organize, and publicize multiple community meetings at schools and senior citizen centers, and to recruit volunteers to help distribute the pedestrian safety retro-reflective materials.

Maintenance Needs: Not applicable.

3.14. EDUCATION

Purpose and Description:

The PedSafe outreach program is described in more detail in Chapter 5 and in Appendix A.

The outreach plan focused on delivering basic safety tips in addition to information regarding PedSafe countermeasures. The outreach was implemented in two ways. The first component involved conducting outreach with municipal agencies responsible for pedestrian safety through regular inter-agency contacts. In addition, outreach was conducted jointly with grassroots community groups and the City Pedestrian Safety Advisory Committee, integrated with other projects.

The second phase of the plan involved specific PedSafe safety measure education outreach with three components: (1) in-person education in five schools and six senior centers located within the PedSafe area zones, (2) distribution of retro-reflective materials, and (3) distribution of two video public service announcements (PSAs) to local media outlets. This public outreach was coordinated with San Francisco's Safe Schools Project, funded in part by the State of California, Office of Traffic Safety (OTS).

The video PSAs, were translated into Spanish, Russian, Chinese-Mandarin, and Chinese-Cantonese. These were distributed to cable and ethnic/small TV stations for airplay at no charge. Their messages focused on the need for drivers to yield the right-of-way to pedestrians, and for pedestrians to obey safety signals.

Federal/State Approval Status (MUTCD): Not a safety device.

National Use:

Many cities and towns in the United States have implemented pedestrian safety campaigns. The Federal Highway Administration and Walking Info.org, (the Pedestrian and Bicycle Information Center) offer information and resources for conducting pedestrian safety education campaigns.

The City of San Jose has won an award for their StreetSmarts pedestrian safety outreach program.

Cost:

Item	Total Cost	Unit Cost
Materials/Supplies/Equipment		
Installation Labor	\$1,200	for video production
Engineering/Administration Labor	\$14,600	for video distribution and direct outreach
Total Cost	\$15,800	

Availability:

There are many national and local organizations that provide information and resources about how to conduct pedestrian safety education campaigns. The video PSAs were available free of charge from the FHWA Pedestrian Safety Campaign Toolbox. (http://safety.fhwa.dot.gov/local_program/pedcampaign/index.htm).

Vendors:

Consultants are available to provide media development services.

How/Who Installed:

The pedestrian safety educational outreach efforts emphasized the specific for school children and seniors walking in their neighborhoods and provided area-specific safety suggestions. The presentations focused on providing information about how to use the pedestrian safety devices installed as part of the PedSafe program. The grassroots media campaign consisted of hiring a consultant to translate public service announcement videos into other languages to deliver a targeted message to drivers and pedestrians. The PSAs were sent to several television media outlets for airplay during available public service announcement slots. The PSAs were presented in English as well as Spanish, Russian, and Chinese to communicate with San Francisco's diverse non-English speaking communities.

Utility/Environmental Issues: Not applicable.

Installation Challenges:

Extensive time and coordination was required to organize community meetings at schools and senior center sites

Maintenance Needs: Not applicable

3.15. DEVICES NOT DEPLOYED

Several countermeasures originally proposed in the Phase I Concept Plan were not implemented. The reasons are explained as follows.

3.15.1. SMART LIGHTING AND OTHER LIGHTING IMPROVEMENTS

“Smart lighting” is a promising concept of supplemental street corner and crosswalk lighting triggered by pedestrian detection. Besides the additional illumination, the device could in theory alert drivers to the presence of the pedestrians. The Phase I Concept Plan proposed this countermeasure for several intersections that had experienced higher numbers of nighttime pedestrian injuries, based on findings regarding the general safety benefits of enhanced roadway lighting. The FHWA publication *Signalized Intersections: Informational Guide* refers to two studies indicating that additional lighting led to a 30% reduction in all collisions in one study, and a 43% reduction in fatal crashes and 17% reduction in injury crashes in a second study.¹²

More detailed research early in Phase II could not find a major U.S. city that had experimented with this technology, although it was proposed for use in Miami and Las Vegas.¹³ SFMTA management was concerned about the possible liability exposure from such a device. In addition to the potential liability exposure from the possible malfunctioning of a new device, there was also potential for drivers or pedestrians to claim that glare or distraction created by the device contributed to a crash.

Street lighting is not managed by the Department of Parking and Traffic in San Francisco, and the other two departments that operate street lights (Public Utilities Commission) and design lighting improvements (Public Works) were not interested in cooperating on street lighting improvements considering the funding available. (Although these departments were consulted during Phase I, the departments felt the overall size of the project budget available in Phase II was insufficient.)

3.15.2. UPGRADE OF IN-PAVEMENT CROSSWALK LIGHTS

In-pavement crosswalk lights have been found to be effective at reducing conflicts in San Francisco at four different locations (as described in Chapter 4, Section 4.3-3). However, there is disagreement about which type of lighting display is the most effective. For example, LightGuard products include a “Pedestrian Crossing” warning sign with LEDs and in-pavement lights which is visible from both approaches, while the Traffic Safety Corp. version uses uni-directional lights.

¹² Kittleson & Associates for FHWA, *Signalized Intersections: Informational Guide*, August 2004, Report No. FHWA-HRT-04-091.

¹³ According to FHWA website statistics, four metro areas were using “smart lighting” as of 2004: West Palm Beach, Los Angeles/Orange/Riverside Counties, Chicago, and Dallas/Fort Worth. See <http://itsdeployment2.ornl.gov/deploymentstatistics/Results.asp?ID=828&rpt=M&Year=2004>

In the Phase I Concept Plan, DPT proposed repairing and upgrading the Mission and Santa Rosa crosswalk pavement lights, a Traffic Safety Corp. device, which had been installed prior to the PedSafe project . This could have included a more visible configuration of lights. The Mission & Santa Rosa installation had proven unreliable and had been turned off indefinitely, due primarily to water collecting in the cans below the lights, despite waterproofing efforts by electricians, and due secondarily to problems with the microwave pedestrian detection units. Pressure from policy makers and the news media persuaded DPT to remove the lights and commit to replacing them with flashing beacons, rather than attempt any upgrade. Data were already collected at all four in-pavement crosswalk light locations.

3.15.3. PEDESTRIAN SCRAMBLE (EXCLUSIVE PEDESTRIAN PHASE)

San Francisco has a long history with pedestrian scramble phasing (exclusive pedestrian phases), dating back to the 1950s with several intersections in the financial district. During Phase I of the PedSafe project (but completely separate from the PedSafe project, and without any federal funding), new pedestrian scramble phases were installed at four intersections on Stockton Street. A fifth adjacent intersection was proposed for Phase II at Stockton and Sacramento Streets, and initial work started, including investigation of equipment needs and development of new signal timings.

However, implementation was deferred indefinitely due to concerns about impacts on Muni public transit schedule adherence. Extensive analysis was conducted to measure the impacts of the previous pedestrian scramble phases and to determine whether potential delays to Muni could be mitigated. This additional intersection is particularly sensitive to delays to Muni because there are three major lines on Stockton and one on Sacramento, with combined ridership (about 80,000 weekday passenger trips) exceeding many rail transit lines in the nation.

This improvement is still planned for the future after transit signal priority can be provided and other signal timing adjustments made to satisfy Muni management.

Data are presented in Chapter 4, Section 4.3-1 regarding the performance of several other pedestrian scramble intersections.

3.15.4. ANIMATED EYES SIGNALS

The animated eyes countdown signals were not installed as originally planned, because the vendor, Relume, lost interest in supporting experimentation with the device in San Francisco, apparently after assessing the market potential for the devices. City staff also expressed skepticism about the effectiveness of this concept. Some even characterized it as “cartoon-like.” Because San Francisco is committed to the countdown version of pedestrian signals, any such device would also need to include the countdown element. It is logistically difficult to ensure that all of the symbols (eyes plus hand/walking man), in addition to the countdown numbers, are visible within the standard pedestrian signal head (16” x 18”).

The “LOOK” pavement stencils are considered a “low tech” variation on this concept. However, they are less striking and much easier to “tune out” than a novel pedestrian signal.

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4. DATA ANALYSIS OF COUNTERMEASURES

4.1. DATA ANALYSIS REPORT (BY REFERENCE)

Detailed data analysis of PedSafe countermeasures is presented in the separate January 2008 *Data Analysis Report*. The report was authored primarily by the UC Berkeley Traffic Safety Center (TSC), with support and review by the SFMTA. While that report is summarized in the Executive Summary, readers interested in the safety effectiveness of the PedSafe countermeasures should refer to the full *Data Analysis Report*. This is incorporated by reference.

The *Data Analysis Report* focused primarily on the impacts of the countermeasures on pedestrian and driver behavior and pedestrian attitudes. The report did not include the following material regarding the performance of pedestrian detectors used at several PedSafe study locations.

4.2. PEDESTRIAN DETECTOR PERFORMANCE

4.2.1. PEDESTRIAN DETECTOR OVERVIEW

Automated detection of pedestrians was used in San Francisco prior to the PedSafe project to activate in-pavement crosswalk lights. Both overhead microwave detection units and infrared bollards have been used, and as described in Section 4.3-3, the infrared detection has proven more effective.

Automated detection of pedestrians was installed at two locations specifically for the PedSafe project. For the Mission and Santa Rosa location automated pedestrian detection using infrared bollards and in-pavement surface automated detection (ISAD) was tested. When adjusted correctly, the detector performance was similar to that reported for the in-pavement lights in Section 4.3-3. For the intersection of 9th and Howard Streets video detection for the purpose of increasing pedestrian crossing time was tested, using a camera initially installed at this intersection by the city's new Integrated Transportation Management System, SFgo. Since this is a new detector technology, an evaluation of its performance is included.

Howard and 9th Streets are major, five-lane arterials; Howard Street is one-way westbound and 9th Street is one-way northbound. The video detection camera focused on a single Howard Street crosswalk. Detection zones were set up similar to virtual "detector loops" in three zones. As shown in Figures 4.2-1 and 4.2-2, the detector loops appear as bars within the northeast crosswalk. When a late-crossing pedestrian is detected, the "Ped Call" indicator appears at the top of the screen (see Figure 4.2-3). Equations were developed to predict whether a pedestrian in a zone at a specific time late in the Flashing Red Hand phase would likely still be crossing when cross traffic was released. A compensating extension of up to 3 seconds was triggered, depending on how late the pedestrian appeared to be. This resulted in an extension of the green ball and solid Red Hand phase (as if the traffic green were extended at the very end of its phase, but in this case to encourage pedestrians to finish crossing quickly).

It was intended that the logic would minimize extensions due to vehicles encroaching on the crosswalk. The manufacturer, Econolite, has offered to work on this problem, but this has not yet taken place.

Figure 4.2-1
9th & Howard Intersection with Video Camera at Top of Streetlight Pole



View courtesy of Google, Inc.

Figure 4.2-2
Northeast Crosswalk with Video Detection Zones at 9th & Howard

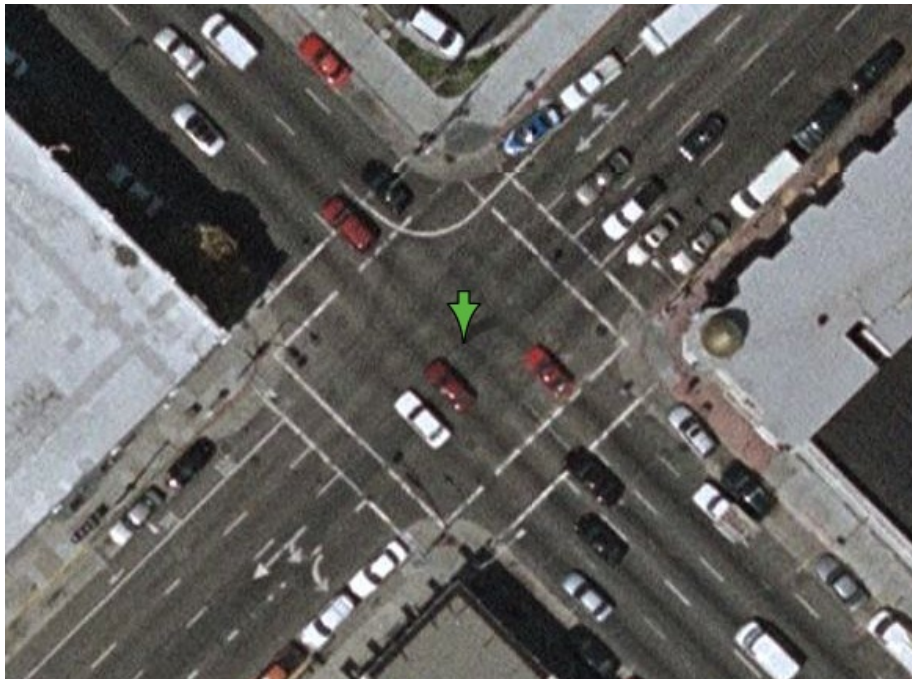
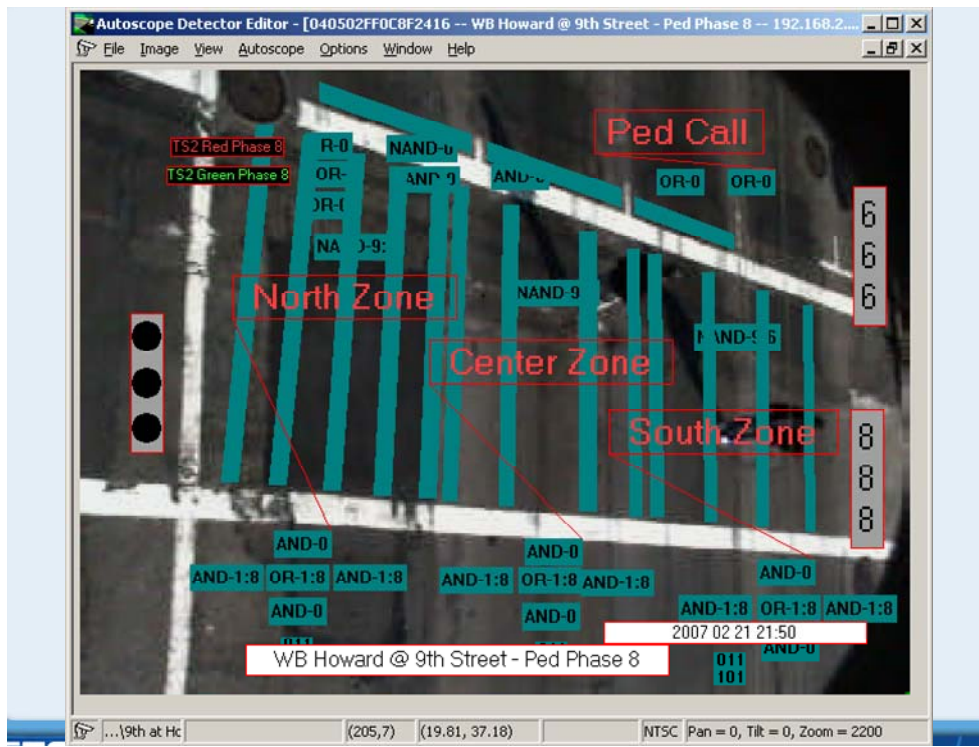


Figure 4.2-3
Econolite Autoscope Pedestrian Detection Zones and Display



4.2.2. VIDEO DETECTION: DATA COLLECTION METHODS

To assess the detector performance at 9th and Howard Streets, we focused on the following primary outcome variables: (1) the percentage of pedestrian who complete crossing during the Red Hand phase or during the red traffic signal, (2) the number of vehicle/pedestrian conflicts, (3) the percentage of missed activations, and (4) the percentage of false activations. After installation, pedestrian data and observations were manually collected at 9th and Howard Streets for a 30-minute period during the noon hour on Tuesday, March 6, 2007. We conducted before and after observations for the primary variables in addition to the following information: number of pedestrians crossing, whether there was a 3-second extension, the reason for the extension (late pedestrian, autos encroaching in crosswalk, or other reason). We also noted whether the pedestrian was running, aborted the crossing, and any vehicle/pedestrian conflicts as well as the location (lane #) of the pedestrian at the end of the Flashing Red Hand (FRH) phase.

Additionally, Econolite Autoscope Detector software is able to generate a log of the signal activations. This can be reviewed to determine how many and how long the actual extensions were.

4.2.3. VIDEO DETECTION: MANUAL DATA COLLECTION RESULTS

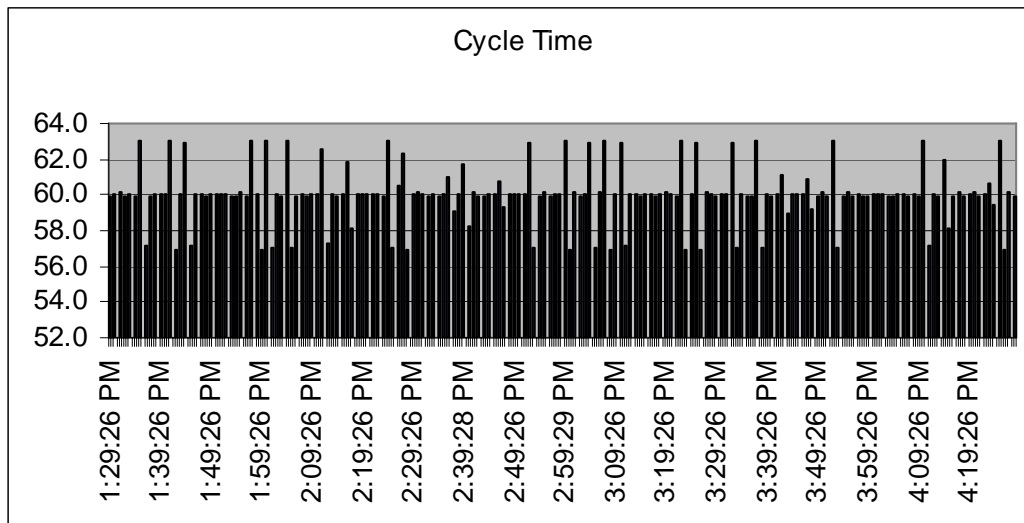
During a 30-minute manual count, the automated pedestrian detection system consistently detected late-crossing pedestrians who activated the 3-second extension. Most late-crossing pedestrians triggered the extension while in the second lane from the curb from either side of

Howard Street. A total of 70 pedestrians were counted crossing the eastside crosswalk at Howard Street. Of the total number of pedestrians crossing, 8 (11%) of the counted pedestrians activated the pedestrian crossing phase extension by crossing late. Four (6%) of those 8 pedestrians were in a group. There were 5 false extension activations due to vehicles encroaching into the crosswalk to make a right turn on a red onto 9th Street northbound from the curb lane. All of the observed late-crossing pedestrians were detected by the camera which triggered the extension. The vehicle encroachment into the crosswalk triggering the pedestrian extension did not impact the traffic flow and no vehicle/pedestrian conflicts were observed. In addition, no pedestrians were observed running or aborting their crossings.

4.2.4. VIDEO DETECTION: AUTOMATED DATA COLLECTION RESULTS

The manual results are consistent with findings by Econolite that during a typical 3-hour afternoon period, there was an extension over 1 second in length for 14% of the cycles. (See Figure 4.2-4.) The signal timing was set so that an extension was followed by a compensating reduction in the Walk phase of the next cycle to maintain the average 60-second cycle. In the figure, the bars exceeding 60 seconds indicate triggering of the timing extension, while bars shorter than 60 seconds indicate the compensating reduction in time during the following cycle. The figure suggests that the extension logic was successfully implemented.

Figure 4.2-4
Pattern of Cycle Lengths



4.3. ANALYSIS OF NON-PEDSAFE COUNTERMEASURES

The following presents analyses performed for countermeasures that were not installed with FHWA funding. These analyses were conducted outside of the PedSafe Evaluation Plan, and often used different measures of effectiveness, data collection techniques, and schedules.

4.3.1. PEDESTRIAN SCRAMBLE

As described above, the SFMTA was unable to implement a pedestrian scramble (exclusive pedestrian phase) during the PedSafe deployment phase. However, extensive data collection and analysis was conducted on four adjacent Stockton Street scramble intersections, with similar traffic and pedestrian characteristics, during the Planning Phase I, under a totally separate project. These four intersections (at Pacific Avenue, Jackson, Washington, and Clay Streets) have somewhat higher pedestrian volumes and slightly lower cross street traffic volumes than the intersection at Sacramento Street. It was also possible to do pedestrian collision analysis for these four intersections and several others.

Pedestrian Scramble Collision Impacts

The raw number of pedestrian injury crashes before and after installation at the four existing Stockton Street study intersections increased (comparing equal 2.5-year periods) from 2 to 4. (See Figure 4.3-1.) However, there were factors suggesting that this result should not imply that the pedestrian scramble phasing itself was causing more pedestrian injuries. First, the pre-installation crash level was relatively low compared to the high pedestrian volumes, suggesting that an increase could represent regression to the mean. Second, two of four post-installation crashes could not be related to signal phasing (in one case the pedestrian scramble was not operating and in the other case, the pedestrian was hit by a vehicle backing up). Also, all of the post-installation injuries were suffered by elderly pedestrians, possibly related to their relative difficulty in adapting to such a change.

The collision impacts of pedestrian scramble phasing at other intersections have been positive. Three other intersections outside of Chinatown experienced substantial reductions in pedestrian-involved collisions after the scramble phasing was introduced. The per-year pedestrian crash averages are as follows:

- Stockton & O'Farrell: 1.0 crashes pre-installation versus 0.3 crashes post-installation
- 4th & Howard: 1.4 crashes pre-installation versus 0.2 crashes post-installation
- 4th & Folsom: 0.4 crashes pre-installation versus 0.2 crashes post-installation

The differences are substantial enough that it is not necessary to compare to control intersections or annual trends.

While there are a number of other pedestrian scramble intersections in San Francisco (particularly on Montgomery Street), these were introduced such a long time ago, that there are no pre-installation crash tabulations available.

The national research has been summarized as follows:

“Using exclusive pedestrian intervals that stop traffic in all directions has been shown to reduce pedestrian crashes by 50 percent in some locations (i.e., downtown locations with heavy pedestrian volumes and low vehicle speeds and volumes).”¹⁴

Figure 4.3-1.

Impact of Pedestrian Scrambles on Pedestrian Safety and Convenience

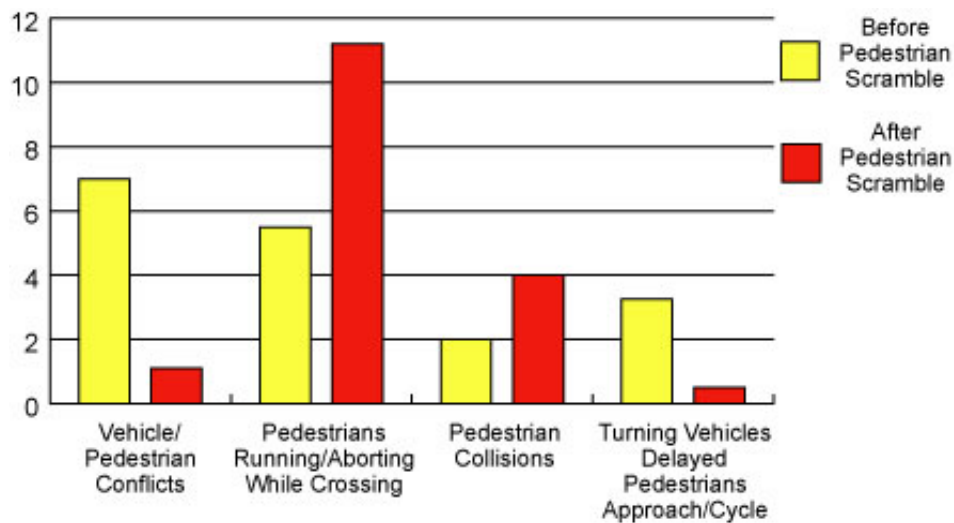
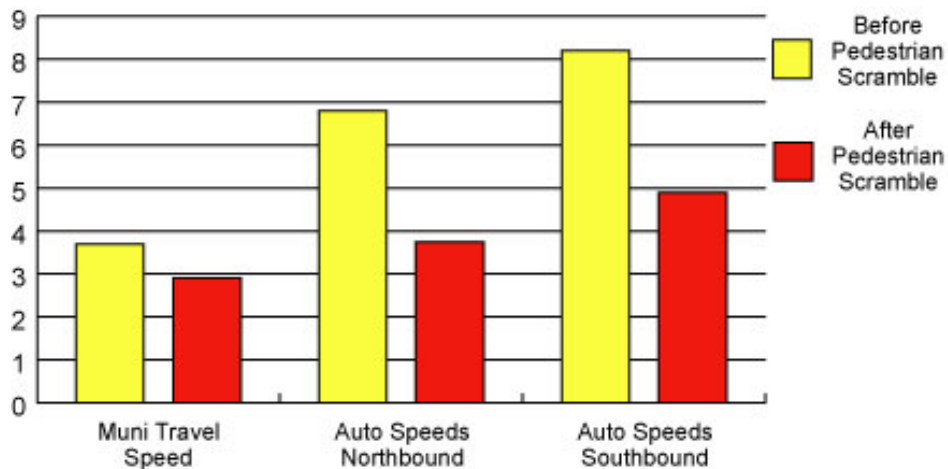


Figure 4.3-1
Impact of Pedestrian Scrambles on
Through Vehicle Speeds on Stockton Street

¹⁴Zegeer, C.V. and C. Seiderman. “Designing for Pedestrians.” In *2001 Compendium of Technical Papers*, ITE, 71st Annual Meeting, Chicago, IL Washington, DC: ITE, 2001. Zegeer, C.V. et al. *Pedestrian Signalization Alternatives*. Report No. FHWA/RD-83/102, Federal Highway Administration, Washington, DC, 1983.



Pedestrian Scramble Impacts on Pedestrian/Driver Behavior

The total number of vehicle/pedestrian conflicts observed at Stockton Street pedestrian scramble intersections decreased from 7.0% to 1.1%. However, the proportion of pedestrians running or aborting their crossing increased at each intersection, in total from 5.3% to 11.2%. One possible reason is that late in the exclusive pedestrian phase, with no conflicting auto movements and the countdown showing few seconds remaining, many pedestrians are emboldened to cross even though they must run to finish crossing before traffic is released.

Pedestrian Scramble and Pedestrian Attitudes

A post-installation pedestrian intercept survey was conducted by UC Berkeley Traffic Safety Center (TSC) researchers on Stockton Street. Among over 150 respondents, 69.5% said they felt safer with the pedestrian scramble phase in use. A strong majority favored the phasing change, with 72% saying they liked it “very much.”

Pedestrian Scramble and Muni Transit Operating Speeds

The northbound impact found by TSC researchers was a reduction in Muni operating speed, including dwell time, from 3.55 MPH to 2.94 MPH (a 21% impact). (See Figure 4.3-2.) The actual impact on running time in the five blocks between Broadway and Sacramento was an average of 55 additional seconds.

There was a high level of variability in Muni travel times, with a standard deviation of 69 seconds and an average 5:51 travel time (coefficient of variation, or standard deviation as a proportion of the mean, was 0.20) for southbound PM peak between Broadway and Sacramento and 41 seconds standard deviation for northbound PM peak.

Mean boarding times on Stockton during the PM peak ranged between 38 and 51 seconds at each stop location (this included only time that the bus was actually stopped, not acceleration/deceleration delay). The standard deviation was 13 to 16 seconds for four of the five stops, but 24 seconds for the Jackson/Washington northbound stop.

Total Muni signal delay averaged 88.6 seconds southbound and 85.7 seconds northbound per bus. This compares to the worst-case scenario of waiting through every red phase of about 220 seconds (which is the sum of the red phases at each intersection).

Pedestrian Scramble and Auto Operating Speeds

Auto speeds for through vehicles on Stockton Street decreased significantly after the installation of the pedestrian scramble, from 6.8 MPH to 3.8 MPH (44%) northbound and from 8.2 to 4.9 MPH (40%) southbound. These estimates were determined by floating car speed runs.

Auto speeds on the side streets were found to improve with the pedestrian scramble. This could be because prior to the installation, heavy vehicle turns from the side streets (often effectively with one lane approaches) were delayed by pedestrians crossing Stockton Street, delaying all vehicles on the approach.

As expected, the pedestrian scramble brought a major reduction in vehicle delays caused by conflicts between turning vehicles and pedestrians. The number of turning vehicles delayed by pedestrians decreased by an unweighted average of 79% at the four intersections (up to 88%). The actual vehicle-seconds of delay caused by pedestrians decreased substantially to nearly zero.

Computerized traffic modeling using the Synchro™ software package was conducted to analyze the effects of signal timing on vehicle progression. The results indicated that offsets were not well timed for a steady 25 MPH progression. However, field observations suggest that it is quite difficult to model or optimize traffic flows during peak activity periods because there is so much friction from double parkers, parking maneuvers, bus maneuvers, and jaywalkers (plus a very distracting visual environment). Speeds are extremely variable.

4.3.2. PEDESTRIAN COUNTDOWN SIGNALS

San Francisco has been a national leader in the use of pedestrian countdown signals, converting virtually all of the pedestrian signals citywide (over 800 intersections) to the countdown version. This was completed outside of the FHWA PedSafe project, and the results of the conversion were reported separately and in greater detail¹⁵. Pedestrian countdown signals have been proposed as the standard form of the device for revisions to the *Manual on Uniform Traffic Control Devices* expected in 2009.

Pedestrian Countdown Signal Pilot Project: Pedestrian Injury Decline

During the 14-intersection pilot project, pedestrian injuries decreased by about half at intersections equipped with countdown signals. However, this decline was not statistically greater than the decline at control intersections not receiving countdown signals. This likely reflects some regression to the mean.

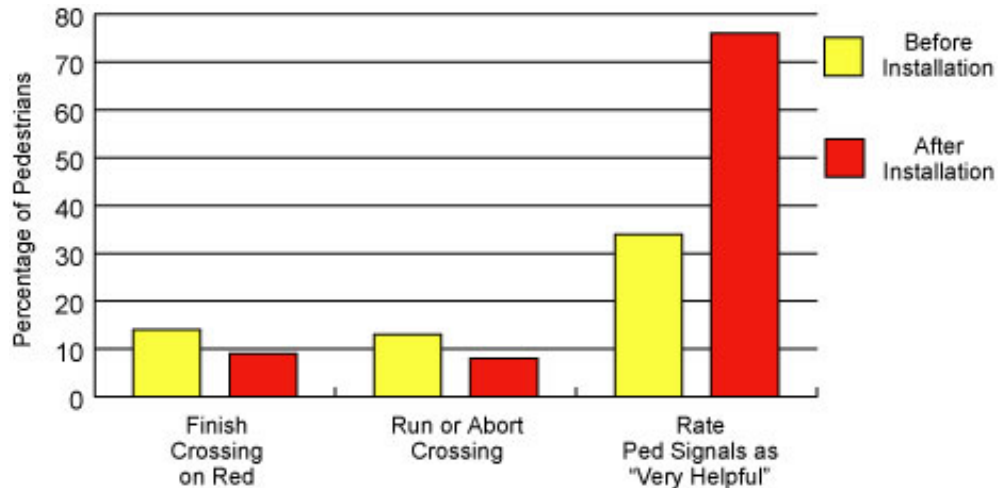
¹⁵ Markowitz, F., Sciortino, S., Fleck, J. and B. Yee. "Pedestrian Countdown Signals: Experience with an Extensive Pilot Installation." *ITE Journal*, vol. 76, no. 1 (January 2006): 43-48. Fielding, S. *Pedestrian Countdown Signals: Evaluation of Citywide Installation in San Francisco*. Pro Walk Pro Bike Presentation, Madison, WI, September 5, 2006.

In general, when countdown signals were installed, both during the pilot installation phase, and during the later citywide installation, signal timing was also changed. Previously, the San Francisco practice was to carry the flashing Red Hand (flashing Don't Walk) pedestrian phase through the yellow traffic indication phase. The solid Red Hand (solid Don't Walk) started concurrently with the start of the red traffic indication. With the countdown signal installation, this changed so that the solid Red Hand began at the beginning of the yellow phase, more consistent with the signal practice of other cities in Northern California.

Pedestrian Countdown Signal Impacts On Pedestrian Behavior and Attitudes

Pedestrian countdown signals were responsible for statistically significant improvements in pedestrian behavior and attitudes. Pedestrians finishing crossing in the red phase decreased from 14% to 9%. The proportion of pedestrians running or aborting their crossing decreased from 13% to 8%. The proportion of pedestrians finding the pedestrian signals "very helpful" increased from 34% to 76%. (See Figure 4.3-3.)

Figure 4.3-2
Pedestrian Countdown Signals Pilot Project: Impacts on Behavior and Attitudes



Pedestrian Countdown Signal: Citywide Conversion Collision Impacts

At 579 intersections converted from conventional to countdown pedestrian signals, the number of pedestrian injury collisions decreased by 22%. During the same period, at 204 other signalized intersections without countdown signals, the decline was only 2%. The proportion of all traffic collisions attributed to red light running decreased from 45% to 34%. While there were numerous factors affecting the decline in the number of drivers running red lights, it is likely that the countdown devices played a major role by providing warning to drivers approaching a green light about to change.

4.3.3. IN-PAVEMENT CROSSWALK LIGHTS

In-pavement crosswalk lights were installed at four locations in San Francisco: three by the city and county (DPT) in 2001 and the first by a private school (in Spring 2000). Three of these locations were mid-block (two connecting school facilities on either side of local streets with minimal non-student use, the other connecting City Hall with a civic plaza across a four-lane collector street with much heavier and more diverse pedestrian volume). The fourth was at an uncontrolled crosswalk at a T-intersection on a four-lane arterial in a neighborhood commercial district and this installation was later replaced by flashing beacons.

Two locations used the LightGuard™ technology with:

- Bi-Directional Lights
- “Ped X-ing” Warning Sign With LED Lights
- Infrared Bollards to Detect Pedestrians Entering the Crosswalk

Two other locations used Traffic Safety Corporation technology, featuring:

- Uni-Directional Lights
- No LED Warning Sign
- Overhead Microwave Detection of Pedestrians Entering the Crosswalk

At the three mid-block locations, prior to and after the installations, crossing guards were deployed. This should be taken into account in comparing the San Francisco locations to other cities. (The City Hall crosswalk is staffed by a police officer throughout most of the day. The Page Street location is staffed by a school crossing guard at peak crossing periods. The Francisco Street crosswalk is supervised by teachers when large groups of students cross.)

In-Pavement Crosswalk Lights: Collision Impacts

There were no clear impacts of the in-pavement lights on reported pedestrian collisions. At the City Hall location, on Polk Street mid-block between Grove and McAllister Streets (a LightGuard site), there were no pedestrian injuries reported five years before or five years after installation. At the other LightGuard site (Page Street, mid-block between Ashbury and Masonic Streets), there was one reported pedestrian injury in each of the five years before and after installation.

At the Francisco Street location, there were no pedestrian injury collisions prior to installation versus two injury collisions after the installation. However, one of the post-installation collisions was not preventable by the device, as it involved a vehicle backing up.

At the Mission & Santa Rosa intersection, pedestrian injury collisions increased from two to five after installation. However, the in-pavement lights were either malfunctioning or removed during much of the five-year post-installation period, so no conclusions could be drawn.

In-Pavement Crosswalk Lights: Detector Performance

At the two infrared bollard locations, 91-94% of pedestrians were detected correctly, and only 2-9% of activations were false. By contrast, at one microwave pedestrian detection location, only 71-86% of pedestrians were detected correctly, and 24% of activations were false.

In-Pavement Crosswalk Lights: Driver/Pedestrian Behavior

For the combined microwave pedestrian detection data (at the two installations), the number of drivers stopping for pedestrians increased from 53% before installation to 72% after installation. The percentage of pedestrians running to complete or aborting their crossing actually increased from 2% to 5%.

At the City Hall infrared bollard installation, the proportion of drivers stopping for pedestrians, increased from 67% to 82%. The percentage of pedestrians running to complete or aborting their crossing was reduced from 6% to 3%.

In-Pavement Crosswalk Lights: Pedestrian Attitudes

At the same location, pedestrian intercept interviews were conducted. Of those aware of the lights, 50% deemed them to be “very helpful” in helping them to cross safely. Also, 73% believed drivers were yielding more frequently.

4.3.4. ACCESSIBLE (AUDIBLE) PEDESTRIAN SIGNALS

Modern accessible pedestrian signals (APS) provide an audible and vibrotactile indication of the Walk signal to the blind and visually impaired. They also can provide audible and Braille information about the intersection name and crosswalk orientation. San Francisco has installed APS devices at 52 intersections.

While intended primarily to serve visually impaired pedestrians, the devices also appear to benefit sighted pedestrians. Observations were conducted at five pilot intersections recently equipped with APS, mostly in the Civic Center area. The proportion of sighted pedestrians finishing on the solid Red Hand decreased from 27% to 17%, while the proportion starting on the Walk phase increased from 59% to 70%.¹⁶

¹⁶ The sample sizes (N) were 296 pre-installation and 418 post-installation.

5. OUTREACH AND EDUCATION

In San Francisco, multiple city agencies and non-profit groups conduct education and outreach about traffic and pedestrian safety topics frequently. Among these efforts are the following:

- The Public Health Department has held traffic calming/pedestrian safety media campaigns annually for several years. Typically, a different theme is chosen for each year, for example, focusing on fines one year, and the benefits of courteous driving and walking the next year.
- The Public Health Department holds an annual pedestrian safety summit for neighborhood organizations and citywide advocacy groups, providing a forum for sharing ideas regarding outreach efforts.
- Advocacy groups such as Walk San Francisco and Senior Action Network hold media and public events, including demonstrations and meetings, to call attention to the need for improving safety.
- The regional office of the California State Auto Association has focused on traffic and pedestrian safety over the last several years. For example, they funded the pilot countdown signal effort and distributed a flyer explaining how the devices work.
- The Police Department Traffic Company participates in many of the above efforts.

The education and outreach program developed specifically for PedSafe consisted of three tracks: (1) development/distribution of video public service announcements (PSAs) to cable and small/ethnic local TV stations, (2) presentations to schools and senior citizen facilities, and (3) distribution of retro-reflective materials at the presentations and independently. Details of the pedestrian outreach and education effort specifically for PedSafe are provided in Appendix A.

The video PSAs were initially included in the FHWA Pedestrian Safety Campaign Planner. One of these very short (20 second) PSAs was targeted toward drivers, and the other had messages for both pedestrians and drivers. SFMTA staff arranged for Spanish, Russian, Chinese/Cantonese, and Chinese/Mandarin voice-over versions. These were distributed to local TV and cable stations, with the assistance of a media expert: Dave Winters of DW Multimedia of Emeryville, California.

The City government cable station claimed that it aired the PSAs 858 times, fairly evenly split among the different languages. The major regional cable operator indicated that their policy limits them to airing only PSAs sent from the corporate office and that they had therefore ignored our submittal. Four other local TV stations (including Spanish and Chinese language stations) declined to reply.¹⁷

¹⁷ The city government station is SFGTV (Channels 26 and 28). The other stations included Royal Channel (KMTP 32), Univision (Channel 14 and 66), KTSF (Channel 26), and KNTC Azteca (Channel 42). The cable operator was Comcast, the largest regional service.

San Francisco PedSafe:
Final Report and Executive Summary

The direct outreach program was presented at five senior centers and six public elementary and middle schools in or near study zones. The presentations included general safety tips and information about the PedSafe project and other topics related to pedestrian safety. Retro-reflective items, such as armbands, were distributed at the presentations.

The retro-reflective accessories were also provided to schools and senior centers that could not accommodate a presentation. The purchase included: 3,000 zipper pulls, 1,250 clipsters/badge holders, 750 armbands, and 250 belt wraps. The accessories were emblazoned safety slogans.

It was not possible to evaluate the effectiveness of the outreach efforts. However, UC Berkeley Traffic Safety Center observers were posted at Spring Valley Elementary School, located in San Francisco's affluent Russian Hill neighborhood, one month after retro-reflective materials (armbands and bag/belt wraps) were distributed at a school assembly. No use was noted between 7:30 and 8:00 AM during the third week of February 2006, as the students arrived at the school. Sunrise was about 6:45 AM, so there was marginal need for the children to be wearing the materials. However, that observation and anecdotal evidence suggest that use of the materials was limited.

6. PHASE II CONCLUSIONS

6.1. LESSONS LEARNED

6.1.1. LESSONS LEARNED: OVERALL PROJECT SUCCESS AND COUNTERMEASURES

The project was successful in demonstrating the ability of a local government/university team to develop a data-based plan to improve pedestrian safety, focusing on higher-injury areas, and then to implement and evaluate this plan. The project catalyzed San Francisco's consideration and use of a number of innovative, generally lower-cost countermeasures. It also provided an opportunity for the San Francisco team to learn more about best practices in pedestrian safety from FHWA and other grantees. There are numerous off-the-shelf materials and references that are directly useful (much of it FHWA-produced such as the Pedestrian Safety Campaign Planner, the *Walkable Community* brochure, and numerous research reports). The lessons from this project will prove very useful in numerous future projects, such as the San Francisco Better Streets Plan.

Because San Francisco had such a extensive pedestrian safety program even before PedSafe was initiated, there was limited room for the project to catalyze major citywide changes or to achieve high visibility, especially considering the project budget. For example, even before PedSafe, San Francisco assessed pedestrian injury "hot spots" and trends. Several San Francisco agencies devoted significant staff to pedestrian safety planning, engineering, education, and enforcement. Inter-agency and public advisory committees were formed outside of the project.

The federal funding (about \$680,000 or \$120,000 per year) was extremely helpful and appreciated. However, on a per-year or per-intersection basis it was fairly limited, even compared to some other funding sources used for pedestrian and traffic safety. San Francisco has a sales tax dedicated to transportation uses that alone provides roughly \$840,000 annually for "pedestrian circulation and safety." The separate "traffic calming" allocation from this sales tax is around \$2 million annually. Typical State of California grants for design and construction of pedestrian improvements (e.g., for improvements within four blocks of a specific elementary school or rail transit station) often range from \$300,000 to \$800,000, with minimal requirements for data collection and evaluation.

The primary lessons learned from the project about countermeasures include the following:

- There is a wide range of pedestrian safety countermeasures available that can be tailored to specific location characteristics. A package of such measures can reduce vehicle/pedestrian conflicts, increase driver yielding, and bring about other changes in driver and pedestrian behavior that should, over the long term, decrease the number of pedestrian injuries. However, due to the project scheduling, it was not possible to directly observe the impacts on pedestrian-involved crashes, which would require several years of post-installation data to have meaningful results.

- Of course, pedestrian safety is heavily affected by a wide range of factors beyond the control of a project such as PedSafe. (These include such factors as: driver licensing and other traffic law changes; Police enforcement activities; employment and other economic activity fluctuations; vehicle safety improvements (e.g., braking abilities), and other safety efforts (such as red light photo-enforcement programs). The ability of a project with the budget the size of this PedSafe effort to have a major citywide impact is limited, although it can certainly catalyze significant changes.
- Particularly cost-effective countermeasures appear to be the in-pavement “Yield To Pedestrians” (YTP) signs and pedestrian countdown signals. (The pedestrian countdown signals, installed citywide in San Francisco, not only appear effective in aiding pedestrians in safer crossing, but also have some value in warning drivers of approach as the green light is about to change.) The In-Street Pedestrian signs were effective and relatively inexpensive, but susceptible to damage when not installed on raised islands.
- By contrast, the “LOOK” pavement stencils seemed to have negligible value.
- Low-cost but effective measures have the advantages of quick implementation and the potential to draw support and funding for further improvements.
- Flashing beacons and in-pavement crosswalk lights both appeared effective at inducing drivers to yield to pedestrians at uncontrolled crosswalks. (The Mission & Santa Rosa flashing beacons are being replaced by a conventional traffic/pedestrian signal as a potentially stronger degree of protection for pedestrians and especially for turning vehicles.)
- The Portable Changeable Message Speed Limit Sign was more effective than the fixed speed display sign at reducing driver speeds. This may be due to drivers “tuning out” the fixed sign weeks or months after it is installed, in addition to the subliminal association of the trailer with police enforcement.
- Pedestrian Scramble phasing is potentially quite effective for certain situations (e.g., smaller intersections with heavy volumes of turning vehicles and pedestrians), but can be difficult to use in some situations (e.g., wide intersections with heavy through traffic volumes, including transit service).
- Pedestrian Head Starts had mixed results. There were substantial reductions in the number of vehicles turning in front of pedestrians at three of four intersections. However, these changes did not lead to a significant reduction in vehicle/pedestrian conflicts.
- Video detection of pedestrians to extend crossing time appeared to be a promising technology, but needs further testing and refinement.
- Infrared detection of pedestrians to trigger beacons or in-pavement lighting has been more effective in San Francisco than overhead microwave detection.

- Accessible (Audible) Pedestrian Signals (APS) were helpful to both sighted pedestrians as well as visually impaired pedestrians.
- Pedestrians appeared to appreciate most countermeasures, but showed minimal awareness of which devices were installed. There were essentially no common suggestions by pedestrians surveyed for improving intersection safety; suggestions varied widely.
- It was not possible to make conclusions about how the overall effectiveness of the countermeasures varied by neighborhood or pedestrian characteristics (e.g., age group). This was primarily because the number of installations for each countermeasure was limited. However, it is likely that such factors were important. For example, the low level of use of the push button to actuate the flashing beacons at 16th & Capp may have been partly due to the generally younger age profile of pedestrians, the relatively narrow crossing, and the extremely lively (distracting) street activity in this area. (However, this finding was also generally consistent with national research.)

6.1.2. LESSONS LEARNED: OUTREACH

- Device-specific safety instruction was typically not necessary, as most devices were intuitive or even invisible to pedestrians.
- To reach the maximum audience, translate outreach messages into multiple languages.

6.1.3. LESSONS LEARNED: IMPLEMENTATION

- Coordinating improvements with other agencies, especially those involved in street construction, is crucial. (In San Francisco, street reconstruction “erased” previous pedestrian safety measures, such as advanced limit lines and ladder style crosswalks.)
- Developing and implementing a comprehensive pedestrian safety plan requires a long time frame. The San Francisco project took nearly six years, including almost two years for planning, two years for design/procurement/approvals, and two years for implementation and evaluation. However, this time frame was partly the result of an extensive and extremely labor-intensive data collection and analysis effort. (In San Francisco, it generally takes 2-3 years to install pedestrian signals at a typical location, from funding commitment through design and construction, usually as part of a large signal contract.)
- It is advantageous to have full-time dedicated pedestrian safety planning and engineering staff. San Francisco MTA Pedestrian Program staff now includes three budgeted full-time positions, two of which are filled by engineers and the third by a planner.
- Institutional issues proved challenging. For example, a proposed pedestrian scramble installation needed to be deferred due to concern about potential impacts on public transit schedules. Street lighting improvements also required the active participation of a non-transportation department.

6.1.4. LESSONS LEARNED: DATA COLLECTION AND ANALYSIS

- Video data collection had the advantage of allowing repeated viewings and precise time stamping of events (such as pedestrian wait time duration). However, the labor requirements for tabulating video recorded events were several times greater than for manual data collection. The field of vision was also often more restricted than optimal, possibly obscuring important vehicle actions. The amount of information provided by video footage (particularly after conversion into a format that is compatible with the playback software) is far less than a live observer could collect, making it more difficult, for example, to determine whether there was a vehicle/pedestrian conflict.

Video data collection also required close communication between the Police, SFMTA, and the data collection organization. Device installation and video observation dates needed to be closely coordinated, in part, because the video van required a particular parking space and a special permit to ensure the availability of the space. In one case, the radar Portable Changeable Message Speed Limit Sign was towed away early in the data collection period by the Police Department.

While, in theory, video footage could be analyzed for vehicle speeds, it was quite difficult to do this with the necessary precision. There were occasional problems with converted video recordings skipping frames or running at inconsistent speeds, making sensitive timing analyses difficult.

- Clear, consistent definitions of the pedestrian/driver behavior measures of effectiveness (MOEs) are needed. There are no accepted, universal definitions of five key project MOEs:
 - Vehicle/Pedestrian Interaction;
 - Vehicle Yielding;
 - Vehicle/Pedestrian Conflict;
 - Vehicle Blocking Crosswalk; and
 - Pedestrian Trapped In Median.

The vehicle/pedestrian conflict was particularly challenging to define. The subjective definition used stated that a conflict happened if the driver swerved or braked quickly (not smoothly) *or* if the pedestrian changed stride or gait, apparently showing concern about an imminent collision. This was a less restrictive definition than a “near miss” as it did not require the pedestrian and vehicle to come “within inches” nor require the driver to “slam on the brakes.” However, it would *not* include the routine, smooth changes in speed that drivers and pedestrians make frequently as they yield to avoid a collision.

Thus defined, the occurrence of a conflict was rare enough that it was quite difficult to detect an adequate number of conflicts during baseline observations to make a statistically significant improvement possible. A strict definition can make statistical significance impossible to achieve even with a reasonable sample size.

- The earlier version of PBCAT (Version 1.0) proved difficult to use in the Phase I analysis. In particular, the classification of each pedestrian collision by a single list of key factors

proved overly simplistic. These key factors forced a decision on whether the most salient feature was the violation type or the vehicle movement. (PBCAT has been updated, and Version 2.1 includes more flexible crash typing and “expert systems” guidance.) Statistical software and the Crossroads™ software proved more flexible and helpful. The SFMTA has also used GIS mapping analysis of pedestrian crashes for over six years, and this has been helpful. Often, the actual police collision reports had to be reviewed to understand the problems specific to an intersection (such as precise vehicle movements involved prior to collisions).

- While analysis of crash patterns is quite helpful in selecting the proper treatment, several years of crash data are needed, and even then, patterns at the same intersection may vary significantly year-to-year. Site visits are therefore very important.
- Crash analysis should consider the pedestrian and/or vehicle volumes as a measure of exposure, rather than only the absolute number of injuries or crashes.

6.2. COMPARISON WITH OTHER CITIES

Similar projects were carried out in the Las Vegas and Miami metropolitan areas. A preliminary final report was available for Miami, but not for Las Vegas as of publication time. The chief findings in Miami that related directly to the San Francisco experience include:

- **Pedestrian push button confirmation light:** a significantly higher proportion of pedestrians waited to cross until the Walk signal. (This result from an additional visual cue was similar to the impacts of audible signals on sighted pedestrians.)
- **Reduced waiting times** at a mid-block signalized crossing resulted in significantly better compliance. (San Francisco has favored shorter traffic signal cycles, usually 60 to 80 seconds, in part for this reason.)
- **Pedestrian Head Start** (leading pedestrian interval) did not significantly improve yielding by right-turning drivers. (The effectiveness of the Pedestrian Head Starts in San Francisco appeared to vary with the intersection characteristics.)
- **In-Street Pedestrian signs:** these signs were highly effective at increasing driver yielding, but were easily damaged (which was very similar to the San Francisco experience).
- **The stutter flash beacon** was effective in increasing driver yielding.

6.3. NEXT STEPS AND FURTHER RESEARCH

The primary opportunity for additional research would be an evaluation of the actual pedestrian injury impacts of the countermeasures. This would require follow up observations 3-6 years after device installation. (Collision data are not even available in tabulated form in California for at least six months. In order to obtain a meaningful sample size, several years of post-installation data are needed.) SFMTA participated in a proposal by the San Francisco Injury Center (a unit of the University of California – San Francisco and San Francisco General Hospital) to the federal

Centers for Disease Control for funding to perform this analysis, but the application was turned down due to limited funding.

SFMTA is also interested in testing other promising devices, particularly the HAWK beacon system and/or stutter flash beacons. (The High-Intensity Activated Crosswalk system is dark until a pedestrian activates the push button. It then switches from flashing yellow to solid yellow, followed by solid red, then flashing red, allowing cross traffic to continue once the pedestrian has crossed.) The City Traffic Engineer has identified the value of converting Stop controls to traffic signals that would be subject to transit and pedestrian priority.

Some of the countermeasures could be refined. For example, red turn arrows could be added to pedestrian head start locations. The video detection logic could be adjusted to prevent vehicles encroaching on the crosswalk from triggering the signal extension.

The cost-effectiveness of innovative devices could be compared to that of more traditional traffic engineering improvements, such as improved roadway lighting and left turn signalization.

It would also be valuable to research how the findings from this study can be translated into citywide pedestrian plans. San Francisco is currently developing a Better Streets Plan, a combination of the planned Pedestrian Master Plan with a citywide streetscape plan. This may provide an opportunity to apply the findings of this project.

APPENDIX A: OUTREACH ASSEMBLY SUMMARY AND EVALUATION

As part of the FHWA PedSafe project, a major outreach program was implemented, encompassing educational presentations and distribution of retro-reflective materials.

The primary audience for the presentation outreach encompassed the residents of communities in the seven PedSafe zones. The goal was to conduct in-person presentations at both schools and senior citizen facilities, providing general safety tips and information about the PedSafe project and other topics related to pedestrian safety.

Municipal Transportation Agency (MTA) staff contacted one school and one senior citizen facility in each of the zones. The schools were chosen based on their size, diverse populations, and demonstrated interest in working with DPT on improving safety. The target grades for the school presentation were Kindergarten through 6th grade, considered more receptive than older students. The educational message of these presentations varied according to the age level of the students. The senior sites were chosen based on their size, diversity, and opportunities for meetings with high attendance (e.g. senior lunches). The material presented at these sites emphasized the challenges to pedestrian safety for students and seniors walking in these specific areas and presented area-specific safety suggestions.

A Power Point slide show (hard copy available) illustrating different pedestrian safety devices employed throughout the City, as well as presenting simple pedestrian safety tips, such as how to utilize pedestrian countdown signals when crossing a street, or the benefits of pedestrian islands was developed. Safe driving tips were also incorporated to balance the presentation. If needed, hard copies of the slides were printed and distributed at senior facilities to make the information more accessible. To aid in conveying the message of “be safe be seen,” grant funded wearable reflective safety devices, such as armbands, belt wraps, and zipper pulls, which were distributed to both students and seniors.

Outreach Approach

The basic approach taken was to contact the sites via phone to either the school principal or senior facility program director, explain the PedSafe project’s goal, and request the opportunity to make a presentation at the site. This one-call approach proved successful for the senior sites, but not for the schools. Easy access to the program directors, who managed the facility’s calendar, led to quick scheduling of presentations. When scheduled, information such as type of room and anticipated number of attendees was gathered. MTA staff followed up each call by sending a confirmation letter and small poster announcing the program. This resulted in senior citizen facilities in five of the seven zones participating.

In regard to the schools, multiple phone calls and letters were employed to schedule these presentations. Calls were initially made to key administrators, principal and/or vice principals. If they did not respond, the next step was to identify those schools that had a health advocate on staff and contact that individual. If this proved unsuccessful, a letter was sent describing the

project and presentation, along with information about other school safety projects/partnership opportunities between schools and the city. The letter was followed up with a phone call. Those schools with presentations scheduled received confirmation letters including the name and phone number of an MTA staff person if further information was needed. The results of these efforts led to presentations at schools in five of the seven zones.

Senior Presentations

In total, 220 senior citizens attended the presentations. The number of attendees varied from a low of 20 to a high of 150 per event. The presentations ranged from 15 to 25 minutes, depending on the number of questions asked. While many sites had held, within the past year or two, presentations made on pedestrian safety, they welcomed the opportunity to have the subject presented again. This could be due to the fact that those sites where drop-in services are available do not have a stable client base, whereas others, such as an adult day health center, have the same attendees every day.

The presentations were attended predominately by seniors who were ambulatory, with a small number of attendees who use mobility aids (canes, walkers, wheelchairs). At those sites where the Power Point presentation could not be shown, (lack of wall, screen, or because the presentation was held during lunch), hard copies of the presentation slides were distributed.

The attendees welcomed hearing about recent and proposed improvements in their zones and appreciated the focus on senior citizen pedestrian safety. Questions from attendees varied. Many were concerned with what they perceived of as a lack of enforcement regarding motorists driving while talking on cell phones, while some were concerned about the increase in pedestrian collisions, and specifically pedestrians who were injured by city /Muni buses. Motorists running Stop signs and disobeying traffic signals were also areas of concerns that were voiced by attendees.

The majority of the attendees were familiar with the bright orange vests that are worn by city service employees, but did not know that they were “reflective.” When informed that all attendees would receive a reflective armband (or other device), the items were not only well received, but there was also a strong tendency for many to request multiple items to be shared with family members. Overall, the silver arms bands were preferred over the orange ones. For those with mobility aids, reflective labels (donated by 3M) were also available and with DPT staff assistance, were placed on the mobility aids of individuals who requested them.

School Presentations

Presentations were made at six San Francisco public schools: three elementary and three middle schools. The presentations ranged from 15 to 25 minutes each, depending on the number of questions asked. While the original goal was to speak with students from Kindergarten through 6th grade, and to conduct small classroom presentations, the overwhelming consensus from four schools that every student needed to hear the message. This resulted in multiple assemblies, either on one day or on multiple days, to accommodate the 7th and 8th graders. As for the other two schools, the middle school held the presentation for the 5th and 6th grades and at the elementary school, attendance was limited to two classrooms of first graders.

The school staff/faculty role on the day of the presentations was primarily to introduce the speaker. In most cases, they addressed the students prior to the talk and spoke about pedestrian behaviors that they observed taking place around their schools. DPT staff was also able to address specific to individual schools by mentioning that they were aware of certain safety behaviors after having consulted the school's crossing guard. Both proved to be helpful in setting the tone while also gaining the attention of the students.

Graphic materials were also developed to accompany the school presentations. Originally created for classroom presentations of a smaller size, these materials could not be used for the all school assemblies. They were used at the schools in which the talks were held in classrooms and they were quite helpful in illustrating various pedestrian safety devices and while engaging the students in a simple quiz.

To accommodate all of the school assemblies, the slide show created for the senior citizen sites was altered slightly. While the main change was the omission of the safe driving tips, additional slides were omitted based on the age of the students. This change was made after a faculty member reviewed the slide show and suggested that certain slides would be too advanced for the younger students. This resulted in grades six through eight viewing all of the slides, while the presentations for Kindergarten through 5th grade included all but one of the slides. At one elementary school, the presentation was held outside as part of an all-school safety/disaster training assembly. This location did not allow for any visual aids to accompany the presentation.

Overall, the presentations were of more interest to elementary students than to those in the upper grades. The younger students tended to ask more questions than those in the middle schools, particularly those in the 7th and 8th grades. Questions focused mainly on speeding cars; how to stop people from speeding. Questions regarding cell phone usage among motorists and the impact they can have on unsafe driving was also of concern and generated many questions. As for the reflective zipper pulls, they were well received by the younger students, which could be seen in their excitement when informed they all would be receiving one. The older students appeared less convinced that the zipper pulls would be effective when told of their ability to help the students be more visible when walking at night.

Unsuccessful Efforts

As previously mentioned, many attempts were made to schedule the presentations. The two zones where senior citizen facility presentations could not be scheduled might be attributed to our telephone inquiries being met with hesitation and confusion regarding which individual in the organization the call should be forwarded to, or whether pedestrian safety was a subject matter that their attendees would benefit from. There was also an attempt to partner with other groups such as the YMCA and the police department, who have held pedestrian safety meetings/presentations, but this was not successful. A promising potential collaboration with San Francisco General Hospital's "Think First" program to prevent brain injuries was only a limited success.

San Francisco PedSafe:
 Final Report and Executive Summary

At two non-responsive schools, school personnel alluded to their calendars being filled during the months when the presentations were to be made, but when pressed to see if an exception could be made, the request was passed on to another staff person, who never returned the call. Subsequent calls were also unreturned. The letter also failed to generate interest. After speaking with personnel at other schools, it became clear that all school assemblies are scheduled months in advance and access to individual classrooms for such presentations is limited. Invitations were generally acquired as a result of partnering with established programs or with previously scheduled assemblies. For example, one talk was done in conjunction with another group, the San Francisco General Hospital’s “Think First” program to prevent brain injuries.

PedSafe Reflective Devices

Item Purchased	Number Purchased	Number Distributed	Remaining Inventory as of March 3, 2006
Zipper Pulls			
Total	3,000	2,525	395
Clipsters/badge holders			
Total	1,250	766	484
Armbands			
Total	750	400	323
Belt Wraps			
Total	250	0	250
Total All Items	5,250	3,691*	1,452

There are 107 pieces not accounted for. This is broken down into 80 zipper pulls, and 27 armbands. This is probably a result of either a miscount of items in bags and/or leaving more at a location than originally planned.

FHWA PEDSAFE SCHOOL PRESENTATIONS: 2006

Zone/Facility	Location	Presentation Date	Comments/Observation
North Mission Marshall Elementary (K-5) Monica Guzman 230 students attended	1575 15th St.	January 26 2006 All school assembly (Outside)	Safety/disaster planning was focus of assembly. Could not use any graphics. Students were mildly engaged. School crossing guards also presented safety tips.
Outer Mission Street Monroe Elementary (K-5) Mark Bolton 470 students attended	260 Madrid	February 14, 2006 All school assembly broken down by K-3 and 4-5.	Students were very aware of pedestrian laws. School was recruiting for student safety patrol; folded this effort into presentation. Used two students to model zipper pulls on their jackets. Reflective devices were well received by all students.
Geary/Richmond Roosevelt Middle (6-8) Diane Panagotacos 780 students attended	460 Arguello	January 26, 2006 Principal requested that all students hear presentations. Separate assembly for each grade levels and held on 3 separate days.	Student attention span decreased as students got older. Reflective devices well received by 6th graders; lukewarm to no interest with 7th-8th graders.
Geary/Cathedral Hill KIPP San Francisco Bay Academy (5-6) Lydia Glassie 131 students (Entire school population 181)	1430 Scott St.	January 11, 2006 Presentation made on 2 separate days.	Very attentive student body. Went through entire presentation, including driver tips. They asked good questions.
Chinatown/North Beach Francisco Middle (6-8) Rosa Fong 610 students attended	2190 Powell	February 1, 2006 All school assembly, broken down by class year.	Student attention span decreased as students' got older. Area police officer attended and provided additional safety information. Spoke to Vice Principal about assistance with mid-block crossing.
Chinatown/North Beach Spring Valley Approximately 40 students attended	1451 Jackson	October 20, 2005. The presentation was made to two classes of 1st grade students in conjunction with the "Think First" program to prevent brain injuries.	The students were a very receptive audience and were active participants in the presentation
South of Market Bessie Carmichael	375 7th Street 94103	Made numerous calls. Sent letter and made follow- up call after sent. Never connected with principal or any staff person who would be responsible for scheduling event.	No presentation made
Upper Market Everett Middle School	450 Church Street	Made numerous calls. Sent letter and made follow- up call after sent. Never connected with principal or any staff person who would be responsible for scheduling event.	No presentation made

Total number of Students attending Presentations: 2,260
Schools part of the San Francisco Unified School District

San Francisco PedSafe:
Final Report and Executive Summary

FHWA PEDSAFE SENIOR PRESENTATIONS - 2006

Zone/Facility	Location	Number	Contact Person	Result/ number of attendees	Presentation Date
South of Market West Canon Kip Senior Center	705 Natoma St.	487-3786 771-1135	Lita	45 attendees Held in multi-purpose room Used slides	December 1, 2005 (KW & JG)
Outer Mission Street Mission Neighborhood Excelsior Senior Center	4752 Mission @ Ondaga	206-7759	Martha Calderon	20 attendees Generally the orange armbands were the most popular, though the men tended to pick the green over the orange. Clipsters seemed to be a popular item to attach to bags.	Wednesday, December 21, 2005 (JG)
Geary/Cathedral Hill Kimochi	1840 Sutter	931-2287 931-2299	Steve Ishi	150 attendees Held in lunch room during lunch Did not use slides	January 19, 2006 (KW)
Upper Market Street Diamond Senior Center	117 Diamond	863-3507	John Yengich	45 attendees Used slides Very attentive Good questions	Thursday, January 12, 2006 (KW)
Geary/Richmond Self Help for the Elderly ADHC	408 22nd Street	677-7565	Diane Ngo	45 attendees Did not use slides Very attentive Largest number of attendees using mobility aids.	Monday, February 27, 2006 10:30 AM (KW)

Total number attending: 220

NO PRESENTATIONS IN FOLLOWING ZONES:

Zone/Facility	Location	Number	Contact Person	Results of Contact Attempts
North Mission Mission Housing Dev. Corp.	474 Valencia St.	864-4632		Left numerous phone messages. Could not connect at location.
Chinatown/North Beach Lady Shaw Senior Center (Self-Help for the Elderly)	1483 Mason	292-2383 292-2462	Helen Yuen	Contacted program director in early January 2006 to schedule event. Made 3 attempts to schedule something. Last message left 1/25/06

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