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CITY OF OAKLAND

MEMORANDUM

TO: HONORABLE MAYOR & CITY COUNCIL

FROM: Ken Gordon

SUBJECT: Evaluation of P25 Public Safety Radio System Performance

DATE: July 17, 2012

City Administrator Approval **/s/ Deanna J. Santana**

Date **7/17/12**

INFORMATION

The City of Oakland has released the findings and recommendations of an independent evaluation of the P25 public safety radio system performance. The evaluation was conducted by RCC Consultants, Inc., a global telecommunications and engineering firm specializing in the testing of Interoperable Radio Systems.

The purpose of the evaluation was to establish an operational baseline of the system as it currently exists so that a plan of action can be prescribed to resolve the issues experienced by the City's first responders. It is vital that our Police and Fire personnel are able to use the new system with a high degree of confidence.

The scope of the evaluation was to:

1. Measure current system performance against first responders' expectations and recommend near-term fixes and solutions that build confidence in the new radio system;
2. Develop an interoperability plan to ensure effective communications with our mutual aid partners and connectivity with regional public safety radio networks compliant with national P25 standards;
3. Analyze the City's existing operations and maintenance procedures and identify necessary changes to support the new system.

New P25 Technology Launched in June 2011

Oakland deployed new P25 public safety interoperable radio communications technology in June 2011. The P25 technology was designed to ensure interoperability with P25 systems in neighboring jurisdictions in times of emergency or when necessary in the course of daily

operations. The new digital technology complies with the national P25 interoperability communications standard.
The City's public safety radio "system" is comprised of a variety of systems and equipment that have evolved over nearly 20 years. These include: radio towers, electrical power systems, antennas, microwaves, radios, and dispatch consoles. The various components have been replaced or upgraded at different times since its original installation in 1993. As the evaluation report noted, "The upgrade to P25 technology was the latest step in a series of improvements over the years. Many aspects of the previous system still remain in place."

Prior to launching the new P25 technology, the City's first responders were equipped with an analog radio system that was nearing 20 years old and was experiencing well-publicized and significant service interruptions and periods of instability. Due to the urgency of addressing the issues related to our aging radio system, deployment of the P25 technology was accelerated. Although a regional interoperable system [East Bay Regional Communications Systems Authority (EBRCSA)] was in development, given the significant issues associated with the City's aging analog technology, it was not an option to wait another 12 – 18 months for the regional system to come on line.

Technical Issues Impede Adequate Performance of New System

Technical issues invariably arise from the deployment of new technology, especially with a system as complex as the new P25 technology. A number of upgrades and enhancements have been deployed over the past year to improve system performance: hardware upgrades; replacement of aging batteries; addition of a third P25 radio site to expand coverage; installation of in-building radio antennas to improve in-building coverage. The report noted that, "The upgrades represent partial, step-by-step upgrades to the system, not a complete system replacement."

Despite significant effort on the part of the City and its vendors to resolve identified problems, first responders have continued to report ongoing problems with the performance of the radio system. These problems have understandably undermined users' confidence in the new system.

The consultant noted that "failure of any component, even a headset jack, that affects the end users is perceived as a systems failure for users." A public safety communications system must be both reliable and perceived as reliable by the users. The evaluation determined that the system in its present form is not "public safety" grade. Although "the majority of transmissions are understandable with a minimum of noise or distortion, the list of user complaints and frequency of problems are too high for a modern public safety radio system."

Major Findings of the P25 System Evaluation

The consultant team interviewed police and fire personnel to gain a first-hand account of the problems first responders experience using the radios. Police and firefighters expressed concerns with poor coverage in some areas of the city as well as inside buildings, problems receiving and transmitting, unclear and varying audio levels, and problems with speaker mics.

The evaluation found that "numerous improvements are required in order to bring the Oakland P25 radio system up to the performance level of a typical urban or metropolitan Public Safety radio system." The report identified the most critical categories requiring improvement to be:

- Radio system coverage
- System reliability (back-up power and alarm systems)
- System maintenance and monitoring
- Accessory maintenance
- Training for users and radio technicians

Recommendations and Next Steps

The report identified five primary alternative solutions:

1. Do nothing; continue as-is
2. Upgrade current facilities
3. Expand existing system
4. Replace existing system with new City-owned system
5. Migrate to regional P25 system (EBRCS)

The evaluation team recommended that the City upgrade existing facilities in the short-term while developing a conceptual design and budget estimate to identify how many sites would be required to address coverage issues.

In parallel with this process, the City was advised to resume direct negotiations with the East Bay Regional Communications System Administration to identify the costs associated with joining the regional system, the level of coverage it would provide, and the level of control the City would maintain over its own operations.

Other recommended next steps included upgrading the City's Radio Shop equipment and training staff on P25 maintenance; and review and inspection of user equipment to address instances of poorly installed equipment, defective accessories and poorly tuned equipment.

Our police and firefighters put their lives on the line to protect this community, and a functioning radio system is their lifeline. City officials acknowledge and appreciate that they have experienced many frustrations with the deployment of this new technology, and staff is committed to work diligently and quickly to provide them with a radio communications system that meets their needs.

The City's Department of Information Technology staff will work with the consultant to examine the alternatives identified and develop a cost estimate and timeline required to close the performance gap. The objective will be to achieve short-term (less than six months)

improvements to address gaps in performance where possible until long-term and more permanent improvements can be implemented.

Respectfully submitted,

/s/
KEN GORDON
Interim Director/DIT

For questions please contact Ken Gordon, Interim Director, at (510) 238-2023.

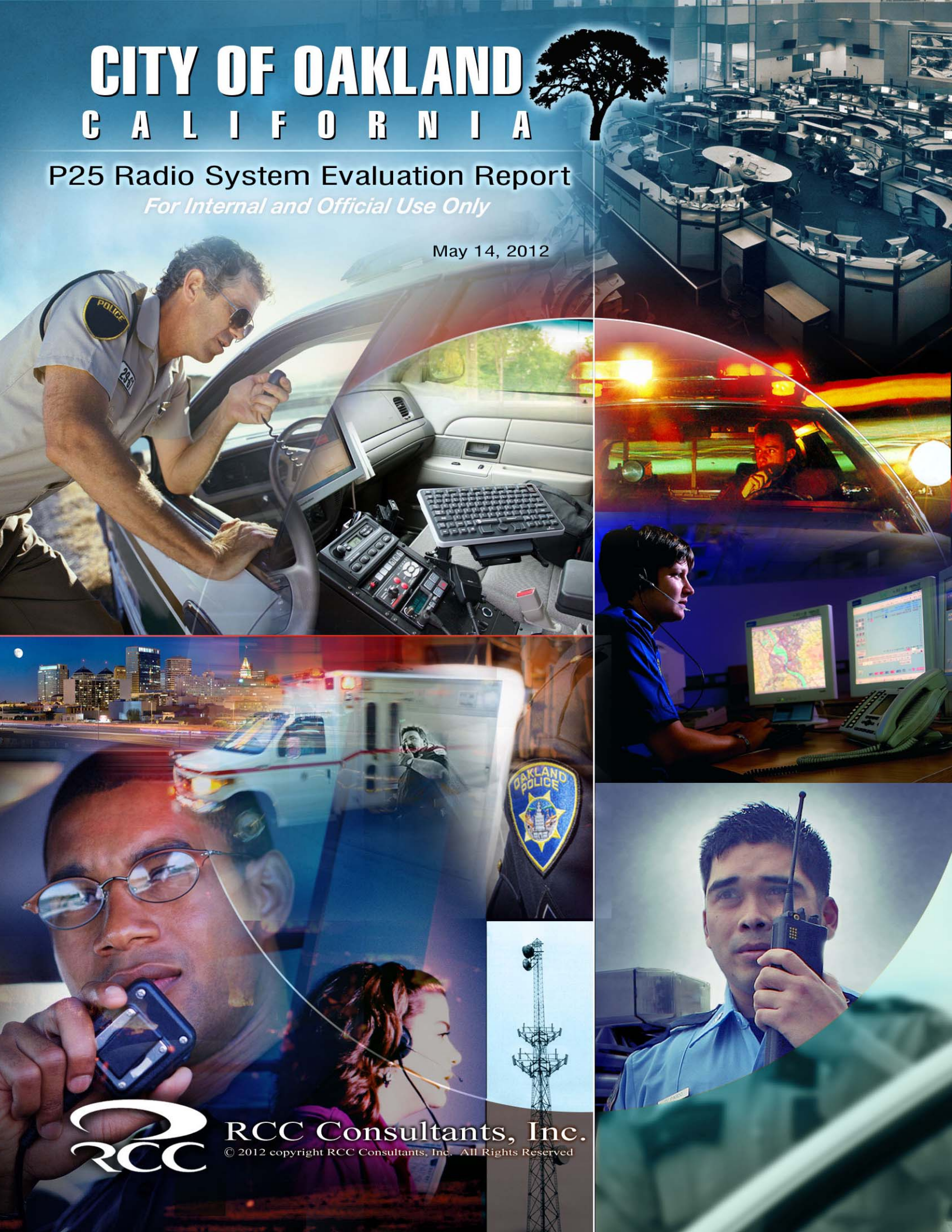
Attachment (1)

CITY OF OAKLAND
CALIFORNIA

P25 Radio System Evaluation Report

For Internal and Official Use Only

May 14, 2012



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May 14, 2012

Deanna J. Santana, City Administrator
Howard Jordon, Oakland Chief of Police
Teresa Deloach Reed, Oakland Fire Chief
Ken Gordon, Interim Director, Department of Information Technology
City of Oakland, CA

Ladies and Gentlemen,

Please find attached the RCC prepared P25 Performance Evaluation Report. This Report addresses RCC's findings in both the evaluation of user's perception, and actual RCC observations of the Oakland P25 Systems performance. In addition RCC conducted a citywide coverage and Bit Error Rate (BER) test that gives an indication of both coverage and signal content delivery.

RCC staff are available to discuss and present these findings at your direction. If you have any questions or comments, please feel free to contact me directly.

Sincerely,

Thomas Gray
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TG:amj

Section 1 Executive Summary

The City of Oakland, CA has retained the services of RCC Consultants, Inc. (RCC) to perform the following three tasks:

- Perform a Performance Evaluation of the City's P25 trunked radio system
- Develop an Interoperability Plan for communications with Oakland's neighbors
- Develop an Operations and Maintenance Plan for ongoing support of the City's radio system

Toward that end, RCC personnel have visited the following facilities:

- The Oakland Police Department Dispatch Center,
- The Oakland Fire Department Dispatch Center,
- The Piedmont Public Safety Dispatch Center,
- The Electronics Room at the Oakland Police Department Dispatch Center,
- The Electronics Room at the Oakland Fire Department Dispatch Center,
- The Electronics Room at the Piedmont Public Safety Dispatch Center,
- The Radio Site in the penthouse and on the roof of the American Presidents Line (APL) Building,
- The Radio Site at Seneca Reservoir,
- The Radio Site at Gwin Reservoir, and
- The Radio Shop at the Municipal Services Center (MSC).

RCC personnel have interviewed the:

- Oakland Police Department Dispatch Management,
- Oakland Police Department Dispatchers,
- Oakland Police Department Patrol Officers (at 12 shift changes),
- Oakland Fire Department Dispatch Management,
- Oakland Fire Department Dispatchers,
- Oakland Fire Department Radio Team Members,
- Oakland Department of Information Technology Management,
- Oakland Radio Services Management,
- Oakland Radio Services Staff,
- Dailey-Wells Communications Staff associated with the project,

- Bay Area Rapid Transit (BART) Communications Engineers, and the
- East Bay Regional Communications System (EBRCS) Executive Director.

1.1 Purpose of this Evaluation

The purpose of this evaluation has been to review the current state of the City of Oakland's P25 Radio System and assess its present condition and suitability for use by the City's public safety agencies.

This evaluation also includes a review of various means of communicating with neighboring agencies, to achieve communications "interoperability" with those agencies.

This evaluation also includes a review of the City's current Radio Shop's staffing, facilities and equipment, and makes recommendations for improving those facilities and capabilities.

1.2 What this Evaluation Includes

This report includes RCC's findings as a result of the site inspections and interviews listed in Section 1.1 along with documentation provided by the City regarding the various subsystems that make up the P25 Radio System.

This report also includes preliminary results from radio signal drive testing performed by RCC during the period from May 2nd to May 9th, 2012. During that period, RCC used test equipment installed in one of the City's Crown Victorias (a typical police patrol vehicle) to continuously measure signal strength throughout the City, using test equipment with antennas mounted on the trunk of the vehicle where police mobile antennas are mounted, and inside the vehicle where a portable radio antenna would typically be worn. Signal measurements include both composite simulcast signals (transmitted from all three sites simultaneously) and individual site signals (to help determine what coverage each site contributes to the whole). In addition, RCC also recorded Bit Error Rate measurements, which provide a more accurate picture of how clean a signal a digital radio "sees" in the Oakland area.

With the exception of the drive test performed in May, RCC's evaluation is based upon visual inspection of facilities, verbal information provided through the interview process and project meetings, and existing system documentation. The purpose of this phase of the project is to discuss the most likely causes and most likely solutions for the problems reported. RCC has not attempted to independently verify or troubleshoot the various problems that have been reported by the end users. RCC has not yet been involved in technical troubleshooting of those problems.

This evaluation provides a brief, high level history of the Oakland Radio System, it explains how the System evolved to its present state, it discusses the reported problems with the system, and it discusses alternative means to investigate, address or resolve those issues.

RCC discusses several approaches for improved communications available to the City, and evaluates each with respect to the following parameters:

- Relative Cost,

- Relative Coverage improvement,
- Relative Time required to implement,
- Level of Interoperability provided with neighbors, and the
- Amount of Control the City could be expected to retain over its communications systems.

The amount of "Control" the City would have is assessed in terms of the amount of control the city would be expected to have over:

- Future costs,
- Number of talkgroups (functional channels) on the system,
- Priority Push-To-Talk access to the system,
- Ability to authorize and de-authorize access to City talkgroups,
- Amount of proactive system monitoring and alarm notification,
- Priority service response, and
- Service response time.

1.3 What this Evaluation is Not

This report does not include independent measurement or diagnosis of the problems reported by end users. This report relies upon information provided by the City, provided by the other stakeholders interviewed, and by RCC's visual inspection of the City's communication facilities.

RCC assumes that the incidence of problems reported is more frequent than the statistics provided, as RCC does not realistically expect every radio user to report every incident they experience. For the purpose of the evaluation, it is important simply to recognize that those conditions exist, and that they exist at least at the rates reported by the users.

RCC provides an evaluation of the pros and cons associated with the alternatives available to the City, but does not select any one approach as the recommended course of action. RCC believes that the City must weigh the critical issues of cost and control against the issues of interoperability and the degree to which the City's current problems would be addressed or resolved. The least cost solution is not the most effective solution, while the more effective solutions can be expected to require more time and money to achieve.

The course of action chosen by the City must be one that the City can afford, and must provide both short term relief and long term improvements for the system's end users.

1.4 Radio System History / Background

The City of Oakland's current 3-site P25 Trunked Simulcast Radio System configuration is the result of 19 years of evolution, and it continues to grow and change today. The current System (with a capital "S") is a combination of subsystems and components that have been procured and installed in stages since 1993. A full understanding of the current issues and reported problems associated with the City's radio system requires an understanding of how the City has

gotten to where it is today. In particular, it is important to understand which system components were installed when, along with an overview of who is maintaining those components.

During the course of RCC's interviews with Oakland personnel, it became apparent that most of the City's radio users were under the impression that the City's P25 radio system was a brand new radio system that would completely replace the City's older EDACS[1] system and eliminate any problems that they had experienced with the older system. In reality, the upgrade to P25 technology was the latest step in a series of improvements over the years. Many aspects of the previous system still remain in place.

1.4.1 The Oakland P25 Radio "System" is a collection of subsystems

The City of Oakland's Radio "System", much like similar complex systems in other cities consists of a collection of subsystems that include but are not necessarily limited to the following:

- Radio Tower Sites;
- Equipment Shelters at the sites;
- Environmental Control Systems;
- Grounding and surge protection systems;
- Primary Electrical Power Systems;
- Backup Power Systems;
- Transmit and Receive Antenna Systems;
- Microwave and other connectivity systems;
- Alarm Systems;
- Radio Repeaters;
- Dispatch Consoles;
- Console Furniture;
- Network Controllers;
- Simulcast Synchronization Systems;
- Interoperability Gateways;
- Mobile Radios and Accessories;
- Portable Radios and Accessories;
- Desktop Control Stations and Accessories;
- In-Building Bi-Directional Amplifier Systems, and a
- Voice Logging Recorder System.

Each of the above subsystems can be broken down further into smaller subsystems or components.

[1] ("EDACS" is a Harris product name for "Enhanced Digital Access Communication System".)

A failure of any one of those components or subsystems can potentially keep the end user from being able to communicate with other users or with dispatch.

1.4.2 Evolution of the "System"

The "System" has evolved over time, with various subsystems being replaced or upgraded at different intervals. The following outline represents RCC's understanding of the evolution of the City's trunked radio system from its first installation as a single tower site analog EDACS system in 1993 to its present configuration as a 3-site, 10-channel P25 digital simulcast system.

In 1993, the City installed a new EDACS trunked radio system on the American Presidential Lines (APL) Building rooftop. The APL site, which was intended to serve the majority of the City, was equipped with 14 radio channels. The City later added a site at the East Bay Municipal Utility District's Seneca Reservoir. The Seneca site, which was intended to serve units in the southeast portion of the City that could not reliably reach the APL site, was equipped with 5 radio channels.

In 1999, the City upgraded the "brains" of the system to a dual controller configuration as part of a Y2K upgrade. The City also installed new C3 Maestro dispatch consoles at that time.

In 2006, a number of upgrades were performed:

- A three-channel standalone P25 site was added at the East Bay Municipal Utility District's Gwin Reservoir site, which sits on high ground along Grizzly Peak Blvd, overlooking much of Oakland and the Bay Area.
- The City also performed an upgrade to its Communications System Director (CSD), which is the system administration package used to access and control / manage the radio system.
- That year the City also installed a "Stargate" to interface or "link" the Oakland system to neighboring EDACS systems in Richmond and at BART, allowing users from one system to talk to users on the other system. The Stargate was intended to facilitate better radio communications interoperability between the three cities, but the Stargate link is no longer active. The Stargate interface is being replaced by a new Harris ISSI interface.
- The City upgraded the equipment that is used to select the best incoming radio signal from the tower sites (called a voting comparator), and upgraded the radio repeaters (the base stations) at APL from the old MASTR II series to the new MASTR III series.
- The City added a single-channel site at Fire Station 28 to provide additional coverage in the far southeast corner of the city, in the Golf Links Road area east of 580.

In 2006 the City also managed to use the FCC's 800 MHz Rebanding mandate to its advantage, by replacing and upgrading older user radios (at Nextel's cost) with newer P7100s and P7200s. (The FCC Rebanding Mandate instructed licensees to retune their systems, at Nextel's expense, in order to minimize interference between Nextel's transmitter sites and public safety systems.)

In 2008, a single 3 channel P25 pilot radio site was installed at the Gwin Reservoir site.

In 2010, a number of problems with the City's aging EDACS system forced them to accelerate their conversion to a new P25 digital system.

In 2011, the City completed the following:

- Rebanding retune of its radio infrastructure;
- Upgraded the APL and Seneca sites to a P25 digital simulcast system;
- Upgraded its dispatch console computers to Harris' new IP version of its C3 console system (C3IPs); and
- Installed a new Aviat 11 GHz microwave network to connect the sites and dispatch centers.

The P25 simulcast system went live in June 2011. Unfortunately the launch of the P25 system was accompanied by a number of initial problems due to a software mismatch between the user radios and the radio infrastructure software versions. These problems created a very poor first impression of the new system, an impression that still lingers to this day.

The launch of the P25 system was also accompanied by the users' expectations that the conversion to P25 digital operation would take care of or correct all of the problems associated with the old EDACS system, even though no new sites were being added to the system. Consequently, user disappointment that they still had many of their old dead spots and trouble areas was significant.

In late 2011, the City swapped out old portable radio batteries that had been kept in use for several years beyond their normal lifecycle with newer, longer-lasting Lithium Polymer batteries. Batteries for public safety radios should be swapped out every year or two depending upon their rate of use. Prior to replacement of the batteries, battery failure was among the main contributing factors to the poor handheld radio performance.

In 2012, the City converted the standalone Gwin Reservoir P25 site to a simulcast site, making the system a 3 site simulcast system. The City also expanded the simulcast sites from 7 to 10 channels to increase system capacity.

Other upgrades by the City are currently planned and ongoing, such as the addition of backup power generators at the Gwin and Seneca sites, and the installation of a new logging recorder system.

It should be noted that the growth and migration of the Oakland system over the past decade was performed using grant funds and other sources as the funding became available. The City reports that it has never incurred debt by issuing bonds or borrowing funds for any of the work performed on the system.

It should also be noted that the upgrades represent partial, step by step upgrades to the system, not a complete system replacement.

At no time since 1993 has the entire system actually been re-engineered or replaced at the same time as part of a single program. As a result, after each "upgrade" step along the way some components of the System have been brand new, while some older equipment remained.

In many instances, the aged components begin to present problems that affected the system as a whole.

For example, when the P25 System went live in June 2011, the Seneca site shelter, tower, grounding systems, antenna systems, power systems and alarm systems were still as they had been when the site was first constructed. One system performance problem was later traced back to a bad antenna, whose radome had collected water, shorting out the antenna elements.

A couple of other problems at the Seneca site were related to the lack of backup power systems. A backup UPS was installed in 2011 after the system went live. A backup power generator is presently waiting to be installed.

While the dispatch consoles in the dispatch centers have been upgraded with new computers and dispatch software, some of the supporting accessories are older or original equipment, such as the audio cabling, headset jacks, foot pedals, display monitors, and speakers. The headset jacks in particular have been reported to be problematic, as they are now so worn out that they no longer make a solid connection with the dispatcher's headset. These loose connections can result in audio problems that are perceived to be "part of the system".

As noted earlier, the batteries that were in use when the City cut over to the P25 system had exceeded their useful life, and were contributing to user complaints about the system. Those batteries were replaced in October 2011.

The following list gives an overview of which system components are still relatively old, and which components are newer. (Note that items like infrastructure components – shelters, towers, etc. typically have a longer useful life than electronic components or accessories):

Components aged more than 5 years:

APL equipment room
Seneca equipment shelter
Seneca radio tower
Seneca antenna systems
Backup power generator (or lack thereof) at Seneca (being installed in 2012)
Alarm and notification systems / sensors, etc.
Voice logging recorder system (being replaced in 2012)
Dispatch consoles at Piedmont (being replaced in 2012)
Dispatch console accessories (furniture, headset jacks and wiring, foot pedals)
Desktop radio antenna systems
Mobile radio antenna systems
Mobile radio power harnesses
Portable radio accessories

Intermediate aged items installed as part of P25 pilot or Rebanding (2 to 5 years old):

Mobiles and portables replaced as part of Rebanding
Combiners replaced as part of Rebanding
APL antennas and line
Gwin equipment shelter
Gwin radio tower

Gwin antenna system

Newer items installed as part of P25 Upgrade (2 yrs old or less):

P25 Digital Repeaters
P25 Backbone Electronics
Radio Dispatch CPUs and Software at Police and Fire Dispatch Centers
Aviat Microwave System

Items less than 1 Year old (installed after the P25 System cutover):

UPS systems at Gwin and Seneca
Portable radio batteries
Air conditioner at Gwin
Gwin simulcast equipment
Second transmit antenna and line at Gwin
Replaced combiner at Gwin
Bi-Directional Amplifiers for PAB and Eastmont PD substations

1.5 Summary of Major Findings of the P25 System Evaluation

As noted in the previous section, the P25 Radio "System" is really a collection of subsystems, each of which play a role in the overall performance and reliability of the City's radio system. RCC made a number of observations regarding opportunities for improvement in the City's communications facilities and end user equipment, which are covered in more detail in the body of the report. RCC also noted opportunities for improvement in the Radio Shop's equipment and support capabilities.

The City's Radio Shop and IT department has continued to work on improving the Radio System during the course of RCC's evaluation. Consequently, solutions for a number of these identified opportunities for improvement may have already been implemented or may currently be underway.

Overall, RCC finds that numerous improvements are required in order to bring the Oakland P25 radio system up to the performance level of a typical urban or metropolitan Public Safety radio system.

The most critical categories of improvement needed to bring the system up to typical Public Safety standards of performance fall into the following categories:

- Improvements in radio system coverage;
- Improvements in system reliability (currently primarily backup power systems and alarm systems);
- Improvements in system maintenance and monitoring (more frequent monitoring of system performance conditions and improvements in alarm alerting capabilities), and
- Improvements in subscriber (user radio) and subscriber accessory maintenance.

There is some overlap in the above categories, as some of the identified opportunities for improvements to the sites, subscriber equipment, and maintenance program will result in improvements to the overall coverage of the radio system.

The primary end user complaints from the Oakland Police and Fire Departments are related to audio problems and an inability to access the system (get on the air) when needed. These complaints typically fall under the category of "coverage issues", though there may be a number of other root causes in addition to the coverage provided by the system's tower sites, such as:

- Weak radio batteries reducing the range or coverage of portable radios (batteries were replaced for most public safety users last fall)
- Broken or defective accessories (broken speaker mics, loose connectors, damaged antennas on portable or mobile radios)
- Local sources of radio frequency (RF) interference (from local cellular sites, for example)
- Portable or mobile radio equipment out of tune or out of alignment
- Portable or mobile radio equipment software mismatch with system
- Mobile radio installation problems (such as loose connectors, lack of proper equipment grounding, lack of ground plane for the antenna, broken antenna, etc.)

Coverage related problems have significant effect on officer safety, as the ability to coordinate backup or warn fellow officers of a hazardous situation is of critical importance. Public safety personnel told RCC that lack of coverage, or even lack of confidence in their radio equipment, can have an impact on the way they perform their jobs.

Coverage-related User complaints have been described (and tracked) by the Police Department under the following descriptions:

- CC Scan (radio unavailable looking for a control channel);
- Cutting In and Out;
- Dead Spots;
- Failed Radio;
- Poor Reception;
- Poor Transmission;
- Radio Problems;
- Unable to Copy Radio;
- Unable to Receive Radio, and
- Unable to Transmit.

The OPD also tracked incidents of "bleed over", where audio (communications) was heard on the wrong channel, and "Other", which represents a miscellaneous problem category other than the categories above.

RCC attended a total of 12 shift changes in order to hear about Oakland Police Department patrol officers' experiences first hand. The following is a partial list of the more specific complaints that officers voiced about their experience with the radio system:

- Poor coverage in foothills;
- Poor coverage inside buildings (hospitals, PAB basement, buildings in various parts of the City, etc.);
- Users perceive that the system works better outside the city than inside;
- CC SCAN appears randomly. One officer noted LESS occurrence of CC SCAN while testing the single-site GWIN system than he normally sees when operating on the simulcast system. Officers report mobiles frequently in CC SCAN when portables are not;
- Radios take a long time to register (stay in CC SCAN a long time after powering up);
- Radio picking up traffic on other channels;
- Radio transmitting on wrong channel;
- Radio switching on its own to another channel;
- Variable incoming audio levels, especially between different radio types (mobile, console, portable);
- Fellow officers can hear transmissions, but dispatch does not respond;
- Radio lack of backlight (or at least backlight option) on portable radios. Patrol officers want backlight ON by default, with ability to turn it off when needed;
- When siren is on, officers are unable to transmit;
- Speaker mics pop off radios (Cracked retention slots, screws not tight enough);
- "Speaker mics work GREAT accidentally, but not when the officer needs to use it". (One officer noted that if he accidentally sits on the microphone, the whole world will hear every word he says. But if he's in a struggle or a pursuit, then no one can understand what he's saying);
- Speaker mic PTT button is fussy – has to be pressed in just the right spot in order to key up the radio;
- Users report that the longer you key the mic, the weaker the transmission becomes. (potential battery problem);
- Users would like a louder, more distinct talk permit tone;
- One officer noted that radio buttons are pressed by radio holster if user transmits while running. (Interferes with voice audio);
- Several users reported getting shocked when hanging up the mobile mic in the microphone clip, and
- Mobiles "freeze up" when changing channels – have to power off, then on, in order to reboot the radio.

RCC personnel made a few other observations (listed below) during their visits to Oakland.

- System alarm system limited in its capabilities; limited site alarms; no ability to automatically ALERT on-call technician when a problem arises.
- [redacted]
- [redacted]
- The old EDACS Analog System is the backup radio system
- Many users are not aware that they have talk-around (direct unit to unit) channels in their radios, which would allow them to talk to each other radio-to-radio when they are close to each other but are beyond the range of the system (such as when one officer is inside a building and the other is outside).
- Radio channel (selection) programming in the user radios is horrendously and unnecessarily complex. It was very difficult to navigate to interoperability channels and back using radios as they were configured at the end of 2011.
- No “cheat sheet” provided. Larger organizations whose radios have many systems and talkgroups programmed into them give their officers a small laminated “cheat sheet” card that serves as a menu to help them find their way through the matrix of systems and channels that are programmed into their radios. Some attach the card to a flat surface on their radio, while others attach the card to the same clip that holds their ID and magnetic security card.
- No "Home" button programmed to quickly and easily get users back to their dispatch channel. A “Home” button is a very helpful way to get a user back to their primary channel when they get lost in the multitude of systems that are programmed into their radios.
- End user training inadequate. It is RCC’s understanding that the subjects of proper radio usage, radio etiquette, and radio protocol for routine, emergency, and multi-agency situations are not presently taught at the police academy, and most officers get their information regarding the proper use of the system from periodic instructional e-mails.

The site and alarm system issues are addressed in more detail in Section 3 and Section 12.

It should be noted that despite the long list of user complaints and the additional observations made by RCC, the vast majority of transmissions on the system are clear and understandable.

However, it is critically important that steps be taken to make sure that public safety personnel are able to communicate clearly and reliably wherever and whenever they key their radio.

1.5.1 Radio Coverage Testing

There are a number of steps that can be taken in an effort to diagnose radio coverage problems. One of the first steps is to measure the strength of the radio signals delivered by the system throughout the City. RCC performed a signal strength drive test in May 2012 in an attempt to determine to what extent the City’s radio coverage problems are simply the result of not having enough tower sites to provide the level of coverage required by the City. The data from those drive tests is discussed in the body of the report in Section 6.

Coverage performance is typically defined in terms of the percentage of the radio system's desired service area that is covered for a specific radio usage type (95% of the service area is a typical coverage specification for public safety radio systems). For example:

- ***Mobile Coverage -*** Mobile radio coverage is the type of coverage provided when using vehicular (car) radios. These radios are more powerful than smaller handheld portable radios. Typically, mobile radios have about ten times the transmitter power of handheld radios and they also have a much better antenna which is mounted on the exterior of the vehicle. Consequently, mobile radios provide substantially better coverage or "communications range".
- ***Portable Coverage -*** Due to the reduced "range" of handheld radios, portable radio coverage is more difficult to provide. Coverage in buildings is tougher to provide than coverage outdoors on the street because the building structure blocks some of the radio's signal. Heavier buildings exhibit more signal loss than smaller buildings. The amount of loss is measured or quantified using a term called the decibel (dB). A higher building loss has a greater reduction in the radio's ability to communicate within the facility. For the purposes of this report there are typically three levels of portable coverage discussed, which are described as follows:
    - ***Portable Coverage Outdoors On-Street (no building loss):*** Assumes the radio user is outdoors in a relatively average environment. Typical vegetation and local terrain are accounted for. This category does not include the use of a portable radio inside a vehicle.
    - ***Residential In-Building Coverage (up to 10 dB of building loss):*** Examples of buildings in this category may include convenience stores, gas stations, fast-food restaurants, small single-story homes/businesses, and other establishments with numerous windows or extensive glass exteriors.
    - ***Commercial In-Building Coverage (10dB - 20dB of building loss):*** Examples of buildings in this category include light to medium construction buildings such as medium size businesses with windows, small to medium size schools, etc. It may include some heavy buildings with numerous exterior windows that allow radio signals into the building. Radio signal levels are the strongest near the tower sites, and that is generally where you will have the best in-building communications.

Analysis of RCC's May 2012 test provided the following levels of radio coverage for each of the usage scenarios in Figure 1.5.1.

Figure 1.5.1 – Usage Scenarios for Portable and Mobile Radios

Some agencies hold the radio at head level during use, while other agencies, including most public safety agencies, wear the radio on the belt with an extended microphone on a cord. Elevating the radio to head level improves coverage because the radio's antenna is higher above the ground and the antenna is less obstructed by the user's body. Placing the radio on the belt decreases coverage due to the lower placement of the antenna and the signal blockage by the user's body. How the portable radio is used makes a significant difference is therefore an important factor in assessing coverage performance.

Figure 1.5.2 – Use of Portable Radio at Hip Level

Drive tests performed by RCC in May 2012 indicate that the current three site simulcast design provides enough signal within the Oakland service area to provide the following levels of coverage for the listed radio usage scenarios:

Usage Type	Target Signal Level	Percentage of Area Covered
Mobile at Trunk Level	-108 dBm	95.8 %
Portable at Head Level	-105 dBm	94.9 %
Portable on Belt	-95 dBm	89.4 %
Portable on Belt in 10dB Building	-85 dBm	72.9 %
Portable on Belt in 20dB Building	-75 dBm	22.1 %

For this test, "the Oakland service area" was defined as the land areas within the City limits of Oakland, Piedmont, Emeryville, and Alameda.

The drive test results indicate that approximately 95% of the service area has enough signal to provide clear communications to both mobile radios and to portable radios held at head level. Better than 89% of the area is covered for a portable at belt level outdoors. Approximately 73% of the area has enough signal to provide coverage to a portable on the belt inside a residential building, and approximately 22% of the area has enough signal to provide coverage inside medium commercial buildings.

However, RCC's drive tests also indicate that there are a number of points within the service area where sufficient signal levels exist, yet for various reasons the digital signal has an elevated rate of bit errors (meaning the signal suffers from some form of distortion or interference). The cause or source of that interference or distortion has not yet been determined, but should be investigated by the City or by RCC in a future phase of this project. Section 6 contains a more detailed discussion of the drive test results and what they indicate.

1.6 Summary of Interoperability Study

Following the events of September 11, 2001, and the clear negative operational impacts that ineffective communications had on a coordinated multi agency response, the nation became focused on improving public safety radio interoperability. It is important to draw a distinction between public safety and emergency management and response. In broad terms, public safety involves the protection and prevention from events that could endanger the safety of the general public. Our public safety first responders, and the culture of these agencies is to be "ever vigilant" to ensure that the citizens served are protected. Public safety involves monitoring, proactively preventing, and responding in such a way that the citizens served are safeguarded. Individual law enforcement and fire agencies traditionally oversee the citizens that are commissioned to "preserve and protect". The core of public safety is the receipt of calls for service (9-1-1), and the dispatch of services and an internal coordination of that response. This public safety activity goes on routinely each day in cities and counties throughout the Country. Typically the need for real time incident coordination between agencies, radio interoperability, is not needed to ensure effective public safety services; this is reinforced and reflected in the current culture of the public safety community.

Emergency Management however is a strategic approach to larger events unlike the tactical public safety daily oversight. This is not to say that public safety does not have a strategic aspect to preparedness and prevention of crime and fire response, it does. Emergency Management is the strategic response that requires interoperability between multiple agencies regionally and even nationally to ensure a well-coordinated response and recovery. This is where radio interoperability becomes essential. In response to the events of 9/11 the Department of Homeland Security (DHS) was put in place and an initiative put in place to improve radio interoperability between first responders, not necessarily impacting day-to-day public safety services, but to address mitigate and prepare for major disasters and catastrophes that require interagency coordinated Emergency Management. The DHS created a program initiative called SAFECOM, as part of the Nation's first strategic plan to improve emergency communications SAFECOM addresses an approach that recognizes the reality that this process will be evolutionary in nature and addresses radio interoperability in terms of governance, operations, technology, training and exercises, and usage. There is not a technological distinction between public safety infrastructure and its use in support of an emergency management event; therefore it is the responsibility, especially for large urban areas such as the City of Oakland, to provide an effective interoperability solution for operations regionally.

Emergency Management however is a strategic approach to larger events unlike the tactical public safety daily

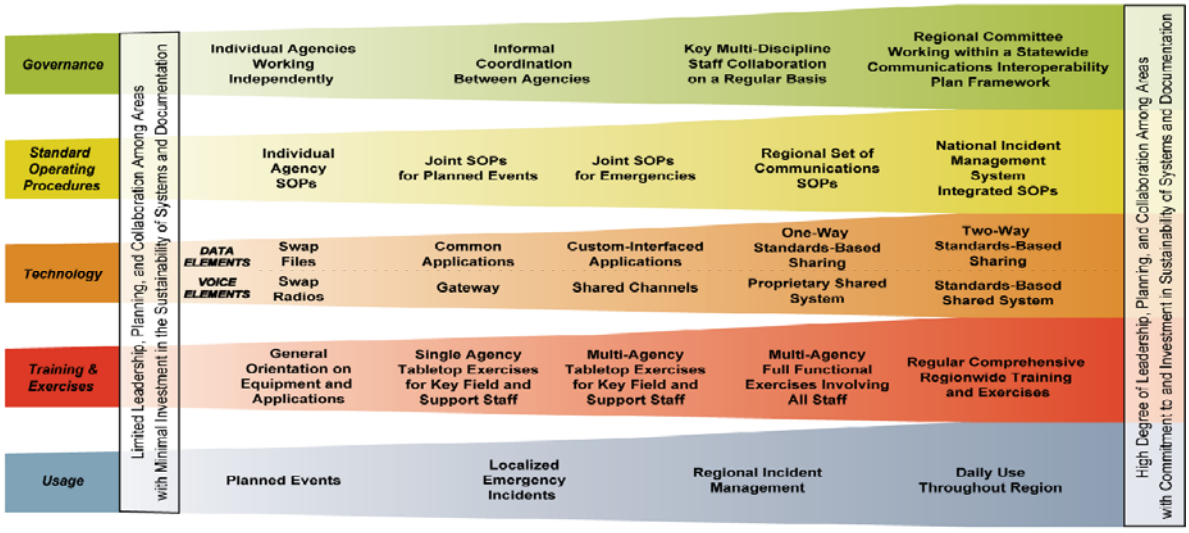
The 2007 California State Interoperability Communications Plan (CalSCIP) has adopted the following vision for interoperability in the State:

> *"to ensure all local, regional, tribal, state and Federal public safety first emergency responders and designated public service organizations operating within California will be able to communicate in real time, across disciplines and jurisdictions, to respond more effectively during day-to-day operations and major incidents by 2017."*

Toward that goal, California has established regional interoperability planning regions, of which Oakland falls into the Capital-Bay Area Planning Region.

California's statewide communications interoperability effort is coordinated and implemented by the California Emergency Management Agency (Cal EMA) and is guided by the State Communications Interoperability Plan (CalSCIP). Through the California State Interoperability Executive Committee (CalSIEC), and the Public Safety Radio Strategic Planning Committee (PSRSPC), which receive guidance from stakeholder groups, regional planning committees, public service and private sector groups. Through collaboration, both the CalSIEC and the PSRSPC work toward moving the State forward in achieving sustainable interoperability along the lanes of the Interoperability Continuum.

SAFECOM Interoperability Continuum Chart



When following the SAFECOM Interoperability Continuum, the highest levels of interoperability are possible by achieving success in each of the Continuum lanes. Greatest levels of success are achieved when there is regional cooperation to implement a shared, standards based, interoperable communications system.

There are a number of technologies available to allow agencies to communicate with each other. The most common solutions used by public safety agencies are:

- Swapping Radios
- Cross-patching systems and channels (consoles patches, gateways, etc.)
- Cross-Programming User Radios with other agencies' systems and channels
- P25 System Level Interfaces – ISSI
- Shared Mutual Aid Overlay System
- Shared Networks / Regional System

Each technology is discussed in more detail in Section 10 of this evaluation. In general, the highest level of interoperability occurs when all users share the same radio system and have access to common channels on that system.

Pros and cons of each approach are also discussed in Section 10.

1.7 Summary of Operations and Maintenance Plan

The City's radio shop is currently responsible for directly maintaining or overseeing the maintenance of the following systems:

- P25 Simulcast Radio System (Post – warranty support),
- 11 GHz microwave system (Post – warranty support),
- Dispatch console system,

- Radio system logging recorder,
- 19 GHz Harris Farinon Microwave System,
- EDACS Multicast Radio System,
- Public Safety Mobile Data Systems,
- VHF Interoperability Radio Systems,
- Wireless networks used to support City facilities,
- Closed Circuit Television Systems for all City facilities,
- 29-Site Outdoor Warning System,
- Mobile radio installations for public safety departments,
- User radio first echelon troubleshooting and repairs for mobile and portable radios, and
- User programming and template development for all radio users.

Currently there are five (5) technicians employed by the City that in conjunction with some other Information Technology (IT) personnel and some vendor support are responsible for maintaining each of these systems on a 24 hour, 7-days a week basis. The field service technicians are expected to be familiar with each of the systems maintained by the shop. There is some specialization where certain techs are more familiar with some of the systems than others. In many circumstances, technicians will work on systems that they are more familiar with such as fixed radio infrastructure repairs vs. bench repairs.

Field Service includes responding to service on equipment located throughout the City. There is one (1) service van that is equipped with small miscellaneous installation hardware and a few replacement parts. Test equipment is not left in the van, but rather the technician will determine what test equipment is likely to be needed depending on the nature of the call, and then borrows that test equipment from the shop. The majority of spare parts and other installation hardware are stored in the parts room located in the radio shop.

The primary deficiencies identified with current Radio Shop operations are:

- Inadequate staff training on the new P25 portions of the system
- Inadequate test equipment for working on the P25 system
- Room for improvement in internal shop communications
- Room for improvement in Equipment and Service Call Tracking
- Need for pro-active Site Monitoring / Alarm Alerting
- Insufficient spare parts inventory on-hand

Section 12 of this report provides an Improvement Plan to address each of the above deficiencies. Section 12 provides a recommended staffing plan, spells out the training needed for shop personnel, the test equipment they will need, and procedures for better tracking their work volume.

1.8 Summary of Alternative Solutions

There are 5 primary alternatives available to the City of Oakland:

1. Do Nothing; continue As-Is
2. Upgrade Current Facilities
3. Expand Existing System
4. Replace Existing System with new City owned system
5. Migrate to Regional P25 System (EBRCS)

The above solutions are not necessarily exclusive, and it may be prudent to implement some needed short-term solutions while working on the longer range solutions.

The primary differences between these alternatives fall under the headings of:

- Cost;
- Coverage;
- Control;
- Time required to implement, and
- Interoperability.

Do Nothing; Continue As-Is

The “Do Nothing” approach preserves the status quo, and does nothing to address the users’ complaints or the identified opportunities for improvement. This option is appears to be the least expensive to implement, and requires no time to do so. That said, system problems represent risk to the City and its employees. Interoperability with neighbors remains unchanged. Control of the system remains with the City as today.

Upgrade Current Facilities

The “Upgrade Current Facilities” approach will address a number of "easy to fix" problems without adding additional tower sites to the system. Depending on the extent of the upgrades, and large number of root causes of current user complaints and opportunities for improvement could be addressed. This approach will require some time and money to implement, but not likely as much as would be required to add sites or replace the entire system. The primary disadvantage to this approach is that it does little to improve the level of coverage within the City – dead spots would remain.

Expand Existing System

The “Expand Existing System” option, if chosen, should include upgrades to existing facilities in order to eliminate as many of the root causes of user complaints as possible. This option will require more time and money to implement than the previous alternatives, but may cost less than a full system replacement. The primary advantage of this alternative is that additional

sites, if properly designed and selected, should make a significant improvement in system coverage.

Replace Existing System

The "Replace Existing System" option provides the most comprehensive remedy for the problems identified in this evaluation. This option should include careful development of specifications for a new system, and a competitive bidding environment to minimize costs and ensure the most favorable terms for the City. This option can provide the optimal solution to the City's coverage problems, subject to the City's financial ability to procure and maintain additional sites. This solution also provides the most comprehensive means to eliminate problems caused by equipment and subsystems of differing vintage and condition. The most complete solution to these problems, however, also involves the highest cost and the greatest amount of time to implement, which would require a minimum of two years to carry out after the design is completed and funding is secured. Upgrades to existing facilities may be required in the meantime to address the more pressing problems of the current system.

Migrate to Regional P25 System

The "Migrate to Regional P25 System" is a different alternative that will require further exploration in the form of both: a) negotiations with the East Bay Regional Communications System Administration (EBRCSA), and b) testing of the EBRCS system in the Oakland service area. Negotiation with EBRCSA is the only way to ascertain precisely what participation in the regional system would cost the City, and how much control the City would be able to preserve over its own operations. The current EBRCS design includes 4 simulcast sites where the City presently has 3, plus a fifth standalone site at Gwin which would also provide coverage in Oakland's service area. Whether the EBRCS site configuration will provide an acceptable level of coverage or merely an incremental improvement remains to be seen, and should be tested by Oakland once the system is on the air and accepted by EBRCSA. In particular, the City will want to assess whether or not the one additional site above Skyline Blvd makes a difference in providing in-building coverage in the central portions of Oakland, where users currently complain of limited in-building coverage. The City should participate in EBRCSA's acceptance testing of the Oakland area cell this summer. The primary advantages of this alternative is that it provides the highest level of interoperability with Alameda County agencies and neighboring Cities that join the EBRCS system, and should take less time to implement than replacing the City's own system.

The City's involvement with the EBRCS system could take a number of forms, depending upon arrangements negotiated with EBRCSA. The three main variations are:

1. Simply program Oakland Public Safety Radios to operate on the EBRCS system for interoperability purposes, while preserving the Oakland system for primary day-to-day operations.

2. Connect the City of Oakland P25 system to the EBRCS system through either an ISSI interface or as a cell of the EBRCS network. This option would keep the City's system and dispatch facilities intact, while allowing users to roam onto the rest of the EBRCS system when outside of the Oakland radio system's coverage area.

3. Merge the City of Oakland's assets with the EBRCS network, and begin using the EBRCS system for primary day-to-day operations. Precisely which assets would make the move to the EBRCS system would need to be negotiated with EBRCSA, but all of the City's current assets should be discussed, including but not limited to mobiles and portables; tower sites and tower site equipment; backbone connectivity; dispatch center and EOC equipment; Radio Shop facilities, capabilities and equipment; and Oakland frequencies and licenses.

With each of the above EBRCS options, the details regarding cost, coverage, and control will need to be determined through both negotiations and testing. The City will also want to closely examine and evaluate the technical details regarding the EBRCS system's design and construction so that they understand any and all pros and cons of the Regional system design and operation.

The table below illustrates the relative pros and cons of the primary approaches available to the City of Oakland:

Alternative	Cost	Coverage	Control	Time	Interoperability
Do Nothing	Least Expensive	No Improvement	Full Control	No time required	Same as Today
Upgrade Current Facilities	Modest Expense	No Improvement	Full Control	Short time	Same as Today
Expand Existing System	Expensive	Major Improvement	Full Control	Intermediate	Same as Today
Replace Existing System	Most Expensive	Major Improvement	Full Control	Longest	Same as Today
Migrate to Regional System	TBD	TBD	TBD	TBD	Full Interop

Color Key:

	Pro
	Relative Pro
	Neutral
	Relative Con
	Con

RCC recommends that the "Do Nothing" approach be ruled out, for obvious reasons. "Doing Nothing" allows the noted deficiencies to persist, with greater risk of undetected system problems.

RCC recommends that the City take steps to upgrade existing facilities in the short term, while proceeding with the Conceptual Design and Budgetary Estimate phase to develop a clearer picture of how many sites would be required to address Oakland's coverage issues. At the same time, Oakland should re-engage EBRCSA in direct negotiations to iron out issues of cost and control associated with the City's participation in the new system.

In 2010 and 2011, the Alameda Grand Jury performed an investigation into reported problems with the City's aging EDACS radio system. In their report they made a number of recommendations for improving the City's radio system and for improving regional interoperability between City and County agencies. On page 31 of their Report, they noted that discussions between the City and County regarding improving interoperability between the two agencies had broken down, and they recommended that the City and County resume discussions towards that goal:

> "The Grand Jury concludes that accommodations must be made both by EBRCSA and by Oakland. It does not seem reasonable to expect Oakland to change its vendor or completely abandon the new system they are building. The funding formula for Oakland may need to be different than that for other cities in order to motivate Oakland's full participation."

The City should also participate in coverage testing of the ALCO Northwest simulcast cell, which should include both voice testing and drive testing. Drive testing should include both signal measurement and Bit Error Rate (BER) measurement, similar to the tests of the city's own system in May 2012.

1.9 Recommended Next Steps

RCC recommends that the City's key decision makers read the remainder of this evaluation in detail, to obtain a more complete understanding of the issues identified by RCC and the proposed solutions. RCC recommends the City take the following additional steps:

Recommendation 1:

RCC recommends that the City take steps to upgrade existing facilities in the short term. Priority improvements should include backup power systems and site alarm systems with alerting capabilities.

Recommendation 2:

The City should proceed to the Conceptual Design and Budgetary Estimate phase to develop a clearer picture of how many sites would be required to address Oakland's coverage issues.

Recommendation 3:

At the same time, Oakland should enter into direct negotiations with EBRCSA to iron out issues of cost and control associated with the City's potential participation in the new system.

Recommendation 4:

The City should participate in coverage testing of the ALCO Northwest simulcast cell, which should include both voice testing and drive testing. Drive testing should include both signal measurement and BER measurement, similar to the tests of the city's own system in May 2012.

Recommendation 5:

The City should immediately take steps to upgrade the City's Radio Shop's equipment and to train its personnel on the maintenance of the new P25 system.

Recommendation 6:

The City should implement a fleetwide review and inspection of subscriber equipment to clean up lingering issues with unsatisfactory equipment installation, defective accessories, and poorly tuned equipment.

Recommendation 7:

City employees should participate in the next end to end Preventive Maintenance (PM) program of the P25 radio system backbone, and must be trained and equipped to perform a full system PM on their own.