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AN EVALUATION OF MOTORIST AID CALL BOXES IN WASHINGTON

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"AN EVALUATION OF MOTORIST AID CALL BOXES IN WASHINGTON"

Introduction

The purpose of a motorist aid call box system is to provide motorist assistance, to improve safety, and to serve as an incident detection tool. It also provides motorists with a sense of security and good will toward operating agencies. In spite of these positive aspects, call box system effectiveness is not perceived uniformly among areas where they are used. The Washington State of Department of Transportation is incrementally expanding their existing call box system due to public requests. This project provides a greater understanding of the current system performance by examining the level of effort to monitor and maintain Washington's call box system, the frequency of call box usage, and the system benefits to better understand current practice and to direct future deployment of call boxes.

Research Approach

The researchers examined the effectiveness of Washington's motorist aid call boxes through a series of tasks. These tasks included (1) conducting a national literature review to identify similar evaluations, (2) producing an inventory of call box systems in Washington, (3) collecting quantified usage and cost information for Washington's call box systems, and (4) designing and administering a mail-out survey to solicit public opinions towards Washington's call box systems and call boxes in general.

Recommendations

Incremental call box expansion in Washington state is recommended as funding becomes available because (1) no negative impacts are noted from the maintenance and monitoring agencies, (2) costs for installation and maintenance are reasonable, (3) usage rates are consistent with national experience, and (4) public acceptance is high.

Public education is important to build support for ongoing operation. Public brochures containing information related to call box locations could be made available.

Call box standards should be adopted which may include (1) uniform color and signs to ease the public's recognition of call boxes, and (2) appropriate call box installation guidelines (i.e., placing the call box toward opposing traffic so motorist will face oncoming traffic) to ensure the safety of the user. These standards should be incorporated into new installations and as existing equipment needs replacing.

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DISCLAIMER

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CHAPTER 1
INTRODUCTION

Call box systems were first implemented in the 1960s. At that time, call box systems were the major form of motorist aid systems. The technologies for call boxes significantly improved over the next 30 years as other motorist aid systems developed. Today, motorist aid services can be provided by several means, including dedicated freeway/service patrols, roadside surveillance (Closed Circuit TV), CB radios, cellular phones and call boxes. Different tools may compliment each other to ensure the motorist's safety.

The usefulness of call box systems becomes more prominent when (1) alternatives are limited, such as when service patrol hours are limited or when surveillance technologies are unavailable; (2) private ownership of cellular phones is limited; and (3) cellular phone owners making non-emergency calls for other drivers are rare. Call boxes are typically available 24 hours a day, 7 days a week. They have the potential to assist in incident reporting and delay reduction, and to maximize safety on heavily traveled roads. Although call boxes are located throughout half of the nation, the universal adoption of call boxes on highways is not widespread. California, Hawaii, Delaware, Rhode Island, and Florida are the only states that have statewide call box programs on interstate highways [1].

Currently, two primary call box systems operate in the Puget Sound Region, one on the I-90 bridge from the Mt. Baker tunnel to the Mercer Island tunnel, and the other across the SR-520 floating bridge. Other call box systems in the state are on the Tacoma Narrows Bridge and the "Blue Bridge" located on US 395 in Pasco. The State's practice has been to implement a small number of call boxes (ten or so) when the need has been high enough and money has been available. This was the case with the ten call boxes recently installed near selected off-ramps on I-405 between Bothell and Renton and on I-90 between Bellevue and North Bend. Figure 1 shows the proximity of the call box system locations in Washington. A more detailed, descriptive map is provided later in this report.

The Washington State Department of Transportation (WSDOT) has received many public requests for the installation of call boxes. In answer to these requests, WSDOT has deployed additional call boxes. However, a greater understanding of the performance of the current call box systems (i.e., how often the boxes are used, the level of required maintenance, etc.) would help to ensure the usefulness of the system. Therefore, the level of effort to monitor and maintain the system, the frequency of call box usage, and quantifiable benefits resulting from existing call boxes should be examined. Ultimately, an evaluation of the usefulness of existing motorist aid call boxes should help us understand current practice and direct future implementation in Washington.

BACKGROUND

The purposes of call boxes are to provide motorist assistance, improve safety, and serve as an incident detection tool. They also give drivers a sense of security and good will toward operating agencies. However, their effectiveness is not perceived uniformly in areas where they are used. For instance, California is aggressively expanding its system and integrating it with Intelligent Transportation Systems (ITS) technologies to test its capabilities in areas such as traffic management and traveler information. On the other hand, Minnesota is gradually pulling its call box system out because of low usage levels and high maintenance costs. In California, call boxes have worked well with complementary systems such as freeway service patrols and special cellular access. California's call boxes have proved to be reliable, popular, and operationally effective through political support from elected officials.

Call box implementation may vary between urban and rural highway applications. In urban areas, they are placed where the most traffic and accidents occur because high traffic volumes make detection as important as motorist assistance. Call boxes usually

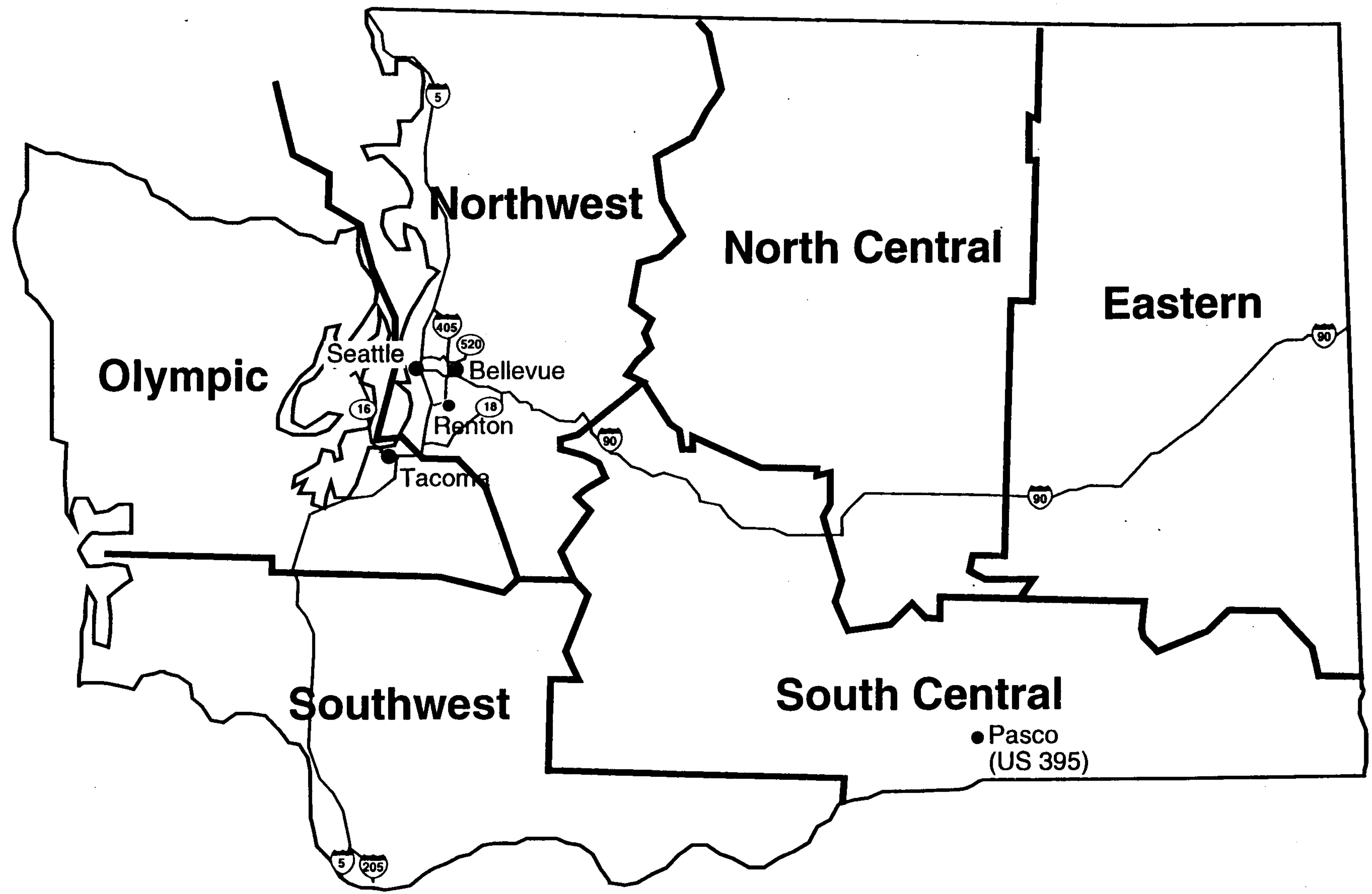


Figure 1. General Proximity of Call Boxes in Relation to WSDOT Regions

coexist with other alternatives to achieve congestion management on high-volume, urban expressways, and they are considered an integral part of an ITS core infrastructure, as defined by the Federal Highway Administration (FHWA) [1]. On rural highways, where congestion is less of a problem, emphasis is on motorist aid. Where few alternatives exist, emergency communications may depend on call boxes. However, the effort for maintenance may increase because of longer travel distances. This study focused on call box applications on both urban/suburban and rural highway networks.

The need for a call box system is challenged by the growth in cellular phone ownership. Today, the relatively low price of owning a cellular phone has encouraged more people to purchase cellular phone services. An operational test of a motorist aid system in Minnesota found that call boxes were used less than cellular phones, and most incidents were detected, in descending order of use, by (1) cellular phones (free 911 calls), (2) closed-circuit TV, (3) highway helpers, (4) service patrols, and (5) state DOT maintenance vehicles. In the Seattle area, the Washington State Patrol typically receives at least three cellular calls and often many more for each major incident on the region's primary roadways.

However, the heavy use of the call box system in San Diego, which has one of the highest concentration of cellular phones, indicates that call boxes do provide a needed service. And although major incidents in urban areas are usually reported via cellular phone, non-emergency calls made by cellular owners for other drivers are rare. California data does not support a decrease in call box usage with increasing cellular penetration. Furthermore, as indicated in a recent Wall Street Journal, the cellular market penetration level is expected to peak at around 30%, unless major decreases in usage charges and significant system capacity increases.

Other factors that may affect the implementation of call boxes include their perceived cost effectiveness, the system performance, engineering design factors, and how well the call box system complements other motorist aid options such as service patrols and freeway surveillance systems. Other concerns include vandalism, knockdowns, prank calls, accessibility to the handicapped, motorists leaving the scene before service arrives, noise interference with different sources, cellular block-out (depending on the type of call box system in a certain area), and maintenance costs.

PROJECT OBJECTIVES

The objectives of this project were to (1) conduct a national literature search on call box systems for reference and comparison; (2) describe Washington's call box service area with a map showing the number and location of call boxes; (3) identify those responsible for call box installation, administration, monitoring, operations, and maintenance; (4) collect opinions on call boxes from involved agencies and the general public; and (5) make recommendations for the use of existing and future call box systems.

With a better understanding of our current systems and of experience with call boxes in other parts of the country, decision makers will have more objective, accurate, and detailed data on which to base their decisions.

REPORT ORGANIZATION

Following this introductory material, Chapter 2 provides a literature review on call boxes nationwide. Chapter 3 outlines the research approach used to obtain the supporting information for this effort. Chapter 4 describes the operational elements of the call box systems in Washington. Chapter 5 describes the call box usage and cost information in Washington. Chapter 6 presents the results of the mail-out survey. Chapter 7 concludes the study and recommends improvements on the call box system.

CHAPTER 2
NATIONAL REVIEW OF CALL BOX SYSTEMS

Numerous studies of call boxes were conducted in the 1970s; however, many systems have been abandoned or updated since then. Therefore, the literature search focused on more recent call box systems. Unfortunately, although call box systems have been implemented in many states, few states have formally studied their effectiveness. To date, the only formal benefit/cost study for call box systems was conducted in Minnesota in 1991. Informally, call box systems have received mixed reviews.

Below is a discussion of (1) general call box system technologies and issues described in the literature, (2) a descriptive summary of call box systems nationwide, and (3) a discussion of Minnesota's benefit/cost analysis for call box systems.

CALL BOX SYSTEMS TECHNOLOGIES AND ISSUES

Below is a discussion of call box system technologies, data transmission methods, operational feature, and implementation issues. Each of these aspects plays an important role in the success of any call box system.

System Technologies

In the U. S., the communication technologies used in call box systems falls under (1) the Common Carrier Bureau of the Federal Communications Commission (FCC), which includes **cellular radio** and **common carrier wireline** technologies, or (2) the **Private Radio** of the FCC using the radio-frequency technologies, which may be voice or data, trunked or conventional, and owned by public agency or privately [1].

Currently, all known cellular call box systems are analog. Cellular call boxes have lower installation costs (no wire network required) but higher operating costs reflected through cellular phone bills.

Wireline call box systems are mostly used in tunnel and bridge installations. Initial installation costs are generally high, but operating costs are lower. The decline of wireline systems is largely due to telephone industry deregulation in 1984, when free dial tone installations to locations on the highway and total system maintenance were no longer required of local telephone companies, and to the rising popularity cellular call boxes.

Two private radio system architectures are available: trunked radio and conventional radio [1]. A trunked radio system is similar to a cellular system, which has multiple channels to allow a mobile unit call to be switched to the next available channel to complete the transmission. However, the call box service has to be licensed as a shared user in order to operate on trunked frequencies (800 and 900 MHz). In a conventional private radio system, either a single or multiple frequencies can be used to provide data or voice coverage in a given area. These systems are best suited to areas where communication traffic loads are light to moderate.

Data Transmission Methods

There are two predominant methods for transmitting information between the motorist requesting assistance and the agency personnel receiving notification. These include voice systems and data or coded systems. Typically, coded systems utilize a radio frequency system of 72 MHz. Although more information can be collected with a voice system, the cost of staffing operators is an important issue.

In general, voice systems allow answering agencies to acquire specific information so that the appropriate type of response can be dispatched. Voice systems should also be used if future upgrades are considered. They offer a higher level of service and better priority response. However, voice systems increase staff required for the same arrival rate of calls because the call service time is typically longer. Therefore, the system's operational requirement must be determined and agreed upon among participating agencies, given the trade-off of cost versus system capability.

Coded (data) systems generally incorporate different buttons for the user to select. These may include medical, police, fire, service, call confirm, or cancel. Some of the benefits of using a coded system include lower operation costs and ease of use by the hearing impaired. However, coded systems often do not provide the monitoring agency with enough information to assess the problem and send appropriate assistance.

A new hybrid data/voice call box is now being evaluated in Los Angeles. It is a full-duplex cellular call box with a graphic ATM-type screen and three buttons: <YES>, <NO>, and <LANGUAGE> which also includes an optional Telecommunications Device For the Deaf (TDD) device. The screen and three buttons provide a preliminary screening before contacting the CHP dispatch center. The voice transmission is still available, however, the overall call processing time can be decreased significantly.

<u>**Operational Features**</u>

The following operational features can be added to a call box system to make system operation more efficient [2].

Most of the current systems in the U.S. have an **automated location reporting** capability to allow the monitor to automatically verify the caller's location. This decreases the call processing time and eliminates inaccurate location data.

Automated Status Reporting allows quicker detection of system failures, thus reducing the labor needed for periodic system testing. The reporting interval is programmable, allowing flexibility in surveillance schedules. For instance, reporting may be frequent during system installation and startup, then tapered off after the system has stabilized.

Self Diagnostics/Alarm Features allows the call box to automatically report system failure due to malfunctions and problems such as low battery charge, solar panel damage, missing handset, an open service cabinet, or problems with the phone electronics. A programmable reporting interval allows flexibility in changing the schedule according to the need. Real-time alarms for major malfunctions, tampering, or knockdowns report immediately, allowing the monitoring center to quickly dispatch someone to make repairs. Alarms play a major role in making maintenance scheduling efficient and in reducing the threat of vandalism. To accomplish the latter, it is recommended that the existence of such alarms should be well emphasized as part of the public relations effort [1].

Automatic Disconnect for the circuit after a predetermined period of inactivity is another potential operational feature. This is an important feature on cellular systems in areas without free 911 calls, since cellular user fees are based on time.

Automatic Data Collection and Reporting allows useful operational data to be recorded showing system usage and providing troubleshooting. Information can be obtained from the (1) vendor's maintenance computer, (2) the common carrier's or private network operator's call records, and (3) the call-taker agency's computer-generated or telephone system records. With voice systems, date and time of call, length of call, operator busy statistics, and type of call can be captured. With signaling systems, the same information can be obtained, plus information on response time.

Remote Programming is an important feature in the flexible design of current call box systems; the reprogramming can be done by a technician in the field, as well as through the same communications network that supports the call box systems. All boxes in the system can be remotely programmed for changes in report times, a new or alternative number to be called, masking of alarms, number of redial attempts, intervals between report, call-back time, and up to nine different call box operational personalities.

Implementation Issues

Prior to implementing a call box system, one should consider the physical design of the system (i.e., spacing and location), the reliability of the technology and the implementation and on-going system costs.

The spacing and location of call boxes plays an important role in the success of the system. The decision of spacing between call boxes may depend on terrain, available revenue, urban/rural characteristics, historical accident rates, average daily traffic, and anticipated use. American Assoc. of State Highway Transportation Officials (AASHTO) provides guidelines for spacing and location of call boxes, and California has its own set of guidelines as well. Governing elements of the spacing and location of call boxes include cost and anticipated use. In California, the typical spacing for solar-powered cellular call boxes is between intervals of 0.4 to 3.2 km [3].

However, in areas where complex interchanges exist, motorist access should be emphasized rather than the spacing guidelines. In many cases, shoulder space to accommodate a stopped vehicle is limited when all available widths of urban bridges and tunnels are utilized for moving traffic. Spacing becomes less of an issue in rural systems, particularly on two-lane, non-limited access roads where spacing depends on pedestrian safety and limited communications coverage [3].

The reliability of the call box system is certainly an important issue in determining the effectiveness of the motorist aid system. The reliability of the call box system can decrease when units fail because of vandalism, deterioration due to the weather, and circuit problems caused by construction or maintenance operations (wireline system) or an ineffective maintenance program. A California study speculated that the removal of several call box systems in the U.S. has been related to inadequate operations and maintenance funding, inappropriate or unreliable technology choice, and a lack of attention to public information programs promoting the service.

The main purpose of having call boxes is to help motorists in both non-emergency and emergency situations. However, the benefits gained by motorists may depend heavily on the financial status of the public sector. Adequate funds are needed to purchase the call boxes, set up the communication networks, and support their ongoing operation and maintenance. Components selected on the basis of need and financial feasibility include (1) cellular service, (2) call answering/dispatching, (3) administration, and (4) maintenance.

The price for acquisition and installation of call boxes has dropped significantly since the 1980s because of competition, quantity purchases, and technological advancements.

CALL BOX SYSTEMS NATIONWIDE

Call box systems can be found in nearly half of the states. Five states (California, Delaware, Florida, Hawaii, and Rhode Island) have achieved or are planning for statewide coverage of call box systems on the Interstate highway system (some have call boxes on non-interstate routes as well) [1]. Table 1 shows the current call box systems in the U.S. More than 70 percent of the call boxes (~23,969) nationwide are voice type; the rest use push-button technology. Of the call boxes, 66 percent are cellular type call boxes. A few call box systems have been abandoned because of lack of use and high maintenance costs such the systems in Alabama and Connecticut. Minnesota is currently abandoning its call box system because of low usage and high maintenance costs.

The two largest statewide call box systems are in California and Florida. They differ in design purposes: the California system aims for full coverage in all highway environments with full highway patrol access, whereas the Florida system provides motorist aid communications on isolated rural Interstate highways. The two statewide call box systems were compared in an assessment report from California. Table 2 illustrates the similarities and differences of the two call box systems, technologies and program management. Both systems have been effective and successful because of active system management and an organized and funded maintenance program.

California's statewide roadside call box program has been proven successful and has been a model for many other roadside assistance programs. California's statewide call box program was formed in 1986 and is administered at the county/regional level by local Service Authorities for Freeway and Expressways (SAFEs). Today, over 15,000 call boxes have been installed in California covering 59 percent of total highway miles in 29 of California's 58 counties [4]. A report on the first 10 years of California's SAFE program, which assesses the call box program and proposes plans and prospects, has just been published. Below is an overview of its program highlights.

Table 1. Call Box Systems in the U.S

STATE	TECHNOLOGY	COMMUNICATION MEDIUM	NUMBER OF CALL BOXES	SPACING	FACILITY	RELATIVE USAGE RATE	PROGRAM NOTE
Alaska	Conventional Radio	Voice	4	10 Mi.	Highway/Rural	High	Desires to expand but wary about dispatcher overload
Arizona	Cellular Cellular	Voice Voice	12 14	1 Mi.	Interstate/Urban	N/A	Problems with battery charge
California	Cellular Hardwire	Voice Data	15,381 699	300 ft - 2 Mi.	Highway, Interstate/Rural, Urban/Bridges, Tunnels	High	User funded statewide program
Colorado	Push-Button Hardwire Cellular Cellular	Data Voice Voice Voice	37 54 9 103	1/2 Mi. - 5 Mi.	Interstate/Tunnel	50 calls/month/all 37 call boxes (1.4 calls/box/month)	Problems with radio frequency interference
Connecticut	Cellular	Voice	16	N/A	Interstate/Tunnel	N/A	270 call boxes abandoned Obsolete technolology, maint. budget cuts
Delaware	Push-Button	Data	150	1/2 Mi.	Interstate/Urban	N/A	Statewide Interstate system coverage
Florida	Push-Button	Data	2,742	1 Mi.	Interstate/Rural	High	Statewide program Estimated capital $6,400 - $10,000 per box Maint. budget $500/box/year

Table 1. Call Box System Installation in the U.S (Continued)

STATE	TECHNOLOGY	COMMUNICATION MEDIUM	NUMBER OF CALL BOXES	SPACING	FACILITY	USAGE	COST
Hawaii	Cellular	Voice	131	Irregular	Rural	4.5 calls/box/ month	Planning to expand to 457 call boxes by 1999
Illinois	Push-Button	Data	310	12 Mi.	Interstate/Suburban	N/A	Annual Maint. $90,000/yr
Louisiana	Push-Button	Data	338	1/2 Mi.	Interstate	1.4 calls/box/ month	Maint. cost $300/box/year
Massachusetts	Push-Button	Data	840	1/2 Mi.	Interstate	N/A	Upgrading program $6,506/box Maint. cost $202 /box/year
Michigan	Cellular	Voice	4	N/A	Interstate	7.5 calls/month/box	Randomly calling maint. computer when motorist tries to use system
Minnesota	Push-Button Push-Button	Data Data	90 37	1/2 Mi.	Interstate/Urban, Rural	1296 calls/year/ 90 call boxes (1.2 calls/box/month)	System being abandoned because of high maintenance costs
New Jersey	Trunked Radio Push-Button Cellular	Voice Data Voice	300 94 4	1/2 Mi.	Interstate	50-200 calls /month/94 call box (up to 2 calls/box/ month)	Statewide Interstate program
New York	Trunked Radio Cellular	Voice Voice	64 863	1/2 Mi. - 2 Mi.	Interstate/Rural	N/A	Maint. cost $ 540/box/year Maint. cost for Cellular $19.71/box/month

Table 1. Call Box System Installation in the U.S (Continued)

STATE	TECHNOLOGY	COMMUNICATION MEDIUM	NUMBER OF CALL BOXES	SPACING	FACILITY	USAGE	COST
North Carolina	Hardwire	Voice	22	1 Mi.	Interstate	N/A	Additional project cancelled due to funding priorities
Ohio	Cellular	Voice	30	1/2 Mi.	Interstate	N/A	N/A
Pennsylvania	Push-Button	Data	1,040	1 Mi.	Interstate	Various	Distinct seasonal trend - high during the summer
Rhode Island	Push-Button	Data	298	1/2 Mi.	Interstate	2 calls/box/ month	Annual maint. budget $200,000/298 call boxes
Texas	Cellular	Voice	118	Various	Interstate/Urban, Rural	350 calls/ month (3 calls/ box/month)	N/A
Wash. DC	Cellular	Voice	22	N/A	N/A	N/A	N/A
Washington	Celular Hardwire	Voice Voice	43[1] 100[1]	Various	Interstate/Rural, Urban/Bridges, Tunnels	2.7 calls/box/ month	Maint. Cost for cellular call boxes $100/box/year
TOTAL			23,969				

Source: Taken from "State of the Call Box Program," California Service Authorities for Freeways and Expressways Committee (CalSAFE), May 1996.

[1]The total number of call boxes in Washington has been updated to be 42/165 in this report.

Table 2. Comparison Between California and Florida Call Box Systems

CALIFORNIA SYSTEM	FLORIDA SYSTEM
Similarities	
Both are answered by the respective **highway patrol communications facilities** on a statewide basis.	
Both have **effective management** and **adequate maintenance** programs.	
Both systems have **decentralized maintenance**. California's maintenance is privately contracted, whereas Florida uses a combination of state and privately contracted maintenance.	
Both systems are experiencing an **ongoing growth** and **system expansion**.	
Both systems will provide essentially **statewide coverage** when fully implemented.	
Differences	
Uses common carrier facilities for communication	Uses private radio network for communication
Two-way voice	One-way data
Urban and rural	Rural
Ownership and operation at the county level	Ownership and operation at the state level
User-funded through DMV fees	Federal funds for construction State general fund for operations
Additional functionality from call box terminals may be realized	Already realizing additional functionality from its communications network

Source: Taken from an unofficial draft version of "The Nationwide Motorist Aid Assessment".

Operational Management

Perhaps the most distinctive feature of California's call box program is its user funding, which is provided through a $1 per vehicle annual registration surcharge imposed in each SAFE county to cover the purchase and maintenance of equipment and the ongoing operations of the call box system on Interstate highways, limited access state routes, rural non-limited access three- and four-lane state routes, and rural two-lane state routes. This $1 per vehicle surcharge also supports other motorist aid programs such as service patrols. California is the only state that has developed a county by county self-funding mechanism. As mentioned earlier, California's motorist aid systems are owned and operated at the county level. Management and staffing of the call box program for each SAFE is operated individually by county public works departments. Each public works department handles their own finances and contract with commercial vendors to install and maintain call boxes. Every two months, each SAFE organization shares information and resources and studies important issues with other SAFEs through the California SAFE Committee (CalSAFE), which consists of representatives from each SAFE. Caltrans and California Highway Patrol provide technical and operational support. To facilitate support, statewide guidelines exist to ensure statewide standardization and consistency. The responsibilities of the various state and local agencies involved in the program are clearly stated in the statewide guidelines [5].

Self-funding for the call box systems in California has helped the participating agencies to maintain the reliability of the call boxes by conducting preventive/corrective maintenance for component failures or malfunctions, knockdowns and vandalism. Furthermore, the degree of operation has been enhanced by the provision of adequate financial assistance for response agencies; the response centers are well staffed and have appropriate equipment.

ITS Applications (Smart Call Box Operational Test)

California realized early on that call boxes have potential for Intelligent Transportation Systems (ITS) applications. San Diego has initiated the SMART Call Box Field Operational Test, which is testing a number of potential ITS applications on call boxes to evaluate the feasibility of using call boxes as surrogate ITS roadside controllers. The applications include: (1) traffic census taking, (2) hazardous weather detection and reporting functions, (3) real-time traffic measurements for incident detection, (4) changeable message sign control, and (5) closed circuit television surveillance, verification and control [6]. Future tests will include traveler information systems, automatic vehicle location, weigh-in-motion detectors, vehicle speed determination, and vehicle exhaust emission measurement. The report, "The Smart Call Box Field Operational Test" more fully documents each of the subtests. Although the SMART Call Box Field Operational Test is not yet complete, other California SAFEs have already began deployment of ITS technologies with call boxes.

Call Box Usage

In California, call volumes peak during the rainy season and during the tourist-heavy summer months in some areas. The average monthly call box calls in California is estimated to be 7.4 calls per box (ranging from 1.7 to 9.7 calls per box). In general, most calls request service during the day.

Location

In California, concerns have been raised for the safety of drivers who stop their vehicles on the left-hand shoulder or on the side of a median HOV lane and attempt to cross the main freeway lanes to reach a call box.

In a study done to determine the advisability of installing call boxes in medians or adjacent to median HOV lanes, the following were investigated: the safety implications of installing or not installing such call boxes, the experience and concerns of existing call box providers and law enforcement personnel, and the potential cost of such installations.

Administrators of SAFEs, call box vendors/consultants to SAFEs, and Caltrans headquarters/district personnel and administrators involved in the call box program were interviewed for their experience and concerns on this matter as well. The study found that (1) the number of people struck while attempting to cross freeway lanes to access call boxes was exceedingly small, (2) the costs of call boxes are quite modest in comparison to alternative means of providing motorist assistance, and (3) installation of call boxes in median areas is not warranted except in the case of barrier-separated HOV facilities where there would otherwise be no access to motorist assistance services [3].

Accessibility

All California call boxes have been built following general guidelines regarding telephone handset design, cord length, and box height. Ventura County took a step further in addressing accessibility for the mobility impaired. The SAFE's Accessibility Committee and the SAFE Board agreed to implement two major components to deal the accessibility issue: distribution of portable cellular telephones for the mobility impaired and development of a TDD call box for the hearing impaired [7].

Cost

The average annual operating cost is approximately $950 per call box unit.

- **Cellular service.** Because of mutually beneficial agreements, cellular network access has become the most affordable communications medium.
- **Call answering/dispatching.** Legislation requires that all call box calls be answered by the CHP. Cost for time devoted to handling calls and equipment have been determined so that each SAFE can pay the CHP to process call box calls.
- **Administration.** The costs include program staff salaries, legal and professional services, liability insurance, and error and omissions insurance.
- **Maintenance.** Costs are associated with twice-a-year preventive maintenance, ongoing corrective maintenance, knockdowns (3 to 7 percent a year by vehicles), and vandalism (graffiti). Maintenance plays a major role in keeping the whole

program functional (see financial section). If a call box is down and not fixed as soon as possible, the impact on reliability may be substantial. In fact, ineffective maintenance planning and funding is one of the reasons that some programs have failed. Maintenance costs (per year per box) for California range from $85.06 (Los Angeles) to $213.12 (Ventura).

As noted earlier, the cost of the installation, operation and maintenance of a roadside call box system in California is supported by the $1 fee on every registered vehicle. The cost of providing basic cellular service is typically $10/month per call box, 10 cents per minute, including 30 to 60 free minutes per call box. The overall rate is one-third to one-fourth of what a regular mobile subscriber pays, in exchange for which cellular providers benefit from being associated with a popular public program.

In California, prices including installation are now between $3500 to $4500 depending on the call box configuration. A Minnesota study noted that with recent improvements in cellular system cost and reliability, expansion of the current coded message system would cost more than installing a new cellular system. Typically, installation alone costs about $600 to $1,000, depending on whether additional work is required, such as a cut or fill with special installation.

For comparative purposes, maintenance costs (per call box per year) for several different systems are illustrated in Table 3 [1]:

Table 3. Examples of Maintenance Cost (per call box per year)

STATE	Maintenance Cost
California	from $85.06 (Los Angeles) to $213.12 (Ventura)
Florida	$250; however, budget allows $500
Illinois	$290 (including call box, base station, and answering center console)
Louisiana	$300
Massachusetts	$202

FORMAL CALL BOX SYSTEM EVALUATIONS

A measure of the success of the total system is the cost-effectiveness ratio. Measures of effectiveness include (1) reductions in delays and notification times, (2) level of service benefits (i.e., enhancement in State Patrol efficiency, providing public convenience, and improved safety), and (3) health benefits (i.e., decreased ambulance notification time in aiding motorists involved in accidents or requiring medical care). These time-related events are hard to quantify without cooperation from public safety officials involved in an incident. Currently, no substantial cost effectiveness analyses have been performed for major motorist aid system installations. However, the Minnesota Department of Transportation examined the cost effectiveness of their call box system.

A benefit-cost analysis performed on the 19-mile call box system in the Minneapolis-St. Paul metropolitan area by Minnesota DOT produced a ratio of .61 on the basis of a reduction in delay time (congestion reduction) only.

The purpose of this pilot call box program in the Twin Cities metropolitan area was to help address problems resulting from nonrecurring congestion by speeding the identification, response, and clearance of incidents. The project was able to compare the status before and after the implementation of the call box project during the first 12 months for the 90 call boxes along a 22-mile stretch of I-35W between Minneapolis and Forest Lake. The estimated average time for incidents remaining on the freeway for the motorists who used the system was reduced by 33 percent in the urban area and by 72 percent in the rural area. The evaluation found that the program was more successful when viewed as a public safety motorist aid device rather than a means of congestion mitigation. Table 4 provides the evaluation parameters and results from the Minnesota motorist aid call box evaluation. However, in spite of the positive benefits reported, the system is being abandoned due to lack of use and high maintenance cost.

A study by Hesse and Stobbe for the California Highway Patrol (CHP) in 1995 reviewed Cellular 9-1-1 and Call Box Operations within the CHP communications system

Table 4. Minnesota's Motorist Aid Call Box System Evaluation Results

CATEGORY	PARAMETERS	RESULTS FROM MINNESOTA
Usage	• % of all call box calls by type	Service only - 62% Patrol only - 27% Service and Patrol - 5% Patrol and Medical - 4%
	• comments logged by patrol dispatchers (car-assist, no-service, and accidents)	[37% of total calls are with comments] Gone on arrival - 12% Accident (property damage, injury, fatality) - 8.2% Call box user error - 4.7% Trooper assisted motorist - 3.5% Received calls from many sources - 0.4% Refusal to pay - 1.2% Motorist refused help - 1.1% Wanted own private tow - 2.9 % Found vehicle abandoned - 2.9% Vehicle fire - 0.2% Non-response by MSP - 0.2%
Statistics	• average calls per day • number of calls per box • call box calls by time/day/month	3.6 calls per day High call volume 3pm to 7pm Friday September & December
	• daily vehicle miles traveled When accidents occurred, motorists in the rural area used call boxes two times more often to report them than in the urban area.	Urban: 1 call per 373,000 DVMT Rural: 1 call per 203,000 DVMT [1 call per 65,000 DVMT in CA]
Incident Duration Time	• survey before and after system installation [time to contact help, avg. arrival to removal time, total time on freeway]	Urban: Total time on freeway reduced by over 16 min. (notification time reduced by 3 min) Rural: Total time on freeway reduced by 81 min. (notification times reduced by 43 min)
Public Acceptance	• Did you have any trouble using the call boxes? • How would you rate the service you received? • Do you think the call box should be kept as is, expanded, or eliminated?	73% had no trouble using the call boxes. 73% rate the received service as excellent/very good. 78% think the call box service should be expanded.
Benefit/Cost Ratio	•*Benefit* = State Patrol efficiency+Public Convenience/safety+Health Benefit • *Cost* = Capital+Maintenance+Operation	.61

and included participation by several of the major SAFEs within the state. Part of the study's data collection included a public opinion survey concerning call box and cellular 9-1-1 usage.

Most survey respondents (95 percent) have noticed call boxes along California's highways or freeways. About half responded that they would use a roadway call box to call for help if they saw or experienced an emergency situation. However, the survey revealed that only 26 percent of the respondents knew who answered the calls placed from the call boxes. Of all the respondents, 18 percent had placed a call from one of the call boxes. Most of these calls were for a personal breakdown or emergency (75 percent). The manner in which the calls were handled was rated by 68 percent as "very satisfied" and 21 percent as "somewhat satisfied".

REVIEW SUMMARY

The national review of call box systems revealed several interesting issues pertinent to this research effort. These issues are described below.

- Call box system design is variable depending on its **intent or goal.** Design factors include rural or urban, perceived needs for detection and/or assistance, and coexistence with other alternatives.
- California and Florida have demonstrated the importance of **effective management and adequate maintenance programs** in system success, regardless of the differences in technologies used (assuming reliable technology) and operation styles.
- Management is easier when **responsibilities** are well defined and agreed upon by each participating party, as seen in the California statewide program. Equally important, **communication** between responsible agencies and within each agency is essential.
- **Sufficient funding** (illustrated by California's user-funded method, and Florida's dedicated federal and state funds) is crucial for an ongoing maintenance program; it should be thoroughly explored when system expansion is considered.
- **Maintenance** is a critical element in a system's effectiveness; it affects the system's reliability in providing aid in a timely and economic manner.
- Ultimately, the success of the call box system is dependent on the **motorists' awareness and use of the system.**

CHAPTER 3
RESEARCH APPROACH

The intention of this project was to evaluate the usefulness of existing motorist aid call boxes, including (1) the level of effort required to monitor and maintain the system, (2) the frequency of call box usage, and (3) quantifiable and perceived benefits and drawbacks. A contact list was first developed to help pinpoint local and national sources of the information. Following a national review of call box systems, quantified information about call boxes in Washington was collected and summarized. Finally, a mail-out survey was distributed to determine the public's awareness of call boxes from general public and how those who have used them perceive their performance.

CONTACT LIST DEVELOPMENT

The first task in this project was to identify people locally and nationally who were familiar with call box operation in their service areas. The contact candidates were from state patrols, departments of transportation, and other agencies. This list helped in (1) identifying formal studies and other reference material nationally, (2) better describing technologies and issues of the systems, and (3) collecting Washington-specific data. The contact list is included as Appendix A.

NATIONAL REVIEW

The national review revealed that few formal studies have recently been conducted in the field of motorist aid call box systems. Most of the more complete studies were documented during the 1970s and in the early 1980s; only a small number of states have evaluated their systems since then. Unfortunately, these studies were performed on now out dated call box technology and often reported information in different formats because they used different evaluation criteria.

The purposes of reviewing other state-specific programs were to (1) compare methodologies and measures of effectiveness to gain a better understanding of the factors that may be important in describing system effectiveness and the methodology used to arrive at the results, and (2) use the findings based on their experience as a relative comparative measure of call box effectiveness in Washington State.

SYSTEM DESCRIPTION AND QUANTIFIED USAGE AND COST

Information obtained from the national review was used to plan the data collection efforts in Washington. Potential measures of effectiveness included the call box usage rate and the costs of installation, operation, and maintenance. Call box information including installation, maintenance, operation procedures and costs were collected through phone calls to and interviews with representatives from the Washington State Patrol (WSP), Washington State Department of Transportation (WSDOT), and other related agencies. Call box usage rates for all the cellular type call boxes were obtained from the maintenance computer located in the WSDOT electronic maintenance Shop.

The researchers also visited (1) all the major call box locations (i.e., floating and suspension bridges, tunnels, and near selected off-ramps), (2) the I-90 Tunnel Operation Center, (3) the maintenance shop of WSDOT's electronics department, and (4) the Tacoma Fire Department to learn the role of each in the operation of the call box system, talk about site-specific issues, and observe in-person some of the issues described in the literature and by contacts. Substantial information was gathered from field personnel descriptions of their experiences with the call box systems.

MAIL-OUT SURVEY

To gather usage rates and information about perceived benefits, the public was surveyed regarding their attitudes toward and experiences with call boxes. To both understand public awareness of boxes and obtain users' evaluations of the performance of the boxes, two sampling methods were developed.

To understand public awareness of call boxes, 956 random license plate numbers were obtained along the routes that have call boxes. Addresses were obtained through a special agreement with the Washington State Department of Licensing (WSDOL).

Determining a method for sampling motorists who may have actually used a call box was more difficult. Because the WSP does not keep specific information on call box usage, the researchers targeted people who were assisted on the roadway in hopes that a high proportion of these people requested assistance using call boxes. The Washington Incident Response Team (IRT) incident report logs containing information about motorists who have needed assistance from the IRT were used. 191 mail-out surveys were sent out to this target group, whose addresses were obtained through the special agreement with the State of Washington Department of Licensing.

All participants were asked questions such as (1) whether they were aware of call boxes, (2) whether they recognized call boxes were for public use, (3) whether they had used a call box, (4) if so, how they perceived the performance of call boxes, and (5) whether they would like more public education about call boxes. Information obtained from the mail-out survey was then analyzed and integrated into the report.

CHAPTER 4
CALL BOX SYSTEM OPERATION IN WASHINGTON

This chapter describes characteristics of Washington's call box systems including system descriptions, ownership, monitoring responsibilities, and system maintenance for both wireline and cellular call box systems. Recommended improvements to future system are also described.

SYSTEM DESCRIPTION

The two primary call box systems in the Puget Sound Region are on the I-90 floating bridge from the Mt. Baker tunnel to the Mercer Island tunnel, and across the SR-520 floating bridge. Other call box systems in the state are on the Tacoma Narrows Bridge, the "Blue Bridge" in Pasco, and near selected off-ramps on I-405 between Bothell and Renton and on I-90 between Bellevue and North Bend (as depicted in Figure 1 earlier in this report). The operations of the Blue Bridge call boxes was not studied for this report; data was not readily available.

Two types of call box technologies exist in Washington state: (1) a hardwire land-line or wireline system on the I-90 bridge and tunnels and the Tacoma Narrows Bridge, and (2) a cellular-based system on SR-520 and near selected off-ramps on I-405 and I-90. All systems are in urban areas except for a few off-ramps in rural areas. The characteristics of the call boxes in these locations are described in Table 5.

Since 1992, 165 total wireline call boxes have been placed in the I-90 tunnels and on the I-90 floating bridge. There are also 26 total call boxes on the Tacoma Narrows Bridge which were placed in 1965 and upgraded in 1985. A total of 32 cellular call boxes exist along the SR-520 floating bridge since 1993. Ten cellular call boxes have more recently (in 1995) been placed near select off ramps on I-405 and I-90. For the bridge and tunnel structures on I-90, call boxes are placed on both sides of each direction of the roadway. The other call boxes are installed only on the right side shoulders.

Table 5. Characteristics of the Existing Call Box Systems in Washington

Highway	**I-90**		**HWY 16**	**SR-520**	**I-405**	**I-90**
Location	**Tunnels (Mt. Baker and Mercer Island)**	**Floating Bridge**	**Tacoma Narrows Bridge**	**Evergreen Floating Bridge**	**Off Ramps (Bothell to Renton)**	**Off Ramps (Bellevue to North Bend)**
Number of cb	133 plus 5 on ramps	27	26	32	4	6
Length (miles)	1.07	1.9	~ 1 mile	4	19	19
Spacing	.01 - .11	.17 - .47	500 ft	1/4 mile	5 - 7	2 - 7
Year in Service	1992	1992	1965 upgraded in 1985	1993	1995	1995
Communication Medium	Wireline	Wireline	Wireline	Solar Cellular	Solar Cellular	Solar Cellular
Communication Format	Voice	Voice	Voice	Voice	Voice	Voice
Owner	WSDOT	WSDOT	WSDOT	WSDOT	WSDOT	WSDOT
Response	WSP	WSP	Fire Dept.	WSP	WSP	WSP
Maintenance	WSDOT	WSDOT	Fire Dept.	WSDOT	WSDOT	WSDOT

Wireline System (unshaded)

Cellular System (shaded)

Wireline Call Box Systems

Recall that the wireline call box systems in Washington are on the I-90 bridge and tunnels and on the Tacoma Narrows Bridge. Call boxes on most bridges and tunnels are closely spaced, and are often wireline because (1) cellular reception can be problematic in tunnels and (2) utilities (i.e. telephone lines) are more readily accessible. Through the I-90 tunnels, call boxes are located about every 300 feet on each side of the tunnels. Appendix B provides information on the exact location of each call box on I-90, including the station, milepost, and call box identification number. Wireline systems are typically costly to install, and ineffective maintenance may cause underground wiring to become damaged.

Problems experienced with the wireline phones on I-90 include the following:

- corrosion build-up on the internal circuit board inside the call box; the phone may quit working or will make false 911 calls
- doors left open and cords hanging out; the door does not have spring action to allow automatic closure and the long phone cord must be coiled to fit inside (see Figure 2)
- no central control is available; maintenance personnel have to check system operation by attending each phone to test its ability to call 911.

A noise suppressant technology was added to call boxes in the tunnel to improve voice quality by filtering out sound other than human voice.

Cellular Call Box Systems

The communications network for the cellular call boxes in Washington is provided through a cellular common carrier (AT&T Wireless). The maintenance and installation problems inherent with wireline call box technology are eliminated by using a cellular transceiver to provide the communications link between the call box and the cellular telephone network. Cellular call boxes are portable; they can be moved without removing or installing external wire. However, cellular call boxes may lose utility when cellular sites get saturated or when a high volume of calls are trying to get through. To provide a degree of public safety override, coordination with the call box provider and the cellular common

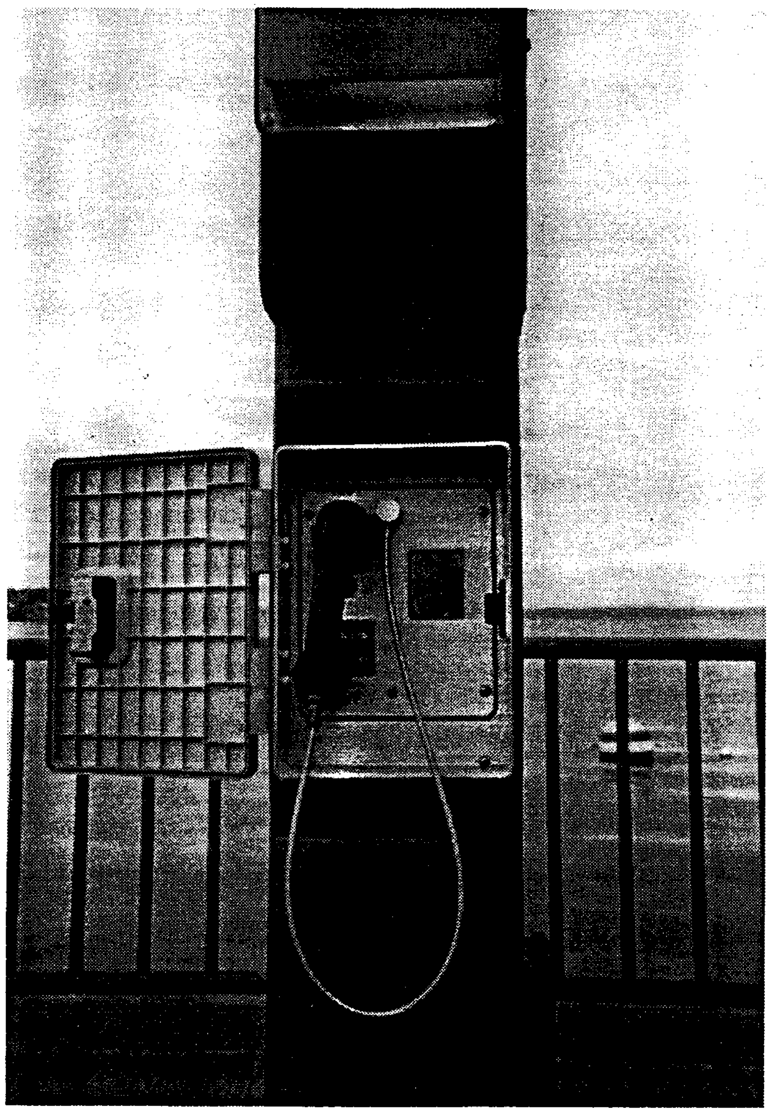


Figure 2.   Design Problems with Wireline Call Boxes

carrier can result concerning the comment on cell sites prevent call box calls from being dropped due to overload.

The cellular call boxes, which are bright yellow, are made of a strong material called Lexan polycarbonate that is resistant to rust and corrosion (this material is also used in making football helmets, underwater oceanographic devices, automobile bumpers, and truck bodies). The call box is mounted on a bridge wall or pole capped with a solar panel and antenna, as shown in Figure 3. The assembly also includes a slip base, which allows the entire call box structure to break away on impact.

The front panel of the call box consists of a handset, a push button, a panel light, and instructions for using the call box. Inside the cellular call box is a cellular transceiver, a controller board, a power distribution charger board, and a sealed lead-acid battery. The cellular transceiver provides the communication link between the call box and the cellular telephone network; it can be programmed to call different destination phone numbers (e.g., 911 or a maintenance computer) using a local carrier and an antennae located at the top of the pole. The controller board is the brain of the call box. It monitors the internal and external operations of the phone, stores usage information, communicates with the maintenance system, and provides a number of programmable features. The power supply board takes power from the solar panel and battery and redistributes the power to the cellular phone and the controller board.

OWNERSHIP

All call boxes in the state of Washington, both wireline and cellular, were purchased and are owned by the Washington State Department of Transportation. Acquisition of the call box system occurred incrementally, beginning as early as 1965.

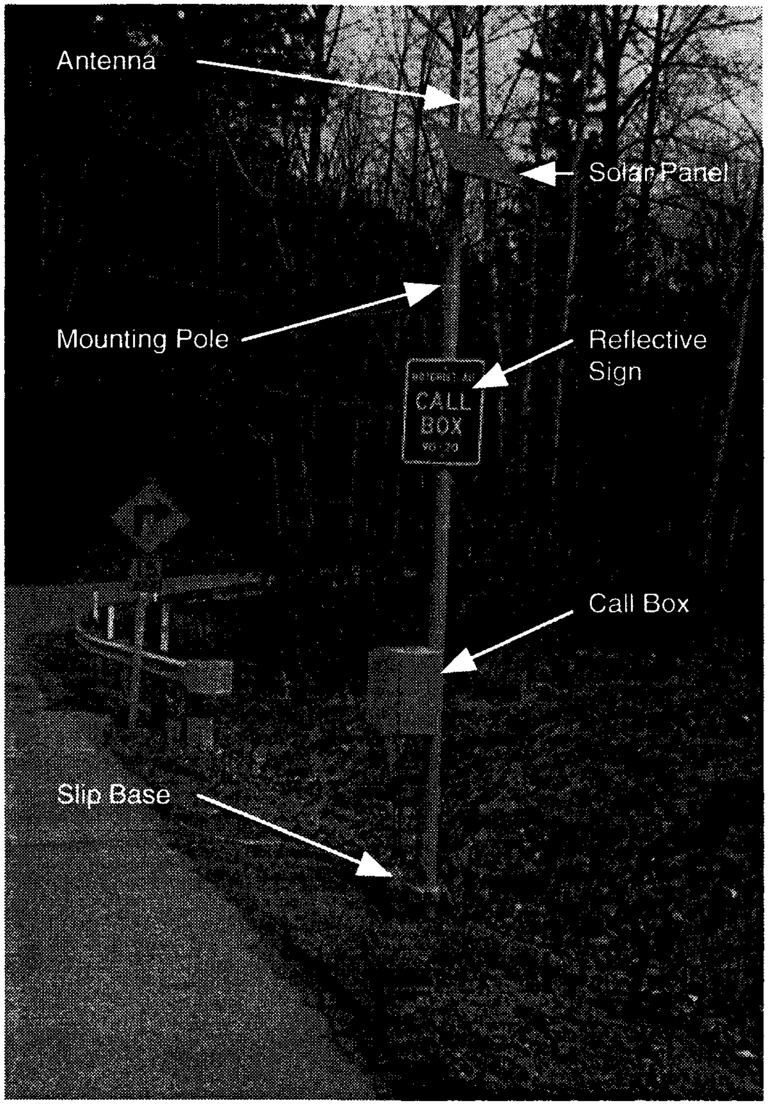


Figure 3. Example of Pole-Mounted Cellular Call Box Assembly

The two largest call box systems in Washington, along I-90 and SR-520, were implemented concurrently with other bridge-related projects. Call box expansion to off-ramps (ten cellular call boxes were installed near selected off-ramps on I-405 and I-90) was initiated through public request. Residents near interchanges that had no public phones nearby complained that disabled motorists were knocking on their doors at all hours looking for a phone. Because installing call boxes was viewed as a safety improvement for motorists and the nearby residents, and because funding was available, all of the interchanges on I-90 and I-405 in the Northwest Region that did not have public phones nearby were identified, and a single call box was installed at each location.

MONITORING

Call box system monitoring consists of receiving assistance requests from motorists and routing the call to the appropriate response agency, typically, the Washington State Patrol. Ideally, call box monitoring should take place concurrently with other motorist aid or incident management strategies in a centralized location (i.e., a traffic control center or a communications center).

Existing monitoring responsibilities do not warrant additional dispatchers. However, if the call box system is expanded, workload for the dispatch personnel is expected to increase.

Wireline Call Box Systems

The I-90 Tunnel Operations Center (TOC) serves to monitor the call box system on the bridge and in the tunnels. Call box calls are routed to the Washington State Patrol (WSP) via the WSP 911 dispatcher. When a call box has been activated, the call box system notifies the TOC operator with (1) a flashing light above the console, (2) the location of the call box on the appropriate console graphics screen, and (3) the call box system in the control room.

Although I-90 TOC operators are not able to monitor a call box call, they can assist the WSP by utilizing the surveillance system (CCTV) to visually observe the scene on the bridge or in the tunnels although visibility is sometime poor at night.

Motorist aid calls originating from the Tacoma Narrows Bridge call boxes are directed to the Tacoma Fire Department's Communications Center. From this center, requests for response are either routed to the WSP or internally for fire-related response.

Cellular Call Box Systems

The location and identification information for all the cellular call boxes are provided in Appendix C. Currently, cellular call box calls are routed through the cellular telephone network by the Public Switched Telephone Network (PSTN) to (1) the WSDOT maintenance center, and (2) the WSP 911 dispatch center. Figure 4 illustrates the call routing process. All cellular call boxes have designated Automatic Number Identification (ANI) intended to simplify identification for service providers, the dispatch centers, law enforcement officers, and the motoring public. The motorist must identify his/her location based on information located within the call box and on the sign; the automated location reporting capability is not currently available to the WSP dispatcher. However, the WSP dispatch center is pursuing the possibility of obtaining the automated location identification service. One possible option is to utilize a low cost device which displays up to six digits based on the tonal information received from the call box. A manual look-up book can be made to match the tonal information with site maps and specific call box numbers.

With the cellular call box systems, dispatchers have limited control over the call box units. Using a standard telephone keypad, dispatchers can perform the following call box-related functions:

- raise or lower the call box handset volume
- extend the call box call time duration
- place a call box on standby for later call back
- call back a call box on standby
- terminate a call box call.

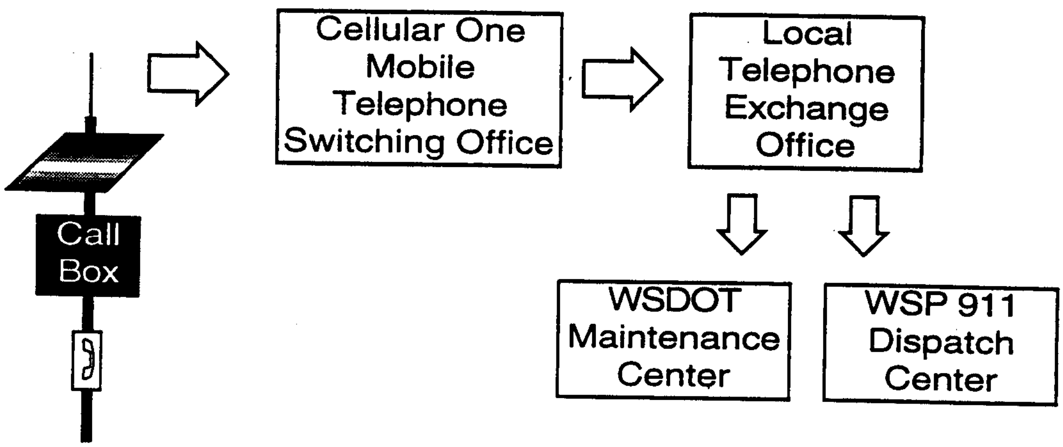


Figure 4. Call Box Call Routing Process
Source: Taken from "SR-520 Roadside Emergency Call Box System Manual." WSDOT, prepared by GTE Information Services, Inc.

MAINTENANCE

Generally, the priority for maintaining call boxes is low except when the call box impedes motorist safety (e.g., a call box pole falls in the middle of the road or call boxes tie up 911 with "ghost" calls). Currently, one WSDOT Maintenance employee is responsible for maintaining all of the wireline call boxes on the I-90 tunnels and bridge and all of the cellular call boxes in addition to his/her regular duties. Similarly, one Tacoma Fire Department, Electrical Maintenance Division employee is responsible for maintaining the wireline call boxes on the Tacoma Narrows Bridge.

No special training for call box maintenance is provided. Maintenance personnel are trained on the job and through contact with the manufacturer and other parties involved in call box operation (i.e., 911 and tunnel workers). From a maintenance viewpoint, existing personnel and funding for call box maintenance are adequate; however, system expansion requiring installation or upgrade would require additional personnel and funding.

Wireline Call Box Systems

The wireline call boxes on the I-90 tunnels and bridge are maintained by one WSDOT Maintenance employee who is also responsible for maintaining all of the cellular call boxes in addition to his/her regular duties. The wireline call boxes on the Tacoma Narrows Bridge are maintained by one maintenance employee from the Tacoma Fire Department; maintenance expenses for this system are provided through the WSDOT Highway Maintenance Fund.

The operation of the Tacoma Narrows Bridge call box system is tested twice daily. Every phone is tested every 60 days to achieve 100 percent reliability. The system has not experienced any major problems or vandalism; only routine wear and tear from bridge vibration and weather. Voice quality is sometimes poor with moving traffic and wind.

Cellular Call Box Systems

As stated previously, one WSDOT Maintenance employee is responsible for maintaining all of the call boxes, both wireline and cellular in WSDOT's Northwest Region. The effort expended for call box maintenance is estimated to be only 5 percent of a single worker's total responsibilities, which include repairing cameras and variable message signs on freeway and highways. This 5 percent equates to approximately 8 hours per month maintaining call boxes.

Maintenance of the cellular call box system is more automated than that of the wireline system. A maintenance center keeps cellular call boxes virtually 100 percent operational through the use of a computer database to record complete, near real-time alarm information on the entire cellular call box system. Two main computers are employed in the maintenance of the cellular call box systems: (1) the "watchdog" computer and (2) the maintenance computer. The cellular call boxes are programmed to call both the watchdog computer, located at WSDOT's Traffic Systems Management Center or TSMC (where WSDOT's dispatch operators monitor traffic 24 hours a day), and the maintenance computer, located at the signal shop.

The purpose of the watchdog computer is to ensure quick response to any problem that would prevent the call box from calling 911. If an alarm is sent to the watchdog computer, the telephone will ring up to 25 times. If no one answers, the call box will call back in 4-hour increments. To receive the message from the call box and have it displayed on the computer monitor, the operator has to lift the handset and press the green "Answer" button. Then dispatch operators can report the problem, which can be attended to immediately.

The maintenance computer keeps track of the alarms and usage information that is received, as well as updating call box programming. All the call boxes report to this computer every night. The computer tracks each call box with an assigned Automatic Number Index (ANI). The computer can monitor up to 1000 ANIs. It automatically prints out reports daily at 7:00 AM to ensure the phones are working properly or to indicate a problem. However, if a call box calls in for any reason, the call is immediately printed out by ANI number, time of call, and problem reported. The reports are saved for 62 days.

Cellular call boxes provide ten programmable features that can be treated as major and minor alarms. The alarm priorities can be adjusted. Currently, the following alarm types are programmed as high priority and will report immediately: (1) tilt alarm (if the phone is moved more than 45 degrees in any direction), (2) handset cord cut, and (3) inner door switch (after 5 PM). Five other alarms are less critical to system operation and are only reported during the nightly call in. Two more alarms are for informational use only (see Table 6).

Some vandalism has been noted with the cellular call box systems. In January 1996, a call box unit, including the top-mounted solar panel, was stolen from its location. Figure 5 depicts the remaining structure.

RECOMMENDED IMPROVEMENTS

Operation of the current call box system in Washington has resulted in a number of noted improvements for future systems. These recommended improvements are described below.

The location of the call boxes should be highly visible. Potential danger exists when the visibility of a call box is obstructed, such as under an overpass or where the call box is surrounded by bushes. Such decreased visibility could increase the danger to stranded motorists. Curbing or a raised concrete pad could increase the safety of the motorist; if a vehicle inadvertently leaves the roadway, the curbing or cement pad could prevent the exposed motorist from being hit.

Call box signing should be easy to identify and facing oncoming traffic. Note that in Figure 6, the sign is placed in a way that makes the call box hard to identify, and the motorist must turn his/her back to oncoming traffic to use the call box decreasing their level of safety.

Table 6. Report Program Personalities

ALARM OPTIONS	DESCRIPTION
Immediate Report	
TILT	This alarm is activated when the call box has been tilted greater than 45 degrees from vertical in any direction (using an internal tilt switch).
HANDSET	This alarm is activated when the handset stops working or is removed or cut.
INNER DOOR	This alarm is activated when the access to the inner box, the electronics compartment, is opened for an extended period or after 5 PM (after normal working hours).
Nightly Report	
SOLAR PANEL	When the solar panel's voltage is too low to keep the battery charged.
CONTROLLER-BITE	When the program in the phone senses an internal problem while using its self test to continually check its own operation.
BATTERY	When the voltage level of the battery indicates low capacity.
LAMP	When the display light will not turn on.
OUTER DOOR	When the outer door stays open for a defined period(set by the software).
For Information Only	
PROGRAM	This alarm shows up only on the reports and shows that the phone's program was updated by the maintenance computer.
CELL ERROR	Occurs because an option is not installed that would prevent this (there is a internal counter that, if not reset properly, will give this error when a certain number of counts are achieved. The means of resetting this was not purchased). This alarm should be ignored.

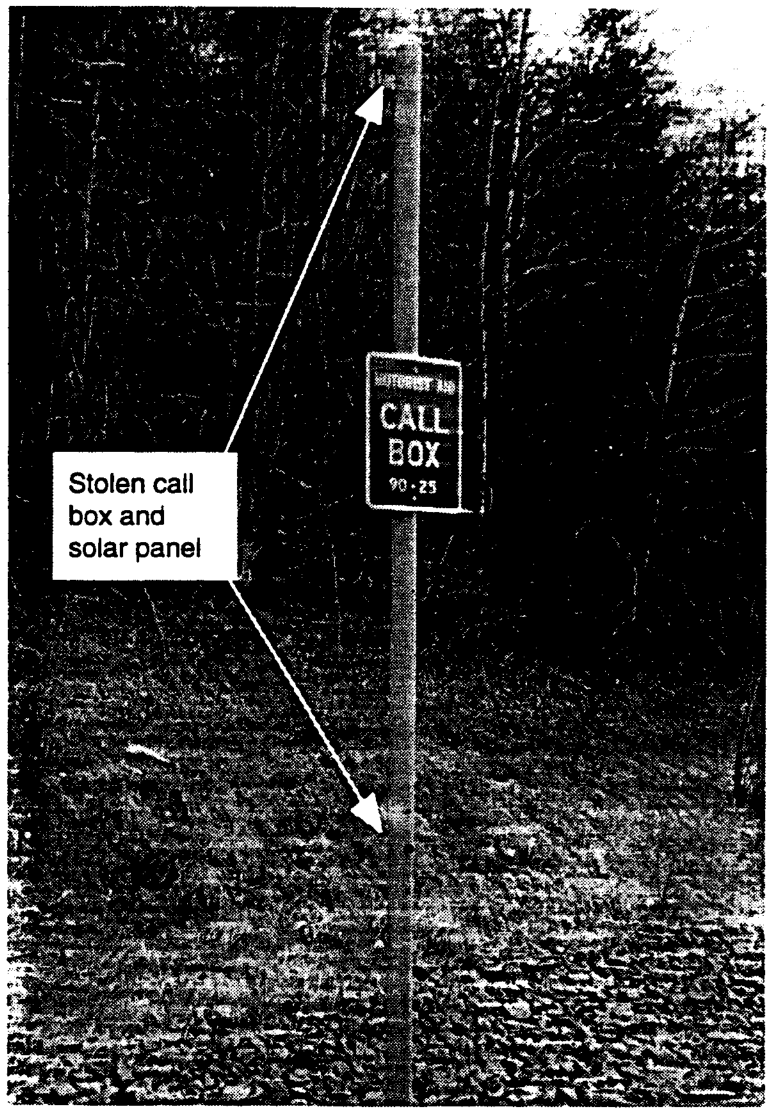


Figure 5. Call Box Vandalism - Theft

Figure 6. Call Box Safety Concerns and Signing Issues

Figure 7 emphasizes the importance of proper sign sizing. The size of call box signs should be adjusted to provide sufficient visibility.

Call boxes should be easily accessible. Some call boxes are widely spaced or located off the freeway, so that motorists have to walk some distance to request help. This increases their exposure time to traffic and decreases their level of safety. Call boxes located near off-ramps are not recommended. Pedestrian safety is compromised by exiting traffic when crossing the off-ramp to reach a call box. Further information regarding call box system design issues are discussed in the call box and motorist aid guidelines developed by the California Highway Patrol and Caltrans.

Figure 7. Call Box Signing with Poor Visibility

CHAPTER 5. QUANTIFIED USAGE AND COST INFORMATION

The evaluation revealed limited historical data related to call box usage rates in Washington. Information on all the cellular-type call boxes is available; a maintenance computer is used to record usage statistics and to monitor the status of the call boxes to achieve a nearly 100 percent reliability rate. Information is available on the Tacoma Narrows Bridge wireline system; no records are kept for the larger wireline call box system on I-90 between the tunnels. The system on the Blue Bridge in Pasco is relatively small and isolated, and the data are not readily obtainable. Because usage and maintenance information was more complete for the cellular-type call boxes, and because current trends suggest that cellular call boxes may dominate the market (cellular boxes can be uprooted and put in any location where a cellular site exists), this evaluation focuses on the SR-520 system and call boxes on selected off-ramps on I-90 and I-405.

Detailed statistical data related to call box usage and costs were available for only the 42 cellular call boxes. Detailed usage records were not available for wireline call boxes and only limited cost data was available. Data collected for a one-year duration (April 1, 1995 to March 31, 1996) was analyzed. The usage and cost results are described below.

USAGE

Usage rates for the cellular call box systems on SR-520 floating bridge and selected off-ramps on I-90 and I-405 are reported as the total number of calls, calls by season, calls by day of week, and calls by time of day.

Number of Calls

The maintenance computer registers two types of calls: 911 calls and report/alarm calls. During the year, there were 1,365 calls to the dispatch center (911 calls), or 3.7 calls per day, 2.7 calls per box per month, and 2.11 minutes per call. Other states' usage rates range from 1.4 calls to 7.4 calls. Comparatively, the usage rate of 2.7 calls per box per month for the cellular call boxes in Washington is consistent with other systems in the nation (see Table 1 for other systems). The number of report calls during that year was 14,468, that is, 344.48 report calls per box per year. On average, each call box made about 377 calls (the equivalent of 415 minutes), including 911 and report/alarm calls during this one year interval. Figure 8 shows the division of air time between report calls and 911 calls.

Figure 8. Call Time From April 1, 1995 to April 1, 1996

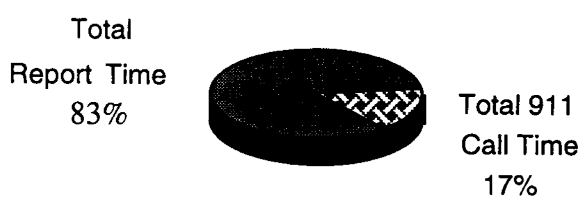
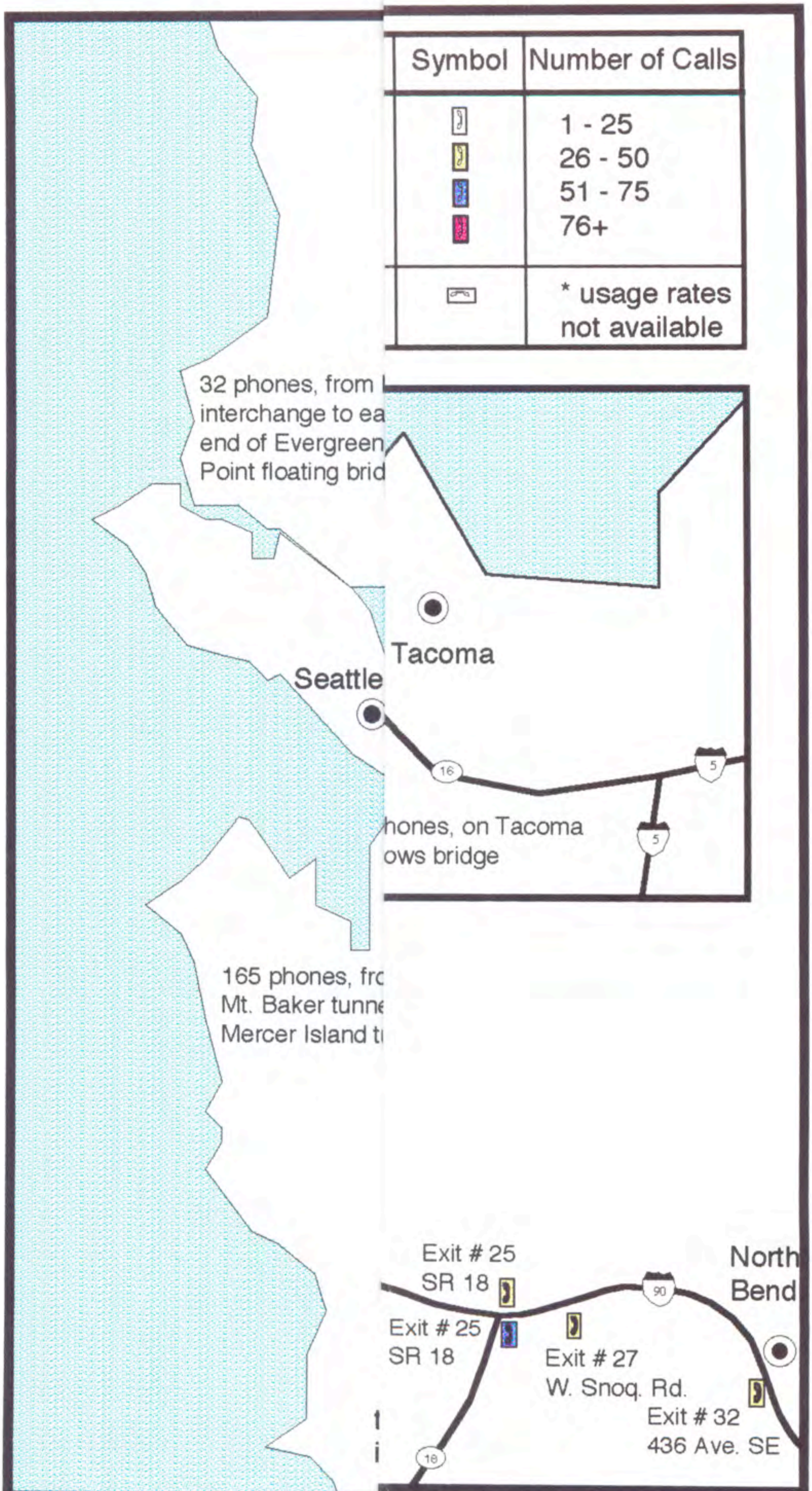


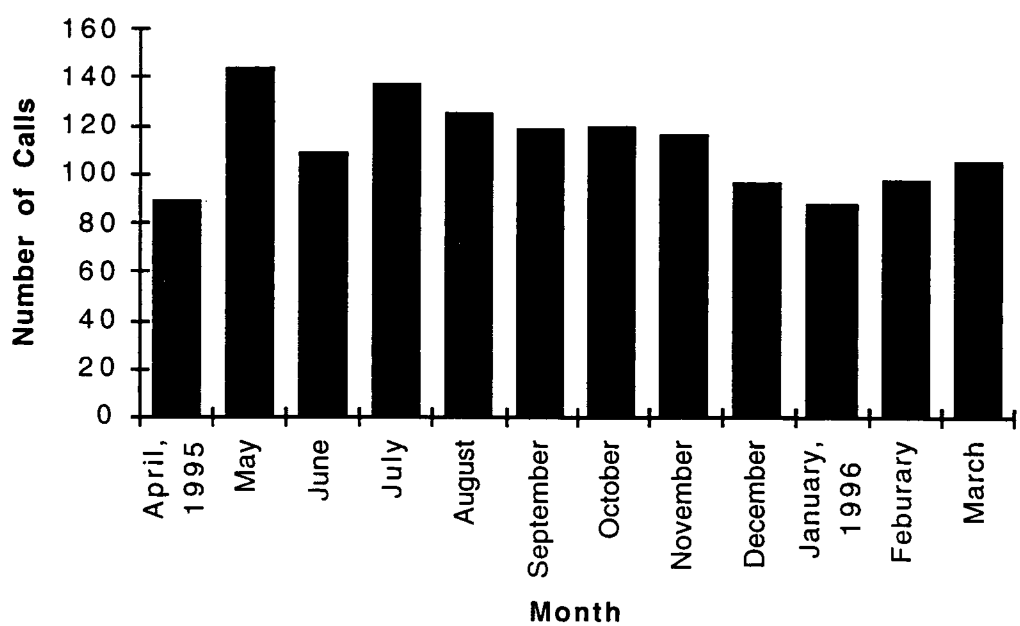
Figure 9 shows the locations of the wireline and cellular systems with the respective usage rates where data was available. The most frequently used phones on the Tacoma Narrows Bridge were #2 and #25, located at the ends of the bridge. Of all the cellular call boxes, the most frequently used call box (177 annual calls) was on westbound SR-520 on Foster Island. The next busiest call boxes were near the off-ramps of I-90 and High Point Road (142 annual calls), and I-90 and Coal Creek Parkway in Bellevue (87 annual calls). The call boxes near the off-ramps of I-90 and I-405 were relatively busy in comparison to the call boxes on SR-520. Many of the call boxes on SR-520 had low usage rates (in comparison to other call boxes, some as low as 25 calls), especially from the Roanoke area to Portage Bay to the Montlake interchange. Higher usage rates were noted where pull-out space is available for parking, such as at the midspan and at the end of the floating bridge (i.e., Foster Island).


Symbol
Number of Calls
1 - 25
26 - 50
51 - 75
76+
* usage rates not available
32 phones, from
interchange to ea
end of Evergreen
Point floating brid
Tacoma
Seattle
16
5
5
hones, on Tacoma
ows bridge
165 phones, fro
Mt. Baker tunne
Mercer Island tu
Exit # 25
SR 18
Exit # 25
SR 18
90
North
Bend
Exit # 27
W. Snoq. Rd.
Exit # 32
436 Ave. SE
18

Calls by Season

During this one-year interval, the frequency of call box calls did not vary significantly by month. The number of calls increased slightly during spring and summer, with the yearly peak in May (see Figure 10). The 10 new call boxes were installed during April 1995; the low usage rates in that month can possibly be explained by system setup adjustment.

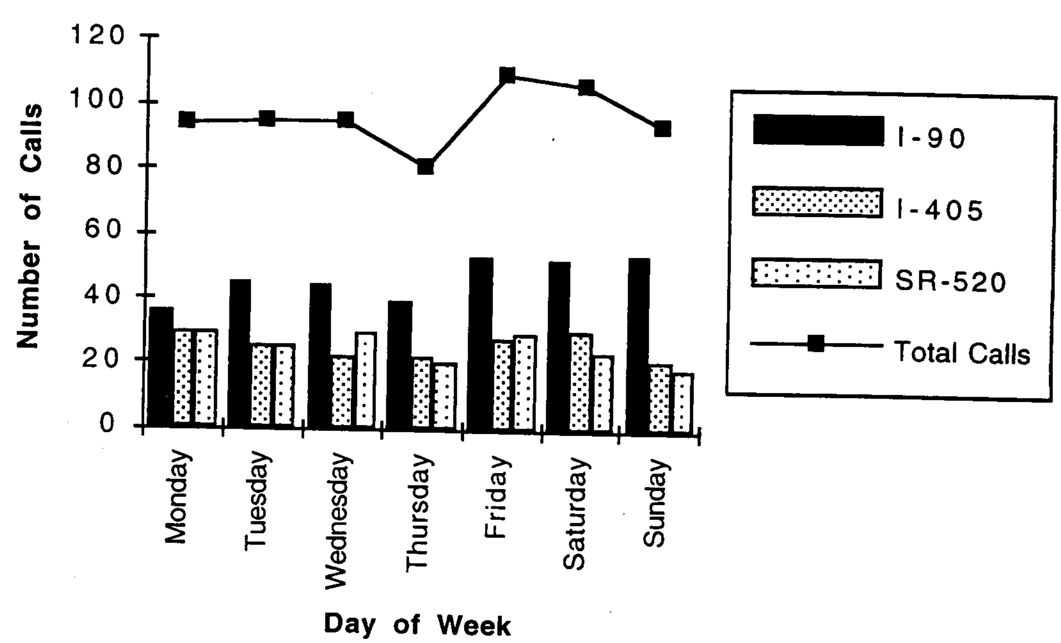
Figure 10. Calls by Season



Calls by Day of Week

The number of call box calls was highest on Fridays and lowest on Thursdays (see Figure 11). Call boxes on selected off-ramps on I-90 which extend from urban to rural area have a higher usage during weekend (Fridays, Saturdays, and Sundays). High usage rate was observed on Fridays as well as Mondays and Wednesdays for call boxes on the floating bridge on SR-520 which is a major commuting route between Seattle and the Eastside.

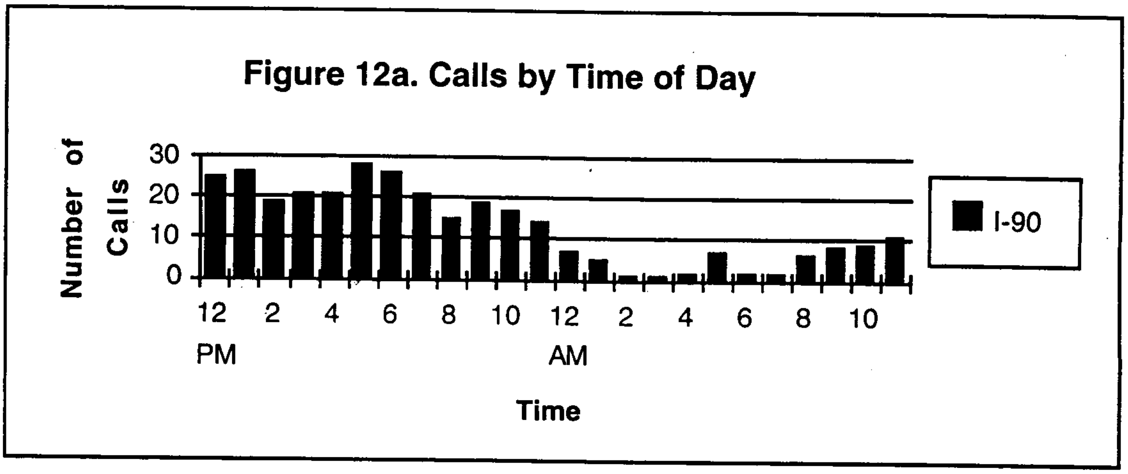
Figure 11. Calls by Day of Week

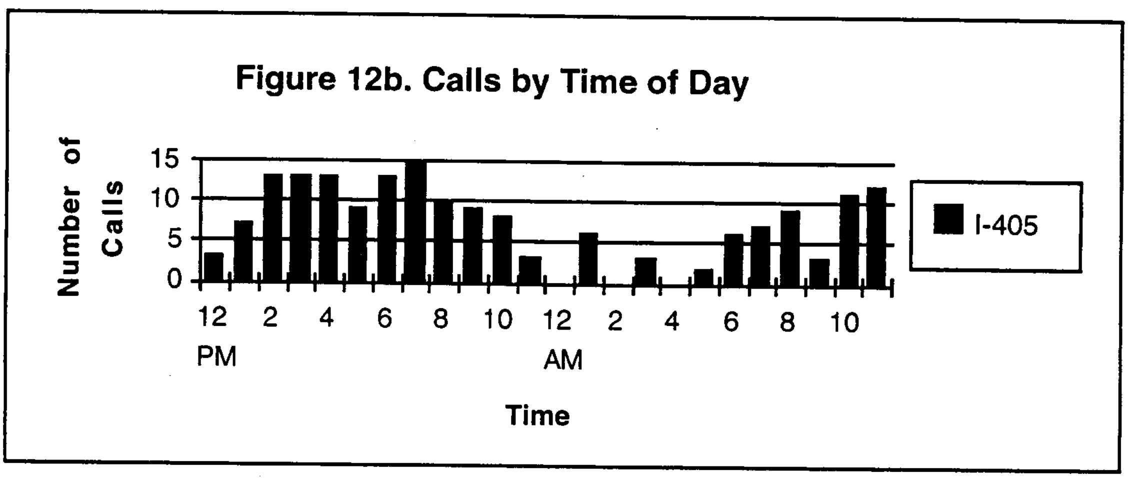


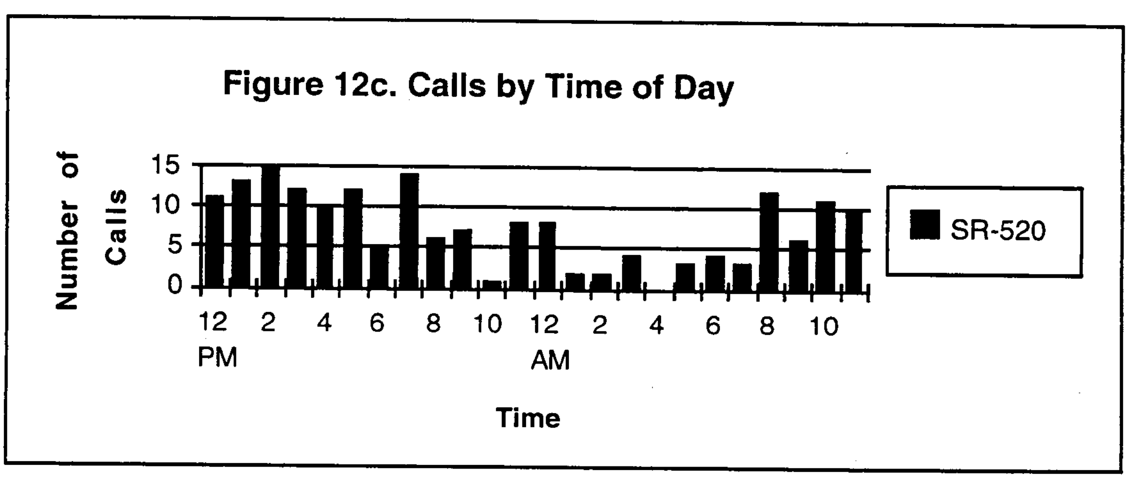
<u>Calls by Time of Day</u>

Figures 12a, 12b, and 12c show the call volume distribution throughout the day for all the cellular call boxes near the off ramps on I-90, I-405 and for a single call box with the highest volume on the SR-520 floating bridge (only a single call box on SR-520 was considered in the time-of-day distribution because the volume of calls was high and the data was tabulated manually from telephone bill records).

Similar patterns of use were found for most of the call box systems throughout the day. That is, call boxes are used at all hours of the day (even after midnight); call box usage starts to pick up from the morning peak hour period and starts decreasing after 6 to 7 PM. Afternoon call box usage tends to be higher than the morning usage. On SR-520, call volumes were higher from 8 AM to 7 PM, and lower from 1 AM to 7 AM. For the call box system on the floating bridge, the analysis revealed that multiple calls were initiated within a very short time (about 5 minutes) from the same call box; these calls were considered to be a single 911 call. All the cellular call boxes are programmed to call in during low usage of the cellular sites, which is between midnight and 7 AM.







COST

Currently, no dedicated fund is available for expanding the call box system and for maintenance in Washington. The cost of a cellular call box system can be divided into several components: (1) capital for installation (i.e., equipment and labor), (2) cellular phone bill, and (3) maintenance (i.e., to repair/replace parts). Because call volumes are not significant enough for the WSP to require supplemental staffing, there is no "additional" cost for monitoring the calls. There is also no apparent "additional" administrative cost. The cost breakdown is as follows:

Installation

The fund for the most recently installed 10 call boxes on I-90 and I-405 was from the state "Traffic Operations" fund, which is used for small signal, signing, and channelization projects to improve traffic flow and safety. All these 10 call boxes were purchased and installed by GTE. The call boxes on the SR-520 floating bridge were packaged with other projects. The installation was done through a contractor, who had a subcontractor buy them from GTE. It is hard to compare prices with the extra administrative layers; however, it is obvious that call boxes are cheaper when ordered in a large quantity, and the price is marked up when they are ordered indirectly. The maintenance computer is a standard IBM PC with a $600 special modem, which was set up in January 1994. It can keep the usage records for up to 1000 cellular call box units. In general, the cost for equipment and installation for cellular call boxes is about $3,500 per unit which does not include the cost of a personal computer.

Phone Bill

The yearly cellular phone bill is approximately $3,200 with a $6.35 average monthly cellular phone bill per call box. The peak usage rate is in June 1995 was $855.44 per month. If future cellular call box system expansion requires long distance calls, a "Toll Saving" feature, which cost $7.99 a month per phone, can be added to avoid long distance charges.

Maintenance

The funding for maintaining the call boxes is not specifically allocated. Because the call box system demands relatively low maintenance, due to the limited number of call boxes in operation, the money generally comes from sub sources such as that for miscellaneous electronic equipment from the Northwest Region's electrical/electronic department .

Of the total funds expended for call box maintenance, it is estimated that half is spent on the 42 cellular phones with the other half spent on the 165 wireline phones. The 42 cellular phones each have ongoing preventative (i.e., major cleaning every two years, minor cleaning every year) and corrective maintenance. The 165 wireline phones only receive corrective care. Although the wireline phones do receive corrective maintenance, costs are difficult to tie to a specific phone: many corrective maintenance measures affect the system simultaneously. The following maintenance cost estimates are reported for only the cellular system and does not include wireline maintenance costs. Washington's annual maintenance costs for 42 cellular call boxes are comparable to other reported maintenance costs (see Table 3). Maintenance costs (i.e., labor, equipment, and spare parts) are estimated to be $143 per year per call box.

Total Cost

For cellular call boxes in Washington, the total annual costs are again comparable to other area costs (see Table 3). Total system costs, based on 42 cellular call boxes, are provided in Table 7. The average annual system maintenance cost for wireline phones on Tacoma Narrows Bridge is $3,000 ($115 per year per box). Comparatively, the cost of phone bills plus maintenance for the cellular systems is $9,206 ($219 per year per box) excluding the cost of the phones.

Table 7. Total Cellular Call Box System Costs

Cost Component	$ Per Year Per Call Box		$ Per Year For 42 Call Boxes	
	Total	Averaged Over 10 yr. Life Span	Total	Averaged Over 10 yr. Life Span
Acquisition	$3,500	$350	$147,000	$14,700
Cellular Usage	$76		$3,200	
Maintenance	$143		$6,006	
TOTAL	$569		$23,906	

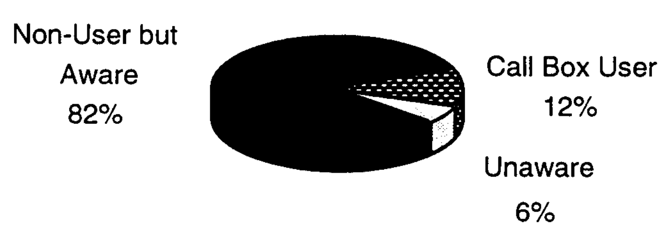
CHAPTER 6. MAIL-OUT SURVEY

The purpose of the mail-out survey was to determine public awareness of call boxes, the public's perception related to call boxes, and how call box users evaluate the performance of the call boxes. A copy of the mail-out survey can be found in Appendix D.

Among 1147 surveys that were sent out (956 from random sampling to survey awareness and 191 selected from the IRT database to target potential call box users), 254 (22 percent) surveys were returned. Of those respondents, 31 represented call box users, 207 were aware of call boxes but had never used them before, and 16 were unaware of call boxes (see Figure 13).

The percentages of male and female respondents were evenly distributed. Most respondents were between the ages of 31 and 45. Over 75 percent of the respondents were married. College or university was indicated by 42 percent of all the respondents as their highest level of education, and 32 percent had achieved post-graduate work.

Figure 13. Survey Response Rate



It is interesting to note that most respondents (94 percent) had already been aware that call boxes existed along some of the bridges, tunnels, and interchanges in Washington before participating in this survey. Most respondents became aware by noticing the signing at call box locations (see Figure 14). It is speculated that this sign recognition occurred along SR-520, between the tunnels on I-90, and on the Tacoma Narrows Bridge, and not from the off-ramp call box signs; the signs are more closely spaced along bridges and in tunnels and hence, may be more noticeable. Media advertising was shown to have minimal effect on public's recognition of the call box system. The results for each question in the survey is shown in Figure 15 presented within the layout of the original survey.

Figure 14. Call Box Awareness

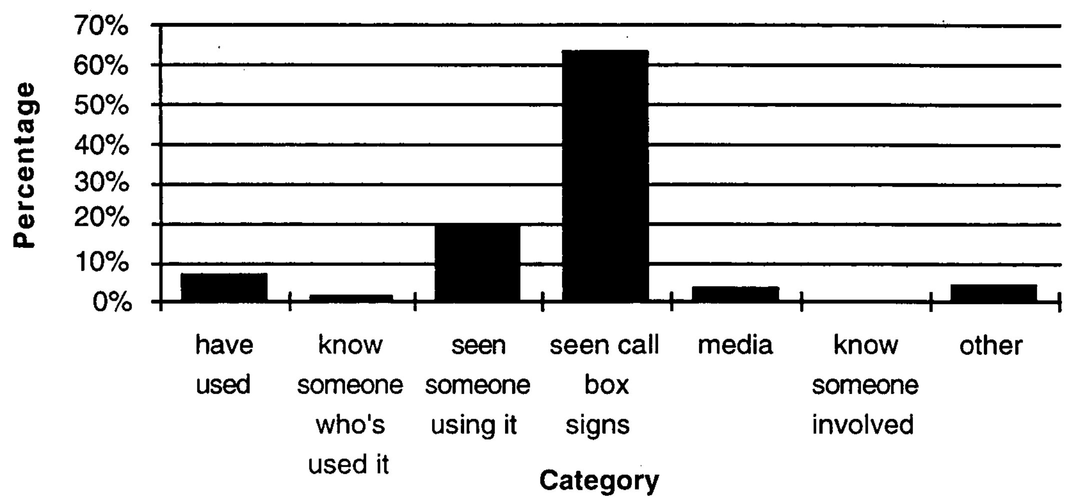


Figure 15. Survey Response

Motorist Aid Call Box Information

1. Before this questionnaire, were you aware that call boxes existed along some of the bridges, tunnels, and interchanges in Washington? 94% Yes 6% No

2. If yes, how did you become aware? (Check all that apply)

   7% I have used a call box in Washington..
   (location)______
   2% I know someone who has used a call box in Washington.
   20% I have seen other people using a call box in Washington.
   64% I have noticed the signing at a call box location in Washington.
   4% In Washington, I have heard about call boxes through the media (TV, radio, newspaper)
   0% I know someone involved with the call box systems in Washington.
   4% Other (please specify) **have seen call boxes on I-90 and SR-520**

3. Including locations in Washington, have you ever used a call box?

   12% Yes (where if outside Washington)
   21 in WA, 8 out of state (CA and FL), 2 foreign (Germany and England)
   82% No (If no, please proceed to Question 12)

   4. At what time of day did you use the call box?

      59% weekday morning or afternoon rush hour
      21% weekday midday
      7% weekday nighttime
      10% weekend daytime
      3% weekend nighttime
      0% other ______

   5. Did you feel safe walking to and using the call box? 83% Yes 17% No

   6. Did you find the call box difficult to use? 3% Yes 97% No

   7. Was the call box operating properly when you needed it? 93% Yes 7% No

   8. Was the voice quality acceptable when you communicated with the operator?
      83% Yes 17% No

   9. Was it obvious that the call box was for public use? 90% Yes 10% No

   10. Were you satisfied with the time it took for help to respond after you called?
       93% Yes 7% No

   11. Would you use the call box system again? 100% Yes 0% No
       If no, why?______

12. In your opinion, how effective are call boxes at (also see Table 5):

	Very		Somewhat		Not Very
1 improving safety	1(37%)	2	3	4	5
3 preventing other accidents	1	2	3(38%)	4	5
3 reducing congestion	1	2	3(28%)	4	5
1 helping services respond more quickly	1(62%)	2	3	4	5
_ _ other ______					

13. In your opinion, should the call box system in Washington be expanded to more routes or areas?

87% Yes 13% No

Travel Characteristics

14. How often do you travel on the following routes?

SR-520 across the floating bridge	1-5 times per week
I-90 from the Mt. Baker tunnel to the Mercer Island tunnel	1-5 times per week
Tacoma Narrows bridge	1-5 times per week
Blue Bridge in Pasco	0 times per week
selected off ramps on I-90 and I-405	1-5 times per week

15. What is your usual mode of travel on these routes? (choose only one)

81% drive alone
3% bus
14% carpool/vanpool
0% motorcycle
2% other ______

16a. How many times have you been involved in an accident along any of these routes (SR-520, I-90, Tacoma Narrows Bridge, Blue Bridge in Pasco, and selected off ramps on I-90 and I-405)?

85% never 14% once 0% twice 0% more than twice

16b. How did you obtain help? (check all that apply)

39% Washington State Patrol stopped to provide assistance
2% Washington State Department of Transportation stopped to provide assistance
0% requested help with a CB radio in a vehicle
11% requested help with a cellular phone in a vehicle
5% walked to a call box to request help
18% someone passing by requested help
16% someone stopped to provide assistance other than the State Patrol or the Department of Transportation
9% Other **used public telephone**

17a. How many times have you been in a vehicle that became disabled (because of mechanical failure, out of gas, etc.) along any of these routes (SR-520, I-90, Tacoma, Blue Bridge in Pasco, and selected off ramps on I-90 and I-405)?

68% never 22% once 6% twice 4% more than twice

17b. How did you obtain help? (check all that apply)

- 22% Washington State Patrol stopped to provide assistance
- 12% Washington State Department of Transportation stopped to provide assistance
- 1% requested help with a CB radio in a vehicle
- 10% requested help with a cellular phone in a vehicle
- 14% walked to a call box to request help
- 7% someone passing by requested help
- 25% someone stopped to provide assistance other than the State Patrol or the Department of Transportation
- 10% Other **used public telephone**

18. If you own a cellular telephone or CB radio, how frequently do you report an accident or vehicle breakdown that you see but are not involved in?

38% never   43% sometimes   18% always

About You

19. Are you 53% Male? 47% Female?

20. What is your approximate age?

- 0% under 16
- 11% 17 to 30
- 40% 31 to 45
- 32% 45 to 60
- 17% over 60

21. What is your approximate annual household income?

- 0% under $10,000
- 12% $10,001 - $30,000
- 30% $30,001 - $50,000
- 21% $50,001 - $70,000
- 17% $70,001 - $90,000
- 20% over $90,000

22. Are you currently 76% Married? 24% Single?

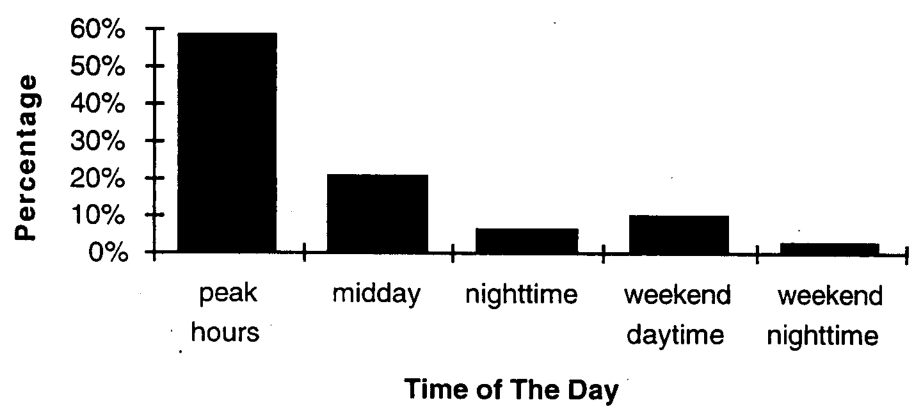
23. What is your highest level of education?

- 2% Did not finish high school
- 11% High school
- 13% Community college
- 42% College or university
- 32% Post graduate work

Call Box Users

Among people who had used call boxes, 21 had used them in Washington, eight respondents had used them in California and Florida, and two respondents had used them in Germany and England. Most had used the call boxes during the weekday morning/afternoon rush hour, followed by weekday midday (see Figure 16). A few had used call boxes during nighttime. Most of them had felt safe walking to and using the call box. In general, they did not find them difficult to use, it was obvious that the call box was for public use, voice quality was acceptable, and the phone was operating properly when they needed it. About 93 percent responded that they were satisfied with the time it took for help to arrive after they had called. All the users responded that they would use the call box system again.

Figure 16. When Call Boxes Get Used



All Survey Respondents

All of the respondents were asked to estimate the level of effectiveness of call boxes in areas such as safety and traffic management. As Table 7 illustrates, call boxes were viewed to be very effective in ***improving safety*** and especially in ***helping services respond more quickly.*** As for preventing other accidents and reducing congestion, call boxes were viewed as somewhat effective by most of the respondents. Many respondents also expressed a feeling of safety and security knowing that help could be summoned in case of an emergency or vehicle breakdown. As one respondent put it, "It provides help in a very frustrating situation." Many people suggested that more call boxes should be added (87 percent). Certain routes such as Highway 169 were suggested for call box installation.

Table 8. Perceived Effectiveness

Category	1 (Very)	2	3 (Somewhat)	4	5 (Not Very)
Improving Safety	37%	28%	25%	5%	5%
Preventing other Accidents	24%	20%	38%	8%	9%
Reducing Congestion	25%	21%	28%	9%	17%
Helping Services Respond More Quickly	62%	24%	11%	2%	1%

There are other respondents who expressed concern about the cost of system expansion. Growing cellular ownership was the main reason respondents objected to the expansion of call box systems. However, the survey revealed that only 18 percent of the respondents would always report an accident or vehicle breakdown that they see but are not involved in with either a cellular phone or CB radio; 43 percent indicated sometimes, and 38 percent indicated never. In addition, with automatic location identification feature, call boxes can help dispatchers more quickly and accurately identify the motorist's exact location than many cellular callers.

The respondents' travel characteristics were also surveyed. Most of them travel one to five times per week on the routes where call boxes are now provided (data on the Blue Bridge in Pasco were not readily available). The vast majority of people surveyed drive alone. Less than 3 percent take the bus.

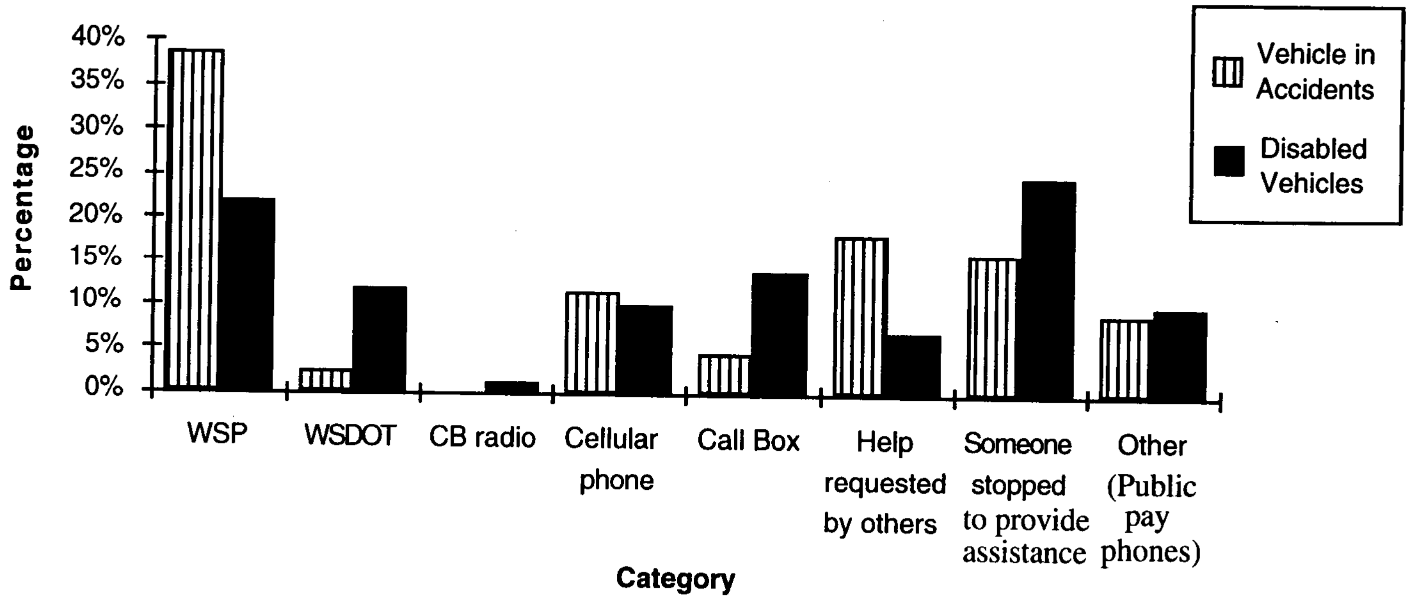
Although 85 percent have never been involved in an accident along these routes, 32 percent have been in a vehicle that became disabled once or more than once. The results showed a slight variation in obtaining help between vehicles involved in an accident and disabled vehicles (see Figure 17). More people in accidents received assistance from the WSP than did people with mechanical failures or empty gas tanks. The chance that someone passing would request help for people involved in an accident was greater than for people who had a disabled vehicle. This may be because enforcement agencies are usually needed at an accident scene to determine the responsible party. Also accidents are typically more noticeable, depending on their severity. Call boxes were used more often by motorists who were in disabled vehicles than by those involved in an accident. The survey showed that more motorists in a disabled vehicle obtained help by using call box (14 percent) than by using a cellular phone (10 percent). Public pay phones were the other alternative in getting help, as indicated by some of the respondents.

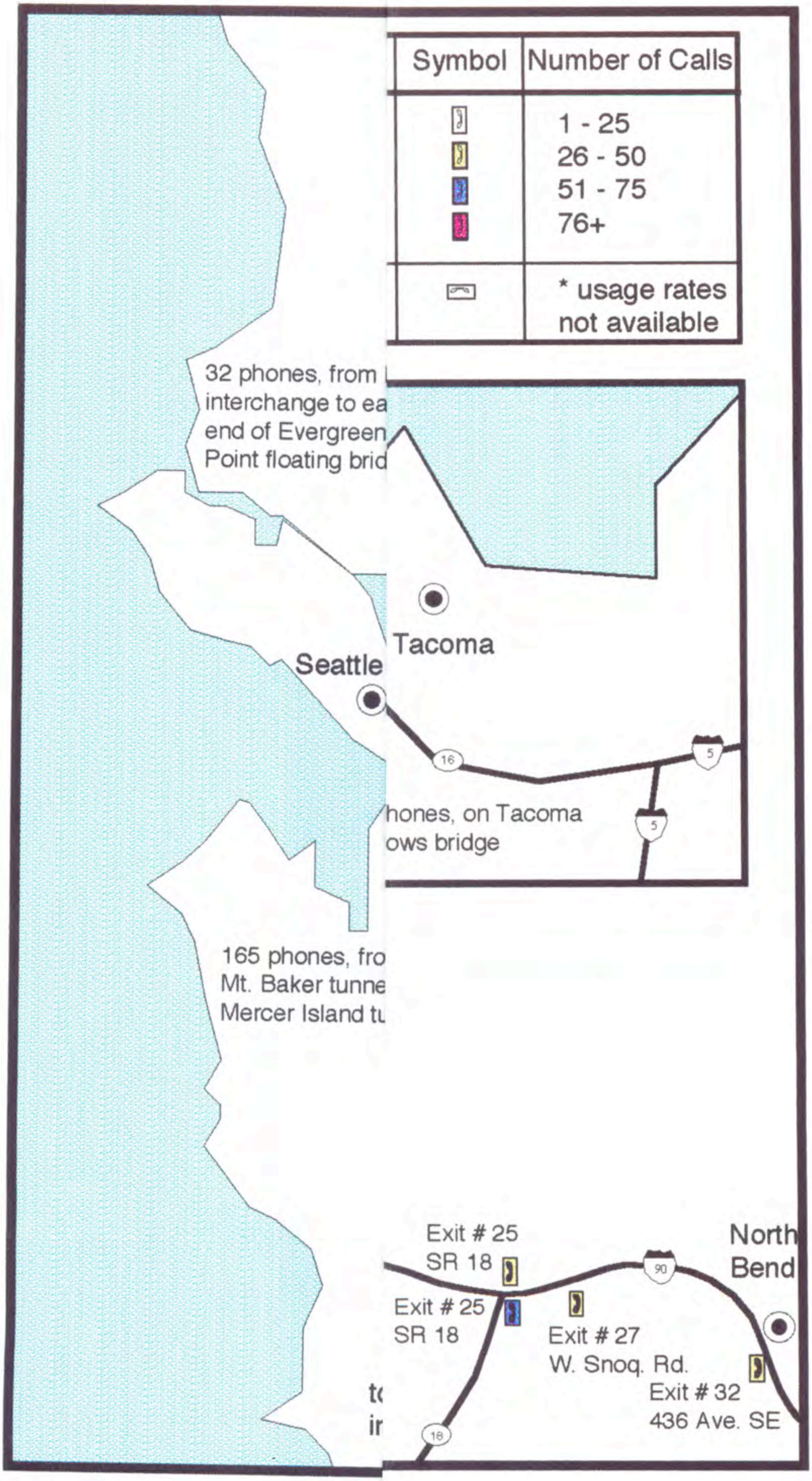
When the total accident rates along the cellular call box sites were compared with the annual call volume of those call boxes (see Figure 18), it was observed that higher accident rates do not correspond to higher call box usage rates and vice versa. Usage of some call boxes remained relatively low along routes where a high total accident rate (both minor and major accidents) was observed. For example, the total accident rate along SR-520 floating bridge was above 2 millions vehicle miles traveled (MVMT), call box usage rates on the bridge typically remained low (up to 50 annual calls).

Respondents made some suggestions for improvement. Some respondents said that the call boxes are spaced so far apart that one has to walk a long way to call for help. (On the other hand, one respondent thought that the phones on the SR-520 bridge are too closely spaced.) Another suggestion is that there should be more advertisement about where call boxes are available so that people can make better decisions about how to get assistance. Also, call boxes should be clearly marked so it is obvious to travelers that the phones are for public use. One respondent thought that the call boxes in the I-90 tunnel (911 emergency) may have been dedicated for medical and/or accident reporting instead of getting assistance for the public. Noise is another issue mentioned by a respondent who used a call box on SR-520; with freeway traffic nearby, it can be difficult to hear the operator.

The results of the survey help understand patterns of call box usage and to get feedback from the public. The comments ranged from positive (very effective) to negative (redundant and not cost effective because cellular phones and cameras already exist); all the comments gathered can be found in Appendix E. Overall, the majority of respondents surveyed (87 percent) support expanding the existing call box systems in Washington.

Figure 17. Methods of Obtaining Help





Symbol
Number of Calls
1 - 25
26 - 50
51 - 75
76+
* usage rates not available
32 phones, from
interchange to ea
end of Evergreen
Point floating brid
Tacoma
Seattle
16
5
hones, on Tacoma
ows bridge
165 phones, fro
Mt. Baker tunne
Mercer Island tu
Exit # 25
SR 18
North
Bend
90
Exit # 25
SR 18
Exit # 27
W. Snoq. Rd.
Exit # 32
436 Ave. SE
18

CHAPTER 7. SUMMARY AND RECOMMENDATIONS

SUMMARY

Below is a summary of operation and performance of current call box systems in Washington.

Ownership

All of the existing call boxes in Washington are owned by WSDOT. Unlike the monitoring and maintenance of a call box system which can be the responsibility of other agencies, WSDOT should be responsible for the purchase and implementation of an expanded system.

Monitoring

All call boxes in Washington are monitored and responded to by the Washington State Patrol with the exception of the call box system on the Tacoma Narrows Bridge, which is monitored by the Tacoma Fire Department. The monitoring agencies voiced no negative comments about the call box system; they do not currently experience or anticipate enough calls to increase staffing.

Maintenance

All of the call boxes are maintained by WSDOT personnel with the exception of the call box system on the Tacoma Narrows Bridge which is maintained by the Tacoma Fire Department. Call box maintenance responsibility usually falls on one maintenance personnel, one from WSDOT who is responsible for call boxes on I-90, and all other cellular phones (SR-520, I-90, and I-405), and one from the Tacoma Fire Department who is responsible for call boxes on Tacoma Narrows bridge. Except for the wireline phones on I-90, which require maintenance personnel to test each phone (165 total) physically, all other call boxes are kept 100 percent reliable with remote system checking. The maintenance requirements noted here imply that an expansion of the cellular call box system should be recommended over the wireline system; the wireline system has higher labor requirement. Both systems however require relatively little maintenance.

No major complaints have been expressed by maintenance personnel regarding the current wireline and cellular systems. Minor problems noted with the wireline phones on I-90 include:

- corrosion build-up on the internal board inside the call box; the phone may quit working or will make false 911 calls
- doors left open and cords dangling out because the door of the call box does not have spring to allow it to close automatically, and the phone cord is long enough that it has to be coiled to fit inside (see Figure 2)
- no central control available, so maintenance personnel has to check system operation by attending each phone to test its ability to call 911.

Also, one cellular unit was stolen early in 1996.

<u>Cost</u>

Current call volumes are not significant enough for monitoring agencies to have additional staffing; there is no direct additional cost for monitoring for the calls. For cellular type call boxes in Washington, the annual cost of ten-year life is estimated to be $23,906 for the cellular call boxes ($569 per call box). This cost is based on (1) $14,700 per year for ten year life (42 phones at $3,500 each unit for a total of $147,000), and (2) $3200 for the average annual cellular phone bill, and (3) $6006 for the average annual system maintenance cost.

The average annual system maintenance costs for wireline phones on the Tacoma Narrow Bridge are $3,000 ($115 per box per year). Comparatively, the combined cost of phone charge (i.e., phone bill) and maintenance for the cellular systems is $219 per box per year excluding the cost of the phone.

Funds for the purchase, installation and maintenance of the call boxes are not dedicated in Washington State. The largest call box systems on both floating bridges (I-90 and SR-520) were installed as part of other bridge-related projects. The newer cellular system near off-ramps were installed when the need arose and when funds became available. Any future expansion of the call box system in Washington should pursue similar opportunities.

Usage

- The average yearly usage is 1365 calls.
- The average monthly usage is 2.7 calls per box.
- The usage of the cellular call boxes tends to be higher from morning traffic peak until late at night.
- The number of calls increases slightly during spring and summer.
- Usage was highest on Fridays, lowest on Thursdays.

The usage rate for cellular call boxes in Washington, 2.7 calls per box per month, is consistent when compared to other call box systems in the nation with usage rates available. Typically, usage rates range from 1.4 to 7.4 calls per box per month (Michigan's usage was as high as 7.5 calls per box per month, but it is based on only 4 call boxes).

Public Perception

Public awareness of call boxes is high as indicated through system signing. Sign recognition is predicted to be higher at locations that have multiple, closely-spaced call boxes (i.e., SR-520, between tunnels on I-90, and Tacoma Narrows Bridge) than at isolated locations (i.e., near selected off ramps). The call boxes were viewed by the public to be very effective in the areas of improving safety and helping services respond more quickly. The majority (87 percent) of respondents supported expanding the call box system. Opposition stems from the increased popularity and affordability of cellular phones. For motorists not owning a cellular phone, motorists aid call boxes provide a valuable alternative. Especially because less than 20% of cellular phone owners responded that they would frequently report an accident or vehicle breakdown that they see but are not involved in (i.e., reporting for another motorist).

RECOMMENDATIONS

On the basis of the information gathered through this project, a number of recommendations can be made for current and future call box systems in Washington:

- Because (1) no negative impacts are noted from the maintenance and monitoring agencies, (2) costs for installation and maintenance are reasonable, (3) usage rates are consistent when compared with national experience, and (4) public acceptance is high, call box **expansion** in Washington state is recommended as funding becomes available. Potential funding sources include an Adopt-A-Call Box program made possible through a provision in the National Highway System (NHS), federal demonstration program funding, public/private partnerships, or, user fees (usually requires political support).

- Although public's awareness of call boxes was reportedly high in the survey, **public education** is important to build support for ongoing operation. **Public brochures** could be made available, and contain information related to call box locations (especially in rural or isolated areas) and service expectations (i.e., who will answer their call, what they will be charged for, etc.).

- **Standards for the installation of a call box and related signing** should be adopted which may include (1) uniform color and signs to ease the public's recognition of call boxes, and (2) appropriate call box installation guidelines (i.e., placing the call box toward opposing traffic so motorist will face oncoming traffic) to ensure the safety of the user. These standards should be incorporated into new installations and as existing equipment needs replacing.

- System expansion should be done in **incremental steps** based on documented performance; improvements can be noted for future endeavors.

When system expansion is considered, several factors should be considered: (1) the effort that the **maintenance** personnel have to spend for the additional units and the associated operating and maintenance expense increase, and (2) the possibility of staff increase for the **monitoring** agency. **Communication** between responsible agencies and within an agency is also important. Good communication helps coordination between and within agencies involved; administrative personnel have better information regarding system operation. **Operational features** such as remote system checking, should be considered as part of new call box units to ease system operation both in maintaining and monitoring of a call box system and to allow for record keeping for future system evaluation. Again, new call box units can incrementally replace existing call boxes as they become damaged or inoperable.

REFERENCES

1. "The Nationwide Motorist Aid Assessment," an unofficial draft version which has not been approved by FHWA.

2. Legg, Bill, "A discussion on Motorist Aid Call Boxes With Recommendations for Their Application in Washington State," Washington State Department of Transportation, February, 1995.

3. Banks, James H., "Should Emergency Call Boxes be Placed in Freeway Medians?", Transportation Research Board, January 1995.

4. "State of The Call Box Program," California Service Authorities for Freeways and Expressways Committee (CalSAFE), May 1996.

5. "CHP/Caltrans Call Box and Motorist Aid Guidelines," November 1992.

6. "San Diego SMART Call Box Field Operational Test, Early Results Report," TeleTran Tek Services, January 31, 1996.

7. "Is it Safe? The Ventura County Callbox Accessibility Program"-from WSDOT Library

8. "Motorist Aid Call Box Evaluation Report," Minnesota Department of Transportation, Office of Freeway Operations, Traffic Management Center, July 1991.

BIBLIOGRAPHY

Banks, James H., "Should Emergency Call Boxes be Placed in Freeway Medians?", Transportation Research Board, January 1995.

"CHP/Caltrans Call Box and Motorist Aid Guidelines," November 1992.

Churchill, Bruce W., "Motorist Aid Systems - Intelligent Roadside Controllers," Pacific Rim TransTech Conference, Vol.1, July 25-28, 1993.

Legg, Bill, "A discussion on Motorist Aid Call Boxes With Recommendations for Their Application in Washington State," Washington State Department of Transportation, February, 1995.

"Motorist Aid Call Box Evaluation Report," Minnesota Department of Transportation, Office of Freeway Operations, Traffic Management Center, July 1991.

"Is it Safe? The Ventura County Callbox Accessibility Program"-from WSDOT Library

"San Diego SMART Call Box Field Operational Test, Early Results Report," TeleTran Tek Services, January 31, 1996.

"SR-520 Roadside Emergency Call Box System. Manual," WSDOT, prepared by GTE Government Information Services, Inc.

"State of The Call Box Program," California Service Authorities for Freeways and Expressways Committee (CalSAFE), May 1996.

"Tennessee Interstate Motorists Aid Study," Tennessee Department of Transportation, Bureau of Planning & Development, July 1989.

"The Nationwide Motorist Aid Assessment," an unofficial draft version which has not been approved by FHWA.

APPENDIX A
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APPENDIX B
INFORMATION OF WIRELINE CALL BOXES

MOTORIST AID CALL BOXS ON I-90
BETWEEN MOUNT BAKER AND MERCER ISLAND

Location	Station	Mount Type[1]	Sign Type[2]	Milepost	I.D.	Sided	Quantity
WB Mercer Island Tunnel	LL 210 + 76 (Left)	Tunnel Wall	Call Box/Fire	6.07	90W-6-1	Double	1
WB Mercer Island Tunnel	LL 210 + 76 (Right)	Tunnel Wall	Call Box/Fire	6.07	90W-6-2	Double	1
WB Mercer Island Tunnel	LL 213 + 85 (Left)	Tunnel Wall	Call Box/Fire	6.13	90W-6-3	Double	1
WB Mercer Island Tunnel	LL 213 + 85 (Right)	Tunnel Wall	Call Box/Fire	6.13	90W-6-4	Double	1
WB Mercer Island Tunnel	LL 216 + 85 (Left)	Tunnel Wall	Call Box/Fire	6.19	90W-6-5	Double	1
WB Mercer Island Tunnel	LL 216 + 85 (Right)	Tunnel Wall	Call Box/Fire	6.19	90W-6-6	Double	1
WB Mercer Island Tunnel	LL 219 + 94 (Left)	Tunnel Wall	Call Box/Fire	6.24	90W-6-7	Double	1
WB Mercer Island Tunnel	LL 219 + 94 (Right)	Tunnel Wall	Call Box/Fire	6.24	90W-6-8	Double	1
WB Mercer Island Tunnel	LL 222 + 86 (Left)	Tunnel Wall	Call Box/Fire	6.30	90W-6-9	Double	1
WB Mercer Island Tunnel	LL 222 + 86 (Right)	Tunnel Wall	Call Box/Fire	6.30	90W-6-10	Double	1
WB Mercer Island Tunnel	LL 225 + 90 (Left)	Tunnel Wall	Call Box/Fire	6.36	90W-6-11	Double	1
WB Mercer Island Tunnel	LL 225 + 90 (Right)	Tunnel Wall	Call Box/Fire	6.36	90W-6-12	Double	1
WB Mercer Island Tunnel	LL 228 + 47 (Left)	Tunnel Wall	Call Box/Fire	6.41	90W-6-13	Double	1
WB Mercer Island Tunnel	LL 228 + 47 (Right)	Tunnel Wall	Call Box/Fire	6.41	90W-6-14	Double	1
WB Mercer Island Tunnel	LL 230 + 87 (Left)	Tunnel Wall	Call Box/Fire	6.45	90W-6-15	Double	1
WB Mercer Island Tunnel	LL 230 + 87 (Right)	Tunnel Wall	Call Box/Fire	6.45	90W-6-16	Double	1
WB Mercer Island Tunnel	LL 233 + 24 (Left)	Tunnel Wall	Call Box/Fire	6.50	90W-6-17	Double	1
WB Mercer Island Tunnel	LL 233 + 24 (Right)	Tunnel Wall	Call Box/Fire	6.50	90W-6-18	Double	1
WB Mercer Island Tunnel	LL 235 + 67 (Left)	Tunnel Wall	Call Box/Fire	6.54	90W-6-19	Double	1
WB Mercer Island Tunnel	LL 235 + 67 (Right)	Tunnel Wall	Call Box/Fire	6.54	90W-6-20	Double	1

[1] For mounting details see attached sheets
A - Tunnel Wall, B - Box Pedestal, C - I-Beam

[2] For sign fabrication details see attached sheets
A - Call Box/Fire, B - Call Box

Location	Station	Mount Type	Sign Type	Milepost	I.D.	Sided	Quantity
EXP Mercer Island Tunnel	LM 211 + 45 (Left)	Tunnel Wall	Call Box/Fire	6.07	90C-6-1	Double	1
EXP Mercer Island Tunnel	LM 211 + 45 (Right)	Tunnel Wall	Call Box/Fire	6.07	90C-6-2	Double	1
EXP Mercer Island Tunnel	LM 214 + 49 (Left)	Tunnel Wall	Call Box/Fire	6.12	90C-6-3	Double	1
EXP Mercer Island Tunnel	LM 214 + 49 (Right)	Tunnel Wall	Call Box/Fire	6.12	90C-6-4	Double	1
EXP Mercer Island Tunnel	LM 217 + 43 (Left)	Tunnel Wall	Call Box/Fire	6.17	90C-6-5	Double	1
EXP Mercer Island Tunnel	LM 217 + 43 (Right)	Tunnel Wall	Call Box/Fire	6.17	90C-6-6	Double	1
EXP Mercer Island Tunnel	LM 220 + 43 (Left)	Tunnel Wall	Call Box/Fire	6.23	90C-6-7	Double	1
EXP Mercer Island Tunnel	LM 220 + 43 (Right)	Tunnel Wall	Call Box/Fire	6.23	90C-6-8	Double	1
EXP Mercer Island Tunnel	LM 223 + 25 (Left)	Tunnel Wall	Call Box/Fire	6.28	90C-6-9	Double	1
EXP Mercer Island Tunnel	LM 223 + 25 (Right)	Tunnel Wall	Call Box/Fire	6.28	90C-6-10	Double	1
EXP Mercer Island Tunnel	LM 226 + 42 (Left)	Tunnel Wall	Call Box/Fire	6.34	90C-6-11	Double	1
EXP Mercer Island Tunnel	LM 226 + 42 (Right)	Tunnel Wall	Call Box/Fire	6.34	90C-6-12	Double	1
EXP Mercer Island Tunnel	LM 229 + 38 (Left)	Tunnel Wall	Call Box/Fire	6.40	90C-6-13	Double	1
EXP Mercer Island Tunnel	LM 229 + 38 (Right)	Tunnel Wall	Call Box/Fire	6.40	90C-6-14	Double	1
EXP Mercer Island Tunnel	LM 232 + 42 (Left)	Tunnel Wall	Call Box/Fire	6.48	90C-6-15	Double	1
EXP Mercer Island Tunnel	LM 232 + 42 (Right)	Tunnel Wall	Call Box/Fire	6.48	90C-6-16	Double	1
EXP Mercer Island Tunnel	LM 235 + 27 (Left)	Tunnel Wall	Call Box/Fire	6.51	90C-6-17	Double	1
EXP Mercer Island Tunnel	LM 235 + 27 (Right)	Tunnel Wall	Call Box/Fire	6.51	90C-6-18	Double	1

Location	Station	Mount Type	Sign Type	Milepost	I.D.	Sided	Quantity
EB Mercer Island Tunnel	Lr 212 + 20 (Left)	Tunnel Wall	Call Box/Fire	6.07	90E-6-1	Double	1
EB Mercer Island Tunnel	Lr 212 + 20 (Right)	Tunnel Wall	Call Box/Fire	6.07	90E-6-2	Double	1
EB Mercer Island Tunnel	Lr 215 + 40 (Left)	Tunnel Wall	Call Box/Fire	6.13	90E-6-3	Double	1
EB Mercer Island Tunnel	Lr 215 + 40 (Right)	Tunnel Wall	Call Box/Fire	6.13	90E-6-4	Double	1
EB Mercer Island Tunnel	Lr 218 + 85 (Left)	Tunnel Wall	Call Box/Fire	6.20	90E-6-5	Double	1
EB Mercer Island Tunnel	Lr 218 + 85 (Right)	Tunnel Wall	Call Box/Fire	6.20	90E-6-6	Double	1
EB Mercer Island Tunnel	Lr 221 + 50 (Left)	Tunnel Wall	Call Box/Fire	6.25	90E-6-7	Double	1
EB Mercer Island Tunnel	Lr 221 + 50 (Right)	Tunnel Wall	Call Box/Fire	6.25	90E-6-8	Double	1
EB Mercer Island Tunnel	Lr 224 + 48 (Left)	Tunnel Wall	Call Box/Fire	6.30	90E-6-9	Double	1
EB Mercer Island Tunnel	Lr 224 + 48 (Right)	Tunnel Wall	Call Box/Fire	6.30	90E-6-10	Double	1
EB Mercer Island Tunnel	Lr 227 + 44 (Left)	Tunnel Wall	Call Box/Fire	6.36	90E-6-11	Double	1
EB Mercer Island Tunnel	Lr 227 + 44 (Right)	Tunnel Wall	Call Box/Fire	6.36	90E-6-12	Double	1
EB Mercer Island Tunnel	Lr 230 + 47 (Left)	Tunnel Wall	Call Box/Fire	6.47	90E-6-13	Double	1
EB Mercer Island Tunnel	Lr 230 + 47 (Right)	Tunnel Wall	Call Box/Fire	6.47	90E-6-14	Double	1
EB Mercer Island Tunnel	Lr 233 + 59 (Left)	Tunnel Wall	Call Box/Fire	6.50	90E-6-15	Double	1
EB Mercer Island Tunnel	Lr 233 + 59 (Right)	Tunnel Wall	Call Box/Fire	6.50	90E-6-16	Double	1
EB Mercer Island Tunnel	Lr 235 + 98 (Left)	Tunnel Wall	Call Box/Fire	6.52	90E-6-17	Double	1
EB Mercer Island Tunnel	Lr 235 + 98 (Right)	Tunnel Wall	Call Box/Fire	6.52	90E-6-18	Double	1

Location	Station	Mount Type	Sign Type	Milepost	I.D.	Sided	Quantity
WB Mount Baker Tunnel	LI 70 + 66 (Left)	Tunnel Wall	Call Box/Fire	3.57	90W-3-1	Double	1
WB Mount Baker Tunnel	LI 70 + 66 (Right)	Tunnel Wall	Call Box/Fire	3.57	90W-3-2	Double	1
WB Mount Baker Tunnel	LI 73+ 55 (Left)	Tunnel Wall	Call Box/Fire	3.63	90W-3-3	Double	1
WB Mount Baker Tunnel	LI 73 + 55 (Right)	Tunnel Wall	Call Box/Fire	3.63	90W-3-4	Double	1
WB Mount Baker Tunnel	LI 76 + 43 (Left)	Tunnel Wall	Call Box/Fire	3.69	90W-3-5	Double	1
WB Mount Baker Tunnel	LI 76 + 44 (Right)	Tunnel Wall	Call Box/Fire	3.69	90W-3-6	Double	1
WB Mount Baker Tunnel	LI 79 + 31 (Left)	Tunnel Wall	Call Box/Fire	3.74	90W-3-7	Double	1
WB Mount Baker Tunnel	LI 79 + 31 (Right)	Tunnel Wall	Call Box/Fire	3.74	90W-3-8	Double	1
WB Mount Baker Tunnel	LI 82 + 18 (Left)	Tunnel Wall	Call Box/Fire	3.80	90W-3-9	Double	1
WB Mount Baker Tunnel	LI 82 + 18 (Right)	Tunnel Wall	Call Box/Fire	3.80	90W-3-10	Double	1
WB Mount Baker Tunnel	LI 85 + 07 (Left)	Tunnel Wall	Call Box/Fire	3.85	90W-3-11	Double	1
WB Mount Baker Tunnel	LI 85 + 07 (Right)	Tunnel Wall	Call Box/Fire	3.85	90W-3-12	Double	1
WB Mount Baker Tunnel	LI 88 + 19 (Left)	Tunnel Wall	Call Box/Fire	3.91	90W-3-13	Double	1
WB Mount Baker Tunnel	LI 88 + 19 (Right)	Tunnel Wall	Call Box/Fire	3.91	90W-3-14	Double	1
WB Mount Baker Tunnel	LI 90 + 25 (left)	Tunnel Wall	Call Box/Fire	3.95	90W-3-15	Double	1
WB Mount Baker Tunnel	LI 90 + 25 (Right)	Tunnel Wall	Call Box/Fire	3.95	90W-3-16	Double	1
WB Mount Baker Tunnel	LI 93 + 14 (Left)	Tunnel Wall	Call Box/Fire	4.00	90W-3-17	Double	1
WB Mount Baker Tunnel	LI 93 + 14 (Right)	Tunnel Wall	Call Box/Fire	4.00	90W-3-18	Double	1
WB Mount Baker Tunnel	LI 96 + 03 (Left)	Tunnel Wall	Call Box/Fire	4.06	90W-3-19	Double	1
WB Mount Baker Tunnel	LI 96 + 03 (Right)	Tunnel Wall	Call Box/Fire	4.06	90W-3-20	Double	1
WB Mount Baker Tunnel	LI 98 + 90 (Left)	Tunnel Wall	Call Box/Fire	4.11	90W-3-21	Double	1
WB Mount Baker Tunnel	LI 98 + 90 (Right)	Tunnel Wall	Call Box/Fire	4.11	90W-3-22	Double	1
WB Mount Baker Tunnel	LI 101 + 78 (Left)	Tunnel Wall	Call Box/Fire	4.17	90W-3-23	Double	1
WB Mount Baker Tunnel	LI 101 + 78 (Right)	Tunnel Wall	Call Box/Fire	4.17	90W-3-24	Double	1

Location	Station	Mount Type	Sign Type	Milepost	I.D.	Sided	Quantity
EXP Mount Baker Tunnel	Lm 71 + 83 (Left)	Tunnel Wall	Call Box/Fire	3.57	90C-3-1	Double	1
EXP Mount Baker Tunnel	Lr-Lm 71 + 89 (Right)	Tunnel Wall	Call Box/Fire	3.57	90C-3-2	Double	1
EXP Mount Baker Tunnel	Lm 74 + 72 (Left)	Tunnel Wall	Call Box/Fire	3.62	90C-3-3	Double	1
EXP Mount Baker Tunnel	Lr-Lm 74 + 77 (Right)	Tunnel Wall	Call Box/Fire	3.62	90C-3-4	Double	1
EXP Mount Baker Tunnel	Lm 77 + 60 (Left)	Tunnel Wall	Call Box/Fire	3.67	90C-3-5	Double	1
EXP Mount Baker Tunnel	Lr-Lm 77 + 65 (Right)	Tunnel Wall	Call Box/Fire	3.67	90C-3-6	Double	1
EXP Mount Baker Tunnel	Lm 80 + 47 (Left)	Tunnel Wall	Call Box/Fire	3.72	90C-3-7	Double	1
EXP Mount Baker Tunnel	Lr-Lm 80 + 53 (Right)	Tunnel Wall	Call Box/Fire	3.72	90C-3-8	Double	1
EXP Mount Baker Tunnel	Lm 83 + 35 (Left)	Tunnel Wall	Call Box/Fire	3.78	90C-3-9	Double	1
EXP Mount Baker Tunnel	Lr-Lm 83 + 43 (Right)	Tunnel Wall	Call Box/Fire	3.78	90C-3-10	Double	1
EXP Mount Baker Tunnel	Lm 86 + 27 (Left)	Tunnel Wall	Call Box/Fire	3.81	90C-3-11	Double	1
EXP Mount Baker Tunnel	Lm 86 + 27 (Right)	Tunnel Wall	Call Box/Fire	3.81	90C-3-12	Double	1
EXP Mount Baker Tunnel	Lm 89 + 43 (Left)	Tunnel Wall	Call Box/Fire	3.87	90C-3-13	Double	1
EXP Mount Baker Tunnel	Lm 89 + 43 (Right)	Tunnel Wall	Call Box/Fire	3.87	90C-3-14	Double	1
EXP Mount Baker Tunnel	Lm 91 + 31 (Left)	Tunnel Wall	Call Box/Fire	3.92	90C-3-15	Double	1
EXP Mount Baker Tunnel	Lm 91 + 31 (Right)	Tunnel Wall	Call Box/Fire	3.92	90C-3-16	Double	1
EXP Mount Baker Tunnel	Lm 94 + 19 (Left)	Tunnel Wall	Call Box/Fire	3.98	90C-3-17	Double	1
EXP Mount Baker Tunnel	Lm 94 + 19 (Right)	Tunnel Wall	Call Box/Fire	3.98	90C-3-18	Double	1
EXP Mount Baker Tunnel	Lm 97 + 06 (Left)	Tunnel Wall	Call Box/Fire	4.04	90C-3-19	Double	1
EXP Mount Baker Tunnel	Lm 97 + 06 (Right)	Tunnel Wall	Call Box/Fire	4.04	90C-3-20	Double	1
EXP Mount Baker Tunnel	Lm 99 + 95 (Left)	Tunnel Wall	Call Box/Fire	4.09	90C-3-21	Double	1
EXP Mount Baker Tunnel	Lm 99 + 95 (Right)	Tunnel Wall	Call Box/Fire	4.09	90C-3-22	Double	1
EXP Mount Baker Tunnel	Lm 102 + 84 (Left)	Tunnel Wall	Call Box/Fire	4.16	90C-3-23	Double	1
EXP Mount Baker Tunnel	Lm 102 + 84 (Right)	Tunnel Wall	Call Box/Fire	4.16	90C-3-24	Double	1

Location	Station	Mount Type	Sign Type	Milepost	I.D.	Sided	Quantity
EB Mount Baker Tunnel	LR 71 + 92 (Left)	Tunnel Wall	Call Box/Fire	3.57	90E-3-1	Double	1
EB Mount Baker Tunnel	RSE 71 + 92 (Right)	Tunnel Wall	Call Box/Fire	3.57	90E-3-2	Double	1
EB Mount Baker Tunnel	LR 74 + 56 (Left)	Tunnel Wall	Call Box/Fire	3.62	90E-3-3	Double	1
EB Mount Baker Tunnel	RSE 74 + 56 (Right)	Tunnel Wall	Call Box/Fire	3.62	90E-3-4	Double	1
EB Mount Baker Tunnel	LR 77 + 62 (Left)	Tunnel Wall	Call Box/Fire	3.68	90E-3-5	Double	1
EB Mount Baker Tunnel	RSE 77 + 62 (Right)	Tunnel Wall	Call Box/Fire	3.68	90E-3-6	Double	1
EB Mount Baker Tunnel	LR 80 + 56 (Left)	Tunnel Wall	Call Box/Fire	3.73	90E-3-7	Double	1
EB Mount Baker Tunnel	RSE 80 + 56 (Right)	Tunnel Wall	Call Box/Fire	3.73	90E-3-8	Double	1
EB Mount Baker Tunnel	LR 83 + 44 (Left)	Tunnel Wall	Call Box/Fire	3.78	90E-3-9	Double	1
EB Mount Baker Tunnel	RSE 83 + 44 (Right)	Tunnel Wall	Call Box/Fire	3.78	90E-3-10	Double	1
EB Mount Baker Tunnel	LR 86 + 33 (Left)	Tunnel Wall	Call Box/Fire	3.84	90E-3-11	Double	1
EB Mount Baker Tunnel	RSE 83 + 33 (Right)	Tunnel Wall	Call Box/Fire	3.84	90E-3-12	Double	1
EB Mount Baker Tunnel	LR 88 + 86 (Left)	Tunnel Wall	Call Box/Fire	3.85	90E-3-13	Double	1
EB Mount Baker Tunnel	LRS 88 + 86 (Right)	Tunnel Wall	Call Box/Fire	3.85	90E-3-14	Double	1
EB Mount Baker Tunnel	LR 91 + 40 (Left)	Tunnel Wall	Call Box/Fire	3.89	90E-3-15	Double	1
EB Mount Baker Tunnel	LR 91 + 40 (Right)	Tunnel Wall	Call Box/Fire	3.89	90E-3-16R	Double	1
EB Mount Baker Tunnel	LRS 91 + 40 (Right)	Tunnel Wall	Call Box/Fire	3.89	90E-3-16L	Double	1
EB Mount Baker Tunnel	LR 94 + 30 (Left)	Tunnel Wall	Call Box/Fire	3.94	90E-3-17	Double	1
EB Mount Baker Tunnel	LR 94 + 30 (Right)	Tunnel Wall	Call Box/Fire	3.94	90E-3-18R	Double	1
EB Mount Baker Tunnel	LRS 94 + 30 (Right)	Tunnel Wall	Call Box/Fire	3.94	90E-3-18L	Double	1
EB Mount Baker Tunnel	LR 97 + 30 (Left)	Tunnel Wall	Call Box/Fire	3.99	90E-3-19	Double	1
EB Mount Baker Tunnel	LR 97 + 30 (Right)	Tunnel Wall	Call Box/Fire	3.99	90E-3-20R	Double	1
EB Mount Baker Tunnel	LRS 97 + 30 (Right)	Tunnel Wall	Call Box/Fire	3.99	90E-3-20L	Double	1
EB Mount Baker Tunnel	100 + 10 (Left)	Tunnel Wall	Call Box/Fire	3.05	90E-3-21	Double	1
EB Mount Baker Tunnel	100 + 10 (Right)	Tunnel Wall	Call Box/Fire	3.05	90E-3-22L	Double	1
EB Mount Baker Tunnel	100 + 10 (Right)	Tunnel Wall	Call Box/Fire	3.05	90E-3-22R	Double	1
EB Mount Baker Tunnel	103 + 00 (Left)	Tunnel Wall	Call Box/Fire	3.11	90E-3-23	Double	1
EB Mount Baker Tunnel	103 + 00 (Right)	Tunnel Wall	Call Box/Fire	3.11	90E-3-24R	Double	1
EB Mount Baker Tunnel	103 + 00 (Right)	Tunnel Wall	Call Box/Fire	3.11	90E-3-24L	Double	1

Location	Station	Mount Type	Sign Type	Milepost	I.D.	Sided	Quantity
EB LVM Bridge	106 + 00 (Left)	Box Pedestal	Call Box	4.34	90E-4-1	Single	2
EB LVM Bridge	106 + 00 (Right)	Box Pedestal	Call Box	4.34	90E-4-2	Single	2
EB LVM Bridge	120 + 28 (Left)	Box Pedestal	Call Box	4.51	90E-4-3	Single	2
EB LVM Bridge	120 + 28 (Right)	Box Pedestal	Call Box	4.51	90E-4-4	Single	2
EB LVM Bridge	154 + 38 (Left)	Box Pedestal	Call Box	4.93	90E-4-5	Single	2
EB LVM Bridge	154 + 38 (Right)	Box Pedestal	Call Box	4.93	90E-4-6	Single	2
EB LVM Bridge	179 + 59 (Left)	Box Pedestal	Call Box	5.48	90E-5-1	Single	2
EB LVM Bridge	179 + 59 (Right)	Box Pedestal	Call Box	5.48	90E-5-2	Single	2
EB LVM Bridge	203 + 60 (Left)	Box Pedestal	Call Box	5.95	90E-5-3	Single	2
EB LVM Bridge	203 + 60 (Right)	Box Pedestal	Call Box	5.95	90E-5-4	Single	2
WB LVM Bridge	106 + 00 (Left)	Box Pedestal	Call Box	4.34	90W-4-1	Single	2
WB LVM Bridge	106 + 00 (Right)	Box Pedestal	Call Box	4.34	90W-4-2	Single	2
WB LVM Bridge	120 + 28 (Left)	Box Pedestal	Call Box	4.51	90W-4-3	Single	2
WB LVM Bridge	120 + 28 (Right)	Box Pedestal	Call Box	4.51	90W-4-4	Single	2
WB LVM Bridge	142 + 99 (Left)	Box Pedestal	Call Box	4.93	90W-4-5	Single	2
WB LVM Bridge	142 + 99 (Right)	Box Pedestal	Call Box	4.93	90W-4-6	Single	2
WB LVM Bridge	167 + 75 (Left)	Box Pedestal	Call Box	5.48	90W-5-1	Single	2
WB LVM Bridge	167 + 75 (Right)	Box Pedestal	Call Box	5.48	90W-5-2	Single	2
WB LVM Bridge	202 + 80 (Left)	I-Beam	Call Box	5.95	90W-5-3	Single	2
WB LVM Bridge	202 + 80 (Left)	I-Beam	Call Box	5.95	90W-5-4	Single	2
EXP 3rd Lake Wash. Bridge	106 + 00 (Left)	Box Pedestal	Call Box	4.34	90C-4-1	Single	2
EXP 3rd Lake Wash. Bridge	106 + 00 (Right)	Box Pedestal	Call Box	4.34	90C-4-2	Single	2
EXP 3rd Lake Wash. Bridge	120 + 28 (Right)	Box Pedestal	Call Box	4.51	90C-4-4	Single	2
EXP 3rd Lake Wash. Bridge	142 + 99 (Right)	Box Pedestal	Call Box	4.93	90C-4-6	Single	2
EXP 3rd Lake Wash. Bridge	167 + 75 (Right)	Box Pedestal	Call Box	5.48	90C-5-2	Single	2
EXP 3rd Lake Wash. Bridge	202 + 80 (Left)	I-Beam	Call Box	5.95	90C-5-3	Single	2
EXP 3rd Lake Wash. Bridge	202 + 80 (Right)	I-Beam	Call Box	5.95	90C-5-4	Single	2
EB Island Crest Way Tunnel	LR-S RAMP 262 + 50	Tunnel Wall	Call Box/Fire	7.02	90E-7-2	Double	1
WB Island Crest Way Tunnel	S-W RAMP 265 + 50	Tunnel Wall	Call Box/Fire	7.07	90W-7-4	Double	1
WB Island Crest Way Tunnel	S-W RAMP 268 + 50	Tunnel Wall	Call Box/Fire	7.12	90W-7-6	Double	1
EXP Island Crest Way Tunnel	LM-S RAMP 262 + 95	Tunnel Wall	Call Box/Fire	7.02	90C-7-8	Double	1
EXP Island Crest Way Tunnel	LM-S RAMP 264 + 75	Tunnel Wall	Call Box/Fire	7.05	90C-7-10	Double	1

APPENDIX C
CELLULAR CALL BOXES IN WASHINGTON

Automatic Number Identification (ANI)	Call Box ID Number	Vicinity Description
1	520W-0-1	Roanoke Vicinity
2	520E-0-1	Roanoke Vicinity
3	520W-0-2	Portage Bay
4	520E-0-2	Portage Bay
5	520W-0-3	Montlake Interchange - West
6	520E-0-3	Montlake Interchange - West
7	520W-1-1	Montlake Interchange - East
8	520E-1-1	Montlake Interchange - East
9	520W-1-2	Arboretum Interchange
10	520E-1-2	Arboretum Interchange
11	520W-1-3	Foster Island
12	520E-1-3	Foster Island
13	520W-1-4	Union Bay
14	520E-1-4	Union Bay
15	520W-2-1	Union Bay
16	520E-2-1	Union Bay
17	520W-2-2	Western Hi-Rise - Evergreen Point
18	520E-2-2	Western Hi-Rise - Evergreen Point
19	520W-2-3	Western Hi-Rise - Evergreen Point
20	520E-2-3	Western Hi-Rise - Evergreen Point
21	520W-2-4	Western Hi-Rise - Evergreen Point
22	520E-2-4	Western Hi-Rise - Evergreen Point
23	520W-3-1	Midspan - Evergreen Point
24	520E-3-1	Midspan - Evergreen Point
25	520W-3-2	Midspan - Evergreen Point
26	520E-3-2	Midspan - Evergreen Point
27	520W-3-3	Eastern Hi-Rise - Evergreen Point
28	520E-3-3	Eastern Hi-Rise - Evergreen Point
29	520W-3-4	Eastern Hi-Rise - Evergreen Point
30	520E-3-4	Eastern Hi-Rise - Evergreen Point
31	520W-4-1	Eastern Hi-Rise - Evergreen Point
32	520E-4-1	Eastern Hi-Rise - Evergreen Point
50	90-32	I-90 & 436th Ave SE, North Bend
51	90-27	I-90 & W. Snoqualmie Road
52	90-25	I-90 WB & SR 18
53	90-25	I-90 EB & SR 18
54	90-20	I-90 & High Point Road
55	90-13	I-90 & W. Lake Sammamish Parkway
56	405-24	I-405 & NE 195 th Street, Bothell
57	405-17	I-405 & 70th Place, Kirkland
58	405-10	I-405 & Coal Creek Parkway, Bellevue
59	405-5	I-405 & NE Park Drive, Renton

APPENDIX D
MAIL-OUT SURVEY

Washington State Department of Transportation

University of Washington

TRAC Washington State Transportation Center

MOTORIST AID CALL BOX INFORMATION SURVEY

The Washington State Department of Transportation and the Washington State Transportation Center at the University of Washington are working together to evaluate the effectiveness of motorist aid call boxes in Washington. A motorist aid call box is a phone installed along the roadway for stranded motorists to use to summon assistance. The purposes of a call box are to provide assistance to motorists, to increase safety, and to improve the detection of incident. The two primary call box systems operating in the Puget Sound Region are on the I-90 bridge from the Mt. Baker tunnel to the Mercer Island tunnel, and across the SR 520 floating bridge. Other call box systems in the state are on the Tacoma Narrows Bridge, the "Blue Bridge" in Pasco, and select off ramps from Bothel to Renton on I-405 and from Bellevue to North Bend on I-90.

To make the motorist aid call boxes more effective for you, we need to know your opinions. We ask that the most frequent driver in your household fill out this questionnaire, carefully selecting the most appropriate answers for your situation. This survey is anonymous, and your answers will not be associated with your name. Thank you for your participation.

Motorist Aid Call Box Information

1. Before this questionnaire, were you aware that call boxes existed along some of the bridges, tunnels, and interchanges in Washington? ____Yes ____No

2. If yes, how did you become aware? (Check all that apply)

____ I have used a call box in Washington.
(location)____
____ I know someone who has used a call box in Washington.
____ I have seen other people using a call box in Washington.
____ I have noticed the signing at a call box location in Washington.
____ In Washington, I have heard about call boxes through the media (TV, radio, newspaper)
____ I know someone involved with the call box systems in Washington.
____ Other (please specify) ______________________________

3. Including locations in Washington, have you ever used a call box?

____ Yes (where if outside Washington)______________________
____ No (If no, please proceed to Question 12)

4. At what time of day did you use the call box?

____ weekday morning or afternoon rush hour
____ weekday midday
____ weekday nighttime
____ weekend daytime
____ weekend nighttime
____ other________________________________

5. Did you feel safe walking to and using the call box? ____Yes ____No

6. Did you find the call box difficult to use? ____Yes ____No

7. Was the call box operating properly when you needed it? ____Yes ____No

8. Was the voice quality acceptable when you communicated with the operator?

____Yes ____No

9. Was it obvious that the call box was for public use? ___Yes ____No

10. Were you satisfied with the time it took for help to respond after you called?

____Yes ____No

11. Would you use the call box system again? ____Yes ____No

If no, why?____

12. In your opinion, how effective are call boxes at:

	Very		Somewhat		Not Very
____ improving safety	1	2	3	4	5
____ preventing other accidents	1	2	3	4	5
____ reducing congestion	1	2	3	4	5
____ helping services respond more quickly	1	2	3	4	5

____ other____

13. In your opinion, should the call box system in Washington be expanded to more routes or areas?

____Yes ____No

Travel Characteristics

14. How often do you travel on the following routes?

SR-520 across the floating bridge	____times per week
I-90 from the Mt. Baker tunnel to the Mercer Island tunnel	____times per week
Tacoma Narrows bridge	____times per week
Blue Bridge in Pasco	____times per week
selected off ramps on I-90 and I-405	____times per week

15. What is your usual mode of travel on these routes? (choose only one)

____ drive alone
____ bus
____ carpool/vanpool
____ motorcycle
____ other____

16a. How many times have you been involved in an accident along any of these routes (SR-520, I-90, Tacoma Narrows Bridge, Blue Bridge in Pasco, and selected off ramps on I-90 and I-405)?

____ never ____ once ____ twice ____ more than twice

16b. How did you obtain help? (check all that apply)

____ Washington State Patrol stopped to provide assistance
____ Washington State Department of Transportation stopped to provide assistance
____ requested help with a CB radio in a vehicle
____ requested help with a cellular phone in a vehicle
____ walked to a call box to request help
____ someone passing by requested help
____ someone stopped to provide assistance other than the State Patrol or the Department of Transportation
____ Other____

17a. How many times have you been in a vehicle that became disabled (because of mechanical failure, out of gas, etc.) along any of these routes (SR-520, I-90, Tacoma, Blue Bridge in Pasco, and selected off ramps on I-90 and I-405)?

____ never ____ once ____ twice ____ more than twice

17b. How did you obtain help? (check all that apply)

____ Washington State Patrol stopped to provide assistance
____ Washington State Department of Transportation stopped to provide assistance
____ requested help with a CB radio in a vehicle
____ requested help with a cellular phone in a vehicle
____ walked to a call box to request help
____ someone passing by requested help
____ someone stopped to provide assistance other than the State Patrol or the Department of Transportation
____ Other ________________________________

18. If you own a cellular telephone or CB radio, how frequently do you report an accident or vehicle breakdown that you see but are not involved in?

____ never ____ sometimes ____ always

About You

19. Are you ____Male? ____Female?

20. What is your approximate age?

____ under 16
____ 17 to 30
____ 31 to 45
____ 45 to 60
____ over 60

21. What is your approximate annual household income?

____ under $10,000
____ $10,001 - $30,000
____ $30,001 - $50,000
____ $50,001 - $70,000
____ $70,001 - $90,000
____ over $90,000

22. Are you currently ____Married? ____Single?

23. What is your highest level of education?

____ Did not finish high school
____ High school
____ Community college
____ College or university
____ Post graduate work

Additional Comments

____
____
____
____
____

THANK YOU FOR COMPLETING THIS SURVEY

When you are done, fold the survey along the dotted line and secure it with tape, then drop it in a mailbox. No postage is necessary. Thank you!

APPENDIX E
SURVEY COMMENTS

Call Box Users

"The volume is an issue. With racing freeway traffic right next to you, it is very difficult to hear the operator.--SR520"

"In dangerous Florida, call boxes can be found at roughly 1 mile intervals alone ? stretches of interstate highways and on the Florida Turnpike. Something to consider for Washington?--Florida (Tampa area, I-75)"

"It would probably help travelers using the call box if it were more clearly marked for use in getting assistance. If it wasn't marked 911 emergency it would probably help. I know it may seem obvious to some that it is there for help, but the way it is marked makes it seem like it is for medical and/or accident reporting.--I-90 tunnel"

"I think the phones are great.--I-90 floating bridge"

Call Box "Aware"

"We are senior citizens in our 70's and feel much safer on the Narrows Bridge with the call boxes."

"Keep up the good work! Thanks."

"Both my husband and I work in Tacoma and travel separately to work. Hence the high number of bridge crossings per week is necessary. We appreciate any number of safety elements the state offers on the Tacoma Narrows Bridge!"

"Never having used one , a call box gives one a feeling of security."

"I strongly support the call box program."

"With the use of cell phones, cameras and news crews watching these and other routes, I believe this system to be redundant and not cost effective."

"Need more call boxes on major highway and roads. Example: Highway 16 between The Narrows bridge and Bremerton should have at least 12 to 16 call boxes spread out for motorist to use in case of an emergency."

"I have seen them but did not know the public could use them."

"The call boxes are quite beneficial. The system should have a fairly high priority for expansion."

"It is tempting to say that more call boxes are not necessary due to the number of car phones. However, drivers with less reliable cars probably can't afford a car phone."

"Purchase cellular phone for situations on the highway. Call boxes are too far apart to be very effective."

"Should install call boxes where cellular phones don't work such as I-90 west of the Summit."

"I don't really have a lot of data needed to judge the effectiveness of the call box systems or to recommend their expansion."

"With each day more cellular communication are available, cellular free emergency numbers should be available on roadside signs."

"Since more and more people have cellular phones, the focus should not be on spending more tax payer's $ on call boxes. People do offer to help others by calling for help for them."

"Cellular phones are so prevalent that call boxes may be redundant. A Toll-free number for cellular phones might be as workable (although there might be many calls from many observers). No matter how convenient the call, the bottom line is how quick is the response time to resolve the problem. The focus of the study might better be how long does it take to respond once a problem has been reported and how can that response time and resolution of the problem be improved. Also, how can backed up traffic be more quickly alleviated.'

"Some of the more frequently traveled SRs could also use call boxes; SR-20, SR-104, US101 on the Olympic Peninsula."

"Too much $ for amount of service, more people have cellular phones and as long as calls remain low cost when calling 911, will be a cheaper way for state to address this problem."

"I think there should be more call boxes - especially on I-405."

"Please install more call boxes."

"It is hard to see call boxes. They are spaced far apart; if there was an accident or ran out of gas, you have to walk a long walk to the call box. They need to be advertised so that more people know that they are there."

Call Box "Not Aware"

"Thank you for letting me know what those things on the bridge are!"