

Silicon Valley Smart Corridor: *Draft Evaluation Strategy*



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Silicon Valley Smart Corridor Project

Draft Evaluation Plan

1.0 INTRODUCTION

This document outlines the strategy for evaluating the integrated freeway, arterial, and incident management system known as the Silicon Valley Smart Corridor (SVSC). Centered in San Jose, California, the SVSC is one of approximately 65 deployments occurring nationally under the direction and partial funding of the FY 1999 National ITS Integration Earmark Program.

This national program, born under the auspices of the Transportation Equity Act for the 21st Century (TEA-21), is designed to accelerate the integration and interoperability of ITS across system, jurisdictional, and modal boundaries. Projects approved for funding under the program are intended to support increased transportation efficiency, promote safety, increase traffic flow, reduce emissions of air pollutants, improve traveler information, enhance alternative transportation modes, build on existing ITS projects, and / or promote tourism.

San Jose's SVSC addresses many of these goals. Using advanced technologies and real-time system management techniques, the project seeks to keep all transportation facilities within the region's critical Highway 17/Interstate 880 corridor operating at maximum efficiency, even following a major disruptive incident. Based upon a partnership of several agencies, the system combines advanced freeway, arterial and incident management techniques and resources to reduce delays. The system will also improve travel time reliability, increase safety, and keep drivers better informed and ultimately less stressed.

To investigate the success of the SVSC deployment in meeting these goals and to provide insights into the potential strengths and weaknesses of the overall national integration program, the SVSC was one of 8 sites selected for targeted, independent national evaluation. This document presents the plan for conducting this independent evaluation and is structured to provide the following:

- **Section 1 – Introduction** – Provides background information on the project including project participants, planned deployment schedule, system components, and system objectives.
- **Section 2 – Evaluation Plan** – Provides guidelines for conducting the evaluation, identifies evaluation objectives and measures, and defines the evaluation approach.
- **Section 3 – Management Plan** – Defines the evaluation management structure, schedule, and deliverables.

This Draft Evaluation Plan represents the first deliverable of the evaluation effort. Following review and approval by the FHWA, this plan will provide the guidelines for the development of detailed test plans, the collection and analysis of data, and the development of the Evaluation Report.

1.1 Project Background

Over the past several years, the Silicon Valley area has been experiencing significant growth. Between 1992 and 1999 over 250,000 new jobs were added in the San Jose Metropolitan area, while an additional 200,000 jobs are expected by 2010. Not surprisingly, this economic growth has been accompanied by a substantial increase in roadway congestion and traveler concerns.

For example, between 1998 and 1999 alone, peak-period speeds on San Jose's freeways dropped an average of 9%, while off-peak speeds similarly dropped by an average of 7%. These service reductions also extended to the arterial network, where both peak and off-peak speeds dropped roughly 13% over the course of the year.

As a result, travelers in the area are now experiencing peak-period freeway speeds approximately 40% below posted speed limits, arterial conditions at or below level of service D¹, and an overall average of approximately 45 hours of delay per traveler per year². Not surprisingly, in a recent survey of area residents, over 40% of those surveyed felt that traffic congestion was the most pressing issue facing residents heading into the next century.

Fortunately, however, local officials have recognized these concerns and have launched a multi-prong approach to dealing with the problem. First they are working towards providing additional capacity by taking advantage of a local sales tax initiative to complete nearly \$1.4 Billion in new road, rail and bicycle improvements before 2006. Second, they are working towards reducing demands through the promotion of integrated transportation and land use philosophies such as offering transit incentives and ensuring a healthier job/housing balance. Finally, they are developing strategies that neither add significant capacity, nor reduce demands but rather do a better job of managing existing conditions. A significant element of this third prong is the SVSC.

The SVSC Project was initiated in 1994 with the development of a feasibility study. This feasibility study identified a program to implement ITS elements for the I-880/SR 17 corridor. The Smart Corridor defined in the feasibility study extends approximately 15 miles from the City of Milpitas in the north, to the Town of Los Gatos in the south. This evaluation focuses on one specific section of the corridor that is described in Section 1.2.

Different integrated sub-systems were identified and planned for deployment including: closed circuit television traffic surveillance, message signs, coordinated signal timings, and communication infrastructure. Completion of the initial implementation is

¹ *Annual Transportation Report: Sixth Edition – 1999*, City of San Jose, 1999.

² TTI Urban Mobility Study, Texas Transportation Institute, 1999.

anticipated in August 2000. Future phases of the project will expand the geographic coverage of the deployment and are anticipated to integrate additional systems with the project, such as traveler information and public transit systems. The goals of corridor improvements identified by the project participants include³:

- Minimum intrusion of freeway traffic onto local streets due to freeway congestion and freeway incidents;
- More rapid response to and clearing of incidents on both the freeway and surface streets;
- Active management of traffic already diverting from the freeway to minimize its impacts on the arterial;
- Improved traffic signal coordination that is responsive to fluctuations in demand;
- Improved collection and dissemination of current travel condition information;
- Coordination of these activities between agencies;
- Sharing resources among agencies.

Once implemented, the initial system will improve traffic management capabilities on freeways and arterials for selected routes in the corridor. It is anticipated that this initial implementation will facilitate the future integration with other systems and jurisdictions. It is expected that all project efforts for phases described in this plan will be completed by the end of year 2001, while the overall SVITS program will continue well beyond 2001.

1.1.1 Project Participants

Twelve various local, regional, and state agencies involved in the integrated effort entered into a joint agreement in 1995. The Santa Clara Valley Transportation Authority (VTA) was designated as the program coordinator responsible for leading efforts related to funding, programming, grants, and countywide planning. Mr. Casey Emoto serves as the VTA liaison to the group.

The City of San Jose is the lead program manager, responsible for technical program management and design/engineering contract management. Mr. Yves Zsutty is the City of San Jose and overall project manager, and has also volunteered to serve as the evaluation point of contact for the Smart Corridor project.

The Silicon Valley ITS Program Steering Committee (see Appendix) is made up of participants from the various agencies. Partner jurisdictions are shown in Table 1.1. Private sector participants include the system contractor, DKS Associates, and their various sub-consultants. The SVITS Committee meets monthly to discuss issues surrounding the project and program.

³ *I-880/SR 17 Smart Corridor Improvements: Project Information for Participation in the ITS Integration Component of the ITS Deployment Program*, Santa Clara Valley Transportation Authority, 1999.

Table 1.1 Silicon Valley Smart Corridor Project Partners

<ul style="list-style-type: none">• City of San Jose	<ul style="list-style-type: none">• City of Milpitas
<ul style="list-style-type: none">• City of Campbell	<ul style="list-style-type: none">• City of Santa Clara
<ul style="list-style-type: none">• Town of Los Gatos	<ul style="list-style-type: none">• County of Santa Clara
<ul style="list-style-type: none">• Santa Clara Valley Transportation Authority (VTA)	<ul style="list-style-type: none">• Metropolitan Transportation Commission (MTC) & TravInfo
<ul style="list-style-type: none">• California Department of Transportation (Caltrans)	<ul style="list-style-type: none">• California Highway Patrol (CHP)

1.1.2 Project Schedule

Original schedules estimated the initial deployment and integration of Smart Corridor components to be completed by the end of 1998. Several delays have caused this schedule to be extended to June 2000. While the deployment of components has generally proceeded according to schedule, the more difficult task has proven to be the integration of previously deployed components with the new equipment. This has required a greater amount of time than first anticipated and has been complicated by the fragmented nature of each jurisdiction's previously deployed systems.

Significant progress has been made and the system is currently being tested and refined. The system is scheduled to be fully functional in August 2000. Several unfortunate breaks in the fiber-optic communication infrastructure have been discovered over the past few months, and agencies are working to get them repaired. However, the preservation of the network has become an on-going challenge. The large number of construction projects in the valley has resulted in the fiber optic network being dug up or cut by contractors. The fiber breaks will be repaired this summer, and the integrated system deployed on the northbound section of Bascom Avenue should be operational in late summer. This section of the Smart Corridor will be the focus of a large part of the evaluation effort.

The build-out of the next project phase will expand the communication infrastructure and data sharing capabilities to additional jurisdictions. Components will also be added to project corridors to provide additional coverage and data collection capabilities. The completion of this next phase is targeted for June 2002.

Longer-term plans call for the geographic expansion of the system and the possible integration with other sub-systems including public transit and traveler information systems. The Smart Corridor project is envisioned as a ten-year project. Following the implementation of the initial components, the project partners plan to continue adding management capabilities and integrate the system with additional jurisdictions to address other regional transportation needs.

1.2 System Description

The Silicon Valley Smart Corridor Project involves the integration of arterial traffic management, freeway traffic management, and incident management capabilities along a 15-mile corridor traversing a number of Silicon Valley communities. The integration includes ITS components owned and operated by seven different transportation agencies. The section of the Smart Corridor under evaluation roughly parallels the Highway 17/ I-880 corridor. This corridor includes a major north/south freeway facility leading from Santa Cruz County and exurban areas in the south to downtown San Jose, the San Jose International Airport, and major Silicon Valley and East Bay employment centers to the north.

Besides the freeway itself, the corridor includes several additional north/south roadways including the San Tomas and Montague Expressways and Bascom Avenue. These parallel roadways carry large volumes of through and local traffic, and serve as overflow routes when the freeway is overly congested due to incidents.

Rapid development and employment growth in the Silicon Valley region has resulted in extremely congested conditions along the Highway 17/I-880 corridor and the parallel routes. Incidents occurring on Highway 17/I-880 frequently result in traffic congestion on the freeway and on overflow routes. The Silicon Valley Smart Corridor Project was designed to more effectively manage these traffic situations in an integrated manner.

The system consists of numerous components located along the Smart Corridor routes, as shown in Figure 1.1. These components include integrated freeway management, arterial management, and incident management components. Of primary interest to the evaluation are the system components deployed in the vicinity of Bascom Avenue as it parallels Highway 17 near the southern portion of the project boundaries.

Bascom Avenue is a four and six-lane arterial that closely parallels I-880/SR 17 and frequently serves as an overflow route for travelers attempting to avoid incident backups on the freeway. The study corridor is bound on the south by Lark Avenue in the town of Los Gatos, and on the north at the I-880 interchange in San Jose. This four mile arterial corridor crosses the jurisdictions of Los Gatos, Campbell, Santa Clara County, and San Jose. In addition, Caltrans maintains responsibility for the parallel sections of I-880 and SR 17. This subsection of the Silicon Valley Smart Corridor project represents the greatest concentration of integrated components and best opportunity to test the impact of this integration. Therefore, the evaluation effort will focus on this sub-corridor.

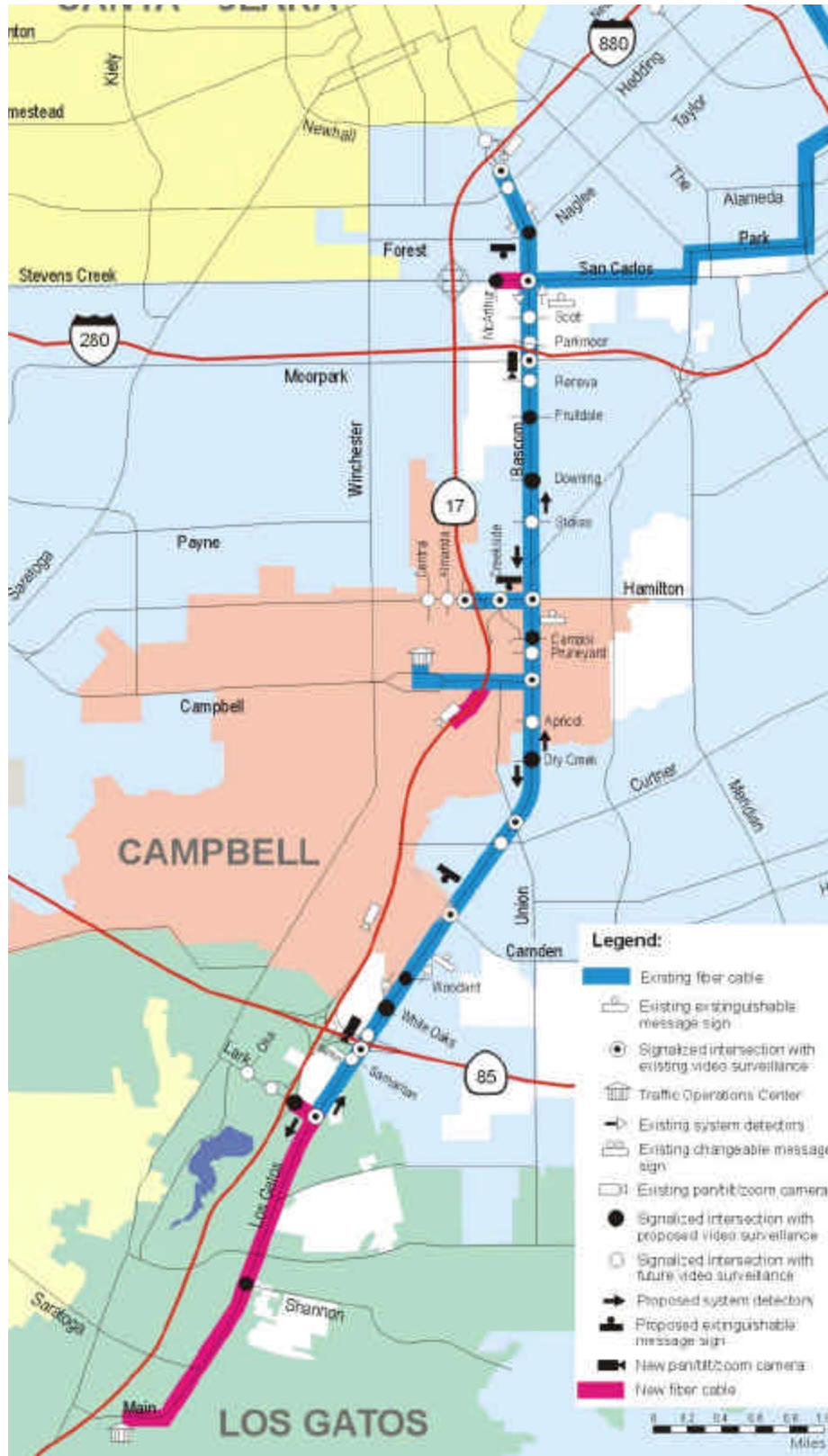
1.2.1 System Components

The following sections provide detail on the planned location and operation of ITS components deployed along the Bascom Avenue corridor to be featured in the subsequent evaluation. When fully deployed, the corridor will contain integrated elements of freeway management, incident management and arterial management components. These components include:

- Communications infrastructure;
- CCTV traffic surveillance;
- Freeway variable message signs;
- Arterial “trailblazer” signs (extinguishable message signs);
- Pavement traffic detectors;
- Coordinated traffic signal timing; and,
- Traffic management centers with center-to-center communications.

Caltrans, the City of San Jose, the City of Santa Clara, the City of Campbell, and the town of Los Gatos operate separate traffic management centers. Each of these traffic management centers currently functions independently in the operation of signals and other ITS components along the Bascom Avenue or I-880/SR 17 rights-of-way. A fiber optic communications infrastructure has been deployed as part of the Smart Corridor project to link the various TMC’s with each other and the various components along the corridor. A detailed view of the corridor components is presented as Figure 1.2.

Figure 1.2 Detail of the Bascom Avenue Corridor



Traffic surveillance and incident detection capabilities along Highway 17 are provided by the deployment of three pan/tilt surveillance cameras. Freeway management capabilities are supported by the deployment of two variable message signs. Ramp metering is deployed along the freeway corridor, but is currently not integrated as part of the Smart Corridor system and may not be operational in some communities.

Arterial traffic management capabilities are provided by the integration of 26 individual signalized intersections (operated by five separate jurisdictions) with the communication infrastructure. Camera traffic surveillance (Figure 1.3) is currently available at eight Bascom Avenue intersections – with seven more intersections to be equipped in the next phase of the project. Additional surveillance is provided by in-pavement loop detection systems capable of collecting volume and speed data at five mid-block locations. Six additional loop detection locations are planned along Bascom Avenue during the next phase of the project.

Figure 1.3: View from CCTV at Bascom Ave and SR85



Trailblazer signs are currently installed at three locations along Bascom Avenue – just south of the intersections of Camden, Hamilton, and San Carlos Avenues. These signs are targeted at the northbound traffic and are located immediately prior to strategic decision points. Specifically, the signs are placed at locations where northbound travelers could take a left turn onto cross streets to access on-ramps to Highway 17. As Figure 1.4 indicates, the trailblazer signs are relatively simple in design and are intended to provide direction for those drivers wanting to access Highway 17. The signs either indicate the Highway 17 logo with a left arrow, or a forward arrow indicating that the driver should stay on Bascom and access Highway 17 at a point further upstream. The default message is blank.

In the current phase of the Smart Corridor project, most components have been deployed to aid in the management and control of traffic traveling northbound along the corridor. This is the prevalent direction of travel in the morning peak period. Additional components are planned in future phases to provide the same capabilities for the southbound direction.

Figure 1.4: Trailblazer Arterial Message Sign



1.2.2 System Operation

Currently, each jurisdiction operates their own signals and components independent of the other jurisdictions. In the event of an incident on Highway 17, travelers will divert from the freeway as a result of information received from the variable message signs, radio traffic reports, or the traveler's own knowledge of corridor characteristics. This diverted traffic quickly adds to the local and through traffic on Bascom Avenue and frequently results in a breakdown of corridor operations.

Local agencies cite inadequate staffing levels as a major barrier to effectively managing commuter traffic in Silicon Valley. Traffic signal coordination between jurisdictions is limited, often consisting of a telephone call between traffic operations personnel. Currently, the various jurisdictions do not have access to the traffic surveillance capabilities of the neighboring jurisdictions, so any operational adjustments are based on localized information.

The Smart Corridor project will link all the traffic management centers and allow greatly improved sharing of information among the various jurisdictions. The communications infrastructure will be integrated with all the components along Bascom Avenue to allow joint operation and control when necessary. During typical conditions, jurisdictions providing operational control of components along Bascom will operate the system according to current plans. Existing time-of-day signal timing strategies will be employed by the various jurisdictions according to historical traffic patterns.

A Concept of Operations for the Smart Corridor defines the planned coordinated operation of the system during incident conditions. In the event of an incident on I-880/SR 17 the Smart Corridor components will be activated and operated as an integrated system to lessen the impact of the non-recurring congestion. Caltrans operates 24-hour incident detection capabilities via CCTV surveillance through its TMC located in Oakland (approximately 40 miles north of the corridor). The center is linked via a frame relay phone connection. Caltrans also monitors the CAD incident reporting site maintained by the California Highway Patrol which provides summaries of all incoming distress and 911 emergency calls. Figure 1.5 presents a view of the CHP CAD incident data. If an incident is detected along the freeway, Caltrans attempts to verify the location and severity of the incident using the video cameras. Caltrans also has several incident response vehicles available, which may be dispatched to verify and clear the incident.

Figure 1.5: View of the CHP CAD Incident Data

The screenshot shows the 'Golden Gate Communications Center' interface. At the top, it says 'Traffic Incident Information Page' and 'Golden Gate Communications Center'. Below that, it displays 'Number of Incidents: 48' and 'Last Updated at: 6/6/00 8:00:04 AM'. The main content is a table of incident data:

ID	Time	Date	Location	Severity	Status
0650	6:00AM	Traffic Incident - Roadside Assistance	SR 880 AT RR 880	Minor	San Jose
0653	6:07AM	Traffic Incident - Vehicle	RR 880 JOY MARINA BLVD	Major	Hayward
0656	6:07AM	Traffic Collision - No Damage	6802 AT SR1	Minor	Golden Gate County Corridor
0657	6:08AM	Traffic Incident - Roadside Assistance	SR 170 AND SILEN POWER RD	Minor	Solano
0658	6:08AM	Traffic Collision - No Damage	RR 880 JAY LARGESS RD	Minor	San Jose
0673	6:09AM	Traffic Incident - Vehicle in Center Lane	RR 880 AND ALAMO BL	Minor	Solano
0677	6:10AM	Request for Traffic Help	RR 880 TO RR 880 CON	Minor	Contra Costa
0678	6:10AM	Traffic Collision - Property Damage	RR 880 AT HILLY RD	Minor	San Jose
0680	6:10AM	Request for Traffic Help	RR 880 AT MILLER RD	Minor	San Jose
0682	6:10AM	Traffic Collision - No Damage	SR 880 JNO 3RD	Minor	San Francisco
0687	6:16AM	Disabled Vehicle	SR 880 TO RR 880 CON	Minor	San Jose
0688	6:16AM	Traffic Incident - Roadside Assistance	SR 880 AT EL CAMINO REAL	Minor	San Francisco
0689	6:16AM	Disabled Vehicle	RR 880 JNO UNION AV	Minor	San Jose
0689	6:16AM	Traffic Collision - Property Damage	CLUBBER RD AT LAUREN RD	Minor	San Jose
0690	6:16AM	Traffic Collision - Automobile Stopped	TESLA RD AT LIVERMORE AV N	Minor	Dublin
0693	6:16AM	Traffic Collision - No Damage	SR 880 JNO GREENVILLE EX E	Minor	Dublin
0697	6:20AM	Traffic Incident - Roadside Assistance	SR 880 AT BASCOM ST	Minor	San Jose
0698	6:21AM	Traffic Collision - Property Damage	RR 880 JNO MOORE RD	Minor	San Jose
0698	6:20AM	Traffic Collision - Property Damage	W 800 JED CUMMINS SWAY	Minor	Contra Costa
0697	6:20AM	Traffic Collision - No Damage	SR 880 AT VARGAS RD	Minor	Dublin
0698	6:20AM	Traffic Incident - Vehicle	CHIL CHR TO W 800	Minor	Dublin
0697	6:20AM	Traffic Collision - No Damage	RR 880 JNO RR 880	Minor	Hayward
0698	6:20AM	Request for Traffic Help	FORRELL ST AT SR 880	Minor	Oakland
0698	6:20AM	Traffic Collision - Property Damage	SR 880 JNO ALVARADO BLVD	Minor	Hayward
0697	6:20AM	Traffic Collision - Property Damage	RR 880 JNO A ST	Minor	Hayward

Below the table, there is a section for 'Incident 0153' with a location of 'CASH AT FORBES AV'. Below that, there is a section for 'Traffic Incident Details' with a list of messages:

- 6:15AM - ALL LANE GREEN AND GREEN TO CLR
- 7:15AM - 1009 CAMPBELL TO 1000
- 8:15AM - 23 LANE STILL BLOCKED - SR TRFC IS LIGHT , RR TRFC IS MODERATE BUT NORMAL FOR MORNING
- 9:15AM - 1009 SOUTH FOR DO RDR
- 10:15AM - PLS 1021 STOP AND SEE IF THEY ROLLED THE CORNER, IF NOT PLS ROLL
- 11:15AM - 1009 CAMPBELL TOW W/ FB
- 12:15AM - ROLL CAMPBELL TOW FOR IMPOUND W/ FB
- 1:07AM - #2 #3 BLOCKED
- 2:07AM - ENGINE #3 WILL 10/3 FOR UNIT

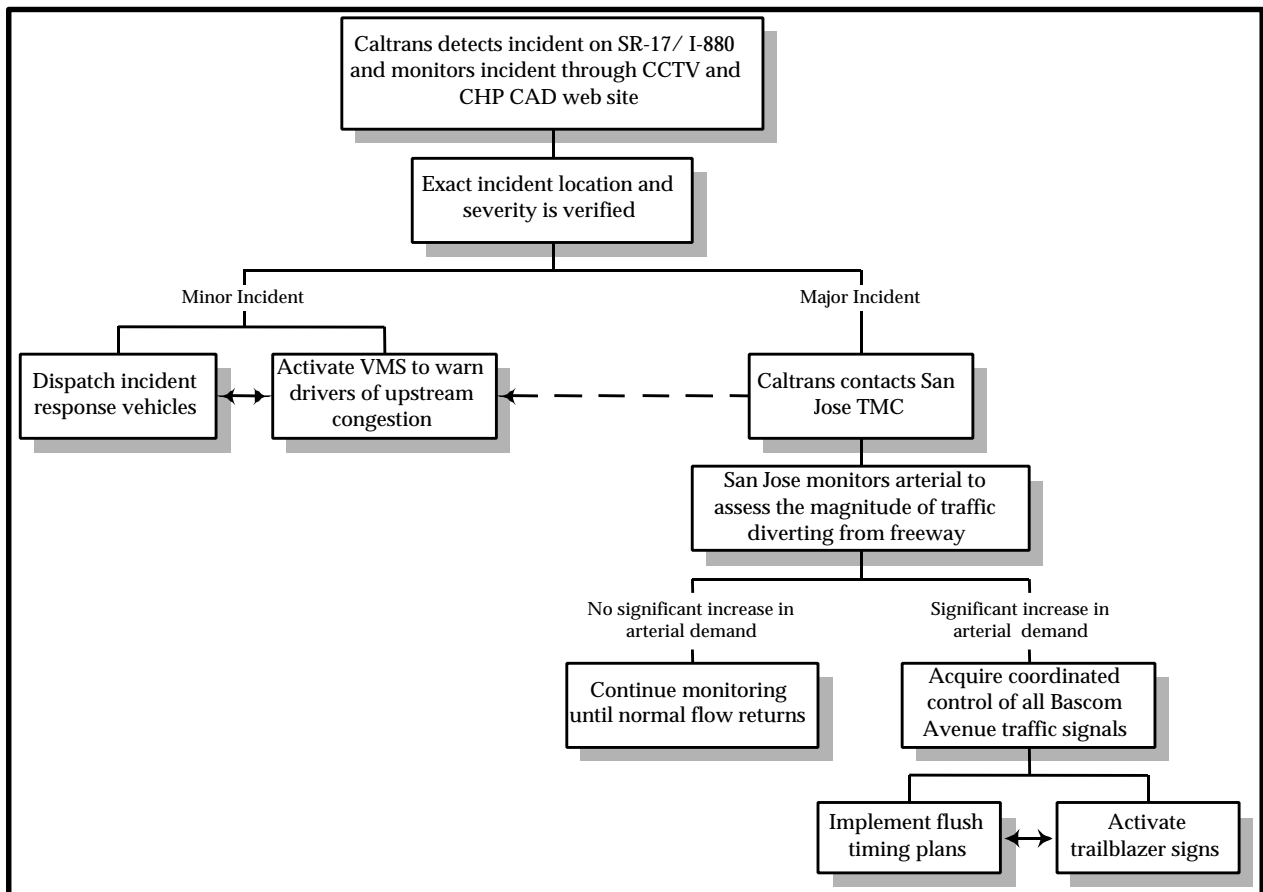
Based on an analysis of the incident severity and anticipated duration, Caltrans may use the variable message signs located on the corridor to warn drivers of the upstream

congestion (see Figure 1.6). The VMS messages will be informational only and will not offer route guidance or divert travelers to surface streets.

If the incident is determined to be significant (roughly judged as blocking one or more lanes of traffic for more than one half-hour), Caltrans will contact either the City of San Jose or Santa Clara County traffic management center via telephone. Personnel at the either TMC will have access to the Caltrans cameras, as well as cameras located at Bascom Avenue intersections in Los Gatos and Campbell. The TMC personnel will use this information to judge the severity of the situation and determine the amount of traffic diverting from the freeway.

If the traffic diverting onto Bascom Avenue is deemed significant, TMC personnel may implement several different strategies. The most significant is the integrated operation of all signals along the corridor according to a coordinated plan designed to "flush" the added arterial traffic that diverts from the freeway by borrowing green phase time from the cross streets. The plans were developed to favor movements that divert traffic off and back on to the freeway. The arterial has been divided into feasible segments for the purpose of signal timing, with each segment sharing a common cycle length (each signal is set to the highest cycle length currently used in each segment). The plans add capacity to the priority direction and provide for smooth progression through each segment along Bascom Avenue.

Figure 2.6 Smart Corridor Decision-Making Process



Either TMC can implement this plan and acquire control over signals in all jurisdictions based on the judgement of personnel. Since the "flush" plans have been approved in advance, permission from the other jurisdictions is not a requirement of implementing the system. However, personnel at the San Jose TMC or Santa Clara County TMC will contact the other agencies' TMC's to inform them of the flush plan implementation.

The second management strategy available to the TMC personnel is the guidance provided by the trailblazer signs. These signs, which are located at key decision points along the corridor, can be used to guide diverted traffic to the easiest freeway access point. If the freeway incident is downstream from the decision point, the trailblazer sign will direct traffic off of Bascom and back onto the freeway. If the incident is upstream from the decision point, the trailblazer signs will direct travelers to stay on Bascom until they have passed the incident location.

Once the incident backup has cleared from the freeway and diverted traffic has cleared the Bascom corridor, the controlling TMC will relinquish the integrated control of the traffic signals back to the respective jurisdictions and extinguish the trailblazer sign message. Caltrans will likewise extinguish the message displayed on the freeway VMS.

The City of San Jose currently has the ability to operate two of the three extinguishable message signs. The City of Campbell must activate the sign located south of the Hamilton Avenue/Bascom Avenue intersection. This barrier significantly limits San Jose's ability to manage incidents regionally during non-business hours, therefore a solution will be sought in the next phase of the project.

1.2.3 System Objective

The Smart Corridor project brings together agencies and organizations in the Silicon Valley area and promotes regional coordination and cooperation. The impetus for this integrated approach to traffic operations was the desire among project participants to minimize the negative impacts caused by freeway incidents and the resulting diversion of traffic onto surface streets.

Participating project agencies report that many of the current corridor travelers maintain a high degree of knowledge of alternative routes along the Highway 17 corridor and often do not hesitate to divert when they encounter unusual congestion levels. Once diverted, however, these drivers add to congestion levels on already heavily traveled major arterials, negatively impacting existing local and through travelers on these facilities. The added congestion also greatly increases the crash risk along the arterial corridors.

The Smart Corridor system was implemented to reduce the delay experienced by existing and diverted travelers along Bascom Avenue during incident conditions on I-880/SR 17. Project participants indicated the improvement of mobility as their primary objective in implementing the integrated system. The smoothing of the traffic flow and the reduction in the number of crashes occurring in the corridor was also a major

objective. The sharing of information and improvement of coordination among the corridor jurisdictions was also cited as an important objective.

Although the Smart Corridor project incorporates freeway management capabilities in the design of the system, it should be noted that the improvement of freeway travel conditions was not a primary goal of the deployment. Following the implementation of the system, the operating procedures on Highway 17 are anticipated to remain largely unchanged. There was not an expressed goal of increasing the amount of traffic diverted from the freeway. Instead, the objective expressed by project participants was to minimize the diversion of freeway traffic onto local streets and to mitigate the traffic that is already diverting to improve arterial operations. Consistent with this objective, the Bascom Avenue improvements are not anticipated to be heavily publicized by the implementing agencies. While some improvement in freeway conditions may result as an indirect impact of the system, the focus of the integrated implementation is to improve surface street conditions.

2.0 EVALUATION PLAN

The Silicon Valley Smart Corridor project was selected by the USDOT for evaluation as a System Impact Study. The Smart Corridor project was selected because it provides opportunities to collect good quality system impact data in areas such as safety performance, system operational performance and customer satisfaction, along with qualitative documentation of lessons learned.

This section provides details on the goals and objectives of the evaluation and presents a systematic approach for evaluating the project. The information contained in this section is intended to guide the successful implementation of the evaluation.

2.1 Evaluation Goals and Objectives

The overall goals of the Silicon Valley Smart Corridor Evaluation are to provide a quantitative analysis of the system impacts of this type of ITS integration and identify qualitative lessons learned. These impacts and issues will be carefully explored and documented to help provide guidance for other regions considering similar integration projects. The findings of this evaluation will be used by other agencies to assess the appropriateness of ITS integration as a potential solution to locally identified needs.

More specifically, however, the goal of this phase of the evaluation is to ascertain whether the Silicon Valley Smart Corridor Project represents a suitable opportunity for collecting system impact data on the integration of ITS. Several study areas have been established for the evaluation to assess the potential for providing reasonable evaluation results. The four major evaluation objectives include:

- Mobility Study – Evaluating the system’s ability to reduce corridor travel time during incidents and reduce travel time variability;
- Safety Study – Evaluating the system’s ability to improve traveler safety in the corridor;
- Customer Satisfaction Study – Evaluating the system’s ability to improve customer (traveler) satisfaction; and,
- Institutional Study – Documenting qualitative lessons learned during implementation and operation of the integrated system.

These objectives reflect the objectives of the project participants and the USDOT’s recommended “few good measures”. The objectives represent the best opportunities for assessing the impacts of the Smart Corridor. Although other impacts are anticipated to result from the system, these impacts have not been included as objectives of the evaluation as they do not represent favorable opportunities for collecting meaningful evaluation data or they were not identified by the project partners as goals of the system integration.

Section 2.2 presents the approach for fulfilling the evaluation objectives and is intended to serve as a guide in implementing the evaluation.

2.2 Evaluation Approach

The evaluation of the ITS Integration Program projects are being conducted in a series of distinct phases including:

- **Phase I** – Included the identification of anticipated impacts of ITS Integration Program projects and the screening of projects that provide favorable opportunities to collect meaningful evaluation data. The selection of few representative projects to serve as *Case Study/Lessons Learned* qualitative studies, and the selection of a subset of this group to serve as more quantitatively detailed System Impact Studies. During Phase I, the Silicon Valley Smart Corridor Project was selected as a System Impact Study.
- **Phase II** – This current evaluation phase is intended to develop and implement the preliminary evaluation approach resulting in the collection and analysis of baseline data. This phase also provides a formal opportunity to assess whether or not a project evaluation will be completed in a reasonable timeframe and if the evaluation will produce meaningful system impact information.
- **Phase III** – This future phase will be conducted if the evaluation is determined to provide a favorable opportunity to provide meaningful results during the implementation of Phase II. If this phase is warranted, data will be collected following system implementation to determine the change from the baseline and provide measurement of the incremental system impact.

The evaluation approach for Phase II must therefore be two-fold. It must be structured to provide for a reasonable risk assessment of the availability and significance of data in the post-implementation scenario. It must also allow for the collection and analysis of baseline data suitable for comparison with the “after” scenario in case the project is selected for a Phase III evaluation.

This *Evaluation Plan* represents the first step in the Phase II evaluation task. It is intended to guide the evaluation by identifying relevant evaluation goals, objectives, and measures. Following review of this plan by the FHWA COTR, the evaluation team will use the plan to guide the development of detailed *Individual Test Plans*. These test plans will specify the data collection and analysis procedures to be performed during the subsequent evaluation tasks. The baseline data collection and analysis will be conducted by implementing the individual test plans. Finally, the evaluation team will conduct a risk analysis of the probability of project completion and the ability of the project to provide meaningful system impact performance data. The results of all tasks will be documented in the *Phase II Evaluation Report*.

2.2.1 Evaluation Structure

As discussed in Section 2.1, the evaluation of the Silicon Valley Smart Corridor will include four major studies, including:

- Safety Study;

- Mobility Study;
- Customer Satisfaction Study; and
- Institutional Study.

Two of these study areas – safety and mobility – are particularly important to the Phase II evaluation. Baseline data for these studies will need to be collected and analyzed as part of this evaluation phase. The remaining two studies – customer satisfaction and institutional – are more focused on the post-implementation scenario. Opportunities for collecting “after” scenario data on these objectives will be established in this evaluation phase; however, little baseline data will be collected.

The Silicon Valley Smart Corridor evaluation structure is based on standard evaluation practices. Within each study area, a hypothesis has been formulated identifying the anticipated system impact. One or more Measures of Effectiveness (MOE's) are then associated with each hypothesis to assess the accuracy of the hypothesis. Required data and data sources are then identified for each MOE. The following section presents the hypothesis and MOE's identified for each study area.

2.2.2 Evaluation Hypothesis and Measures

The operational characteristics of the Smart Corridor components result in the system impacts occurring during random, non-recurring situations. Specifically, the integrated components located along the Highway 17/I-880 and Bascom Avenue corridor are designed to be operational only during incident conditions. During non-incident conditions, the system components are not anticipated to be operational, and will therefore not result in any noticeable system impacts.

The hypothesis and measures identified for each evaluation objective are designed to capture the specific impact of the system during atypical incident conditions. Due to the random and unpredictable nature of these conditions, the data collection process will be ongoing and continuous.

Table 2.1 presents the hypothesis to be tested and the measures of effectiveness to be used for each evaluation objective. The specific data to be collected during the baseline data collection period is also indicated for each MOE.

Table 2.1 Evaluation Hypotheses and Measures

Evaluation Objective	Hypothesis	MOE's	Required Baseline Data
Mobility – Reduce travel time in the corridor.	The Smart Corridor will reduce travel time through the corridor during incident conditions.	<p>Change in travel time in the primary direction during incident conditions.</p> <p>Change in the overall corridor travel time reliability.</p> <p>Change in travel time on cross-links during incident conditions.</p> <p>Change in signal queue lengths during incident conditions.</p>	<p>Observed corridor travel time during incident conditions.</p> <p>Observed travel time variability.</p> <p>Observed cross-link travel times during incident conditions.</p> <p>Observed queue lengths during incident conditions.</p>
Safety – Improve traveler safety in the corridor	The Smart Corridor implementation will reduce accident risks during incident conditions	<p>Changes in the number of crashes or crash severity occurring in the corridor.</p> <p>Changes in speed variability along the corridor during incident conditions.</p> <p>Change in the number of conflicts that occur in the corridor during incident conditions.</p>	<p>Historical crash data.</p> <p>Real-time crash data.</p> <p>Observed speed variability during incident conditions.</p> <p>Observed number of conflict situations occurring during incident conditions</p>
Customer Satisfaction – Improve travel satisfaction for corridor users.	The Smart Corridor will result in improved satisfaction among corridor users.	<p>Corridor traveler perceptions.</p> <p>Corridor traveler behavioral response to system components.</p>	Identified corridor travelers to serve on panel survey.
Institutional – Improve coordination among implementing agencies.	The Smart Corridor will result in improved coordination among implementing agencies	Documented institutional issues.	Documented institutional issues.

The evaluation approach presented above represents a systematic approach to the analysis of potential system impacts of the Silicon Valley Smart Corridor components. The data requirements presented in Table 2.1 will be used to identify and formulate the individual test plans to be produced as the next task of the evaluation.

2.3 Required Test Plans

This *Evaluation Plan* will be used to guide the development of the significantly more detailed individual test plans. The individual test plans will be implemented during the data collection and analysis phase.

In order to implement this *Phase II Evaluation Plan*, multiple test plans are required to be developed to internally guide the evaluation team in the collection and analysis of baseline data. These individual test plans will detail what specific baseline data should be collected, what procedures should be used in collecting and archiving the baseline data, and how the baseline data should be analyzed. The test plans will also include a preliminary plan for testing the baseline data against data to be collected for the post-implementation scenario.

Four specific test plans will be developed --one for each of the evaluation objectives. Two of these test plans – mobility and safety – will focus on quantitative system impacts. Although there is some overlap in the data required to evaluate these system impacts, the differences are sufficient to warrant the development of separate test plans. The development of these test plans will be coordinated to the degree possible to minimize the data collection burden and conserve evaluation resources.

The two remaining test plans – customer satisfaction and institutional – are primarily focused on qualitative data, such as user perceptions and stated preferences. For example, the customer satisfaction test plan will describe how a panel group of regular corridor travelers will be recruited to provide insights into traveler’s attitudes and responses to various levels of traffic management in the corridor. Using a combination of extensive before and after surveys and a series of smaller incident specific questionnaires, this panel should provide insight into the benefits of the system and identify possible areas for improvement. Similarly, the institutional test plan will describe how a combination of interviews and document review will be used to identify the influence of institutional arrangements on the success of the Smart Corridor, and vice versa.

3.0 MANAGEMENT PLAN

The management plan for carrying out the evaluation is detailed in this section. The evaluation management plan is provided to define specific responsibilities and expectations for the evaluation.

3.1 Evaluation Management Structure

The management organization for the Silicon Valley Smart Corridor evaluation effort is presented in Table 3.1. This evaluation project is being jointly conducted by personnel of Science Applications International Corporation (SAIC) and Cambridge Systematics, Inc. The project team reports directly to Dr. Joseph Peters of the FHWA ITS Joint Program Office.

Table 3.1 Evaluation Management Structure

Management Role	Personnel
FHWA Evaluation Oversight	Dr. Joseph Peters <i>FHWA COTR</i>
Evaluation Team Management	Mark Carter – SAIC <i>Project Manager</i> Vassili Alexiadis – Cambridge Systematics <i>Senior Advisor</i> William Perez – SAIC <i>Senior Advisor</i>
Study Area Management	Doug Sallman – Cambridge Systematics <i>Mobility and Institutional Study Lead</i> Tim Luttrell – SAIC <i>Safety Study Lead</i> Mark Carter – SAIC <i>Customer Satisfaction Study Lead</i>
Project Contact	Yves Zsutty – City of San Jose <i>Silicon Valley Smart Corridor - Project Manager</i>

3.2 Work Breakdown Structure

The evaluation team is required to complete Phase II of the evaluation and produce the final *Phase II Evaluation Report* before continuing on any potential post-implementation evaluation tasks. Table 3.3 presents the work breakdown structure highlighting the major tasks to be completed and the anticipated level of effort needed to complete the tasks. Since there is a great deal of overlap in responsibilities for developing and implementing the individual test plans, the different study areas have not been divided out as separate line items.

Table 3.2 Phase II Evaluation Work Breakdown Structure

Task	Proposed Level of Effort (hours)	Percent of Total
Develop <i>Evaluation Plan</i>	150	10%
Develop detailed test plans based on evaluation plan	150	10%
Implement test plans – collect “before” system performance data	525	35%
Data analysis of baseline data and additional data collection (if necessary)	375	25%
Conduct risk assessment as the probability of project completion and its ability to provide system impact performance data	75	5%
Develop <i>Draft Phase II Evaluation Report</i>	150	10%
Develop <i>Final Phase II Evaluation Report</i>	75	5%
TOTAL	1,500*	100%

* Estimated hours

3.3 Evaluation Schedule

An evaluation schedule has been established to guide the timely development of evaluation products and analysis. Table 3.2 identifies the proposed schedule for the Phase II evaluation tasks.

Table 3.3 Phase II Evaluation Schedule

Task	Proposed Schedule
Develop <i>Evaluation Plan</i>	April – May, 2000
Deliver <i>Evaluation Plan</i> to FHWA COTR	June 5, 2000
Receive <i>Evaluation Plan</i> comments from FHWA COTR	June 19, 2000
Develop detailed test plans based on evaluation plan	July 7, 2000
Implement test plans – collect “before” system performance data	July – August, 2000
Data analysis of baseline data and additional data collection (if necessary)	August – September, 2000
Risk assessment as the probability of project completion and its ability to provide system impact performance data	September – October, 2000
Develop <i>Draft Phase II Evaluation Report</i>	September – November, 2000
Deliver <i>Draft Phase II Evaluation Report</i> to FHWA COTR	November 6, 2000
Receive <i>Draft Phase II Evaluation Report</i> comments from FHWA COTR	November 20, 2000
Deliver <i>Final Phase II Evaluation Report</i> to FHWA COTR	December 18, 2000

3.4 Data Management

Data collected during the baseline data collection task is anticipated to be gathered from multiple agencies and includes both historical and current real-time information. Additionally, the data will be collected from a number of manual and automated sources. The evaluation team has identified a number of opportunities to use data generated by the Smart Corridor components themselves in order to maximize evaluation resources. Some of these automated data collection sources include:

- Videotapes of traffic surveillance at corridor intersections;
- Automated freeway pavement detectors;
- Automated arterial mid-block pavement detectors (speed and volumes); and
- Automated intersection pavement detectors (queue length and volumes).

The evaluation team will also be collecting a great deal of primary data as part of the evaluation effort. The principle primary data to be collected includes observed corridor travel times, anticipated to be collected through floating car runs. In conjunction with this primary data collection, the evaluation team must maintain accurate records of the incidents occurring on corridor roadways and the operational status of the system components (i.e., when the system is turned on). This operational status is a critical

element since the components are only anticipated to be operational during incident conditions.

Collected data will be formatted and archived using standard data analysis software formats (database and spreadsheets). This data will be physically maintained at Cambridge Systematics' Oakland, California office, with back-up copies to be maintained at SAIC's Washington DC area office. All relevant data will be actively maintained through the entire course of the study. Following completion of the study, data will be transferred to a compact disc for long-term archiving.

During the data collection effort, the data will undergo preliminary analysis to determine relevancy to the evaluation effort. This will be a critical step since the evaluation is attempting to collect data on non-recurring, random incidents. If the data is found to be inadequate for the purpose of evaluation, data collection contingency plans (to be detailed in the individual test plans) will be enacted. These contingency plans will likely lengthen the schedule and possibly expand the geographic scope of the data collection effort to ensure the adequate collection of data.

All relevant quantitative data will be statistically analyzed to ascertain the significance of the data compared to normalized data. The results of this statistical analysis will be detailed in the *Phase II Evaluation Plan*. Data failing to meet statistical significance standards may still be presented as anecdotal information, but will be clearly noted as such in the documentation.

Qualitative data observed during the data collection will also be documented and summarized in the *Phase II Evaluation Plan*. Information regarding the potential for the project to achieve full deployment during the timeline parameters of the evaluation effort will be the most critical qualitative data collected during Phase II.

3.5 Deliverable Reports

This *Evaluation Plan* represent the first deliverable for the evaluation of the Silicon Valley Smart Corridor Project. As specified in the statement of work, this document provides:

- Project background;
- System description;
- Evaluation goals and objectives;
- Evaluation approach;
- Identification of individual test plans needed;
- Work breakdown structure;
- Evaluation schedule; and,
- Data management plan.

A draft of this *Evaluation Plan* will be delivered to the FHWA COTR on June 5, 2000. The FHWA COTR will forward comments on the draft to the evaluation team by June 19, 2000.

A second evaluation deliverable will follow the completion of the baseline data collection and analysis. The *Draft Phase II Evaluation Report* will be delivered to the FHWA COTR by November 6, 2000 for review and comment. A final version of this document will be delivered by December 18, 2000. The *Phase II Evaluation Report* will include:

- Evaluation plan;
- Individual test plans;
- Summary of the baseline data collection process;
- Results of the statistical analysis of the system performance data; and,
- Risk assessment as to the probability of project completion and its ability to provide meaningful system impact performance data.

APPENDIX:

Silicon Valley ITS Program Steering Committee

- A. Role: A Program Steering Committee (“Committee”), formerly referred to as the Project Technical Team in the previous MOU, will be responsible for the day-to-day activities of designing, implementing, and operating the SV-ITS Program including preliminary engineering design, plans and specifications, right-of-way and environmental reviews, development and implementation of operating plans, and the construction management program. The Committee will approve the final plans and specifications to be used for each project construction. The Committee will meet as frequently as necessary to fulfill its responsibilities.
- B. Members: The Program Steering Committee will be composed of staff members from each of the following agencies: Town of Los Gatos, City of Campbell, City of San Jose, City of Santa Clara, City of Milpitas, City of Fremont, Santa Clara County, VTA, CHP, and Caltrans.
- C. Meetings: The Committee meetings will be organized around specific design and implementation tasks. Each agency will ensure that the appropriate staff persons who can address the specific issues on the agenda attend the Committee meetings. Decisions will be made by consensus; disagreements that are not resolved and that may impede implementation of the project will be brought to the Board. When coordination is needed with other entities such as neighboring jurisdictions, congestion management agencies, or counties, those entities shall be invited to participate in Committee discussions as needed.
- D. Ex-Officio Members: The Committee members recognize the need to integrate systems based on the national ITS architecture to ensure that regionally integrated traffic management systems result. Similar to its role on the Policy Advisory Board, the MTC will serve as an ex-officio member on the Committee.