AECOM

April 29, 2010

System Design Report

Marin County, CA

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1.0 System Design Report Introduction

In this "System Design" report, we present two preliminary plans for wireless voice and supporting interconnection systems for Marin County. These plans were jointly developed by the Marin County Project Team and AECOM and are focused on meeting the long term needs of Marin County. This report contains information from the prior reports that were completed in support of this project. These reports included:

1. System Coverage and Capacity Analysis Report
2. Possible 700 MHz Solutions Report
3. Radio Frequency Compatibility Report
4. Environmental Impact Analysis Report
5. Analysis of Radio Options Report

These reports contain an analysis of the Radio System options that will meet the needs of the Marin County users, while supporting the BayRICS interoperability goals. We document the existing coverage and capacity challenges that face the radio users in Marin County. We reviewed the interoperability goals for Marin County as well as the goals of the Bay Area UASI and the Counties that border Marin County. We conducted frequency studies to determine frequency availability in the UHF T-Band and 700 MHz frequency band. We analyzed the possible 700 MHz solutions that meet operational and interoperability goals for the County. Finally, we completed an analysis of the voice radio options available to the County.

Throughout the process, we have kept our focus on long term solutions that meet the capacity, coverage and interoperability needs of Marin County radio users. Along the way we have documented several short term solutions that can be implemented in the near term (next 5 years); however, the majority of our work has focused on activities that will meet today's needs as well as 15 years from now.

This System Design report contains a complete overview of two system design alternatives. Both alternatives will meet the long term goals for the County; however, each alternative has notable advantages over the other. We understand that any option must be approved by the Marin Emergency Radio Authority (MERA) and the Marin County Board of Supervisors. We are making no assumption or implication that the system designs in this report has been endorsed by any of the governing agencies in Marin County or by MERA. The purpose of this report is to clearly describe viable system design alternatives for Marin County that will meet the needs of the emergency responders in Marin County and those external agencies that may operate in Marin County.

1.1 Project Purpose

Marin County uses a Motorola SmartZone 3.0 radio communications network, referred to as MERA, to support the communications requirements for 25 public safety and public service agencies. In February 1997, public safety agencies in Marin County agreed to begin developing a proposal for a countywide regional communications system. Under a joint powers agreement, MERA was founded to oversee the design process and MERA continues to serve as the agency responsible for the radio system. Marin County entered an agreement with AECOM to conduct a Public Safety Radio Network Engineering Study that will include an analysis of the traffic loading and coverage of the current system and will research interoperability connection alternatives for the Bay Area UASI, which will include researching a 700 MHz system and a 700 MHz overlay.

This project has seven tasks that are listed below:

1. Develop Project Plan
2. Complete a system coverage and capacity analysis of the existing MERA system
3. Complete a capacity and coverage analysis of a possible 700 MHz P25 solution
4. Complete an RF analysis for each site for UHF TBAND and 700 MHz
5. Develop Environmental Impact Report outlines that can be used for each site
6. Analyze the Radio Communication options available to Marin County
7. Develop a preliminary plan for wireless voice and supporting interconnection system

This report addresses Task 7 (seven) and is the final deliverable for this project.

1.2 Report Outline

AECOM has developed this System Design Report, which includes the following sections:

SECTION 1 Introduction: This section introduces the report.

SECTION 2 Current Radio Environment: This section contains a summary of the existing MERA SmartZone 3.0 system radio system. In particular we focus on an overview of system traffic, including user load profiles, busy hour analysis, and Grade of Service (GOS). We also provide an overview of the optimal number of channels required to meet the required GOS with current and future growth traffic. We end this section with an overview of existing radio coverage that was completed using AECOM's Radio Coverage Evaluator or RaCE [SM1].

SECTION 3 Future Capacity Needs and Frequency Availability: This section contains a summary of radio frequency availability in the 700 MHz and UHF T-Band frequency bands. We provide an overview of the ability to add additional UHF T-Band frequencies to the existing and proposed sites in Marin County. The basis of our analysis was the requirements outlined by frequencies coordinators and the FCC, which are required to be completed as part of the licensing process. The final portion of this section discusses the availability of 700 MHz frequencies for use in Marin County and outlines the requirements to license these frequencies in Marin County.

SECTION 4 Radio Alternatives Analysis: This section provides a summary of the alternatives that were analyzed to meet the long term needs of Marin County. For each of the alternatives we include a description that includes advantages and disadvantages and we rank each alterative using system attributes that are weighted based on how critical the attribute is for the users in Marin County. Our comparison includes radio coverage predictions, capacity, Interoperability, system functions, long term suitability and other factors that are used to objectively access each alternative's ability to meet the long term need of the County.

SECTION 5 Viable System Designs: This section provides a detailed overview of two viable system designs. We include an overview of radio coverage predictions, connectivity, capacity requirements, and other system design components.

SECTION 6 Implementation Plans: This section provides a detailed migration plan for each viable system design. The migration plan includes the procurement method and an implementation schedule. We clearly outline a migration path for MERA agencies and the system upgrades that must be included. The implementation plan takes into consideration operational concerns that uninterrupted voice radio service is continues during the transition.

SECTION 7 Budgetary Cost and Potential Funding Mechanisms: This section provides an overview of Opinion of Probable Costs for each viable option. This section also discusses possible funding mechanisms that can be used to purchase the mobile and portable radios needed to implement each system design. In addition, we have included several case studies that provide an overview of how other agencies have funded radio system upgrades.

Appendix A Microwave Path Profiles: This Appendix provides the Microwave path profiles and calculations for each proposed system designs.

Appendix B MERA System Draft Questionnaire: This Appendix provides a draft questionnaire that can be used to gather information from radio system users, maintenance personnel, dispatchers, policy makers and managers. The information gathered includes organizational structure, existing system data, and perception of existing system effectiveness, existing system limitations, and desired features. The survey has been designed so that the answers provided can be used to improve radio system performance.

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1 **Patent # 7,522,918 B2*

Appendix C Environmental Impact Analysis: This Appendix provides an overview of some of the considerations that must be taken into account in order to complete an Environmental Impact Report for a new site, or to add channels to an existing site. The Environmental Impact Analysis is intended to assist the County in developing a Request for Proposals for this type of service and it is not intended to be a completed study.

2.0 Current Radio Environment

This section contains a summary of the existing MERA SmartZone 3.0 system radio system. In particular we focus on an overview of system traffic, including user load profiles, busy hour analysis, and Grade of Service (GOS). We also provide an overview of the optimal number of channels required to meet the required GOS with current voice radio traffic. We end this section with an overview of existing radio coverage that was completed using AECOM's Radio Coverage Evaluator or RaCE ^{SM}. The two major concerns for the existing MERA system were capacity and coverage. For each of these concerns we also provide a summary of near term solutions that can be implemented do reduce system capacity and increase system coverage.

2.1 Existing System Description

Marin County uses a Motorola SmartZone 3.0 UHF T-Band trunked radio communications network, referred to as Marin Emergency Radio Authority (MERA), to support the communications requirements for 25 public safety and public service agencies. In February 1997, public safety agencies in Marin County agreed to begin developing a proposal for a countywide regional communications system. Under a joint powers agreement, MERA was founded to oversee the design process and MERA continues to serve as the agency responsible for the radio system.

Due to technology and licensing limitations at the time the system was purchased and installed, the MERA system was designed in multiple simulcast cells with additional stand alone sites that provide coverage in the rural areas of the County. Each simulcast cell requires its own set of frequencies and all simulcast cells and stand-alone sites are interconnected using a microwave backbone. The cell and channel allocations for the MERA system are as follows:

East Simulcast	6 Sites	9 Channels (Channel indicates a UHF T-Band Frequency Pair)
West Simulcast	3 Sites	6 channels
Sonoma Mountain	1 Site	5 channels
Bay Hill Rd	1 Site	5 channels
Stewart Point	1 Site	5 channels
Totals	12 Sites	30 Channels

In a simulcast cell, all frequency pairs are shared among all the sites in the simulcast, which leads to greater spectral efficiency (you need less frequencies) than other configurations. The three stand-alone sites on Sonoma Mtn., Bolinas (Stewart Point), and Bay Hill Road all require their own set of frequencies. The current channel assignment is 30 channels. An expansion project is currently in progress that will add 2 channels to the East Simulcast and 1 channel to the West Simulcast.

Users can roam throughout the County and maintain radio communications without manually selecting the site they are near. In such a multisite configuration, several cells are established and as users roam between cells, the system will pass the user on to the next cell or to a stand-alone site. In addition, calls can be made between cells.

Another important design characteristic of the MERA system is the significant Radio Frequency (RF) overlap of each of the cells. The East and West Simulcast and Sonoma Mountain cells have at least 80% coverage overlap based on the measurements we conducted using RaCE^{SM}. The RF overlap provides increased redundancy and provides good reliability for MERA users.

2.2 Existing System Capacity

AECOM conducted a detailed analysis of the existing system traffic, which included user load profiles, busy hour analysis, and Grade of Service (GOS) calculations. Our capacity analysis began with an assessment of existing traffic using system usage/call data gathered from January 2008 through July 2009. From this information, we characterized MERA's call traffic in terms of industry standard parameters such as average call duration. Our goal was to determine the increased call traffic that was a result of the multi-cell design. A multi-cell design contributes to call traffic because

frequency resources are used in every cell or stand-alone site where a user is affiliated and is on the same talkgroup as a user in another cell or stand-alone site.

During normal daily usage, the existing MERA system meets user needs with very few “busies”. A busy signal occurs when a user presses the push-to-talk button, which requests frequency resources from the site they are affiliated with and the frequency resources are not available. However during large incidents, the existing MERA system does not meet user capacity needs. Calls made between cells are a significant contributing factor to the system capacity problems that faces MERA users during large incidents. When users have their radios turned on and are monitoring a talkgroup in different cells, they tie up channel resources in both cells, essentially doubling the number of users from a system loading perspective.

2.2.1 Existing Capacity Calculations

A key element in the overall system design is the determination of the number of channels required to handle the expected load due to voice calls. The mathematical model used to perform this calculation is “Erlang C”, and involves a set of parameters estimated through a statistical analysis. The key parameter used to measure system performance is the delayed call Grade-of-Service (GOS). For public safety, we recommend a delayed call GOS to be no greater than 1%, that is no more than 1 percent of calls shall be delayed more than 1 sec during the busy hour.

According to system documentation, the number of busies experienced during most large scale incidents on the existing MERA system exceeds the 1% grade of service required. We verified the system data using Erlang C calculations and verified that the existing system configuration is unable to meet recommended GOS levels. We also conducted an analysis of the traffic load created by a multi-cell system and estimated that as much as an 85% increase in traffic can be attributed to the multi-cell design.

The multi-cell design traffic increase is further amplified by the fact that the number of users on the system exceeds the original design specifications. During the design of the existing MERA system, initial estimates based on a needs assessment were that 1580 users would be on the system. The system was designed to support 1580 users with modest growth over a 20-year period. As of December 2009, there are an estimated 2875 users on the MERA system, which far exceeds 20-year growth estimates.

The net result of the existing design and number of users is that users are reporting that the existing system does not have sufficient capacity, which we have validated through statistical analysis. These capacity concerns must be addressed in order to meet the long term needs of the County.

2.2.2 Capacity Needs

AECOM conducted an analysis of the capacity needs for the MERA system users. Our focus was three-fold, first determine what affect the expansion project would have and second, determine the number of channels needed if the current multi-cell system design was maintained and third, determine the number of channels needed to meet existing capacity needs if the system was a single simulcast. At this point, we focused on the capacity needed for the existing 2875 users on the MERA system.

When we began to identify the capacity needs, our goal was to calculate the number, or rather percentage, of multi-cell calls. One of the most important factors in determining capacity calculations is to identify the number of radios on the system. In a multi-cell environment, you must account for the number of multi-cell calls because they use channel resources in multiple cells. Keep in mind it only takes one user on the talkgroup to be in another cell for the resource requirements to essentially double.

We used the data available to determine an estimate of the number of multi-cell calls in the MERA system. Table 2-1 summarizes our multi-cell estimates for the MERA system. In order to complete this portion of the task, we added additional loading for wide-area (multi-cell) calls to all cells by assuming a certain percentage of multi-cell callers from/to adjacent cells. This process is equivalent to the process used by Motorola in their

system design documentation. This adjustment includes retaining 100% of the local calls on the local cell and adding the percentage of the adjacent cell load. In addition, we have calculated a distribution of users across each cell, based on user densities, which is primarily concentrated in the East and West Simulcast cells.

Table 2-1 shows the Sites/Cells in Column 1 with the percentage distribution of users between the cells. 85% for the East simulcast indicates that an estimated 85% of the radios have the East cell as their primary area of operation. Column 2 distributes the radios based on the percentages in Column 1. These percentages were based on user distributions provided by the County. The Contributing Sites columns indicate the percentage of users that are in an adjacent cell. For example, the 85% for the West Simulcast in the East Simulcast row indicates that 85% percent of the West Simulcast users, or 85% of 345, will also be contributing to the load in the East Simulcast due to multi-cell call activity. The value of 2750 shown in the last column is the sum of 85% of 345 plus 20% of 58 plus 5% of 14 plus 5% of 14 plus the 2444 radios already in the East Simulcast. The rest of the table is filled out in a similar way.

2.2.2.1 Grade of Service Calculations for Existing System with Upgrade

We used Table 2-1 to determine the number of radios that would be on the system based on the multi-cell design. We then used the mathematical model “Erlang C” to perform the Grade of Service (GOS) calculation, which involves a set of parameters estimated through a statistical analysis. It is important to understand that the multi-site call effects must be added into any analysis as indicated in Table 2-1. The analysis is based on trunked channels, all of which are available on a per call basis, and a probability distribution for the random nature in which calls are placed, call duration, number of calls per unit per hour, etc.

The current non-fixed radio equipment (mobiles, portables, etc.) inventory estimates for the County were provided by the Marin County DPW Communications Division. Since we are determining existing system capacity, we have not included any growth factor. In later sections of this report, we will factor in anticipated growth to determine future channel capacity needs. At this point, we are calculating GOS for the existing system based upon the existing configuration. For this calculation, we used the channel allocations for the upgrade system, which are shown in Table 2-2.

The key parameter to measure is the “Delayed Call Grade-of-Service” shown at the far right of Table 2-2. We have used the following set of assumptions to calculate the GOS for each of our calculations:

- The number of units in each site or simulcast system is summarized in Table 2-1.
- The analysis is based on all units in inventory. There are no assumptions about the percentage of units active during the busy hour.
- There are 1.3 calls per unit during the busy hour. This value is based on real data from similar public safety systems with several years of validated loading data.
- The duration of the average call is 4.9 sec. This value, too, is based on real data from operating systems with several years of loading data.
- System (call setup) overhead adds 1 sec to each call. Actual setup time varies based on whether the call is repeated on a standalone site, a simulcast system, or multiple sites or systems.
- The maximum allowable call delay is 1 sec.
- The required delayed-call grade of service is 1 percent. That is, no more than 1 percent of calls shall be delayed more than 1 sec during the busy hour.
- 1 channel per site was added to the number of working channels calculated for a given site to account for the control channel which serves the working channels.

A maximum acceptable call delay of 1 second – this is the length of time that a user would have to wait to gain access to an available channel after initiating a push-to-talk (PTT). For public safety, we recommend a “delayed call” grade-of-service (GOS) to be no greater than 1%.

The data in Table 2-2 indicates that the current GOS for the East, West, and Sonoma Mtn. all exceed any recommended GOS. Keep in mind that these calculations take into account the affect of adding 1 channel to the West Cell and 2 channels to the East Cell will have on overall system performance. Although there will be an improvement in overall GOS from what the users see today, the GOS calculations still fall well below public safety delayed-call GOS.

2.2.2.2 Grade of Service Calculations Needed for Multi-cell Design

Next, we completed an analysis to determine how many channels would be needed in each simulcast cell to meet GOS requirements for Public Safety delayed-call GOS based on the existing number of users today. We have added rows to Table 2-2 that lists the number of channels needed to meet these requirements. Our estimates show that in the current configuration, and using the current estimates, at least 12 working channels would be needed for the East simulcast cell and 11 Channels for the West Simulcast cell. Keep in mind that these are preliminary estimates. One thing these calculations confirm is that the existing simulcast cells are certainly undersized for existing capacity.

2.2.2.3 Grade of Service Calculations Needed for Simulcast Design

Finally, we completed GOS calculations for the number of channels needed if the existing were modified and the East and West Simulcast cells were combined with Sonoma Mtn. into a single simulcast cell. This single simulcast cell essentially eliminates the affects of multi-cell calls and dramatically reduces the overall number of channels needed. The final rows of Table 2-2 show the GOS calculations for a single simulcast cell.

Below is a comparison of the channels need for a multi-cell design compared to those needed for a single simulcast cell. Clearly, the current multi-cell design with wide area calling has a dramatic affect on the number of channels needed to support the users on the system.

East Simulcast	6 Sites	12 voice channels
West Simulcast	3 Sites	11 voice channels
Sonoma Mountain	1 Site	5 voice channels
Bay Hill Rd	1 Site	4 voice channels
Stewart Point	1 Site	4 voice channels
Total Channels		12 + 11+ 5 + 4 + 4 = 36 plus 5 working channels for a **total of 41**.

If the design were altered and the East and West Simulcast were combined with Sonoma Mtn. into a single simulcast, the number of channels required would be decreased as indicated below:

Combined Simulcast	10 Sites	12 voice channels
Bay Hill Rd	1 Site	4 voice channels
Stewart Point	1 Site	4 voice channels
Total Channels		12 + 4 + 4 = 20 plus 3 working channels for a **total of 23**.

2.2.3 Short Term Capacity Upgrades

Marin County DPW Communications Division has implemented several changes and upgrades that are aimed at improving system utilization and radio system traffic. We have listed these changes below:

1. Conducted training on Radio Discipline – Ongoing Effort
2. Reduced hang time from 2.8 to 1.5 seconds – Effective 2005
3. Non-public Safety users hang time reduced to zero seconds – Effective 2005
4. System preference assigned for radios to prefer the East System whenever possible – Effective Oct 2009
5. Began an expansion project to increase the number of channels on the East Simulcast to 11 and the West Simulcast to 7 – Estimated completion in 2010

While these changes will have positive affects, they will not meet the long term growth and capacity needs. Our effort has been focused on developing long term needs, which are those that will continue to meet the needs of Marin County for the next 15 years. While our focus was on a long term solution, we determined several short term solutions what will improve the existing MERA system and we provide a summary of these short term solutions below.

1. License additional UHF T-Band Channels – Our frequency search identified additional UHF T-Band channels that could be licensed in Marin County. We recommend that you license these channels immediately.
2. Define talkgroups to use Transmission Trunking versus message trunking. Any talkgroup that can tolerate using transmission trunking from an operational perspective should be switched over from message trunking.
3. Reduce hang time from 1.5 seconds to 1 second. Although this seems like an insignificant change, the impact will be noticed if implemented system wide.
4. Complete expansion project to increase the number of channels on the East Simulcast to 11 and the West Simulcast to 7.
5. Continue to conduct training on Radio Discipline.
6. Research the cause of the increased call duration of the EMS talkgroups. A significant change occurred in the EMS agency that resulted in a call duration increase from about 11 seconds to over 28 seconds from March to April of 2009.
7. Consider upgrading the existing system monitoring software to the Genwatch system manager software. This software will enable the Radio System Manager to accurately track how the system is performing in each of the cells and will provide additional technical details that can be used to track system performance and provide insight to potential further parameter changes that may affect the user experience.

2.3 Existing System Coverage

Our existing system coverage analysis focused on establishing a baseline for Marin County's existing coverage from the MERA SmartZone 3.0 system. The coverage analysis was completed using AECOM's Radio Coverage Evaluator or RaCE ^{SM}. We have developed and patented RaCE ^{SM} to provide our clients, non-invasive, end-to-end, two-way evaluation of their communications systems using human voice to measure DAQ understandability and clarity the strength of the radio signal being received by the test radio.

We conducted actual drive studies to evaluate the coverage provided from the existing system using our RaCE^{SM} coverage analysis tool. The testing occurred during the weeks of November 16, 2009 and November 30, 2009. Our coverage analysis included the entire **accessible** service area of the MERA radio network. Our testing collected Delivered Audio Quality (DAQ) and Received Signal Strength Indicator (RSSI). In addition, we collected information on the system affiliation throughout the testing area. The test utilized Motorola Spectra mobiles with attenuators to simulate and test the portable coverage area within the publically accessible grids in the County.

The RaCE^{SM} testing was performed utilizing the gridded test mode. The grids utilized were a mixture of 0.35 x 0.35 miles in the business and residential areas and 0.7 x 0.7 miles in the rural areas of the County. Testing went faster than estimated, so the test teams were able to spend their remaining test time performing testing on many of the County Fire, Open Space and PG&E roads.

In the gridded test mode, the mobile unit is driven throughout the service area, entering grid cells as it goes along. As the mobile unit enters a grid, the RaCE^{SM} algorithm establishes whether that grid has been tested before, and if not, it activates the test sequence beginning with the talk-in transmission. The stationary unit records the talk-in transmission and then initiates the talk-out transmission. The mobile unit records the talk-out transmission and waits until a new untested grid is entered before automatically beginning a new test.

When the test team encountered an area where they were out of range, they performed a manual test initiation to attempt to gain access as they traversed the grid. If they did eventually gain access to the system within that grid, that test call will be indicated in the results.

When time and traffic conditions allowed, and the first test in a grid resulted in a failed talk-out call, the test team initiated an additional test to allow for the occasional repeats as mentioned in TSB-88's definition of a DAQ 3.0. In the cases where the second test call resulted in a passed DAQ value, the second test is indicated in the test results. The results were analyzed and ".wav" files for each test call were provided to the County for further analysis.

2.3.1 Automated Delivered Audio Quality (DAQ) Testing Summary

The DAQ results were recorded for both Talk-in and Talk-out. Out of 1636 test grids, 1562 grids passed Talk-Out DAQ testing. (Passed grid = 3.0 or higher). This equates to a portable on the hip talk-out reliability of 95.5%. Out of 1686 test grids, 1566 grids passed Talk-In DAQ testing (Passed grid = 3.0 or higher). This equates to a portable on the hip talk-in reliability of 92.9%. The difference in grid counts between talk-out and talk-in tests are due to the areas where the test teams were out of range for the system – this leads to a talk-in failure, but no applicable talk-out data is obtained and the resulting talk-in grid count is higher than the talk-out grid count. Table 2-3 summarizes the DAQ Testing Results.

2.3.2 Received Signal Strength Indication (RSSI) Testing Summary

In addition to DAQ testing using RaCE ^{SM}, we also completed Received Signal Strength Indication (RSSI) testing for the Control Channels (CC) for each of the Simulcast Zones and Intelli-Repeater sites throughout the service area. The results showed the received signal levels for the control channel. We indicated if the RSSI level was sufficient to support portable-on-the-hip communications, or sufficient for mobile communications, but probably not strong enough to support reliable portable operation, or too low for reliable communications of any kind to or from the selected radio site.

The results shown in Table 2-4 show the percentage of the County that the simulcast cell or stand alone site covered. For example, the East Simulcast provides Portable on the Hip coverage for 55% of tested area and provides Mobile Coverage to 30% of tested area. This means that the East Simulcast provides sufficient control channel signal strength to support mobile operations in 85% of the County.

Table 2-4 also provides an indication of the amount of overlap between the simulcast and stand alone sites. The East Simulcast provides sufficient mobile coverage for 85% of the test area, the West Simulcast 84%, Sonoma Mtn. 65%, Bay Hill 47%, and Stewart Point 18%. Each of these coverage areas overlaps with one another providing redundancy, but also contributing to the multi-cell call volume as discussed above.

2.3.3 Test Call Affiliation Summary

During each test transmission, our equipment captured the mobile test set's system transmit frequency. From this, we were able to determine which system or site we were affiliated with for the test. There were some limitations to determining Cell Affiliation because the Bay Hill and Stewarts Point Intelli-Repeater site frequencies are also in use for the East Zone Simulcast system. However, we were able to determine the potential for multi-cell calls based on cell affiliation. During our testing, we noted that there were a significant number of calls made within the East Simulcast Zone service area where the actual call was made on the West Cell.

Our data showed that a significant number of locations within the service area of the East Simulcast Zone that are best served by, or have a higher signal strength on the West's Control Channel. The San Rafael area is a good example of this situation. In the southern area of the County, the West Simulcast Zone is handling many calls even though the East Simulcast Zone is the best server. However, the significance of these results is to indicate how inter-mingled the test calls were in the East Simulcast Zone. When referring back to the RSSI

results for the two simulcast zones, Table 2-4, we can see that the West Simulcast Zone has sufficient mobile coverage over 86% of the East Simulcast Zone service area.

If we had been testing mobile radio coverage, the results would have indicated even more calls made on the West Simulcast Zone due to the fact that once a mobile radio affiliated with the West Zone it would remain on the West Zone until its signal level dropped below acceptable levels. This would only occur in about 14% of Eastern portion of the County, primarily in the Novato area. We can conclude that a significant number of calls (as much as 85%) on the MERA system are consuming channel resources in multiple cells. Each of these multi-cell calls are consuming channel allocations in two or more cells, which is further contributing to the capacity issues on the MERA system.

2.3.4 Improving System Radio Coverage

Using RaCE [SM] testing identified and confirmed several areas where poor coverage exists today. We reviewed these areas with the Marin County Project Team and identified areas where improved coverage was needed based on user feedback. We then conducted a search to identify potential sites that would provide improved system coverage. Our focus was to identify existing radio sites in Marin County that could be used to fill in the coverage gaps. We also took a close look at how we could reduce the number of radio sites based on recent technology advances in public safety radio systems.

Marin County has access to several viable existing tower sites. We encourage the County to continue the plan to move the site at Bay Hill to Mt Tomales. The Mt Tomales has coverage advantages over Bay Hill and will provide better coverage in the areas that Bay Hill is unable to reach. In addition, we have selected four sites that could be added to the MERA system in order to provide increased coverage.

- Pt. Reyes Coastal, already a radio site for the State of California, provides coverage in several key areas, including Pt Reyes National Seashore that has poor radio coverage under the existing system. The tower is located at the south of Pt. Reyes, not far from the lighthouse.
- Wolfback Ridge is another already well-established radio site that is host to a number of towers. A site here would fill in several key coverage holes in the densely populated eastern coast. This site would also allow for the removal of the site at Mill Valley City Hall.
- The Radar Tower, located at the southernmost tip of Marin, fills in important coverage holes, including the Golden Gate Bridge as it enters Marin County.
- Martha, located south east of the Tiburon Site, fills in important coverage holes along the coast. This site was added late in the system development process and it may be possible to replace the Mt. Tiburon simulcast site with the Martha site, provided the Martha site is approved as a viable radio communications site.

Table 2-1
Multi-Site Load

Site/Cell and % Distribution		Number of Radios:	Contributing Site Percentage					Multi-Site Load Addition	Total Load
			East Simulcast	West Simulcast	Sonoma	Bolinas	Bay Hill		
			2444	345	58	14	14		
East Simulcast	85%	2444		85%	20%	5%	5%	306	2750
West Simulcast	12%	345	85%		20%	10%	10%	2092	2437
Sonoma	2%	58	20%	20%		5%	5%	559	617
Bolinas	0.5%	14	5%	10%	20%		5%	169	183
Bay Hill	0.5%	14	5%	10%	5%	5%		160	174
Total		2875						3286	6161

Table 2-2
Grade of Service Calculations After Upgrade

Group	Units	Calls/ Hour/ Unit	Calls/ Hour	Average Call Length (sec)	Total Average Call Length (sec)	Traffic Load (call-sec/hr)	Channels	Traffic Load (erlangs)	Queuing Grade of Service (Erlang C)	Delayed Call Probability	Delayed-Call Grade of Service
East Simulcast 85%	2750	1.3	3574.7	4.9	5.9	21090.6	8	5.8585	32.48%	69.56%	22.593%
West Simulcast 12%	2437	1.3	3168.1	4.9	5.9	18691.8	5	5.1922	109.84%	103.31%	113.474%
Sonoma 2%	617	1.3	801.45	4.9	5.9	4728.6	4	1.3135	4.94%	63.42%	3.133%
Stewart Point 0.5%	183	1.3	238.39	4.9	5.9	1406.5	4	0.3907	0.07%	54.24%	0.039%
Bay Hill 0.5%	174	1.3	226.69	4.9	5.9	1337.5	4	0.3715	0.06%	54.06%	0.033%

Grade of Service Calculations Needed for Existing MultiCell Design

Group	Units	Calls/ Hour/ Unit	Calls/ Hour	Average Call Length (sec)	Total Average Call Length (sec)	Traffic Load (call-sec/hr)	Upgraded Channels	Traffic Load (erlangs)	Queuing Grade of Service (Erlang C)	Delayed Call Probability	Delayed-Call Grade of Service
East Simulcast 85%	2750	1.3	3574.7	4.9	5.9	21090.6	12	5.8585	1.90%	35.31%	0.671%
West Simulcast 12%	2437	1.3	3168.1	4.9	5.9	18691.8	11	5.1922	1.95%	37.37%	0.727%
Sonoma 2%	617	1.3	801.45	4.9	5.9	4728.6	5	1.3135	1.19%	53.54%	0.636%
Stewart Point 0.5%	183	1.3	238.39	4.9	5.9	1406.5	4	0.3907	0.07%	54.24%	0.039%
Bay Hill 0.5%	174	1.3	226.69	4.9	5.9	1337.5	4	0.3715	0.06%	54.06%	0.033%

Grade of Service Calculations Needed for Simulcast Design based on Users in 2010

Group	Units	Calls/ Hour/ Unit	Calls/ Hour	Average Call Length (sec)	Total Average Call Length (sec)	Traffic Load (call-sec/hr)	Upgraded Channels	Traffic Load (erlangs)	Queuing Grade of Service (Erlang C)	Delayed Call Probability	Delayed-Call Grade of Service
Single Simulcast	2875	1.3	3574.7	4.9	5.9	21090.6	12	6.1253	2.59%	36.95%	0.958%
Stewart Point 0.5%	183	1.3	238.39	4.9	5.9	1406.5	4	0.3907	0.07%	54.24%	0.039%
Bay Hill 0.5%	174	1.3	226.69	4.9	5.9	1337.5	4	0.3715	0.06%	54.06%	0.033%

Table 2-3
DAQ Testing Results

Talk-Out DAQ Results		
Grid Area	**DAQ < 3.0**	**DAQ >= 3.0**
0.7 X 07. Grids	35 grids (6.4%)	510 grids (93.6%)
0.35 X 0.35 West	16 grids (6.4%)	234 grids (93.6%)
0.35 X 0.35 East	23 grids (2.8%)	818 grids (97.2%)
Totals - 1636 Grids	**74 grids (4.5%)**	**1562 grids (95.5%)**
Talk-In DAQ Results		
Grid Area	**DAQ < 3.0**	**DAQ >= 3.0**
0.7 X 07. Grids	85 grids (14.9%)	487 Grids (85.1%)
0.35 X 0.35 West	15 grids (5.8%)	245 grids (94.2%)
0.35 X 0.35 East	20 grids (2.4%)	834 grids (97.6%)
Totals - 1686 Grids	**120 grids (7.1%)**	**1566 grids (92.9%)**

Table 2-4
RSSI Testing Results

Signal Level	**RSSI < =108 dBm** (Inadequate Signal Level)	**-108 dBm > RSSI < -98 dBm** (Sufficient Mobile Coverage)	**RSSI > -98 dBm** (Sufficient Portable on the Hip Coverage)
East Zone Simulcast RSSI (489.075 MHz)			
(% of Tested Area)	15%	30%	55%
West Zone Simulcast RSSI (489.100 MHz)			
(% of Tested Area)	16%	31%	53%
Sonoma Mountain Intelli-Repeater RSSI (488.725 MHz)			
(% of Tested Area)	35%	42%	23%
Bay Hill Intelli-Repeater RSSI (490.100 MHz)			
(% of Tested Area)	53%	29%	18%
Stewart Point Intelli-Repeater RSSI (489.450 MHz)			
(% of Tested Area)	82%	11%	7%

3.0 Future Capacity Needs and Frequency Availability

This section contains a summary of the radio frequency availability in the 700 MHz and UHF T-Band frequency bands. Our 700 MHz discussion focuses on the Region 6 700 MHz allocation for Marin County and we include our insight on the availability of 700 MHz frequencies for use in Marin County. Our discussion of the UHF T-Band frequencies includes a summary of the frequency search and radio frequency compatibility study, which determined the feasibility of adding additional UHF T-band frequencies to the existing and proposed sites in Marin County. The basis of our analysis is the requirements outlined by frequencies coordinators and the FCC, which are required to be completed as part of the licensing process.

3.1 Future Capacity Needs

No discussion of frequency needs can be completed without an understanding of how many frequencies are needed to support the radio users in Marin County. Based on feedback from the Marin County Project Team and the requirements stated in the scope of work, AECOM took the following steps to determine the number of users the system design should support.

1. The system was sized to handle 100% of the existing radios 2875 Radios
2. An additional 100 radios added each year for 15 years 1500 Radios
3. An additional 20% increase for outside emergency responders 875 Radios

5250 Radios Total

We then sized the system to handle 5250 radios using our radio traffic analysis process. We outlined our process for radio traffic analysis in the Capacity and Coverage Analysis report. Rather than repeat the background information again in this report, we will refer you to the Capacity and Coverage Analysis report for a more thorough explanation. The following is a brief summary of how we completed the radio traffic loading analysis.

The goal of the process is to determine the number of channels required to handle the traffic load due to voice calls. The mathematical model used to perform this calculation is “Erlang C”, and involves a set of parameters estimated through a statistical analysis. We have analyzed this for Marin County based on trunked channels in a simulcast system. The analysis is based upon a number of assumptions that we made based upon our years of experience with public safety systems as well as your current radio inventories. Our method utilizes a more conservative estimate based on 100% of the radios being on the system at the same time to determine maximum loading.

We have taken the approach that the minimum number of channels will be the most economical solution. The key parameter to measure is the “Delayed Call Grade-of-Service” shown in Table 3-1. We have used a maximum acceptable call delay of one second – this is the length of time that a user would have to wait to gain access to an available channel after initiating a push-to-talk (PTT). Generally for public safety, we recommend a “delayed call” grade-of-service to be no greater than 1%, i.e. less than 1% of all calls placed during the busy hour are forced to wait more than one second to gain access to the system. The busy hour is defined as the hour of the day during any 7 day period in which a radio system carries the most traffic.

Trunked systems employ a “control channel”– this is a dedicated channel that performs command and control functions 100% of the time. In a trunked system implementation employing this approach, one of the channels would be assigned this job and would be unavailable as a voice channel. In our modeling, we have assumed that there is a control channel, and the total number of channels is shown in the table as the number of voice channels plus one control channel.

Finally, we should note that our analysis here is based on our professional opinion concerning the number of channels required to handle the expected traffic. The FCC has rules that are more liberal in terms of the number of channels that can be justified. Typically, a trunked voice system for public safety can justify one channel for every 100 users.

In the beginning, the rule can be stretched to one channel for every 70 users. Using these rules, Marin County could justifiably apply for several additional trunked channels.

The number of voice channels needed is not related to the frequency band chosen, which means that the calculations in this section apply to both a UHF T-Band solution and a 700 MHz solution. However, if you recall our discussion of the difference of between P25 Phase 1 and Phase 2, the number of channels needed is affected by the choice to implement a P25 Phase 1 or a P25 Phase 2 solution. In a Phase 2 solution each voice channel provides two talkpaths, which means that generally half the number of voice channels is needed. Table 3-1 provides a comparison of P25 Phase 1 and P25 Phase 2 channel capacity calculations. Our recommendation is a P25 Phase 2 solution, which reduces the number of frequency pairs required as well as the number of repeaters, which in turn reduces the cost of the Land Mobile Radio Infrastructure.

3.2 700 MHz Frequency Availability

AECOM reviewed the Region 6 700 MHz Plan dated Sept 24, 2008, which outlined the spectrum allotment and usage for northern California. The goal of the regional committee was to maximize the amount of reuse, and minimize interference. Each county in Region 6 was allotted 700 MHz channels based on population density. Keep in mind that this is only a geographic allotment plan, and does not allot these channels to a specific agency or jurisdiction. Eligible Public Safety agencies must apply for these frequencies through the process defined in the Region 6 (Northern California) 700 MHz Regional Plan. Frequencies are assigned to the County only after the application process is completed.

The plan contains a table that defined the narrowband 700MHz frequency allotments for Region 6. Marin County has an initial allocation of 27 700-MHz frequency pairs. Our 700 MHz system design for Marin County is a P25 Phase 2 system. The proposed 700 MHz system design for Marin County consists of 11 sites in a simulcast with an additional 3 fill in sites to cover the rural areas of the County. We describe the 700 MHz system design in more detail in section 4, but our discussion here needs to consider the channel needs for this design. Below is a summary of the channel needs to support this design:

1.	Simulcast Channel Needs based on Table 3-1	11 Phase 2 channels
2.	Fill in site channel needs (per site) for four fill in sites	16 Phase 2 channels
	Total Channels	27 Phase 2 channels

Based on a 700 MHz P25 Phase 2 system design, Marin County will need to be able to license twenty-seven 700 MHz channels of the 27 they have been allotted. Provided the allocated Marin County channels can be licensed, the 700-MHz spectrum should support the needs of all the users in the Marin County operational area.

3.2.1 700 MHz Frequency Licensing process

The first step in the 700 MHz licensing process is to submit a 700 MHz application package to the Region 6 700 MHz Regional Planning Committee (RPC). The application package includes details of the applicant and participating agencies, coverage and interference contours, channel loading justification, funding statement and completed FCC forms 601. The 700 MHz application package must come from an agency or its representative or JPA that has budget authority and must be submitted to the Region 6 Chair.

After the application package is received by the Region 6 700 MHz committee, it will be reviewed to verify that no harmful interference is caused to existing users, often referred to as incumbents. The RPC will review the request based on the technical parameters outlined in the Region 6 700 MHz plan. Prior to approval, the Chair will forward the request to all other agencies with allocations in the plan so that they can review the request. This will provide other agencies in the Region an opportunity to ensure that no harmful interference is likely based on the information submitted.

The next step is a review of the application by the Frequency Advisory Subcommittee. The Subcommittee will review the application to ensure it complies with all elements of the Regional Plan. Keep in mind that this is not a review of FCC requirements for filing, but rather a review to ensure the application meets the technical

requirements of the Region 6 700 MHz Plan. An interference prediction map with contour plots must be included in the documentation. TIA/EIA TSB88-C guidelines will be used to produce the interference map. The map must show all interference predicted using TSB88-C guidelines.

In addition, any agency with co-channel or adjacent channel allotments may request field tests of signal levels to verify interference signal levels. This type of request would add a significant amount of cost and time to the application process and the 700 MHz plan clearly states that "Agencies must be prepared to conduct these field tests if a request is made." Furthermore, the 700 MHz plan also states that all documentation must include:

1. Contour Plots
2. Channel loading justification
3. Proof of funding as conveyed by an official with budgetary authority for the equipment proposed
4. Other pertinent data as stipulated by the Frequency Advisory Subcommittee.

The 700 MHz regional plan indicated that frequency advisory meetings will be held as needed to review applications, but normally concurrent with the NAPCO monthly meeting. The regular schedule for NAPCO meetings can be found at www.napco.org.

After approval from the Frequency Advisory Subcommittee, the application can be sent to the FCC through the approved frequency coordinators. Once approved by the FCC, the County typically has 5 years to build out the system.

3.2.2 700 MHz Frequency Risk

Before we conclude our discussion of the 700 MHz frequencies available, we want to point out an important risk factor that must be considered. Counties throughout the Bay Area are aggressively searching for additional 700 MHz frequencies, especially those with larger population centers. Many of these counties have begun to build out 700 MHz systems, or plan to do so in the near future. There is the potential that if Marin County does not begin to license the 700 MHz frequencies they have been allocated, they will risk losing their 700 MHz frequency allocation.

We would not anticipate that the Region 6 Regional Planning Committee (RPC) would give the Marin County allotment to another County, however, the likely scenario is that as additional counties build out 700 MHz systems, the adjacent channel interference and contour overlaps from those potential licensees could preclude Marin County from being able to license all twenty-seven 700 MHz frequencies in its allotment. Marin County has been in discussions with the Region 6 RPC and has already received informal word that 3 channels in the current Marin County allotment may have adjacent channel interference with channels assigned to other counties.

As we discuss below, the County has the UHF T-Band frequencies it needs to provide for the long term needs of the County. It is important to realize that the availability of frequency spectrum in and of itself does not warrant switching frequency bands from UHF T-Band to 700 MHz, but a decision made today to remain in the UHF T-Band may mean that fewer 700 MHz frequencies are available in the future.

3.3 UHF T-Band Frequency Availability

Our UHF T-Band system design for Marin County is a P25 Phase 2 system utilizing the same sites as those in the 700 MHz design. The proposed MERA system would be a P25 Phase 2 simulcast that consists of 11 sites in a simulcast with an additional 4 fill in sites to cover the rural areas of the County. We describe the system design in more detail in section 4, but our discussion here needs to consider the channel requirements for this design.

Below is a summary of the channel needs to support an 11 site simulcast with 4 fill in sites:

1.	Simulcast Channel Needs based on Table 3-1	11 Phase 2 channels
2.	Fill in site channel needs (4 per site) for four fill in sites	16 Phase 2 channels
	Total Channels	27 Phase 2 channels

The main challenge in this design is to find sufficient channels (11) that can be licensed in a simulcast for UHF T-Band. AECOM completed an extensive frequency spectrum analysis that included high level carrier interference, site Intermodulation (IM) and Electromagnetic Energy Safety (EME) concerns for each set of potential channels. The results of this analysis are summarized in this report and a detailed overview of the entire process is contained in the Frequency Compatibility Report. AECOM has prepared and applied the following materials to this frequency compatibility study:

- FCC search for licensees within a 1/4 mile radius of each radio site
- FCC and Co-channel search within a 70 mile radius of the existing radio sites
- AECOM Intermodulation Tool
- AECOM EME Analysis Tool
- AECOM Noise Floor Analysis Tool
- AECOM High Level Carrier Interference Analysis

The County currently has 36 UHF T-band frequency pairs licensed for use in the MERA radio system, which includes the four frequency pairs that will be added to the system during the system expansion, scheduled to be completed in 2010. The number of licensed Marin County frequencies exceeds the number of channels needed 15 years into the future, provided enough channels can be licensed in a simulcast configuration. In addition, our frequency search revealed an additional 2 UHF T-Band channels that the County could license, bringing the total to 38 frequency pairs.

Starting with the County's current channels, we searched for the "best" channels that could be used in a single simulcast configuration. By "best" channel, we mean the channels with the least number of potential co-channel and adjacent channel interference. Our analysis found 18 channels that can be licensed in a countywide UHF T-Band simulcast. From these 18 channels Marin County would need to license at least 11 in a P25 Phase 2 simulcast configuration to meet the County needs for the next 15 years.

The remaining channel requirements for the standalone sites (12 Phase 2 channels) can also be supported according to our analysis. Table 3-2 provides a summary of the potential simulcast channel assignment and the channel assignments to cover the other needs of the County for the next 15 years.

Table 3-1
Future Channel Capacity Needs

Load-based Estimates	P25 Phase 1	P25 Phase 2	Notes
Total Number of Radios	5250	5250	1
Mean Call Duration (Seconds)	5.9	5.9	3,7
Voice Calls/Hour	6825	6825	8
Offered Load (Erlangs)	11.18	11.18	4
Basic Grade-of-Service (%)	2.32	2.32	5
Delayed Call Grade-of-Service (%)	0.618	0.618	6
Trunked Voice Channels + Control Channel	**19 + 1**	**19 + 1**	**2**
Required Frequency Pairs	**20**	**11**	**9**

Note 1: Quantities assume that 100% of inventoried radios will be on the air during the busy hour.
Note 2: Trunked systems utilize one channel for control functions.
Note 3: The Mean Call Duration includes a 1 second overhead per call for digital trunked systems.
Note 4: The Erlang is the dimensionless unit of measure for traffic and is the product of calls/second times mean call duration.
Note 5: Basic Grade-of-Service is the percentage of calls that are blocked.
Note 6: Delayed Call Grade-of-Service (1% design target) is the odds that a caller will have to wait more than 1 second.
Note 7: A mean call duration of 4.9 is an industry standard.
Note 8: Based on an average of 1.3 calls per unit per hour.
Note 9: P25 Phase 2 utilizes time division multiplexing so that one channel supports two talkpaths for voice traffic.

Table 3-2
Potential Simulcast Channel Assignments

Cell	Tx Frequency	Rx Frequency	Current Location
Simulcast	482.6500	485.6500	East Simulcast
Simulcast	482.9750	485.9750	West Simulcast
Simulcast	483.0250	486.0250	Stewart Pt / East Sim.
Simulcast	483.0500	486.0500	West Simulcast
Simulcast	483.1250	486.1250	East Simulcast
Simulcast	483.1500	486.1500	West Simulcast
Simulcast	483.5125	486.5125	West Simulcast
Simulcast	483.5375	486.5375	New Channel
Simulcast	488.4000	491.4000	Sonoma Mountain
Simulcast	488.4250	491.4250	West Simulcast
Simulcast	488.4750	491.4750	Stewart Pt / Sonoma Mtn
Simulcast	488.7000	491.7000	East Simulcast
Simulcast	488.7250	491.7250	Sonoma Mountain
Simulcast	488.8500	491.8500	West Simulcast
Simulcast	488.8750	491.8750	Sonoma Mountain
Simulcast	489.0750	492.0750	East Simulcast
Simulcast	489.1000	492.1000	West Simulcast
Simulcast	482.6250	485.6250	East Simulcast
Radar Tower	482.3500	485.3500	East Simulcast
Radar Tower	482.7875	485.7875	East Simulcast
Radar Tower	482.9375	485.9375	East Simulcast
Radar Tower	490.9375	493.9375	East Simulcast
Stewart Point	483.9500	486.9500	Stewart Point
Stewart Point	484.1375	487.1375	East Simulcast
Stewart Point	489.4500	492.4500	Stewart Point
Stewart Point	490.8000	493.8000	Stewart Point
Tomales	488.9750	491.9750	Bay Hill
Tomales	489.7000	492.7000	Bay Hill
Tomales	490.1000	493.1000	Bay Hill
Tomales	490.7250	493.7250	Bay Hill
Martha	482.1375	485.1375	New Channel
Martha	489.3250	492.3250	Bay Hill
Martha	489.5875	492.5875	New Channel
Martha	489.9125	492.9125	East Simulcast
Interoperability	482.2375	485.2375	Pending License
Interoperability	482.2875	485.2875	Pending License
Interoperability	482.3250	485.3250	Sonoma Mountain
Interoperability	489.0375	492.0375	New Channel

4.0 Radio Alternatives Analysis

In this section, we analyze the Radio System options that will meet the needs of the Marin County users that also support the BayRICS interoperability goals. We include a description of the viable long term solutions available to Marin County and an analysis of how each option meets the capacity, coverage and interoperability needs for Marin County. In support of this analysis, we have developed an Alternative Analysis process that was used to determine a weighted score for each alternative. Although rough order of magnitude costs were considered, at this point in the process, cost and available funding were not the driving factor. We looked for the best solution from a technical and operational perspective.

We understand that any option must be approved by MERA and the Marin County Board of Supervisors. We are making no assumption or implication that the alternatives analyzed in this report have been endorsed by any of the governing agencies in Marin County. The purpose of this report is to clearly describe and analyze the radio options available to Marin County that will meet the needs of the emergency responders in Marin County and those external agencies that may operate in Marin County.

Again, we also want to point out that our focus, based on the scope of work requested, was on long term solutions. Several short term “fixes” might be implemented that will provide temporary solutions to the existing capacity, coverage and interoperability challenges facing Marin County, however, the focus of our analysis was a solution that would meet the needs 15 years from now.

Our analysis included reviewing the following alternatives:
Alternative 1: MERA continues as currently configured and include 700 MHz Overlay
Alternative 2: Upgrade MERA into single P25 Phase 1 simulcast with Bay Hill and Pt Reyes as Standalone sites
Alternative 3: Upgrade MERA into single P25 Phase 1 simulcast and add new sites
Alternative 4: Countywide 700 MHz P25 Phase 2 system

4.1 P25 Technology Summary

We begin this section with an overview of P25, which is essential to understanding some of the details of the options explored. The Association of Public-Safety Communications Officials International (APCO), in conjunction with the Telecommunications Industry Association (TIA) and others, initiated APCO Project 25 (P25) to promote a single non-proprietary set of standards for digital radio communications. The purpose of the standards was two-fold:

- To improve interoperability between public safety agencies; and
- To provide greater vendor competition and resultant cost savings in the procurement of radio equipment.

The first interface of P25 implementation focused on providing a common air interface (CAI). The CAI defined a standard to provide one voice channel in a 12.5-kHz channel. In addition, P25 supports voice, data and control encryption and also supports over-the-air rekeying (OTAR). The CAI made it possible for radios from different vendors to be able to communicate with infrastructure that was manufactured by another vendor.

One key advantage of P25 is backwards compatibility, which enables new digital P25 radios to communicate in analog or digital mode with legacy radio systems and either digital or analog mode with current Project 25 radios. For Marin County, this means that Motorola P25 capable radios can communicate with P25 standards based systems and with the MERA SmartZone 3.0 system, which is a proprietary Motorola system. Backward compatibility will be a key component if the County decides to upgrade the existing SmartZone 3.0 system to a P25 standard based system.

The next distinction in the P25 standard is the difference between Phase 1 and Phase 2. P25 Phase 1 supports **one talkpath** per 12.5 KHz voice channel, while P25 Phase 2 supports **two talkpaths** per 12.5 KHz voice channel. Phase 2 effectively doubles the channel capacity for each voice channel and meets the FCC goal to provide one voice

channel per 6.25 kHz of spectrum. One other distinction must be made. In order to support backward compatibility a Phase 2 system will use the same format for the control channel as a Phase 1 P25 system.

One important question that must be addressed is, "**What does P25 mean to Marin County?**" First, the two talkpaths per voice channel on a Phase 2 essentially doubles the channel capacity of a Phase 1 system. As AECOM researched the alternatives for Marin County, we based our 700 MHz design on a P25 Phase 2 system in order to take advantage of the spectral efficiencies of Phase 2. We did this so that the current 700 MHz allocation for Marin County could support the channel capacity needs of the County.

One important consideration is the fact that P25 Phase 2 is backward compatible with P25 Phase 1. However, if a P25 Phase 1 radio/talkgroup is activated on a P25 Phase 2 system, the Phase 1 talkgroup will use both Phase 2 talkpaths for it traffic, which will have a significant impact on the channel loading of the system. Our recommendation is to only P25 Phase 2 talkgroups are implement so that the capacity calculations in this report will reflect operational realities.

Second, as we looked at upgrading the existing MERA SmartZone system to P25, we also considered the advantages and disadvantages of P25 Phase 1 versus Phase 2. Phase 2 capable mobiles, portables and control stations have just recently become available by the vendor community and none of the existing MERA equipment is P25 Phase 2 capable. Any upgrade from the exiting SmartZone 3.0 system to a P25 Phase 2 system will require complete replacement of all radios and most of the infrastructure. Some of the combiners, antenna systems, shelters towers and other physical facilities can be reused, but the rest of the radio system would need to be upgraded. However, if the County migrates toward a P25 Phase 1 system, 98% of the existing mobiles, portables and control stations can be reused.

Obviously the decision to upgrade from the existing MERA system to P25 Phase 1 or Phase 2 is important. The main factor necessitating a move to Phase 2 would be to meet capacity needs if the UHF T-Band channels were not available to support a Phase 1 system. Our growth model was based on adding 100 new radios each year for the next 15 years, plus a 20% increase that supports interoperability users. Our frequency research has indicated that sufficient UHF T-Band channels are available to meet Marin County's needs, if the current system is reconfigured as a single simulcast with two stand alone sites. Phase 2 is only required if additional channel capacity is needed because actual growth exceeds growth predictions used in this report. As a result, the County can migrate to P25 Phase 1 and meet all capacity and interoperability needs without the added cost of moving to P25 Phase 2.

Throughout this report, we have included comments on the implications of moving to P25 Phase 1 versus Phase 2. In addition, we have continually referenced the difference between a Phase 1 and a Phase 2 system. This section is intended to provide enough background information on P25 Phase 1 and Phase 2 so that the following sections can be easily understood. Whenever you see the word "channel", we are referring to a transmit / receive frequency pair. Whenever you see the word "voice channel", we are referring to the frequency pair used to carry voice traffic. Whenever you see the word "talkpath", we are talking about the path needed to support one conversation. Whenever you see the word "control channel", we are referring to the frequency pair that is used to request a voice channel. Vendors often use terms like compatible, capable and compliant. When we use the terms "compatible or capable" we mean that a software upgrade is needed, which typically requires a fee. When we use the term "compliant" we mean that the equipment is ready out of the box.

Finally, a note on interoperability with P25 radio systems. There are two basic methods for interoperability between geographically adjacent agencies that are using P25 compatible systems in the same frequency band. The first method involves establishing talkgroups on each P25 system so that each agency can use the adjacent P25 system. This method is certainly the easier to implement, but we must note that interoperability talkgroups on each system provide a challenge to the dispatchers. The dispatcher monitoring an incident may have users on talkgroups on different systems and there is a chance that the radio user would not be monitored if they switched to a talk-group on a different system.

The second P25 interoperability method is based on the P25 (both Phase 1 and Phase 2) IP-based interconnection ("inter-subsystem interface" or ISSI) standard for P25 radio systems from different manufacturers. The ISSI will allow seamless roaming and wide-area calling across multiple radio systems in the same frequency band. The big challenge is that the database of radio identifiers from both systems must be coordinated and synchronized in order for ISSI to be implemented. The ISSI is an interface standard, not an actual device. System interface devices that are ISSI compliant are being developed and will be available on P25 systems in the near future.

Other interoperability solutions, such as patches and overlays offer interoperability connections but do not actually tie two radio systems together with the same functionality as what is described here. In our evaluation, we also looked at an overlay solution to provide interoperability for Marin County.

4.2 Radio Communication Alternatives Description

This section provides a detailed explanation of each of the alternatives that were analyzed to meet the long term needs of Marin County. For each of the alternatives, we include a detailed description and we provide an overview of the system design using the existing MERA system as a baseline. In addition, each alternative discusses the major strengths and weakness for each solution with an emphasis on how each option meets the capacity, coverage and interoperability needs for Marin County.

Our analysis included reviewing the following alternatives:
Alternative 1: MERA continues as currently configured and include 700 MHz Overlay
Alternative 2: Upgrade MERA into single P25 Phase 1 simulcast with Bay Hill and Pt Reyes as Standalone sites
Alternative 3: Upgrade MERA into single P25 Phase 1 simulcast and add new sites
Alternative 4: Countywide 700 MHz P25 Phase 2 system

4.2.1 Alternative 1 – Existing MERA system with 700 MHz Overlay

This alternative does not make any modification to the existing MERA system, other than the planned system upgrades. Essentially the idea is to continue to use the MERA system in its existing configuration and communication between agencies in the County will continue as they are today. The planned upgrades to expand the East simulcast cell to 11 channels and to expand the West simulcast to 7 channels would continue as scheduled. In addition, the proposed relocation of the site at Bay Hill to Mt. Tomales would also continue.

One additional modification to the existing system is also being considered. In an attempt to address the capacity problems on the existing MERA system, some users would be moved to conventional channels for all or part of their operational needs. The users that could potentially be moved to conventional channels include the Marin County Jail and Marin County Transit on UHF T-Band Conventional channels, some fire agencies on VHF fireground channels, and some public works agencies on VHF tactical channels. Essentially, the idea is to alleviate some of the strain on the existing system caused by multi-cell calls by moving users to conventional channels.

External 700 / 800 MHz users would utilize either a six site 700 MHz Trunked Overlay or a six site three channel 700 MHz Conventional Overlay when they respond in Marin County. Keep in mind that 800 MHz radio users must have subscriber units that are capable of operating on a 700 MHz P25 radio system. The goal of the 700 MHz overlay design is to provide 700 MHz radio coverage along the main travel corridors where a majority of the population in the County is centered. These areas are the locations where outside agencies are most likely to assist Marin County in an incident. Marin County users would be equipped with three hundred 700 MHz radios for use on the system.

The trunked overlay is a P25 standards based trunked solution with six sites located at Big Rock, Mt. Barnabe, Mt. Burdell, Mt. Tamalpais, San Pedro and Sonoma Mtn. The system would utilize a portion of the 700 MHz frequencies allocated to Marin County. If the overlay is a P25 Phase 2 system, the overlay would have 4 working channels and 1 control channel for a total of 5 channels, which will support up to 8 talkpaths.

In addition, we would also recommend tying the 700 MHz overlay into the existing MERA system through the use of some type of interoperability or patching solution.

The conventional overlay is a P25 standards based conventional solution with six sites located at Big Rock, Mt. Barnabe, Mt. Burdell, Mt. Tamalpais, San Pedro and Sonoma Mtn. The system would utilize a portion of the 700 MHz frequencies allocated to Marin County. The conventional overlay would have 3 conventional channels at each site, one calling channel and 2 tactical channels that would support the command and control needs of an incident.

Both the trunked and conventional overlay provides similar interoperability capabilities, with the trunked solution providing a significant advantage to support interoperability capacity for outside agencies. The decision between which of the two overlays is best for Marin County is largely dependent on the long term strategic plans. If the County is going to move toward a 700 MHz P25 Phase 2 system to replace the existing MERA UHF T-Band system, then the trunked overlay is a natural first step. If the County plans to upgrade its existing MERA UHF T-Band system to a P25 UHF T-Band system, then the conventional overlay is the best choice. Both solutions are provided here and the advantages and disadvantages of each are discussed below.

4.2.1.1 Alternative 1 Strengths

1. This alternative requires the least amount of change / updates to the existing system.
2. Funding for the 700 MHz Overlay portion of this solution may be available through the Bay Area UASI.
3. This solution would likely require the least amount of training prior to being implemented.
4. This solution is the least expensive.
5. If the County were going to replace their existing MERA system with a 700 MHz P25 system, the trunked overlay would be the first logical step.

4.2.1.2 Alternative 1 Weaknesses

1. The short term capacity concerns with the MERA system are addressed, however rather than fixing the problem; this solution should be thought of as a temporary “work around”. Eventually those users moved to conventional channels will need additional capacity and this alternative does not address long term needs. Several short term solutions are put in place, but the long term (5-10 years and beyond) needs are not met.
2. The existing coverage concerns with the MERA system are not addressed with this solution.
3. This solution moves Marin County farther away from a local interoperability solution and segregates or fragments an existing system that supports all users.
4. The operational complications of an overlay are always challenging. Unless a patching or interoperability solution is put in place, only those users with 700 MHz capable radios could use the overlay.
5. Some County users would be dual equipped with UHF T-Band and 700 MHz. Many agencies would have three radios, UHF T-Band, 700 MHz and VHF.
6. The overlay would not be countywide thus increasing the operational complexity, maintenance costs, and subscriber costs with very little increase in countywide operability or interoperability.
7. Some of the sites chosen for the overlay may not be able to support the additional equipment needed in the overlay. Our scope of work did not include a detailed site analysis and this type of detailed study should be researched before purchasing any 700 MHz overlay equipment.
8. This option would require placing additional antennas at all six sites and would increase the equipment at all six sites, which could present some environmental impact challenges.
9. The 700 MHz trunked overlay effectively locks the County into a particular long term solution, namely 700 MHz P25.

4.2.2 Alternative 2 – Upgrade MERA to single simulcast

This alternative addresses the long term capacity needs of Marin County by combining the existing sites in the East Cell and in the West Cell along with Sonoma Mtn. into a single 19 channel P25 Phase 1 simulcast . This channel capacity will meet today needs, and the capacity needs of Marin County users 15 years from now. In addition, this capacity will support a 15% increase in users for interoperability.

The sites located at Bayhill and Pt Reyes would continue to operate as 5 channel stand alone sites. In our frequency compatibility report, we completed a UHF T-Band frequency search that included an analysis of the 32 UHF T-Band channels licensed on the MERA system. Our research determined that the simulcast system described here could be supported from a licensing perspective. Our analysis in other reports completed for this project indicates that the proposed simulcast will work from a technical perspective.

In order to address interoperability with 700 MHz, two options are available to the County. First, the County can install the 700 MHz Conventional Overlay described in Alternative 1. However; due to the inherent weaknesses of an overlay, another solution is included to provide regional interoperability. A majority of the equipment in the MERA system is based on older technology and a migration that includes upgrading to new technology should be included in the long term plans for the system. The idea would be to begin to migrate towards a P25 system, which will provide additional interoperability options to the County.

Many of the existing portable and mobile radios can be upgraded to be P25 Phase 1 for an upgrade fee for each radio. As the radio nears end of life, they should be replaced with UHF T-Band P25 Phase 2 radios, which will provide additional flexibility for interoperability. Furthermore, when purchasing repeater equipment and controllers for the simulcast, care should be taken to purchase equipment that is P25 Phase 2 capable.

The idea is to migrate to a single simulcast keeping in mind an end goal of a P25 Phase 2 system so that all new equipment purchased can be reused in a P25 Phase 2 system. Section 1.2 contains a summary of the difference between P25 Phase 1 and Phase 2 channels. We want to point out that it is not absolutely necessary for the County to move toward P25 Phase 2, Phase 2 adds additional channel capacity by allowing each channel to have two talkpaths. Phase 2 is only required if additional channel capacity is needed because actual growth exceeds growth predictions. The County can migrate to P25 Phase 1 and meet all capacity and interoperability needs without the added cost of moving to P25 Phase 2. Moving to P25 Phase 2 will mean that every base station, portable and mobile radio will have to be replaced.

As the County migrates towards a P25 (Phase 1 or Phase 2) platform they will have the ability to link their P25 system with other P25 systems using the Inter RF Sub-System Interface (ISSI) to establish interoperability across multiple P25 networks. If this path is chosen, then the 700 MHz Trunked Overlay would not be needed and the less expensive and less cumbersome conventional overlay could be used to support conventional 700 MHz channels and only that would be linked into the MERA system. This is an excellent alternative if Federal funding is not available for the 700 MHz countywide system described in Alternative 4.

4.2.2.1 Alternative 2 Strengths

1. This alternative addresses all of capacity issues facing the County. If the migration to P25 Phase 2 is completed then the number of users in the County could increase threefold, and the available UHF T-Band channels could accommodate the capacity requirements. A Phase 2 solution is only needed if the capacity exceeds the current growth estimates.
2. This alternative frees up several UHF T-Band channels so that they can be used to support interfaces with legacy systems, fire station alerting, mobile data and other interoperability needs.
3. If the County moves toward P25 Phase 1, this alternative is the least intrusive (meaning does not require completely replacing the entire system) of the alternatives that still satisfies a majority of the user requirements. The components that would need to be upgraded to support P25 Phase 1 would include the repeater equipment, site controllers, system controller, consoles and some of the base stations,

portables and mobiles. If a Phase 2 solution is implemented then every base station, portable and mobile radio must be replaced.
4. This alternative avoids the operational command complications of an overlay system and does not require Marin users to carry additional 700 MHz radios.
5. This alternative is a natural migration and system improvement to the existing system.
6. This alternative supports all users on a single system, which is a top California Statewide Communications Interoperability Plan (CalSCIP) priority.
7. This alternative has very little operational changes that need to be implemented.
8. This alternative offers the flexibility to leave more options open for the future and does not eliminate the possibility of moving to a 700 MHz alternative. Keep in mind that at some point in this process, the path will be locked into a UHF T-Band P25 Solution based on the costs associated with upgrading the mobile and portable radios.

4.2.2.2 Alternative 2 Weaknesses

1. The coverage concerns with the MERA system are not addressed with this solution since the simulcast will continue to use the existing sites.
2. As the County moves toward P25 Phase 2, all the subscriber units will have to be replaced. There is a significant cost involved in replacing all these units at one time, but as replacement radios are needed, P25 Phase 2 capable radios should be purchased.
3. The existing Microwave network should be upgraded to support this alternative. We included details of the recommended Microwave network in the Possible 700 MHz solutions report.
4. The P25 ISSI connection will only be possible with other agencies that have P25 systems. Due to the installation time, most of the surrounding counties will not have P25 systems for many years. The conventional 700 MHz overlay provides a useful interim solution.
5. Since additional channels will be added to many sites, environmental impact studies will have to be completed for this alternative to be implemented. Keep in mind that this challenge faces all the alternatives that seek to add additional capacity.

4.2.3 Alternative 3 – Upgrade MERA to single simulcast and move to new sites

This alternative addresses the long term capacity needs of Marin County by combining the existing sites in the East Cell and in the West Cell along with Sonoma Mtn. into a single 19 channel P25 Phase 1 simulcast This channel capacity will meet today needs, and the capacity needs of Marin County users 15 years from now. In addition this capacity will support a 20% increase in users for interoperability. The sites used in the simulcast will be the same as the ones selected for the Countywide 700 MHz solution described in Alternative 4.

These site locations were selected to address some of the coverage concerns with the existing MERA system. Again our research has shown that sufficient UHF T-Band frequencies can be licensed to support this solution. In addition, our analysis in other reports completed for this project indicates that the proposed simulcast will work from a technical perspective.

Just as in Alternative 2, two options are available to the County that will address interoperability with 700 MHz users. First, the County can install the 700 MHz Conventional Overlay described in Alternative 1. Second, the County can migrate toward P25 (Phase 1 or Phase 2) and implement an ISSI link to other P25 systems to support interoperability. Section 2.2 has the details on how this migration could be accomplished.

The idea is to migrate to a single simulcast keeping in mind an end goal of a P25 Phase 2 system so that all new equipment purchased can be reused in a P25 Phase 2 system. Section 1.2 contains a summary of the difference between P25 Phase 1 and Phase 2 channels. We want to point out that it is not absolutely necessary for the County to move toward P25 Phase 2. Phase 2 is only required if additional channel capacity is needed because actual growth exceeds growth predictions. The County can migrate to P25 Phase 1 and

meet all capacity and interoperability needs without the added cost of moving to P25 Phase 2. Moving to P25 Phase 2 will mean that every base station, portable and mobile radio will have to be replaced.

4.2.3.1 Alternative 3 Strengths

1. This alternative addresses all the capacity issues facing the County. If the migration to P25 Phase 2 is completed, then the number of users in the County could increase threefold, and the available UHF T-Band channels could accommodate the capacity requirements. A Phase 2 solution is only needed if the capacity exceeds the current growth estimates.
2. The coverage concerns with the MERA system are addressed with this alternative since the simulcast will use sites that were selected to fill in existing coverage gaps.
3. This alternative frees up several UHF T-Band channels so that they can be used to support interfaces with legacy systems, fire station alerting, mobile data and other interoperability needs.
4. This alternative avoids the operational command complications of an overlay system and does not require Marin users to carry additional 700 MHz radios.
5. This alternative is a natural migration and system improvement to the existing system.
6. This alternative supports all users on a single system, which is a top CalSCIP priority.
7. This alternative has very little operational changes that need to be implemented.
8. This alternative offers the flexibility to leave more options open for the future and does not eliminate the possibility of moving to a 700 MHz alternative. Keep in mind that at some point in this process, the path will be locked into a UHF T-Band P25 Solution based on the costs associated with upgrading the mobile and portable radios.

4.2.3.2 Alternative 3 Weaknesses

1. This alternative has some significant changes from the current system configuration. Four new sites are added to the design and several other sites are removed. Based on experience with the MERA system installation, significant time will be required to implement this solution.
2. As the County moves toward P25 Phase 2, all the subscriber units will have to be replaced. There is significant cost involved in replacing all these units at one time, but as replacement radios are needed, P25 Phase 2 capable radios should be purchased.
3. The existing Microwave network should be upgraded to support this alternative. We included details of the recommended Microwave network in the Possible 700 MHz solutions report.
4. The P25 ISSI connection will only be possible with other agencies that have P25 systems. Due to the installation time, most of the surrounding counties will not have P25 systems for many years. An interim solution may be needed.
5. Since additional channels will be added to many sites, environmental impact studies will have to be completed for this alternative to be implemented. Keep in mind that this challenge faces all the alternatives that seek to add additional capacity.

4.2.4 Alternative 4 – Countywide 700 MHz System

Alternative 4 is a Countywide 700 MHz P25 Phase 2 system. The system would consist of an eleven site simulcast with four fill-in sites. The sites were selected to address the coverage gaps in the existing MERA system. The simulcast will consist of 10 working channels and 1 control channel for a total of 11. Since the system will be a P25 Phase 2 system, this will support 20 voice talkpaths, which will meet the needs of the County for the next 15 years based on estimates provided by the Marin County Project Team. The sites selected for the simulcast and the details of the capacity and coverage analysis are described in the Possible 700 MHz Solutions report.

4.2.4.1 Alternative 4 Strengths

1. This alternative addresses all of capacity issues facing the County.
2. The coverage concerns with the MERA system are addressed with this alternative since the 700 MHz system will use sites that were selected to fill in existing coverage gaps.

3. This alternative takes advantage of the frequencies available in the 700 MHz band. The frequencies allocated in the 700 MHz Region 6 Plan will support all the users in the Marin County operational area.
4. This alternative frees up all existing UHF T-Band channels so that they can be used to support interfaces with legacy systems, fire station alerting, mobile data and other interoperability needs.
5. This alternative avoids the operational complications of an overlay system and does not require Marin users to carry additional 700 MHz radios.
6. This alternative supports all users on a single system, which is a top CalSCIP priority.

4.2.4.2 Alternative 4 Weaknesses

1. This alternative is a deviation from the existing MERA system and will require complete replacement of the entire system. Since the MERA system has a limited remaining useful life, a path needs to be chosen now in order to meet long term needs.
2. Federal funding for this alternative is questionable. The current trend in Federal funding is that fewer funds will be available for complete system replacements. Long term projects, implemented in phases that spread the cost throughout several years will likely be easier to fund than large system replacements.
3. This alternative is the most intrusive of any of the alternatives and will require changing frequency bands and replacing all mobiles, portables, base stations, consoles and most of the system infrastructure. In addition, it will require all users to migrate to a new frequency band and all existing interoperability solutions that are in place will have to be updated.
4. Based on experience with the MERA system installation, significant time will be required to implement this solution.
5. The existing Microwave network should be upgraded to support this alternative.
6. Since additional channels will be added to many sites, environmental impact studies will have to be completed for this alternative to be implemented. Keep in mind that this challenge faces all the alternatives that seek to add additional capacity.
7. Since the existing MERA system will have to remain in place and operational during the build-out of the 700 MHz system, all sites must be capable, and have the physical space, to support UHF T-Band equipment for the existing system and 700 MHz equipment for the new system. In addition, the microwave backbone and dispatch centers must support both systems simultaneously as well. This solution clearly has the most complicated implementation plan of the recommended solutions.

4.3 Radio Communication Alternatives Analysis

This section provides a comparison of each alternative. Using our alternatives analysis process we rank each alterative using system attributes that are weighted based on how critical the attribute is for the users in Marin County. Our comparison includes radio coverage predictions, capacity, interoperability, system functions, long term suitability and other factors that are used to objectively assess each alternative's ability to meet the long term needs of the County. In addition, this section considers the operational needs that must be met by the chosen technology as well as the interoperability and funding realities of the Bay Area UASI.

The objective comparison contained in this section will be used in conjunction with the advantages and disadvantages of each alternative in order to provide a recommended long term alternative for Marin County. It is important to remember that the best alternative must be technically feasible, must meet all operable and interoperable needs, and must be able to receive the political and funding support needed to implement the alternative. This section of the report provides the objective comparison between the alternatives.

Our analysis included reviewing the following alternatives:
Alternative 1: MERA continues as currently configured and include 700 MHz Overlay
Alternative 2: Upgrade MERA into single simulcast with Bay Hill and Pt Reyes as Standalone sites
Alternative 3: Upgrade MERA into single simulcast and add new sites
Alternative 4: Countywide 700 MHz system

4.3.1 Alternative Ranking

Our alternatives analysis process included alternatives that were weighted based on order of importance by our engineers validated with the Marin County Project Team. Table 4-1 contains the results of our analysis. You will notice a column labeled Weight Factor that was used to assign a higher priority or weight to certain attributes. The Weight Factor used a scale from 3 to 5 that was filled in using the following descriptions:

3: indicated the attribute was supported by the current MERA system and each alternative could continue to support the attribute with the same ability as the existing MERA system.
3.1 through 4.9: These were important attributes and each alternative had to be able to support them in some degree.
5: This was reserved for the most important system attribute and each alternative had to meet this attribute or the system would not meet the needs of the Marin County users.

These weighting factors were assigned to 22 different key attributes that were related to radio coverage, capacity, interoperability, system functions, and long term suitability. Each of the 22 attributes is described below:

Coverage – The system will provide reliable coverage in all areas of the County that require coverage.
Capacity -- The system has sufficient capacity to support traffic associated with peak or emergency conditions and day to day operating conditions.
Reduced Congestion – The radio system is designed to reduce congestion and does not use a multi-cell design which can cause an increase in radio traffic.
Interoperability -- The system supports the user's ability to communicate between agencies within the jurisdiction.
Regional Interoperability -- The system allows users the ability to communicate between agencies outside of the jurisdiction.
State and Federal Interoperability -- The system allows users the ability to communicate between agencies in the County and State and Federal agencies that may operate inside the jurisdiction.
Flexibility in Personnel Allocation -- The radio system allows the radio manager the ability to assign different attributes and functions to each individual agency or radio.
Emergency Access – The radio system supports an emergency access function that allows users with an emergency to have a priority when requesting channel resources. The radios and system shall provide an emergency function for alerting dispatch and supervisors to the need for assistance.
Encryption: The system shall provide encrypted communications for users that need to prevent unauthorized interception of sensitive information.
Future Expansion: The system shall be capable of future expansion in the number of channels and the number of users. System design shall incorporate expansion to the level of usage predicted for the next 15 years with only the addition of equipment.
Support New Technologies -- The system is able to support new technologies, such as P25, VoIP and other standards based initiatives.
Non-Fixed Radio Features: High-, mid-, and low-tier radio equipment are equipped with feature sets and options that support operational and interoperability needs.
Dispatch Operational Concept – The radio system provides features that align with the operational needs of the dispatcher and no significant operational changes are needed to support the alternative.
Console Features: The consoles used in the radio system are equipped with feature sets and options that support operational and interoperability needs.
Power Backup: All fixed radio equipment shall require backup power with automatic transfer, capable of handling 100 percent loading of radio equipment. An uninterruptible power system (UPS) shall be required for all communications equipment and generator backup for the radio equipment.
Reliability: The radio system and equipment must be designed such that single-mode failures do not perceptibly impact the routine operations of the system. This includes channel failure, site failure, and console failures.

Survivability: The system shall be designed to survive in severe weather or emergency conditions. If dispatch points are shifted from their primary to a backup location, radio control shall be available at the backup location to the same degree it was available at primary dispatch.
Maintainability: The Locality / Agency prefer to centrally maintain and administer the radio system, dispatch systems, and user radios, either in-house or using a service shop. Centralized maintenance provides consistent and coordinated services for all user departments.
System Operational Transparency: System operation will be logical, with the focus on whom the user wants to call rather than where they are located. Changes in the user agencies' operational boundaries shall be transparent to radio users. The radio system shall allow any group or department to operate with full communications capability within the service area.
Operational Boundary Flexibility – When users migrate to an area outside the operational boundaries of the County, the radio system has the ability to support interfacing with other radio systems.
Training -- The radio system vendor shall provide formal training for system administrators, supervisors, dispatchers, radio users, and maintenance technicians.
Commonality of Equipment --A single vendor shall install and supply all required equipment; as much as possible, user equipment shall be similar in operation and maintenance requirements. The goal is to minimize spare parts inventory and multiple vendor training requirements.

Our engineers then ranked each attribute for each alternative. The results are summarized in Table 4-1. We used a scale of 1 to 5 to rate each attribute based on the following scale:

Attribute Scoring Scale
0 - Required Function/Attribute does not exist
1 - Available but totally insufficient for Marin County's needs
2 - Generally inadequate for Marin County's needs, unacceptable alternative
3 - Marginally adequate for Marin County's needs, approximately 60% functionality
4 - Reasonably adequate for Marin County's needs, a good alternative
5 - 95% of Function/Attribute available, excellent alternative

We then multiplied the engineering panel's scores for each attribute by the weighting factor so that the more important attributes received a greater emphasis. Along the bottom of Table 4-1 we added up the weighted scores and provided an overall ranking for each alternative.

4.3.2 Alternative Analysis

Alternative 4, the 700 MHz Countywide alternative received the highest score, and Alternatives 2 and 3 followed closely behind. Keep in mind that at this point in our evaluation, cost, political realities and implementation difficulties did not weigh into the ranking shown in Table 4-1.

The results of our analysis indicate that Alternative 1 does not meet the long term needs for the County and some type of alternative/ upgrade is needed to the existing MERA system. Adding a few additional channels and potentially moving some users to conventional channels may provide limited short term gains, but will not meet the long term needs of the County.

We also want to point out that the numerical or statistical difference between Alternatives 2, 3 and 4 is not significant and each of these options will meet the long term needs of the County. Although Alternative 4 scored higher in Table 4-1, this alternative has some physical restrictions that must be overcome if it is to be a viable option. The most significant of which is the ability to install new 700 MHz trunked equipment in the shelters, on the towers and in the vehicles so that users can continue to use the MERA UHF T-Band system while a new 700 MHz system is built out. In addition, Alternative 4 would require a significant funding source to begin the process. Alternative 3 and 4 have the challenge of installing new equipment at four different sites. This has proven to be a challenging process in the past. Alternative 2 must begin with the licensing of the channels in a single simulcast, and will require purchasing new equipment, which may be difficult to support

from a funding perspective. Each alternative has its challenges and we will continue to work with the Marin County Project Team as we refine the details of each alternative and select the best alternative.

4.4 Short Term Solutions

While our focus was on a long term solution, we determined several short term solutions what will improve the existing MERA system and we provide a summary of these short term solutions below.

1. License additional UHF T-Band Channels – Our frequency search from Task 3, identified additional UHF T-Band channels that could be licensed in Marin County. We recommend that you license these channels immediately.
2. Define talkgroups to use Transmission Trunking versus message trunking. Any talkgroup that can tolerate using transmission trunking from an operational perspective should be switched over from message trunking.
3. Reduce hang time from 1.5 seconds to 1 second. Although this seems like an insignificant change, the impact will be noticed if implemented system wide.
4. Complete expansion project to increase the number of channels on the East Simulcast to 11 and the West Simulcast to 7.
5. Move the site at Bay Hill to Mt. Tomales as planned. Mt. Tomales has coverage advantages over Bay Hill.
6. Continue to conduct training on radio discipline.
7. Research the cause of the increased call duration of the EMS talkgroups. A significant change occurred in the EMS agency that resulted in a call duration increase from about 11 seconds to over 28 seconds from March to April of 2009.
8. Consider upgrading the existing system monitoring software to the Genwatch system manager software. This software will enable the Radio System Manager to accurately track how the system is performing in each of the cells and will provide additional technical details that can be used to track and improve system performance.

Table 4-1

Marin County Ranked Alternatives

ATTRIBUTE	MERA add Conventional & 700 MHz Overlay	MERA Single Simulcast Upgrade	MERA Single Simulcast with New Sites	Countywide 700 MHz System	Weight Factor	MERA add Conventional & 700 MHz Overlay	MERA Single Simulcast Upgrade	MERA Single Simulcast with New Sites	Countywide 700 MHz System
	Alternative 1	Alternative 2	Alternative 3	Alternative 4		Alternative 1	Alternative 2	Alternative 3	Alternative 4
Coverage	3.7	3.8	4.3	4.7	4.8	17.6	18.4	20.8	22.4
Capacity	3.2	4.3	4.5	4.8	5.0	15.8	21.7	22.5	24.2
Reduced Congestion	3.3	4.2	4.3	4.8	4.2	14.0	17.5	18.2	20.3
Interoperability	3.0	3.8	3.8	4.2	4.3	12.9	16.4	16.4	17.9
Regional Interoperability	3.2	3.3	3.3	3.8	4.0	12.6	13.2	13.2	15.2
State and Federal Interoperability	2.7	2.8	2.8	2.8	3.8	10.1	10.8	10.8	10.8
Flexibility in Personnel Allocation	2.2	3.8	3.8	4.2	3.0	6.6	11.4	11.4	12.6
Emergency Access	3.6	4.2	4.2	4.2	3.0	10.8	12.6	12.6	12.6
Encryption	3.4	3.8	3.8	4.0	3.0	10.2	11.4	11.4	12.0
Future Expansion	2.5	4.3	4.2	4.7	3.9	9.7	16.8	16.2	18.1
Support New Technologies	2.5	4.2	4.2	4.8	3.9	9.8	16.4	16.4	19.0
Non-Fixed Radio Features	3.4	4.0	4.0	4.2	3.2	11.0	12.9	12.9	13.5
Dispatch Operational Concept	3.0	4.0	4.0	4.3	3.0	9.0	12.0	12.0	13.0
Console Features	3.8	4.0	4.0	4.0	3.0	11.3	12.0	12.0	12.0
Power Backup	4.0	4.5	4.5	4.5	3.0	12.0	13.5	13.5	13.5
Reliability	2.8	4.0	4.0	4.5	3.0	8.5	12.0	12.0	13.5
Survivability	3.8	4.4	4.4	4.6	3.0	11.4	13.2	13.2	13.8
Maintainability	3.2	4.3	4.3	4.5	3.0	9.5	13.0	13.0	13.5
System Operational Transparency	2.2	3.6	3.6	4.2	4.2	9.2	15.1	15.1	17.6
Operational Boundary Flexibility	2.8	3.6	3.6	4.2	3.6	10.1	13.0	13.0	15.2
Training	3.0	3.8	3.8	3.4	3.0	9.0	11.4	11.4	10.2
Commonality of Equipment	2.5	3.5	3.5	3.7	3.0	7.5	10.5	10.5	11.0
				Alternative Total		239	305	309	332
				Alternative Ranking		4	3	2	1

Ratings

0 - Required Function/Attribute does not exist
1 - Available but totally insufficient for Marin County's needs
2 - Generally inadequate for Marin County's needs, unacceptable alternative
3 - Marginally adequate for Marin County's needs, approximately 60% functionality
4 - Reasonably adequate for Marin County's needs, a good alternative
5 - 95% of Function/Attribute available, excellent alternative

Weight Factor

3 - Attribute supported by current system and each alternative continues to support
3.1 through 4.9 - Important Attribute and each alternative must support to a degree
5 - Most Important Attribute, System will not meet goals without supporting this attribute

5.0 Viable System Designs

This section provides two viable system designs based on AECOM's analysis. During our alternatives analysis process we identified 4 system design alternatives that we compared based on capacity requirements, radio coverage predictions, interoperability, connectivity, and other system design components. These alternatives included:
Alternative 1: MERA continues as currently configured and include 700 MHz Overlay
Alternative 2: Upgrade MERA into single P25 Phase 1 simulcast with Bay Hill and Pt Reyes as Standalone sites
Alternative 3: Upgrade MERA into single P25 Phase 1 simulcast and add new sites
Alternative 4: Countywide 700 MHz P25 Phase 2 system

Alternative 1 scored lowest in our analysis and was rejected because it does not meet long term capacity and coverage needs. The numerical or statistical difference between Alternatives 2, 3 and 4 is not significant and each of these options will meet the long term needs of the County. Alternatives 2 and 3 are essentially the same concept, but alternative 3 includes a new site design to address coverage concerns based on the current site locations. Alternative 4, the 700 MHz Countywide alternative received the highest technical score, and Alternatives 2 and 3 followed closely behind. Keep in mind that the technical score did not consider cost, political realities and implementation difficulties.

The original scope for this project included the County selecting a single best design and AECOM would then develop a detailed opinion of probable cost, implementation plan and schedule for the selected design. Due to the lack of distinction in a single "best" design, AECOM was asked to include two separate viable system designs. Each of these designs is summarized below. The first design described is the Countywide 700 MHz P25 Phase 2 design.

The second design described is a combination of Alternatives 2 and 3, where the County migrates to a single P25 Phase 2 simulcast system by combining the East and West Simulcasts with the site at Sonoma Mtn. into a single simulcast. The fill in sites would include Stewart Point, moving Bay Hill to Mt. Tomales, and new sites at Radar Tower and Martha. Section 5.2 discusses this option in detail.

Each of the two viable designs has initial challenges that must be overcome before any implementation can move forward. The 700 MHz Countywide design must first identify a significant funding source to begin the process. In addition, the County must identify a plan to install new 700 MHz trunked equipment in the shelters, on the towers and in the vehicles so that users can continue to use the MERA UHF T-Band system while a new 700 MHz system is built out. If the County decides to upgrade the existing MERA system to a P25 Phase 2 system, the County must begin with the licensing of the channels in a single simulcast, and will require purchasing new equipment, which may be difficult to support from a funding perspective. These challenges can be overcome, but need to be addressed early in the planning process.

Sections 5.1 and 5.2 below provide a summary of each viable system design.

5.1 Countywide 700 MHz P25 Phase 2 System Design

The first viable system design is a countywide 700 MHz P25 Phase 2 standard-based digital trunking system. The system would consist of an eleven site simulcast with four fill-in sites. The sites were selected to address the coverage gaps in the existing MERA system. The simulcast will consist of 10 working channels and 1 control channel for a total of 11. Since the system will be a P25 Phase 2 system, this will support 20 voice talkpaths, which will meet the needs of the County for the next 15 years based on estimates provided by the Marin County Project Team. The Project 25 standard is a long awaited breakthrough because it introduces competition in the radio marketplace. The industry is in its infancy regarding feature-rich trunked radios capable of working on other-brand infrastructure. We recommend carefully crafted procurement specifications to maximize the benefits and minimize surprises or disappointments.

5.1.1 Major System Elements

Major elements of the final 700 MHz P25 Phase 2 Countywide Simulcast system are:

- 11-site simulcast 700 MHz P25 Phase 2 trunking system.
- Four Stand-Alone P25 Trunked sites to provide additional coverage in areas where the cost of a full scale site is not warranted or where a full scale site cannot be supported due to physical constraints.

5.1.2 11-Site P25 Trunked Simulcast System with Four Stand-Alone Trunked Sites

According to our coverage study and analysis, an 11-site simulcast system will provide Marin County the coverage that is needed over nearly all of the service area. The coverage prediction study and methodology is covered later in this section.

Marin County has access to several viable existing tower sites. In addition, we have selected four sites to be further developed.

- Pt Reyes Coastal, already a radio site for the state of California, provides coverage in several key areas, including Pt Reyes National Seashore that has poor radio coverage under the existing system. The tower is located at the south of Pt Reyes, not far from the lighthouse.
- Wolfback Ridge is another already well-established radio site that is host to a number of towers. A site here would fill in several key coverage holes in the densely populated eastern coast. This site would also allow for the removal of the site at Mill Valley City Hall.
- The Radar Tower, located at the southernmost tip of Marin, fills in important coverage holes, including the Golden Gate Bridge as it enters Marin County.
- The Martha site, located south east of the Tiburon site, fills in important coverage holes along the coast. This site was added late in the system development process and it may be possible to replace the Mt. Tiburon simulcast site with the Martha site, provided the Martha site is approved as a viable radio communications site. At this point in the process we have included Martha as a fill in site, but if this site can be fully developed the County should research replacing Tiburon with Martha.

During the course of this study, we have evaluated existing facilities at a number of locations. The potential and selected locations are summarized in Table 5-1. Tower sites are selected first and foremost for their ability to contribute significantly to the overall coverage goal, taking into account population density and building density requirements. Additionally, spacing between sites was evaluated for linear simulcast performance.

5.1.3 Channel Capacity Summary

We provide a detailed analysis of the channel summary requirements in Section 4 of this report. Based upon the radio projections for the next 15 years, AECOM estimates that to supply sufficient capacity for the existing MERA radio users, the 700 MHz radio system would need to include 19 trunked voice talkpaths and one control channel. Since the recommendation is a P25 Phase 2 system, this would mean that 10 P25 Phase 2 channels would be needed for the voice traffic and one channel would be needed for the control channel for a total of 11 channels for the simulcast. The stand alone sites would require an additional 4 channels per site. User growth projections are based on user growth of 100 radios per year. Traffic loading analysis is discussed in Section 3.3.

5.1.4 Service Area and Site Selections

In our preliminary system design, the coverage area includes all areas within County boundaries. The system shall provide two-way radio coverage, base-to-mobile and mobile-to-mobile throughout the areas of the County that have been identified as needing coverage. We have relied upon the Marin County Project Team to determine the areas where coverage is required and the site selections and service area reflect their input.

Although the service area only includes the County boundaries, using a portable based design will allow actual coverage, especially mobile coverage, to naturally extend well beyond, enabling the majority of mutual aid calls to have adequate coverage.

The in-building service areas are defined as follows:

Light Buildings: Light buildings include single-family houses, duplexes, town houses, stores and office structures of less than three stories, constructed of brick veneer, frame or block; and other buildings with similar radio signal penetration characteristics contained within the boundaries of Marin County. These structures are characterized by a loss of 8 dB at 794 MHz.

Medium Buildings: Medium buildings include small-to-medium size apartment buildings, commercial buildings, enclosed shopping centers, schools and others with similar radio signal penetration characteristics contained within the boundaries of Marin County. These structures are characterized by a loss of 12 dB at 794 MHz.

Heavy Buildings: Heavy buildings include large high-rise buildings, steel covered warehouse buildings, "super stores", prisons, hospitals and others with similar radio signal penetration characteristics. These structures are characterized by a loss of 20 dB at 794 MHz.

Based on our travels and RaCE^{SM} testing in Marin County, we consider medium buildings the predominant building type in the developed areas of Marin County. We consider light buildings to be the predominant building type throughout most of the remaining areas of the County.

The service area is that area within which the radio system is required to provide a specified level of service at a specified level of reliability. The service area for this design is defined by the political boundaries of Marin County. However, there are some rural areas within the County that do not require the 97% reliable inbound and outbound coverage described in the RFP. After we produced our coverage predictions, we verified with the Marin County Project Team that our coverage prediction indicated coverage in all critical areas. In the coverage prediction figures (Figure 5-1 through 5-4), we have used color to represent those areas with reliable inbound / outbound coverage. Those areas that are not colored in, may have coverage, but do not meet the 97% requirement. Further details on how we determined reliable coverage are discussed in the Coverage and Capacity Analysis Report. In addition, the following sections provide details on the service area and coverage prediction parameters and results.

5.1.5 Coverage Parameters

The basis of this coverage estimate is a computer generated coverage prediction program using AECOM in-house facilities. These predictions are based on knowledge of radio signal propagation, and the factors that affect the signal as it travels through the air, over different terrain types, through different vegetation types, into and around buildings and other obstacles.

Parameters that affect the predictions include:

- Transmitter power
- Line losses
- Combiner losses
- Connector losses and other expected losses
- Antenna Gain(s)
- Antenna Height(s)
- Receiver Sensitivity
- Terrain levels
- Tree or foliage type and density

- Environmental noise at the selected frequency

Coverage predictions shown here are based on the Longley-Rice point-to-point model as implemented in the Terrain Analysis Package (TAP™) by SoftWright, LLC. AECOM participated in the early development of this implementation and continues to refine the accuracy of the model through our P-CALA^{SM} suite of engineering tools and through actual field testing accomplished in our RaCE^{SM} mobile testing apparatus.

AECOM has performed a validation of our predictions for Marin County during the RaCE^{SM} testing conducted throughout the County. Our RaCE^{SM} testing results are summarized in the System Coverage and Capacity Analysis Report.

5.1.6 Coverage Estimates

The tower site parameters we used in our propagation analysis are listed in Table 5-1. The following steps were taken to complete the propagation analysis for Marin County:

- Marin County projected radio sites were located on a digitized map of the Marin County area.
- An initial coverage map was plotted for 700 MHz from the existing MERA sites.
- Additional sites were selected to fill in any coverage gaps.
- A propagation analysis was run on the selected sites.
- The coverage contours were plotted to give us an initial look at the kind of coverage the sites provided.
- Tower-top amplifiers were used in the analysis for the 700 MHz band to provide balance between portable talk-out and talk-back coverage.
- The coverage contours were overlaid on a digital map of Marin County to determine which sites provided adequate coverage and which sites did not.

Coverage Maps

AECOM has developed coverage predictions in the 700 MHz band for our recommended selection of tower sites listed in Table 5-1. Map organization is as follows:

Map:	Area and type:
Figure 5-1	700 MHz Portable Outdoors – At the Hip with additional sites
Figure 5-2	700 MHz Indoor Light Building with additional sites
Figure 5-3	700 MHz Indoor Medium Building with additional sites
Figure 5-4	700 MHz Indoor Heavy Building with additional sites

5.1.7 Microwave Network

Marin County has an excellent microwave system implemented to interconnect the Land Mobile Radio sites within the County today, but we recommend that the existing microwave system be upgraded to support the P25 Phase 2 digital communications that we have recommended. Ethernet microwave radios will be required for network connectivity with modern P25 radios. We have provided some recommendations to further upgrade the network and tie in the new and upgraded radio sites. For the microwave ring, we recommend OC3 capacity. DS3 radios will be sufficient for the spurs. See Figure 5-5 for our design. We recommend that the dispatch centers also utilize a fiber backup to the prime site as well for redundancy if possible. This telecommunications subsystem will provide the latest state-of-the-art technology and allow for expansion to accommodate future needs.

AECOM recommends that the microwave backbone be configured as an ATM (Asynchronous Transfer Mode) or MPLS (Multi Protocol Label Switching) network. This will provide a highly reliable, alternate path and protection switched platform for the LMR site requirement connectivity and provide multiple nodes for additional bandwidth requirements of the County.

5.1.8 Microwave Path Profiles

The multiple site configuration of the radio system requires that the sites operate in the simulcast mode and all must be interconnected by highly stable, phase locked microwave links to support the simulcast subscriber-based radio system. The audio characteristics required for each voice channel must be matched to the trunking system.

The microwave path profiles for the new recommended links were reviewed for feasibility. See Appendix A for the path profiles and availability calculations of the proposed microwave links. The links are designed to give a minimum sixty-foot clearance over obstructions at the assigned frequencies. These are estimates using the AECOM's 1-second terrain database. Currently utilized links were not examined.

It is essential that prior to implementing any microwave path, the microwave vendor conduct a physical path survey to verify that the required clearances are maintained.

5.1.9 Additional System Design Considerations

In addition, we have included some considerations for system interface equipment, radio system network manager, dispatch consoles, desktop control stations as backup to radio consoles, physical facilities (towers, buildings, generators, etc.), and user equipment (mobile and portable radios, desktop stations, plus standard accessories).

5.1.9.1 System Interface Equipment

Based upon the radio projections for the next 15 years, AECOM estimates that to supply sufficient capacity for the entire County the radio system would need to include 19 trunked voice talkpaths and one control channel. Since the recommendation is a P25 Phase II system, this would mean that 10 P25 Phase 2 channels would be needed for the voice traffic and one channel would be needed for the control channel for a total of 11 channels. These channel quantities are within the capacity of a single system trunking controller available from most vendors. Currently, M/A-Com trunking controllers can handle 24 channels per system, while Motorola trunking controllers can handle 28 channels and other P25 vendors support similar channel per system.

5.1.9.2 Dispatch Communications Centers

Site surveys and dispatch center surveys were not included in the scope of this project. As a result, we are not able to provide a detailed assessment of the dispatch center needs. We have included the cost of consoles and console interface equipment in our opinion of probable cost based on console numbers and dispatch center information provided on the existing MERA system.

We would recommend that system management equipment be included in any RFP / Specification of a new radio system. The system management equipment provides the ability for user agencies to configure and update their portions of the radio system. Among the primary functions is what is called the fleetmap, a database of talkgroups allocated for agencies on the trunked radio system. A unit database identifies individual radio users and their service options. The administrative reporting function keeps track of user, group, and overall system usage data.

System management capabilities would be required for the system owner, the County. One lesson learned with the MERA system is the need for a robust system monitoring capability. This also includes the ability to view system alarms and diagnostics. The County would also be able to connect their logging recorders to the radio system. Backup dispatch communications is something that we recommend for our clients.

5.1.9.3 Desktop Control Stations

Trunked desktop control stations are used in the new system for fixed-point radio system access. The control stations are essentially a mobile radio repackaged in an AC-powered desktop configuration, and as such,

access the system via the radio frequency. They are not hardwired into the consoles. The control stations are also used as a backup to console positions to provide a limited dispatch feature set as well as to provide additional overflow communications capacity in the communications center environment in emergency situations. One control station will be installed at each console position.

5.1.9.4 Alerting

Assuming in the future that County Fire and EMS operates on a countywide UHF T-Band or 700 MHz P25 trunked radio system; fire station alerting should remain on the existing UHF T-Band system. We see no real reason for changing an effective working system at this time. 700 MHz alerting and paging would be more complex and many of the alerting features supported on your existing system will be challenging to implement in a P25 environment. We suggest that alerting be continued as it is today.

5.1.9.5 In-building Coverage Systems

Our approach to in-building coverage is to recognize early in the project that in-building systems like bi-directional amplifiers (BDA's) will be needed for some building structures (e.g., large warehouses or malls). Instead of allocating BDA's to particular buildings, the new radio system should be installed and tested and then install the BDA's only where they are needed. We have not included any cost for BDA's in our estimate, but the contingency fund is often used for this purpose.

5.1.9.6 User Radios

Project 25 radio system and user radios will allow each agency to have dedicated talk groups with which to communicate within their department in the same manner that the MERA system functions today. Of course, wide open communications among users and agencies is contrary to public safety organizational discipline, but the technical capability is available to be used in a planned and productive manner. Within the structure of SOPs and MOUs, agencies can conveniently interoperate on a common system and common frequency band.

In addition, the many advanced features can be supported by a P25 radio system which includes:

- Encryption
- Location capability–vehicle location, some personnel location
- Text messaging
- Talk group user segregation
- Caller ID
- Improved emergency function
- Automatic best-tower site selection
- Improved audio quality
- Stolen radio kill
- Availability of improved radio accessories
- Rugged radios – simple controls
- Vehicular chargers
- Lighted controls
- Improved channel scanning
- Lockable radio settings
- Radio features tiered for different uses

By and large, all of these features are available on modern trunked P25 radios. Even data-centric functions such as text messaging and GPS location are available on portable radios from some vendors.

Although many vendors are now taking invoices for P25 Phase 1 and P25 Phase 2 radios, they use terms that can be misleading. Keep in mind that there is a difference between capable, compatible and compliant radios and each vender tends to use these terms differently. In general, capable or compatible mean that the radio will work, but typically requires a software upgrade and associated fee. Compliant typically means that the equipment is ready to go out of the box. Make sure these terms are clarified when working with any vendor.

5.1.9.7 Communications Towers and Sites

Existing radio sites are used to design an economical system that provides the required coverage. We also attempted to identify other sites not used by the current radio system, based on locations that would fill in areas that lacked coverage. In order for these sites to provide good coverage, we then determine if the tower heights are higher than the tree line. If the tower height is not adequate, we will either search for another existing site or find a spot for a new tower to meet the coverage requirements. (Note that AECOM does not perform extensive research when it proposes new tower sites. The emphasis is on the feasibility for the coverage design. We make no representations on the availability or suitability of the site for the County to construct facilities.)

Detailed site surveys were not part of this scope of work and we make no assumptions that the existing facilities and towers can support additional equipment. In addition, we cannot provide detailed recommendations on the site improvements needed for each site. Section 6 contains a detailed Opinion of Probable cost and many of our recommended design considerations are included.

5.2 Upgrade MERA to Single UHF T-band P25 Phase 2 Simulcast System Design

This alternative is focused on upgrading the exiting MERA system to meet the long term capacity, coverage and interoperability needs of Marin County. The upgrade is completed in phases to reduce lump sum cost requirements and to allow equipment to be gradually added to each site, thus averting the problem of supporting two systems in different frequency bands that was pointed out with the 700 MHz design in Section 5.1.

Capacity Needs

The first step would be combining the existing sites in the East Cell and in the West Cell along with Sonoma Mtn. into a single simulcast with 11 P25 Phase 2 channels (10 Phase 2 channels to support 20 talkpaths and 1 control channel). This channel capacity will meet today needs, and the capacity needs of Marin County users 15 years from now. In addition, this capacity will support a 20% increase in users for interoperability.

Four fill in sites would be added to provide additional coverage in rural areas and in areas where the cost of simulcast site cannot be justified. Each of the fill in sites are 4 channel (1 control channel and 6 talkpaths) P25 Phase 2 sites.In our frequency compatibility report, we completed a UHF T-Band frequency search that included an analysis of the UHF T-Band channels licensed on the MERA system. Our research determined that the simulcast system described here could be supported from a licensing perspective. Our analysis in other reports completed for this project indicates that the proposed simulcast will work from a technical perspective.

Coverage Needs

In order to address the coverage concerns with the existing MERA system, AECOM has researched and found several sites that can be added into the MERA system to fill in the critical coverage gaps. The idea would be to begin the environmental impact, frequency licensing and planning to add the additional sites to the network. The sites selected for the UHF T-Band P25 Phase 2 system would be the same as those in the 700 MHz option discussed in Section 5.1. This design would also use the same four described in the 700 MHz design. These four sites, located at Pt Reye Coastal, Wolfback Ridge, Radar Tower and Martha help fill in the existing coverage gaps.

These site locations were selected to address some of the coverage concerns with the existing MERA system. Again our research has shown that sufficient UHF T-Band frequencies can be licensed to support this solution. In addition, our analysis in other reports completed for this project indicates that the proposed simulcast will work from a technical perspective.

Interoperability Needs

In order to address interoperability with 700 MHz, several options are available to the County. First, the County can utilize the 700 MHz conventional overlay that is begin planned as part of the State 700 MHz Interoperability Plan. The conventional overlay would utilize the at a minimum six sites in Marin County (Big Rock, Mt. Barnabe, Mt. Burdell, Mt. Tamalpais, San Pedro and Sonoma Mtn). These six sites would provide 700 MHz radio coverage along the main travel corridors where a majority of the population in the County is centered. These areas are the locations where outside agencies are most likely to assist Marin County in an incident. AECOM worked with the Marin County Project team to determine the areas where 700 MHz Overlay coverage was important and we selected sites to target these areas. It is important to realize that the goal of the interoperability overlay is not to provide 100% coverage throughout the entire County.

The 700 MHz conventional overlay will have three conventional 700 MHz channels at each site, one calling channel and two tactical channels. The calling channel will be monitored by dispatch and will be used to request tactical resources and as a command and control channel. The tactical channels will be used by emergency responders to meet the tactical communication needs at an incident. The conventional overlay will work like the existing State Mutual Aide channels, the Marin County VHF Overlay and the CLEMARS radio network. Many opportunities and technologies are available to provide audio connections between the conventional overlay and the upgraded MERA P25 Phase 2 system. The conventional overlay can also be used in conjunction with the 700 MHz State Interoperability plan that is being designed for the Bay Area. Details of the site selections and the channel allocations for the State Interoperability plan have not been fully developed, but they can be used in conjunction with the 700 MHz conventional overlay.

There would also be a need for command vehicles to be equipped with 700 MHz radios so that they would have direct communication with outside responders. In addition 700 MHz command radios could be used by Marin County when they are responding outside the County and assisting other counties that are using 700 MHz or 800 MHz trunked systems.

One additional interoperability alternative is for the County to implement the Inter RF Sub-System Interface (ISSI), which establishes interoperability across multiple P25 networks. After the County has migrated to a P25 Phase 2 UHF T-Band system, they can use the ISSI connection to interconnect with other P25 systems in the Bay Area. There are two significant challenges to implementing the ISSI solution however; first, the databases of the P25 systems must be synchronized so that radios defined on each system have unique identifiers. Second, since Marin County would be using UHF T-Band and other P25 systems would be using 700 MHz or 800 MHz, the only way the ISSI connection will work is if the emergency responder can affiliate with a radio tower in their own system. This means that if a user from Alameda or Contra Costa County were to respond in Marin County, they would need to be able to talk back through their system, through the ISSI connection, then into the MERA P25 system.

5.2.1 Major System Elements

Major elements of the final UHF T-Band P25 Phase 1 Simulcast system are:

11-site simulcast UHF T-Band P25 Phase 2 trunking system using existing MERA sites shown in Table 5-1. As a comparison, we have included the existing UHF T-Band sites in Table 5-2. .

Four Stand-Alone P25 Phase 2 4 channel Trunked sites to provide additional coverage in areas where the cost of a full scale site is not warranted or where a full scale site cannot be supported due to physical constraints.

The site selections will be upgraded to address coverage gaps and the eventual system design will utilize the sites shown in Table 5-1. These sites include the four sites to be further developed, Pt Reyes Coastal, Wolfback Ridge, Radar Tower and Martha, which were described in Section 5.1.

In addition, the system elements described in Section 5.1 also apply to this UHF P25 Phase 2 option, in other words, the UHF P25 Phase 2 system design is essentially the same as the 700 MHz P25 Phase 2 design; the primary difference being the frequency band. .

5.2.2 Channel Capacity Summary

We provide a detailed analysis of the channel summary requirements in Section 4 of this report. Based upon the radio projections for the next 15 years, AECOM estimates that to supply sufficient capacity for the existing and future MERA radio users the UHF T-Band P25 Phase 2 simulcast would need to include 11 P25 Phase 2 channels. User growth projections are based on user growth of 100 radios per year. Traffic loading analysis is discussed in Section 3.3.

5.2.3 Service Area and Site Selections

In our preliminary system design, the coverage area includes all areas within County boundaries. The system shall provide two-way radio coverage, base-to-mobile and mobile-to-mobile throughout the areas of the County that have been identified as needing coverage. We have relied upon the Marin County Project Team to determine the areas where coverage is required and the site selections and service area reflect their input.

5.2.4 Coverage Parameters

The basis of this coverage estimate is discussed in Section 5.1.5.

5.2.5 Coverage Estimates

The tower site parameters we used in our propagation analysis are listed in Table 5-2. The following steps were taken to complete the propagation analysis for Marin County:

- Marin County projected radio sites were located on a digitized map of the Marin County area.
- A coverage map was plotted for UHF T-Band from the existing MERA sites.
- A propagation analysis was run on the selected sites.
- The coverage map was validated by comparing to actual coverage measurements taken using RaCE^{SM}.
- The coverage contours were overlaid on a digital map of Marin County to determine which sites provided adequate coverage and which sites did not.

Coverage Maps

AECOM has developed coverage predictions in the UHF T-Band for our recommended selection of tower sites listed in Table 5-2. Map organization is as follows:

Map:	Area and type:
Figure 5-6	UHF Portable Outdoors – At the Hip
Figure 5-7	UHF Indoor Light Building
Figure 5-8	UHF Indoor Medium Building
Figure 5-9	UHF Indoor Heavy Building

5.2.6 Microwave Network

Marin County has an excellent microwave system implemented to interconnect the Land Mobile Radio sites within the County today, but we recommend increased capacity to be added to this existing network. Ethernet microwave radios will be required for network connectivity with modern P25 radios. We have provided some recommendations to further upgrade the network and tie in the new and upgraded radio sites. For the microwave ring, we recommend OC3 capacity. DS3 radios will be sufficient for the spurs. See Figure 5-5 for

our design. We recommend that the dispatch centers also utilize a fiber backup to the prime site as well for redundancy if possible. This telecommunications subsystem will provide the latest state-of-the-art technology and allow for expansion to accommodate future needs.

Table 5-1
Proposed Sites

Site Name	Lattitude	Longitude	Elevation (ft. AMSL)	Tower Height (ft, AGL)	Tx Antenna Height (ft, AGL)	ERP	Antenna Type	Site Type
Radar Tower*	37 49 13.31	-122 31 51.0	254	100	60	187W	Omni	Stand-Alone
Pt. Reyes Coastal*	37 59 47.7	-123 00 49.0	490	60	40	181W	Omni	Simulcast
Wolfback Ridge*	37 51 03.52	-122 29 54.36	1122	80	60	187W	Omni	Simulcast
Mt. Tomales*	38 15 39.74	-122 54 12.38	380	80	60	180W	Omni	Stand-Alone
Martha**	37 53 7.91	-122 27 00.96	630	60	35	185W	Omni	Stand-Alone
Big Rock	38 3 33.02	-122 36 15.31	1880	100	55	187 W	Omni	Simulcast
Dollar Hill	37 58 49.53	-122 31 45.3	593.9	60	25	188 W	Omni	Simulcast
Mt. Barnabe	38 1 36.12	-122 42 56.82	1358.3	73	70	180 W	Omni	Simulcast
Mt. Burdell	38 8 41.71	-122 35 38.52	1479.7	79	30	185 W	Omni	Simulcast
Mt. Tamalpais	37 55 39.63	-122 34 45.8	2372.2	60	50	166 W	Omni	Simulcast
Mt. Tiburon	37 53 25.7	-122 27 59.2	511	60	35	185 W	Omni	Simulcast
San Pedro	37 59 24.53	-122 30 0.8	1000.7	100	65	185 W	Omni	Simulcast
Sonoma Mt.	38 20 54.3	-122 34 41.33	2441.1	130	85	170 W	Omni	Simulcast
Stewart Point	37 55 47.1	-122 43 2.9	525	35	20	181 W	Omni	Stand-Alone
Pt. Reyes Hill	38 4 47.08	-122 52 4.98	1335.4	17	11.5	191 W	Omni	Simulcast

* - New MERA Site, but existing radio site
** - New MERA Site and no existing radio site

Table 5-2
Existing Sites for Simulcast Configuration

Site Name	Lattitude	Longitude	Elevation (ft. AMSL)	Tower Height (ft, AGL)	ERP	Antenna Type	Site Type
Big Rock	38 3 33.02	-122 36 15.31	1880	100	187 W	Omni	Simulcast
Dollar Hill	37 58 49.53	-122 31 45.3	593.9	60	188 W	Omni	Simulcast
Forbes Hill	37 58 44.73	-122 32 48.5	236	80	180 W	Omni	Simulcast
Mt. Barnabe	38 1 36.12	-122 42 56.82	1358.3	73	180 W	Omni	Simulcast
Mt. Burdell	38 8 41.71	-122 35 38.52	1479.7	91	185 W	Omni	Simulcast
Mt. Tamalpais	37 55 39.63	-122 34 45.8	2372.2	60	166 W	Omni	Simulcast
Mt. Tiburon	37 53 25.7	-122 27 59.2	511	60	185 W	Omni	Simulcast
San Pedro	37 59 24.53	-122 30 0.8	1000.7	100	185 W	Omni	Simulcast
Sonoma Mt.	38 20 54.3	-122 34 41.33	2441.1	190	170 W	Omni	Simulcast
Stewart Point	37 55 47.1	-122 43 2.9	525	60	181 W	Omni	Stand-Alone
Mill Valley City Hall	37 54 28.63	-122 32 50.8	92	60	180 W	Omni	Simulcast
Pt. Reyes Hill	38 4 47.08	-122 52 4.98	1335.4	15	191 W	Omni	Simulcast
*Bay Hill Rd**	*38 20 30.59*	*-123 1 12.87*	*721.8*	*110*	*181 W*	*Omni*	Stand-Alone

*The Bay Hill Road site will be moved to Mt. Tomales

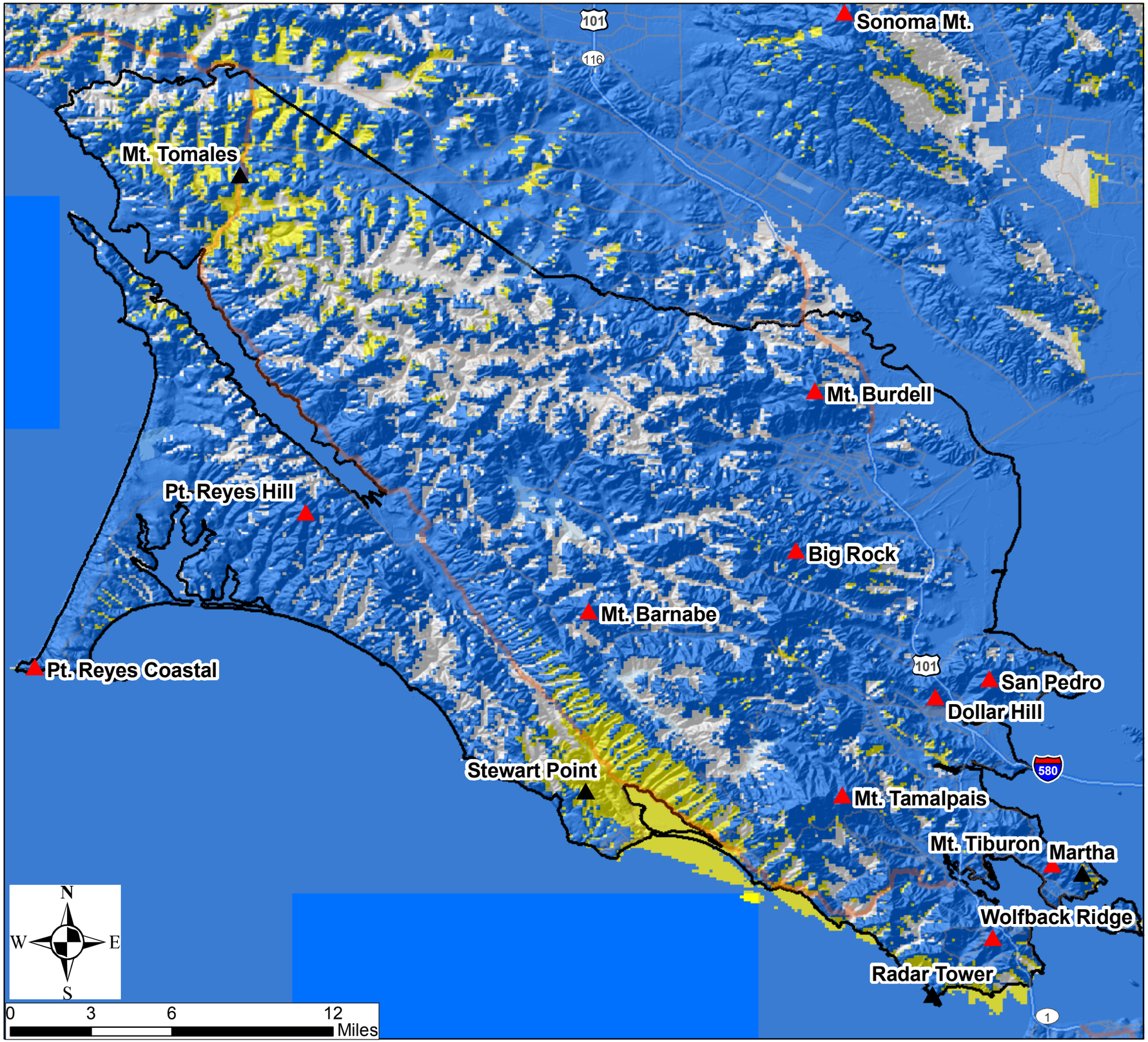

Figure 5-1
Predicted 700MHz Portable Outdoors Coverage With Proposed Sites

Client: Marin County

Commission No. 60140414

Predicted System Portable on Hip Outdoors Coverage Talkout (Base to Portable) with Proposed Sites

- ▲ Simulcast Sites
- ▲ Standalone Sites
- Simulcast Coverage
- Exclusive Standalone Coverage

Coverage displayed on this document is the result of predictive statistical modeling based upon client provided parameters, USGS geographical data. Actual coverage, as experienced by users in the field, may vary due to interference, multi-path fading, and other random effects.

Design: WNC 22 March 2010

Drawn: TRM 22 March 2010

Checked: DWA 27 April 2010

Approved: HWW 27 April 2010

File Name:

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Revised:
1) ADD MARTHA STANDALONE SITE - WNC - 22 APRIL 2010

AECOM

COMMUNICATIONS TECHNOLOGY BUILDING ENGINEERING
20715 TIMBERLAKE ROAD SUITE 106
LYNCHBURG, VIRGINIA 24502
(434)-239-9200 www.aecom.com

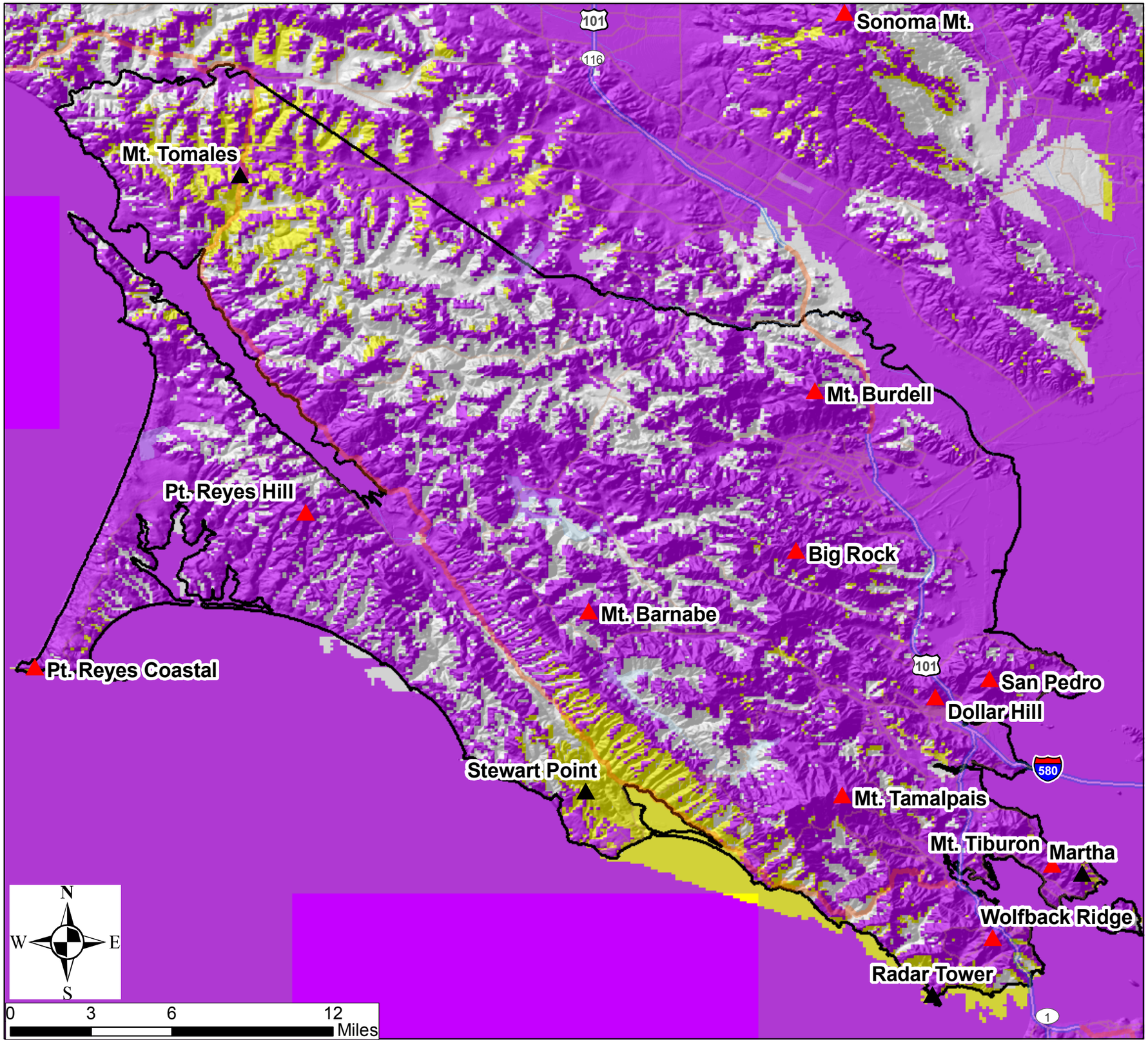

Figure 5-2
Predicted 700MHz Portable Light Building Coverage With Proposed Sites

Client: Marin County
Commission No. 60140414

Predicted System Portable Light Building Coverage Talkout (Base to Portable) with Proposed Sites

- Simulcast Sites
- Standalone Sites
- Simulcast Coverage
- Exclusive Standalone Coverage

Coverage displayed on this document is the result of predictive statistical modeling based upon client provided parameters, USGS geographical data. Actual coverage, as experienced by users in the field, may vary due to interference, multi-path fading, and other random effects.

Design: WNC 22 March 2010

Drawn: TRM 22 March 2010

Checked: DWA 27 April 2010

Approved: HWW 27 April 2010

File Name:
M:\Projects\Radio Projects\60140414_Marin County, CA\Task A.00 Engineering Studies\Technical Data\Coverage Analysis\Propagation Maps\Figure 5-2 Predicted 700MHz Portable Light Bldg Coverage With Proposed Sites.pdf

Revised:
1) ADD MARTHA STANDALONE SITE - WNC - 22 APRIL 2010

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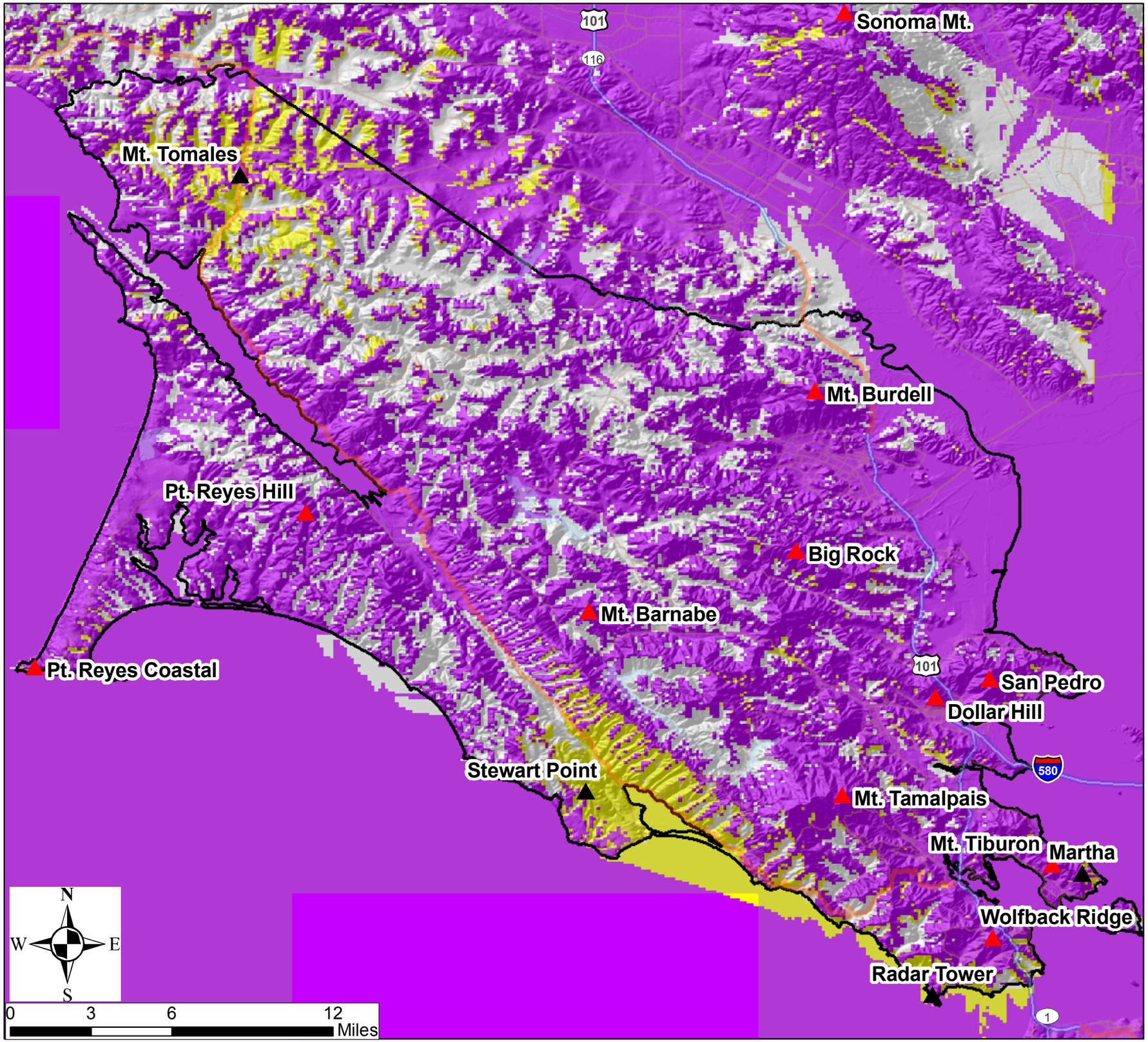

Figure 5-3 Predicted 700MHz Portable Medium Building Coverage With Proposed Sites

Client: Marin County

Commission No. 60140414

Predicted System Portable Medium Building Coverage Talkout (Base to Portable) with Proposed Sites

- Simulcast Sites
- Standalone Sites
- Simulcast Coverage
- Exclusive Standalone Coverage

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Design: WNC 22 March 2010

Drawn: TRM 22 March 2010

Checked: DWA 27 April 2010

Approved: HWW 27 April 2010

File Name:

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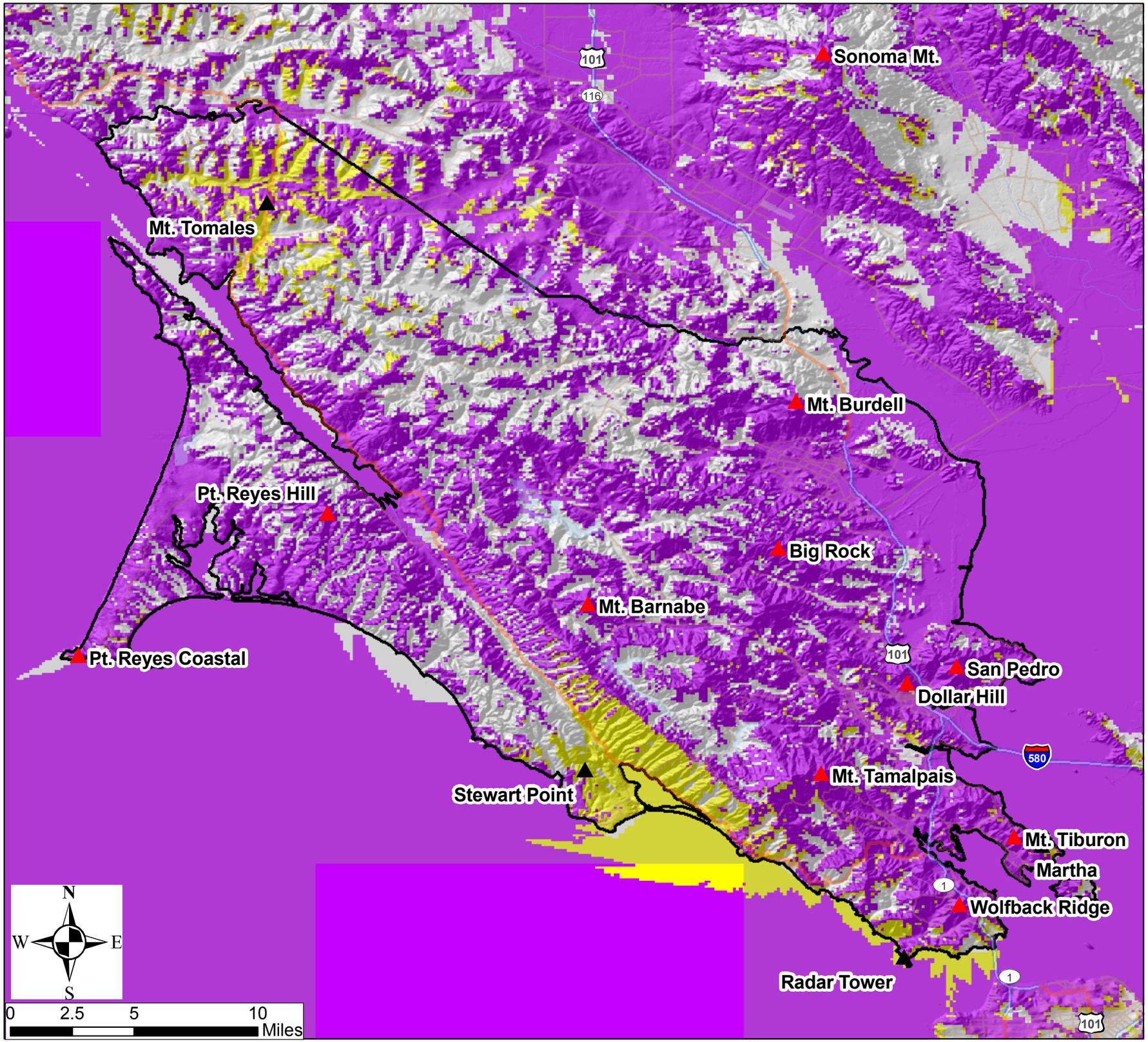

Figure 5-4
Predicted 700MHz Portable Heavy Building Coverage With Proposed Sites

Client: Marin County
Commission No. 60140414

Predicted System Portable
Heavy Building Coverage Talkout
(Base to Portable) with Proposed Sites

- Simulcast Sites
- Standalone Sites
- Simulcast Coverage
- Exclusive Standalone Coverage

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Design: WNC 22 March 2010

Drawn: TRM 22 March 2010

Checked: DWA 27 April 2010

Approved: HWW 27 April 2010

File Name:
M:\Projects\Radio Projects\60140414_Marin County, CA\Task A.00 Engineering Studies\Technical Data\Coverage Analysis\Propagation Maps\Figure 5-4 Predicted 700MHz Portable Heavy Bldg Coverage With Proposed Sites.pdf

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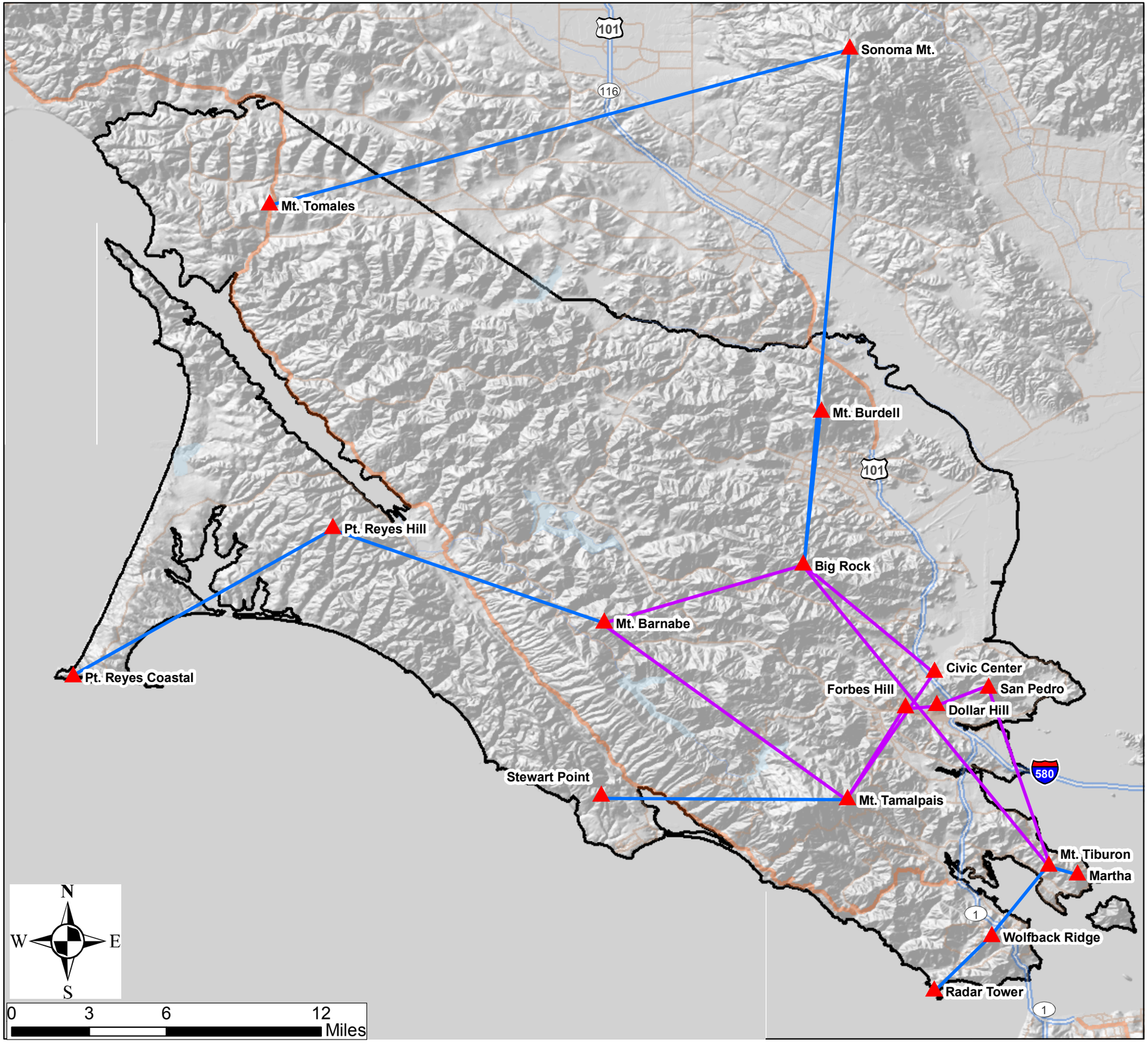

Figure 5-5 Microwave Connectivity Network

Client: Marin County

Commission No. 60140414

Microwave Connectivity

- Sites
- DS3
- OC3

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Design: WNC 22 March 2010

Drawn: TRM 22 March 2010

Checked: DWA 27 April 2010

Approved: HWW 27 April 2010

File Name:

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1. ADD MARTHA TO NETWORK - 22 APRIL 2010

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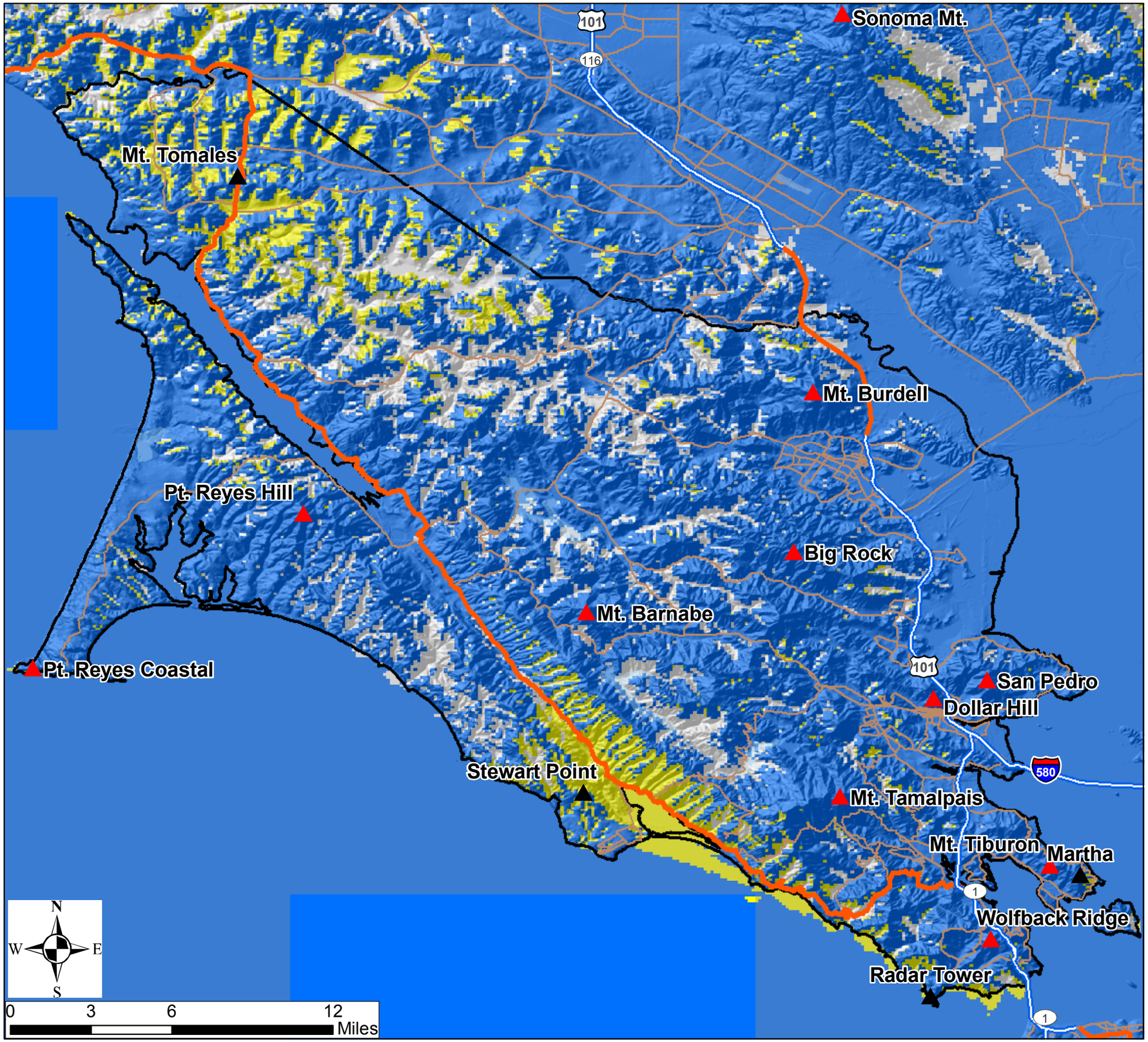

Figure 5-6
Predicted UHF Portable Coverage Using Proposed Sites

Client: Marin County

Commission No. 60140414

Predicted System Portable at the Hip Coverage Talkout (Base to Portable) Using Existing Sites

- Simulcast Sites
- Standalone Sites
- Simulcast Coverage
- Exclusive Standalone Coverage

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Design: WNC 21 APRIL 2010

Drawn: JWF 23 APRIL 2010

Checked: DWA 27 April 2010

Approved: HWW 27 April 2010

File Name:
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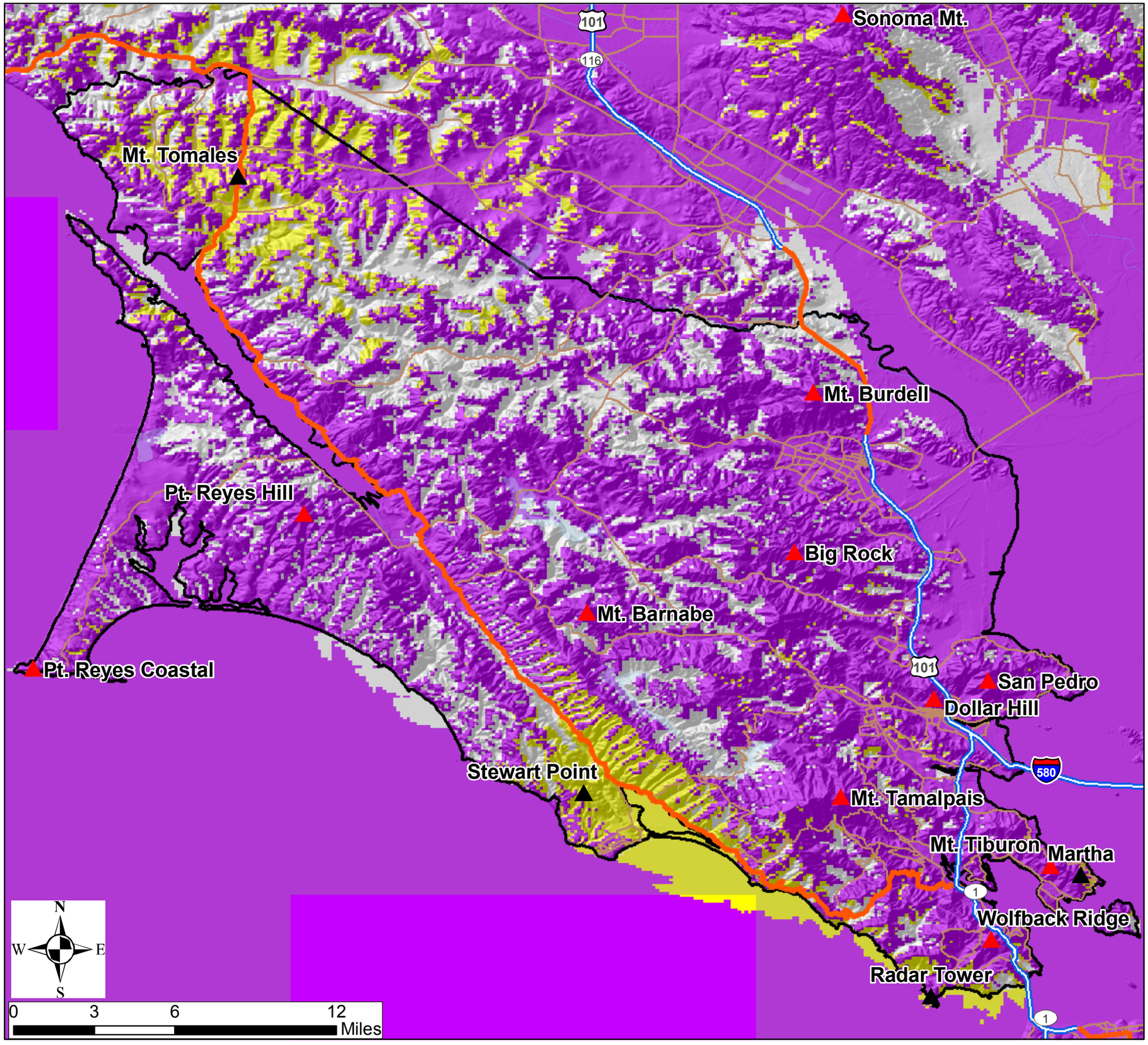

Figure 5-7 Predicted UHF Portable Light Building Coverage Using Proposed Sites

Client: Marin County

Commission No. 60140414

Predicted System Portable Light Building Coverage Talkout (Base to Portable) Using Existing Sites

- Simulcast Sites
- Standalone Sites
- Simulcast Coverage
- Exclusive Standalone Coverage

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Design: WNC 21 APRIL 2010

Drawn: JWF 24 APRIL 2010

Checked: DWA 27 April 2010

Approved: HWW 27 April 2010

File Name:
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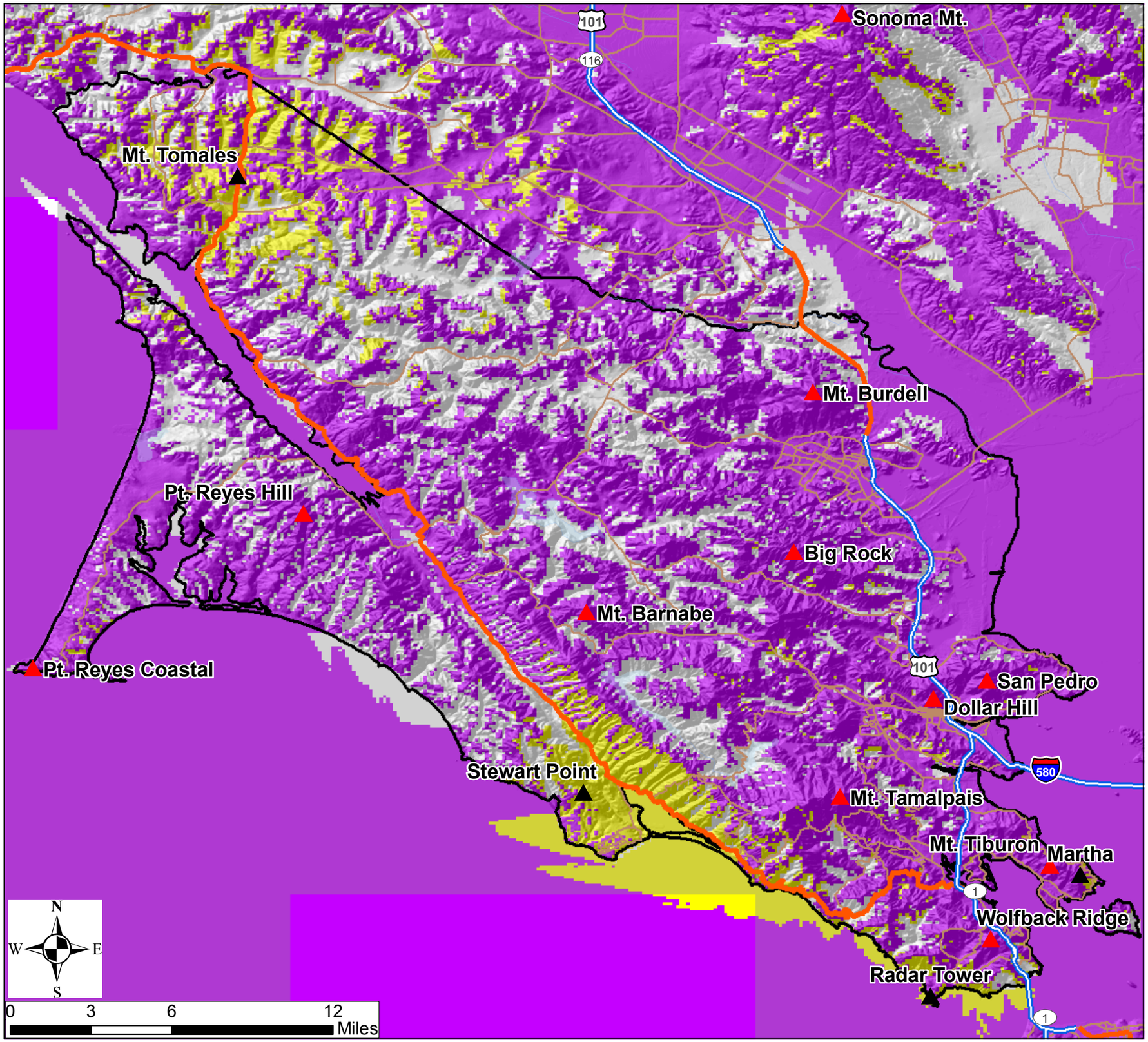

Figure 5-8 Predicted UHF Portable Medium Building Coverage Using Proposed Sites

Client: Marin County

Commission No. 60140414

Predicted System Portable Medium Building Coverage Talkout (Base to Portable) Using Existing Sites

- Simulcast Sites
- Standalone Sites
- Simulcast Coverage
- Exclusive Standalone Coverage

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Design: WNC 21 APRIL 2010

Drawn: JWF 24 APRIL 2010

Checked: DWA 27 April 2010

Approved: HWW 27 April 2010

File Name:
M:\Projects\Radio Projects\60140414_Marin County, CA\Task A.00 Engineering Studies\Technical Data\Coverage Analysis\Propagation Maps\Figure 5-8 Predicted UHF Portable Medium Bldg Coverage Using Proposed Sites.pdf

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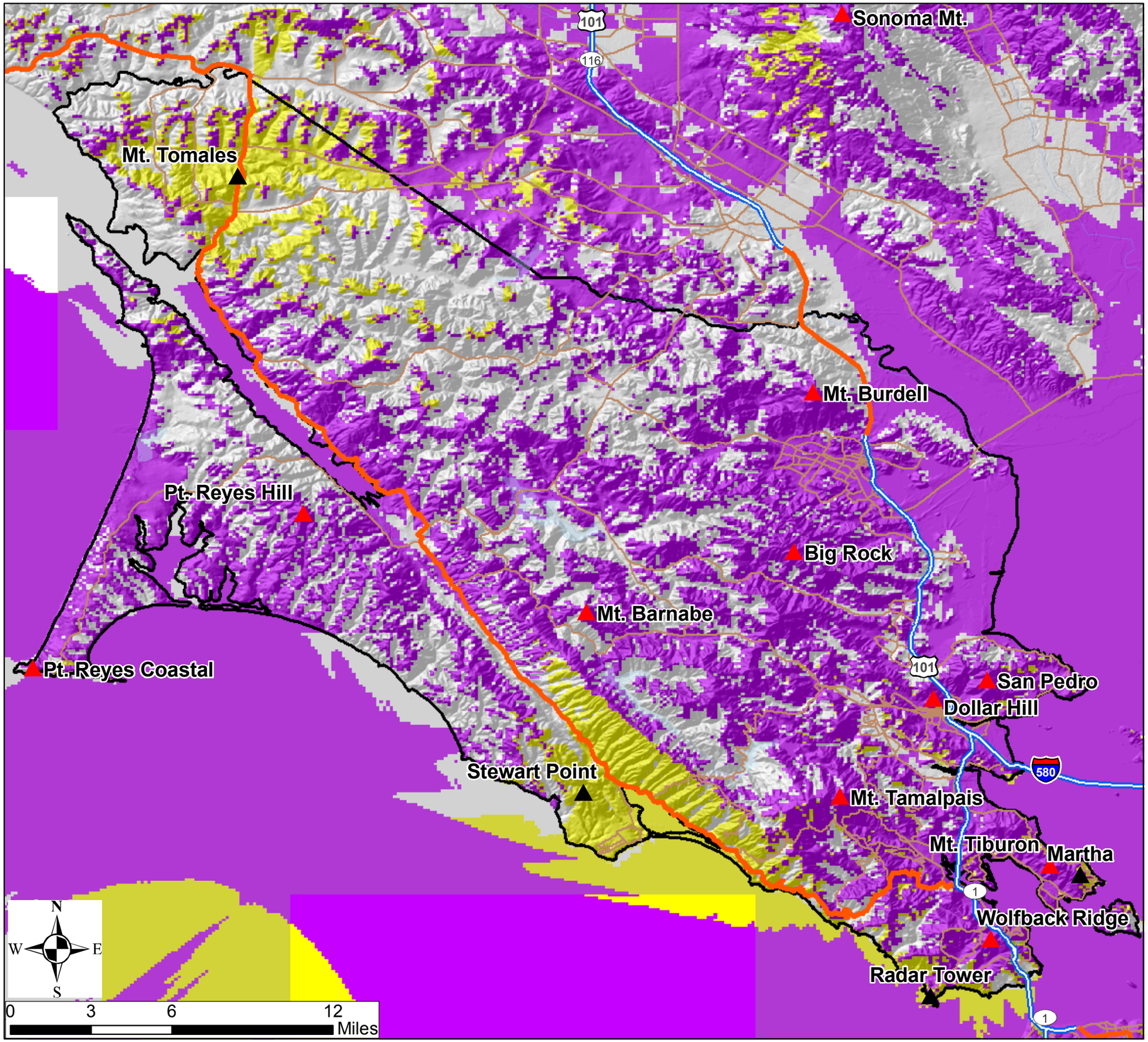

Figure 5-9 Predicted UHF Portable Heavy Building Coverage Using Proposed Sites

Client: Marin County

Commission No. 60140414

Predicted System Portable Heavy Building Coverage Talkout (Base to Portable) Using Existing Sites

- Simulcast Sites
- Standalone Sites
- Simulcast Coverage
- Exclusive Standalone Coverage

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Design: WNC 21 APRIL 2010

Drawn: JWF 24 APRIL 2010

Checked: DWA 27 April 2010

Approved: HWW 27 April 2010

File Name:
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6.0 Implementation Plans

This section provides detailed migration plans for each of the two viable selected system designs. The migration plan includes the procurement method and an implementation schedule. We clearly outline a migration path for MERA agencies and the system upgrades that must be included. The implementation plan takes into consideration operational concerns and the need to ensure that uninterrupted voice radio service is provided during the transition.

AECOM has overseen the procurement and implementation of numerous communications projects. Some clients desire a hands-off approach where the project is under control of the Land Mobile Radio (LMR) vendor to deliver a turnkey radio system. Other clients prefer to expend the effort to manage the process, perhaps manage several vendors, and in the process, receive the radio system they wanted at significantly reduced cost. We believe that Marin County fits in the latter category, and with AECOM's help, can construct the recommended radio system in an affordable manner. The experience and expertise of a qualified communication consultant, like AECOM, can lead to significant cost savings and can dramatically improve the functionality and effectiveness of the system installed by the vendor.

Either of the two system designs presented here will meet the long term needs of the County. Ultimately, the choice will be determined based on operational feasibility, practical implementation limitations and cost. Our intent is that the implementation plans discussed here will assist the County in making this important decision. In Section 7, we provide an opinion of probable costs for each system design.

6.1 Critical Implementation Aspects

We have provided a summary of several important “critical implementation” aspects that should be considered during the implementation and procurement process. A majority of the recommendations in this section are “best practices” that we have developed as part of our process. Each of the following points applied to either of the system designs should be considered as the County implements either solution. Throughout this section, you will see our recommendations and we will highlight some of the value added by having an experienced consultant involved in the implementation process.

Preliminary System Design

The 700 MHz P25 Phase 2 system or the UHF T-Band P25 Phase 2 system described in Section 5 of this report are both viable preliminary system designs. AECOM has developed each of these system designs to validate the feasibility of a countywide simulcast and to provide site selection, connectivity and capacity recommendations based on our LMR radio system development experience. During the RFP process, the County should expect each vendor to provide their own solution and each vendor may make recommendations that differ from the System Design presented in this report. We encourage the County to use our system design as a baseline and any changes recommended by the vendor should be validated using the Marin County Project Team.

RFP Specification Writing

AECOM has developed dozens of RFP specifications and we can, upon request, assist the County with this process. AECOM can develop the technical specifications portion of the procurement documentation for either radio system design. State-of-the-art integrated wide-area radio systems are complex, and by necessity unique to each situation. Our functional/operational approach to specifications allow system proposers the latitude to design around their own proprietary configurations, while retaining the essential attributes and operational characteristics developed specifically for Marin County consistent with the County’s overall telecommunications plan. Our process includes physical facilities requirements, evaluation criteria, draft specifications, vendor review process and the final specifications. We would encourage the County to ensure that these critical components are part of the specification process, regardless of who the County uses to develop the RFP Specification.

Radio Site EIS / EIR, Access and Development

Appendix C contains a summary of the EIS / EIR considerations for Marin County. We understand the unique circumstances and history of the existing MERA system implementation / approval process and we have provided sufficient detail to help the County account for the EIS / EIR considerations of either radio system design.

Dispatch Center Development

None of the existing consoles and dispatch center equipment is compatible with a P25 Phase 2radio system. We have included the cost and timeline to upgrade these facilities. A detailed dispatch center assessment was not part of the scope of work for this project; however AECOM is able to assist the County in planning for this type of upgrade. We have decades of experience in helping agencies upgrade their dispatch centers.

Procurement and Negotiations

The Procurement Phase entails the period beginning with the issuance of the system specifications, and concludes with the signing of the contract between Marin County / MERA and the system supplier. The procurement process will have been defined prior to issuing the procurement documentation, and should be carefully and strictly followed in order to mitigate the risk of vendor protest. AECOM's process includes responding to vendor questions, an evaluation process that mitigates the risk of protest by unsuccessful vendor(s), a detailed technical evaluation of proposals received, a price evaluation of each proposal received, and an evaluation report. Finally, we will work with Marin County in the negotiation process for the selected vendor. Each of these components is critical in order for the contract to meets the needs of the County.

System Acceptance Testing

We recommend that actual test procedures be developed mutually between the selected vendor and Marin County. AECOM's process includes a thorough review and approval process for the test procedures that are aligned with the test plan requirements established in the Final Specifications. System testing procedures should be included in the Detailed Design Review and formal testing should be part of Staging and will continue in the field with complementary site and system tests that exercise and demonstrate all critical functions and properties of the Implemented System. We recommend that the County (or their representative) monitor and provide general oversight for acceptance testing, which will address four systems test areas: Coverage, Fixed Infrastructure, Interference, and Telecommunications Subsystem. It is essential that the infrastructure system tests be critically observed and that the County requires that the selected vendor to spot check specific equipment tests to establish consistency with tests done previously in the factory or the shop.

System Acceptance

The Acceptance Phase entails the period beginning with the system staging tests, including inspection of the installation at each site, and concludes with the acceptance of the project after cutover. The goal is that System Acceptance Tests demonstrate the initial Systems Attributes developed at the beginning of the project. System Acceptance will include staging tests, facility and infrastructure inspections, acceptance tests, thirty-day operational tests, a review of training plan, review of as-built drawings, and the reporting process.

Training

Training should include at least three distinct areas: Field user Training, Dispatcher / Operator Training, Administration Training, and Maintenance Training. The Field User Training should focus on making sure every radio user is trained on the proper use of the radio. Although digital P25 trunked radios are not overly complex, they may be slightly "different" from the existing MERA system, and offer many new features to the users. Training for field radio users should utilize a train-the-trainer approach. Trainers from each agency would attend this training and then the agency trainers will train all their personnel on all shifts. These trainers will then train new personnel as they are added, as well as provide refresher training.

Dispatcher Training: It is also important that dispatchers receive training on the new radio system. Formal user training for dispatchers will make the users knowledgeable and comfortable with their communications tools. Since new consoles will be utilized on the new radio system, dispatchers will need to be trained on the new features and

functionality, as well as on the new radio system itself. Also, if the dispatch centers are connected to the microwave system, they will need to learn the operation of a backup radio.

Vendor-provided training allows questions to be fully answered and explained, and can provide for a more thorough initial training. When every dispatcher receives training from the vendor, a thorough foundation is established for the dispatch operations. Subsequent dispatcher training for new personnel or for refresher training is then accomplished through agency-provided train-the-trainer. It is recommended that every dispatcher receive operator training. Operator training is conducted on-site on the agency's consoles. There should be two to three people per available console used for training. At a minimum, there should be three to four training sessions to accommodate all shifts and people's work schedules.

Administration Training: Administration and management of a P25 radio system is complex. A successful implementation of the radio system will require careful planning of operations at all levels. Radio System Administration Training is very important for the successful implementation of the system. It provides the administrators with the knowledge necessary for planning the operations of the system, as well as the knowledge of how to use the tools required for implementation, such as the database computers and radio programming. Since system-wide planning is important, Administration Training should be early in the implementation schedule. This allows the administrators to appropriately plan for the system as it is being built. It is recommended that this course be held at the factory where all the features and functionality can be demonstrated on a fully-functional system, since their own system may not be implemented. While travel expenses will be incurred, this expense is offset by having a satisfactory training experience. Furthermore, we recommend that robust System Administrator software be included in the RFP Specification.

Maintenance Training: Since the components of the P25 system will be very similar to the existing MERA trunked radio system, the maintenance training should focus on filling in the gaps and differences with the new system. Clearly, the benefits of a preventative maintenance program will be essential to keep the new system running dependably. Radio system maintenance courses can be two weeks in length for overall systems maintenance, with base station and mobile / portable maintenance course being typically one week.

System Migration

During the Implementation process, it is important to understand that the existing MERA system must remain active and fully functional through the process. In an earlier report, we highlighted the challenge this would present on the existing facilities. Since the existing MERA system will have to remain in place and operational during the build-out of the 700 MHz system, all sites must be capable, and have the physical space, to support UHF T-Band equipment for the existing system **and** for 700 MHz equipment for the new system. In addition, the microwave backbone and dispatch centers must support both systems simultaneously, as well. It will be important that the RFP Specification address this need.

In addition, the upgrade to UHF T-Band P25 Simulcast will also require additional equipment and antennas be installed in some shelters and on some of the existing towers. It will be important that the physical constraints at each site are considered. If it is determined that the sites and / or towers do not have the physical space for equipment to support both systems during the cutover, then the County will have to work with the selected vendor in developing a solution that will address this critical need. In addition, some of the dispatch centers may not have the physical space to accommodate both systems during the cutover. Detailed site surveys and dispatch surveys were beyond the scope of this project, but should be conducted if the County decides to move forward with either radio system design discussed in this report.

6.2 700 MHz P25 Phase 2 Option

This section provides a comprehensive migration plan for a countywide 700 MHz P25 Phase 2 standard-based digital trunking system. The 700 MHz P25 Phase 2 system option is described in detail in Section 5.1 of this report. As we begin to discuss the implementation process, it is important to understand some of the procurement implementations offered by P25. The P25 standard is a long awaited breakthrough because it introduces competition in the radio

marketplace. With P25 it is possible to use one vendor for your infrastructure and another vendor for your user radios. Multiple vendors introduce competition into the procurement process and can ultimately drive your cost down, even if you ultimately decide to purchase from a single vendor. The industry is in its infancy regarding feature-rich trunked radios capable of working on other-brand infrastructure. We recommend carefully crafted procurement specifications to maximize the benefits and minimize surprises or disappointments.

6.2.1 700 MHz Implementation Process

Prior to the start of the implementation process, several pre-planning steps must be completed. This radio project was one of those critical steps and identified two viable options that will meet the long term needs of the County. However, the County and MERA must now choose which option will be implemented. Following this choice, other important steps must be taken.

First, the County must validate the radio inventory and verify the number of radios in the existing system. Some agencies may have a desire to add more radios to the system, but have not made this need known. The number of radios on the system will directly impact the channel allocations of the radio system. Next, the County should assess each site and each dispatch center and determine if they are able to support the existing MERA system and also able to provide the physical space needed to implement the 700 MHz radio system. If physical space is not available, a determination should be made if the lack of space can be overcome by a cost effective solution. Finally, the Preliminary EIR and EIS considerations should be factored into the timeline and any concerns should be addressed immediately. We have not included these pre-planning steps in our schedule so that the schedule could be focused on the critical radio system implementation steps.

From a high level, we suggest thinking of the project in terms of four elements that must come together: 1) the LMR infrastructure, 2) facilities work for tower sites and dispatch locations, 3) the microwave backbone, and 4) subscriber equipment. The P25 standard allows us to break out the radio equipment/portion separately. The County could issue contracts for each of these elements independently using negotiated or competitive procurements for each. In practice, the procurement process would result in two RFP cycles. In the first cycle two RFP's are issued, one for the LMR infrastructure and the other for subscriber gear. The infrastructure RFP contains potential sites and coverage goals and yields proposals for coverage based upon an actual design. During the Detailed Design Review (DDR) with the contracted LMR infrastructure vendor, tower sites become finalized.

At this point, procurement of the microwave backbone and facilities/tower work can proceed. Of course the Environmental Impact considerations must be considered at this point, which is summarized in Appendix C. With the coverage design (and sites) now settled, AECOM's specifications for microwave and facilities may be finalized and issued. The microwave vendor is selected and final site feasibility is determined with completed path surveys. Once the microwave design review is complete, the microwave vendor may begin building equipment. With all site details confirmed, the selected facilities contractor(s) may start on the site, shelter and tower work. In this timeframe, the LMR vendor can be approved to begin building the infrastructure. While the facilities work is in progress, LMR infrastructure staging tests may be executed.

LMR staging is also the best time to finalize subscriber gear selection. We recommend a carefully written and executed test plan under which P25 equipment samples from all potential vendors are subjected to side-by-side comparisons for functionality and performance.

Once the shelters are ready, the microwave equipment has been staged, and LMR equipment has been built, the County can receive these shipments directly at the sites and authorize installation.

After the microwave system has been installed, optimized, and demonstrated, LMR testing can proceed. All functional testing which could not be completed at staging is finished at this time. Finally, the finished system is subjected to a carefully planned and executed coverage test (preferably done with foliage on the trees in

the summer) and the system is ready for a 30 day burn-in cycle. During this time, cutover plans can be finalized, the radio programming fleetmap finalized, and training/documentation, and vendor punchlists can be completed. The system is then ready for cutover and final acceptance.

6.2.2 700 MHz Implementation Schedule

AECOM has developed this implementation schedule based on several key factors:

1. The schedule assists in that there is not a disruption of radio service for existing MERA radio users.
2. The schedule points out important considerations that must be addressed if the schedule is to stay on track.
3. We have assumed that for the purpose of scheduling that funding is available.
4. We have assumed a start date of January 3, 2011. This start date allows time for MERA and the County Board to select a desired alternative and to identify a funding source. This start date can be adjusted and we have included an estimate of the months to complete each task / milestone.
5. Any schedule is subject to review and will ultimately be determined by the County working with the selected vendor. The schedule provided here is intended to assist the County in the planning process.

Figure 6-1 illustrates the project schedule for implementing a 700 MHz P25 Phase 2 system. The schedule is based on our experience with similar projects of this scope. Again, the implementation schedule is based upon a "notice to proceed" date of January 3, 2011 for the development of the specifications which can be adjusted based on the specific procurement process of the County. The schedule generally applies to the entire system, and should be tailored for any specific additions or reductions in requirements. The radio contractor will develop as part of his proposal a detailed construction and implementation schedule. The entire project will take approximately 45 months, from the start of Functional Specification development until Final System Acceptance. A start date of January 2011 would lead to an estimated completion date of September 2014.

We would expect the 700 MHz Licensing Process to take up to 11 months. The specification and proposal evaluation for the Radio System, Microwave System and Physical Facilities would overlap, but each would be a separate Request for Proposal (RFP) process. We recommend that the procurement process be carefully planned and follow the schedule shown in Figure 6-1. Keep in mind that there are several pre-planning steps that must be taken prior to beginning the implementation process. We have outlined these in Section 6.2.1.

6.3 UHF T-Band P25 Phase 2 Option

The second viable option for Marin County is to upgrade the existing MERA UHF T-Band system to a P25 Phase 2 simulcast system. This section provides a comprehensive migration plan for a countywide UHF T-Band P25 Phase 2 standard-based digital trunking system. The UHF T-Band P25 Phase 2 system option is described in detail in Section 5.2 of this report. As we begin to discuss the implementation process, it is important to understand that there are some unique distinctions between upgrading to a UHF P25 system and implementing the 700 MHz Option discussed in Section 6.2.

First, this option is an upgrade to the existing UHF T-Band MERA SmartZone 3.0 system. Any radios purchased must be backward compatible with the MERA system, and will by necessity mean that the County will continue to purchase Motorola subscriber units. Although the P25 standard does introduce competition in the radio marketplace, the backward compatibility with the existing MERA system limits the Counties user radio choices. It will be important to negotiate with the vendor so that competitive pricing is put in place for all purchases.

The infrastructure upgrades will also follow a similar pattern. Since the existing system will remain active as each site is upgraded, the County will have to ensure that system infrastructure (the fixed equipment at each radio site) is backward compatible with a Motorola SmartZone 3.0 system. We see the possibility to reuse some of the existing

combiners, antenna systems, and other components, but we have not factored these into our costing our into our implementation plan since we did not conduct site surveys.

6.3.1 UHF Implementation Process

The migration from a SmartZone 3.0 system to a P25 Phase 2 system can be accomplished in phases. Below, each major phase is described along with some of the key considerations for each step. Many of the phases listed below are similar to those discussed with the 700 MHz Implementation discussed in Section 6.2. Keep in mind that the time allocated for each phase is an estimate for planning purposes and that they may need to be adjusted based on the RFP Specification process. We also have included an implementation schedule, shown in Figure 6.2 that corresponds to the descriptions outlined below.

Prior to the start of the implementation process, several pre-planning steps must be completed. Each of these preplanning steps is described below.

Preplanning Step 1: Choosing an Option

This radio project focused on developing viable options two viable options that will meet the long term needs of the County. The County and MERA must now choose which option will be implemented.

Preplanning Step 2: UHF T-Band Licensing

Starting with the County's current channels, AECOM searched for the "best" channels that could be used in a single simulcast configuration. By "best" channel, we mean the channels with the least number of potential co-channel and adjacent channel interference. Our analysis found 18 channels that can be licensed in a countywide UHF T-Band simulcast, which will support the MERA system users for the next 15 years, plus a 20% increase for additional emergency responders. While we completed the initial engineering effort to license these channels in a simulcast configuration, the licensing process must be completed. We recommend that the County begin the licensing process of the channels allocated in Table 3-2 soon so that the frequency licenses can be secured for a UHF simulcast design. Keep in mind that we list 18 channels that may be licensed as a simulcast, but only 11 of these are needed for a P25 Phase 2 solution. The remaining 7 channels can be used to support interoperability, future growth and fire station alerting needs.

Preplanning Step 3: Validate Radio Inventory (count and model)

Next, the County must validate the radio inventory and verify the number of radios in the existing system. Some agencies may have a desire to add more radios to the system, but have not made this need known. The number of radios on the system will directly impact the channel allocations of the radio system. Every subscriber unit must be replaced with subscriber units that are P25 Phase 2 compliant (ready for P25 Phase 2 use when purchased, avoiding a software upgrade fee). Any units replaced in the current MERA system, should be replaced with P25 Phase 2 subscriber units. AECOM contacted Motorola and they are scheduled to begin delivering UHF T-Band P25 Phase 2 compliant subscriber units in the late summer of 2010.

Preplanning Step 4: Conduct Site / Dispatch Surveys

Next, the County should assess each site and each dispatch center and determine if they are able to support the existing MERA system and also able to provide the physical space needed to implement the upgrade to a UHF P25 Phase 2 Simulcast radio system. If physical space is not available, a determination should be made if the lack of space can be overcome by a cost effective solution.

Preplanning Step 5: Preliminary EIR / EIS considerations

The Preliminary EIR and EIS considerations should be factored into the timeline and any concerns should be addressed immediately. Appendix C of this report includes some of the important EIR / EIS considerations.

After the preplanning steps are completed, the County can move forward with the radio system implementation. We have broken the implementation project into four phases that must come together: 1) the Radio infrastructure, 2) the microwave backbone, 3) facilities work for tower sites and dispatch locations, and

4) system implementation and acceptance. Each of these phases is described below and the timeline for each is shown in Figure 6-2.

Phase 1: Radio System

Each of the first three phases has 2 essential components, the RFP / Specification Process and the System procurement process. The tendency might be to avoid a formal RFP Specification, since this is simply an upgrade to an existing system; however, we recommend that the technical specifications portion of the procurement documentation be developed for the UHF T-Band radio system design. The specification process should include a detailed specification for the Radio System, the Microwave and the Physical Facilities and will be used in each of these phases. The process should include site facilities requirements, evaluation criteria, draft specifications, vendor review process and the final specifications. We would encourage the County to make sure that these critical components are part of the specification process, regardless of who the County uses to develop the RFP Specification.

The Radio system phase will end with the Procurement Process and entails the period beginning with the issuance of the system specifications, and concludes with the signing of the contract between Marin County / MERA and the system supplier. The procurement process will have been defined prior to issuing the procurement documentation, and should be carefully and strictly followed in order to mitigate the risk of vendor protest.

Phase 2: Microwave

This phase will also have 2 essential components, the RFP / Specification Process and the System procurement process. The Specification, site selection and other details should be updated based on the system design of the selected vendor. The phase will conclude with the Microwave Procurement process.

Phase 3: Physical Facilities RFP / Specification

Our UHF P25 Phase 2 design uses the same sites as the existing MERA system. Significant upgrades may not be needed; however, the Physical Facilities RFP / Specification should be updated to reflect any changes introduced by the Final Radio System Design, and the Final Microwave System Design. The phase will conclude with the Physical Facilities Procurement process.

Phase 4: System Implementation and Acceptance

The System Implementation will include actual test procedures that validate the system design and that are developed mutually between the selected vendor and Marin County. System testing procedures should be included in the Detailed Design Review and formal testing should be part of Staging and will continue in the field with complementary site and system tests that exercise and demonstrate all critical functions and properties of the Implemented System. We recommend that the County (or their representative) monitor and provide general oversight for acceptance testing, which will address four systems test areas: Coverage, Fixed Infrastructure, Interference, and Telecommunications Subsystem. Each of these test areas are used to validate the System Implementation.

This phase will end with the final system tests, including inspection of the installation at each site, and the acceptance of the project after cutover. The goal is for System Acceptance Tests to demonstrate the initial Systems Attributes developed at the beginning of the project. System Acceptance will include staging tests, facility and infrastructure inspections, acceptance tests, thirty-day operational tests, a review of training plan, review as-built drawings, and the reporting process.

Figure 6-1
700MHz P 25 Implementation Schedule

ID	Task Name	Resource Names	Duration	Start	Finish
0	**AECOM Project Work Plan**		**971.01 days**	**Mon 1/3/11**	**Tue 9/23/14**
1	Notice to Proceed	Marin	1 day	Mon 1/3/11	Mon 1/3/11
2	Specification Initialization Letter	AECOM	1 day	Tue 1/4/11	Tue 1/4/11
3	**Licensing**		**270 days**	**Wed 1/5/11**	**Tue 1/17/12**
4	License Application Preparation	AECOM	30 days	Wed 1/5/11	Tue 2/15/11
5	License Approval	FCC	240 days	Wed 2/16/11	Tue 1/17/12
6	**Radio**		**286 days**	**Wed 1/5/11**	**Wed 2/8/12**
7	**Phase 2 Specifications**		**109 days**	**Wed 1/5/11**	**Mon 6/6/11**
8	**Draft Radio Specification**		**103 days**	**Wed 1/5/11**	**Fri 5/27/11**
9	Rough-Out Meeting	Meeting	1 day	Wed 1/5/11	Wed 1/5/11
10	Equipment Specifications	AECOM,Marin	29 days	Wed 1/5/11	Mon 2/14/11
11	Propagation Finalization	AECOM	10 days	Thu 1/6/11	Wed 1/19/11
12	Sample Terms & Conditions	AECOM	3 days	Thu 1/13/11	Mon 1/17/11
13	Terms & Conditions	Marin	46 days	Tue 1/18/11	Tue 3/22/11
14	Final System Design	AECOM	10 days	Thu 1/20/11	Wed 2/2/11
15	Evaluation Criteria	AECOM	5 days	Wed 3/23/11	Tue 3/29/11
16	Non-Fixed Equipment Finalization	Marin	20 days	Wed 2/2/11	Tue 3/1/11
17	Vendor Pre-Qualifications	AECOM	8 days	Thu 2/24/11	Mon 3/7/11
18	System Service Specifications	AECOM	39 days	Wed 2/2/11	Mon 3/28/11
19	Cost Sheet Preparation	AECOM	20 days	Tue 3/1/11	Mon 3/28/11
20	Radio Draft Assembly	AECOM	2 days	Wed 3/30/11	Thu 3/31/11
21	Vendor Invitation Letter	Marin	11 days	Tue 3/8/11	Tue 3/22/11
22	Radio PM Review	AECOM	3 days	Fri 4/1/11	Tue 4/5/11
23	Radio Technical Edit	AECOM	5 days	Wed 4/6/11	Tue 4/12/11
24	Radio - Finalize Draft Specifications	AECOM	20 days	Wed 4/13/11	Tue 5/10/11
25	Radio - Publish Draft Specifications	AECOM	3 days	Wed 5/11/11	Fri 5/13/11
26	Radio - Proposer Review	Proposer	10 days	Mon 5/16/11	Fri 5/27/11
27	Radio - Client Review / Approval	Marin	10 days	Mon 5/16/11	Fri 5/27/11
28	**Final Specifications**		**6 days**	**Mon 5/30/11**	**Mon 6/6/11**
29	Radio - Finalize Document	AECOM	3 days	Mon 5/30/11	Wed 6/1/11
30	Radio - Publish Final Specifications	AECOM	2 days	Thu 6/2/11	Fri 6/3/11
31	Release Radio RFP	Marin	1 day	Mon 6/6/11	Mon 6/6/11
32	End Phase 2A Radio		0 days	Mon 6/6/11	Mon 6/6/11
33	**Phase 3 Procurement**		**177 days**	**Tue 6/7/11**	**Wed 2/8/12**
34	Radio - Procurement Initialization Letter	AECOM	2 days	Tue 6/7/11	Wed 6/8/11

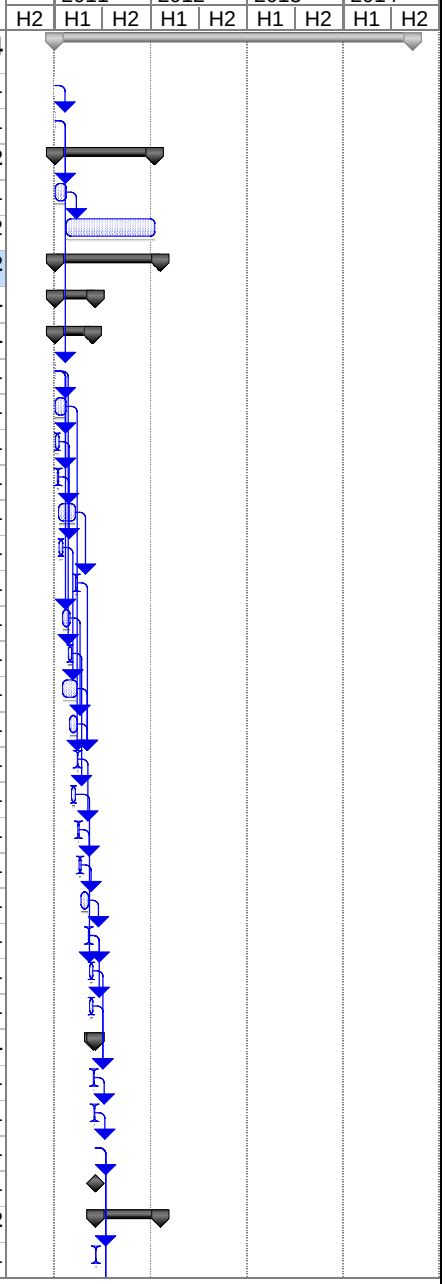


Figure 6-1
700MHz P 25 Implementation Schedule

ID	Task Name	Resource Names	Duration	Start	Finish
35	Proposal Preparation	Proposer	34 days	Tue 6/7/11	Fri 7/22/11
36	Pre-Proposal Conference	AECOM	4 days	Tue 6/21/11	Fri 6/24/11
37	Addenda	AECOM	9 days	Mon 6/27/11	Thu 7/7/11
38	**Technical Evaluation**		**36 days**	**Mon 7/25/11**	**Mon 9/12/11**
39	Technical Proposal Opening	Marin	1 day	Mon 7/25/11	Mon 7/25/11
40	First Pass Evaluation	AECOM/Marin	15 days	Tue 7/26/11	Mon 8/15/11
41	Request Clarifications	AECOM	5 days	Tue 8/16/11	Mon 8/22/11
42	Clarification Response	Proposer	5 days	Tue 8/23/11	Mon 8/29/11
43	Final Technical Evaluation	AECOM/Marin	5 days	Tue 8/30/11	Mon 9/5/11
44	Evaluation Team Meeting	Meeting	5 days	Tue 9/6/11	Mon 9/12/11
45	Proposer Presentation	Proposer	5 days	Tue 9/6/11	Mon 9/12/11
46	**Cost Evaluation**		**6 days**	**Tue 9/13/11**	**Tue 9/20/11**
47	Cost Proposal Opening	Marin	1 day	Tue 9/13/11	Tue 9/13/11
48	Cost Evaluation	AECOM/Marin	5 days	Wed 9/14/11	Tue 9/20/11
49	Recommendations	AECOM	10 days	Wed 9/21/11	Tue 10/4/11
50	Executive Presentation	Meeting	1 day	Wed 10/5/11	Wed 10/5/11
51	Negotiations	Marin	45 days	Thu 10/6/11	Wed 12/7/11
52	Approve Contract	Marin	6 days	Thu 12/8/11	Wed 2/8/12
53	Contract Sign	Marin	6 days	Thu 12/8/11	Tue 2/7/12
54	End Phase 3A Radio		1 day	Wed 2/8/12	Wed 2/8/12
55	**Microwave**		**327.01 days**	**Tue 6/7/11**	**Thu 9/6/12**
56	**Phase 2 - Specifications**		**250.01 days**	**Tue 6/7/11**	**Tue 5/22/12**
57	**Draft Specifications**		**81 days**	**Tue 6/7/11**	**Tue 9/27/11**
58	Microwave Specification	AECOM	53 days	Tue 6/7/11	Thu 8/18/11
59	MW Draft Assembly	AECOM	2 days	Fri 8/19/11	Mon 8/22/11
60	MW - PM Review	AECOM	3 days	Tue 8/23/11	Thu 8/25/11
61	MW Technical Edit	AECOM	5 days	Fri 8/26/11	Thu 9/1/11
62	MW Finalize Draft Specifications	AECOM	5 days	Fri 9/2/11	Thu 9/8/11
63	MW Publish Draft Specs	AECOM	3 days	Fri 9/9/11	Tue 9/13/11
64	MW - Client Review/Approval	Marin	10 days	Wed 9/14/11	Tue 9/27/11
65	**Final Specifications**		**164.01 days**	**Wed 10/5/11**	**Tue 5/22/12**
66	Finalize Microwave RFP	AECOM	55 days	Wed 10/5/11	Tue 12/20/11
67	Publish Final MW RFP	AECOM	9 days	Wed 12/21/11	Mon 3/5/12
68	Release RFP Microwave	Marin	4 days	Tue 3/6/12	Thu 5/17/12
69	End Phase 2 B MW		3 days	Thu 5/17/12	Tue 5/22/12

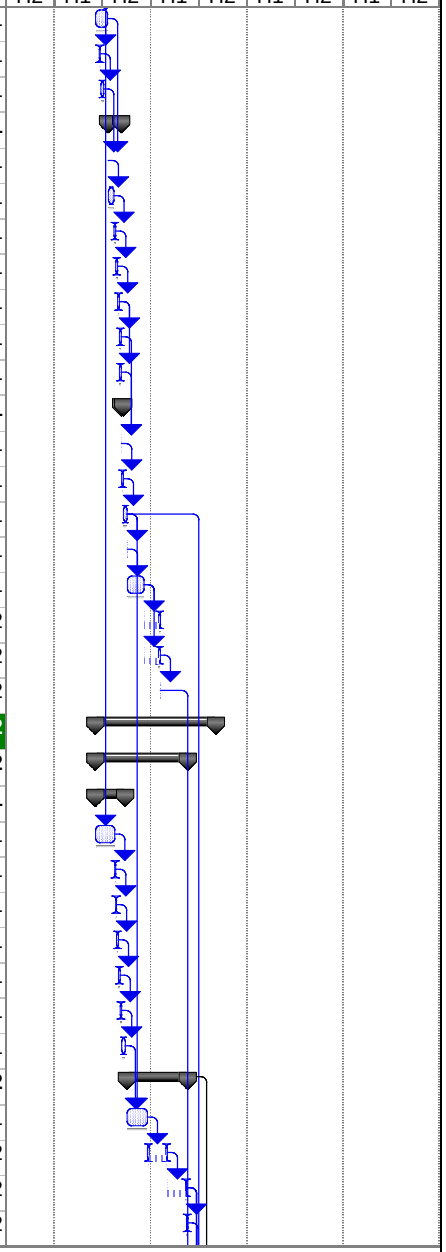


Figure 6-1
700MHz P 25 Implementation Schedule

ID	Task Name	Resource Names	Duration	Start	Finish
70	**Phase 3 - Procurement**		**80 days**	**Thu 5/17/12**	**Thu 9/6/12**
71	MW Procurement Initial Letter	AECOM	11 days	Thu 5/17/12	Fri 6/1/12
72	Proposal Prep	Microwave Vendor	29 days	Thu 5/17/12	Wed 6/27/12
73	MW Pre-Proposal Conference	AECOM/Marin	1 day	Fri 6/1/12	Mon 6/4/12
74	MW Addenda	AECOM	7 days	Mon 6/4/12	Wed 6/13/12
75	**Technical Evaluation**		**21 days**	**Wed 6/27/12**	**Thu 7/26/12**
76	MW Proposal Opening	Marin	1 day	Wed 6/27/12	Thu 6/28/12
77	Technical Evaluation	AECOM/Marin	15 days	Thu 6/28/12	Thu 7/19/12
78	Evaluation Team Meeting	Meeting	5 days	Thu 7/19/12	Thu 7/26/12
79	**Cost Evaluation**		**5 days**	**Thu 7/26/12**	**Thu 8/2/12**
80	Cost and Proposal Opening	Marin	1 day	Thu 7/26/12	Fri 7/27/12
81	Cost Evaluation	AECOM/Marin	5 days	Thu 7/26/12	Thu 8/2/12
82	Recommendations	AECOM	13 days	Thu 8/2/12	Tue 8/21/12
83	Negotiations	AECOM/Marin	10 days	Tue 8/21/12	Tue 9/4/12
84	Microwave Contract Sign	Marin	2 days	Tue 9/4/12	Thu 9/6/12
85	End Phase 3B MW		0 days	Thu 9/6/12	Thu 9/6/12
86	**Physical Facilities**		**117 days**	**Tue 5/22/12**	**Thu 11/1/12**
87	**Phase 2 - Specifications**		**117 days**	**Tue 5/22/12**	**Thu 11/1/12**
88	**Phy Fac Draft Specification**		**30 days**	**Tue 5/22/12**	**Tue 7/3/12**
89	Physical Facilities Specifications	AECOM	7 days	Tue 5/22/12	Thu 5/31/12
90	Phy Fac Draft Assembly	AECOM	2 days	Thu 5/31/12	Mon 6/4/12
91	Phy Fac PM Review	AECOM	2 days	Mon 6/4/12	Wed 6/6/12
92	Phy Fac Technical Edit	AECOM	3 days	Wed 6/6/12	Mon 6/11/12
93	Phy Fac Finalize Draft Specifications	AECOM	3 days	Mon 6/11/12	Thu 6/14/12
94	Phy Fac Publish Draft Specs	AECOM	3 days	Thu 6/14/12	Tue 6/19/12
95	Phy Fac - Client Review/Approval	Marin	10 days	Tue 6/19/12	Tue 7/3/12
96	**Phy Fac Final Specification**		**12 days**	**Tue 7/3/12**	**Thu 7/19/12**
97	Finalize Facility RFP	AECOM	10 days	Tue 7/3/12	Tue 7/17/12
98	Publish Final Facility Specs	AECOM	1 day	Tue 7/17/12	Wed 7/18/12
99	Release Facility RFP	Marin	1 day	Wed 7/18/12	Thu 7/19/12
100	End Phase 2D Phy Fac		0 days	Wed 7/18/12	Wed 7/18/12
101	**Phase 3 - Procurement**		**36 days**	**Thu 7/19/12**	**Fri 9/7/12**
102	Procurement Initial Letter	AECOM	5 days	Thu 7/19/12	Thu 7/26/12
103	Proposal Prep	Facility Vendor	30 days	Thu 7/26/12	Thu 9/6/12
104	Pre-Proposal Conference	Meeting	10 days	Thu 7/19/12	Thu 8/2/12

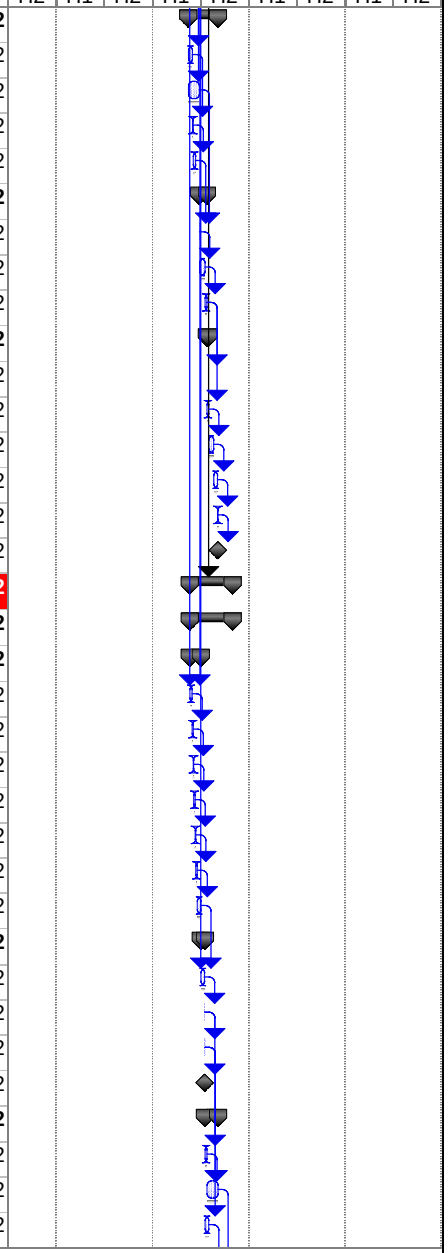


Figure 6-1
700MHz P 25 Implementation Schedule

ID	Task Name	Resource Names	Duration	Start	Finish
105	Addenda	AECOM	10 days	Thu 8/2/12	Thu 8/16/12
106	Proposed Opening	Marin	1 day	Thu 9/6/12	Fri 9/7/12
107	**Technical Evaluation**		**20 days**	**Fri 9/7/12**	**Fri 10/5/12**
108	Tech Evaluation	AECOM/Marin	15 days	Fri 9/7/12	Fri 9/28/12
109	Evaluation Team Meeting	Meeting	5 days	Fri 9/28/12	Fri 10/5/12
110	Cost Evaluation	AECOM/Marin	1 day	Fri 10/5/12	Mon 10/8/12
111	Cost Proposal Opening & Evaluation	AECOM/Marin	1 day	Mon 10/8/12	Tue 10/9/12
112	Recommendations	AECOM	5 days	Tue 10/9/12	Tue 10/16/12
113	Negotiations	AECOM/Marin	10 days	Tue 10/16/12	Tue 10/30/12
114	Physical Facilities Contract Sign	Marin	2 days	Tue 10/30/12	Thu 11/1/12
115	End Phase 3D Phy Fac		0 days	Thu 11/1/12	Thu 11/1/12
116	**Phase 4 - Implementation & Acceptance**		**493 days**	**Thu 11/1/12**	**Tue 9/23/14**
117	**DESIGN REVIEW**		**61 days**	**Thu 11/1/12**	**Fri 1/25/13**
118	Design Materials	Contractors	60 days	Thu 11/1/12	Thu 1/24/13
119	Implementation Plan	Contractors	10 days	Thu 11/1/12	Thu 11/15/12
120	Finalize Detailed Design	rin/AECOM/Contractors	40 days	Thu 11/15/12	Thu 1/10/13
121	DDR Meeting	rin/AECOM/Contractors	1 day	Thu 1/10/13	Fri 1/11/13
122	DDR Approval	AECOM/Marin	10 days	Fri 1/11/13	Fri 1/25/13
123	**TEST PLAN**		**230 days**	**Fri 1/25/13**	**Fri 12/13/13**
124	Staging Test Plan Submittal	Contractors	40 days	Fri 1/25/13	Fri 3/22/13
125	Staging Test Plans Approval	AECOM/Marin	20 days	Fri 3/22/13	Fri 4/19/13
126	Acceptance Test Plan Submittal	Contractors	40 days	Fri 8/23/13	Fri 10/18/13
127	Acceptance Test Plan Approval	AECOM/Marin	40 days	Fri 10/18/13	Fri 12/13/13
128	**RADIO**		**295 days**	**Fri 1/25/13**	**Fri 3/14/14**
129	Manufacture Radio System	Contractors	60 days	Fri 1/25/13	Fri 4/19/13
130	Stage Radio System	rin/AECOM/Contractors	20 days	Fri 7/26/13	Fri 8/23/13
131	Ship Non-Fixed Equipment	Contractors	65 days	Fri 8/23/13	Fri 11/22/13
132	Ship Infrastructure	Contractors	10 days	Fri 11/22/13	Fri 12/6/13
133	Non-Fixed Equipment Installation	Contractors	75 days	Fri 11/22/13	Fri 3/7/14
134	Infrastructure Installation	Contractors	30 days	Fri 12/6/13	Fri 1/17/14
135	Final Inspection	AECOM	20 days	Fri 1/17/14	Fri 2/14/14
136	Optimization	Contractors	30 days	Fri 1/17/14	Fri 2/28/14
137	Telecom Test	Contractors	5 days	Fri 2/28/14	Fri 3/7/14
138	Punch List Update	AECOM	5 days	Fri 2/14/14	Fri 2/21/14
139	Pre-Test Punch List Resolution	Contractors	15 days	Fri 2/21/14	Fri 3/14/14

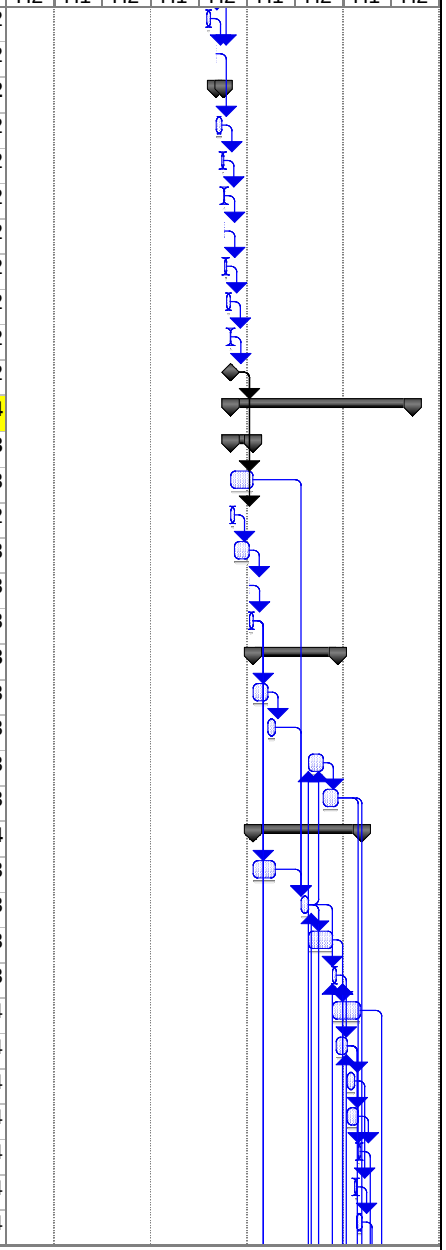


Figure 6-1
700MHz P 25 Implementation Schedule

ID	Task Name	Resource Names	Duration	Start	Finish
140	**MICROWAVE**		**120 days**	**Fri 1/25/13**	**Fri 7/12/13**
141	Microwave Path Survey	Contractors	40 days	Fri 1/25/13	Fri 3/22/13
142	Manufacture Microwave	Contractors	60 days	Fri 3/22/13	Fri 6/14/13
143	Microwave Staging Test Plan Submittal	Contractors	20 days	Fri 3/22/13	Fri 4/19/13
144	Microwave Staging Test Plan Approval	AECOM/Marin	10 days	Fri 4/19/13	Fri 5/3/13
145	Microwave Staging	rin/AECOM/Contractors	20 days	Fri 6/14/13	Fri 7/12/13
146	**PHYSICAL FACILITIES**		**225 days**	**Fri 1/25/13**	**Fri 12/6/13**
147	Site Acquisition	Marin	130 days	Fri 1/25/13	Fri 7/26/13
148	Site Development	Contractors	40 days	Fri 7/26/13	Fri 9/20/13
149	Tower Procurement	Contractors	28 days	Fri 7/26/13	Wed 9/4/13
150	Building Implementation	Contractors	45 days	Fri 9/20/13	Fri 11/22/13
151	Tower Implementation	Contractors	45 days	Fri 9/20/13	Fri 11/22/13
152	Facility Inspection	AECOM	10 days	Fri 11/22/13	Fri 12/6/13
153	**TRAINING**		**150 days**	**Fri 8/23/13**	**Fri 3/21/14**
154	System Administrative Support Training	Contractors	10 days	Fri 8/23/13	Fri 9/6/13
155	Maintenance Training	Contractors	45 days	Fri 1/17/14	Fri 3/21/14
156	**FINAL TEST**		**70 days**	**Fri 3/14/14**	**Fri 6/20/14**
157	Interference Test	Contractors	5 days	Fri 3/14/14	Fri 3/21/14
158	Infrastructure Test	Contractors/AECOM	10 days	Fri 3/21/14	Fri 4/4/14
159	Operations Training	Contractors	10 days	Fri 4/4/14	Fri 4/18/14
160	Punch List Resolution	Contractors	40 days	Fri 4/4/14	Fri 5/30/14
161	Coverage Test	Contractors/AECOM	15 days	Fri 4/4/14	Fri 4/25/14
162	User Training	Contractors	15 days	Fri 4/4/14	Fri 4/25/14
163	Test Report Submittal	Contractors	20 days	Fri 4/25/14	Fri 5/23/14
164	Test Report Approval	AECOM	10 days	Fri 5/23/14	Fri 6/6/14
165	System Maintenance Manual Submittal	Contractors	10 days	Fri 4/25/14	Fri 5/9/14
166	System Maintenance Manual Review	AECOM	10 days	Fri 5/9/14	Fri 5/23/14
167	As Built Document Submittal	Contractors	30 days	Fri 4/25/14	Fri 6/6/14
168	As Built Document Review	AECOM	10 days	Fri 6/6/14	Fri 6/20/14
169	Burn In Test	Contractors	20 days	Fri 4/25/14	Fri 5/23/14
170	**CUTOVER**		**87 days**	**Fri 5/23/14**	**Tue 9/23/14**
171	Cutover Recommendation	AECOM	3 days	Fri 5/23/14	Wed 5/28/14
172	Cutover	Contractors	10 days	Wed 5/28/14	Wed 6/11/14
173	Final System Acceptance	AECOM	2 days	Fri 6/20/14	Tue 6/24/14
174	System Commissioning	Marin	65 days	Tue 6/24/14	Tue 9/23/14

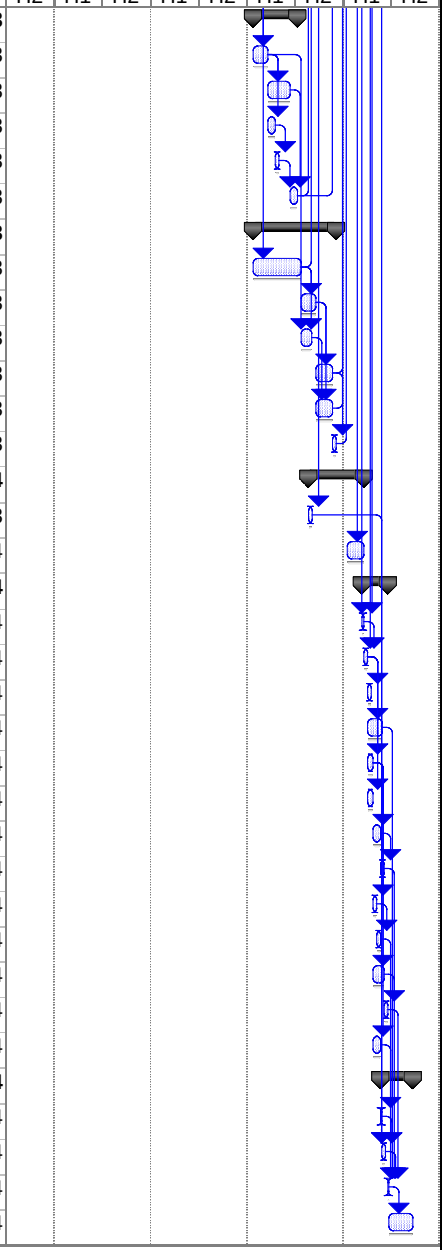


Figure 6-2
UHF P25 Implementation Schedule

ID	Task Name	Resource Names	Duration	Start	Finish
0	**AECOM Project Work Plan**		**970.01 days**	**Mon 1/3/11**	**Mon 9/22/14**
1	Notice to Proceed	Marin	1 day	Mon 1/3/11	Mon 1/3/11
2	Specification Initialization Letter	AECOM	1 day	Tue 1/4/11	Tue 1/4/11
3	**Licensing**		**270 days**	**Wed 1/5/11**	**Tue 1/17/12**
4	License Application Preparation	AECOM	30 days	Wed 1/5/11	Tue 2/15/11
5	License Approval	FCC	240 days	Wed 2/16/11	Tue 1/17/12
6	**Phase 1 Radio System**		**286 days**	**Wed 1/5/11**	**Wed 2/8/12**
7	**Radio Specifications**		**109 days**	**Wed 1/5/11**	**Mon 6/6/11**
8	**Develop RFP Draft Radio Specification**		**103 days**	**Wed 1/5/11**	**Fri 5/27/11**
9	Rough-Out Meeting	Meeting	1 day	Wed 1/5/11	Wed 1/5/11
10	Equipment Specifications	AECOM,Marin	29 days	Wed 1/5/11	Mon 2/14/11
11	Propagation Finalization	AECOM	10 days	Thu 1/6/11	Wed 1/19/11
12	Sample Terms & Conditions	AECOM	3 days	Thu 1/13/11	Mon 1/17/11
13	Terms & Conditions	Marin	46 days	Tue 1/18/11	Tue 3/22/11
14	Final System Design	AECOM	10 days	Thu 1/20/11	Wed 2/2/11
15	Evaluation Criteria	AECOM	5 days	Wed 3/23/11	Tue 3/29/11
16	Non-Fixed Equipment Finalization	Marin	20 days	Wed 2/2/11	Tue 3/1/11
17	System Service Specifications	AECOM	39 days	Wed 2/2/11	Mon 3/28/11
18	Cost Sheet Preparation	AECOM	20 days	Tue 3/1/11	Mon 3/28/11
19	Radio Draft Assembly	AECOM	2 days	Wed 3/30/11	Thu 3/31/11
20	Radio PM Review	AECOM	3 days	Fri 4/1/11	Tue 4/5/11
21	Radio Technical Edit	AECOM	5 days	Wed 4/6/11	Tue 4/12/11
22	Radio - Finalize Draft Specifications	AECOM	20 days	Wed 4/13/11	Tue 5/10/11
23	Radio - Publish Draft Specifications	AECOM	3 days	Wed 5/11/11	Fri 5/13/11
24	Radio - Proposer Review	Proposer	10 days	Mon 5/16/11	Fri 5/27/11
25	Radio - Client Review / Approval	Marin	10 days	Mon 5/16/11	Fri 5/27/11
26	**Final Specifications**		**6 days**	**Mon 5/30/11**	**Mon 6/6/11**
27	Radio - Finalize Document	AECOM	3 days	Mon 5/30/11	Wed 6/1/11
28	Radio - Publish Final Specifications	AECOM	2 days	Thu 6/2/11	Fri 6/3/11
29	Release Radio RFP	Marin	1 day	Mon 6/6/11	Mon 6/6/11
30	End Phase 1 Radio Specification		0 days	Mon 6/6/11	Mon 6/6/11
31	**Radio Procurement**		**177 days**	**Tue 6/7/11**	**Wed 2/8/12**
32	Radio - Procurement Initialization Letter	AECOM	2 days	Tue 6/7/11	Wed 6/8/11
33	Proposal Preparation	Proposer	34 days	Tue 6/7/11	Fri 7/22/11
34	Pre-Proposal Conference	AECOM	4 days	Tue 6/21/11	Fri 6/24/11

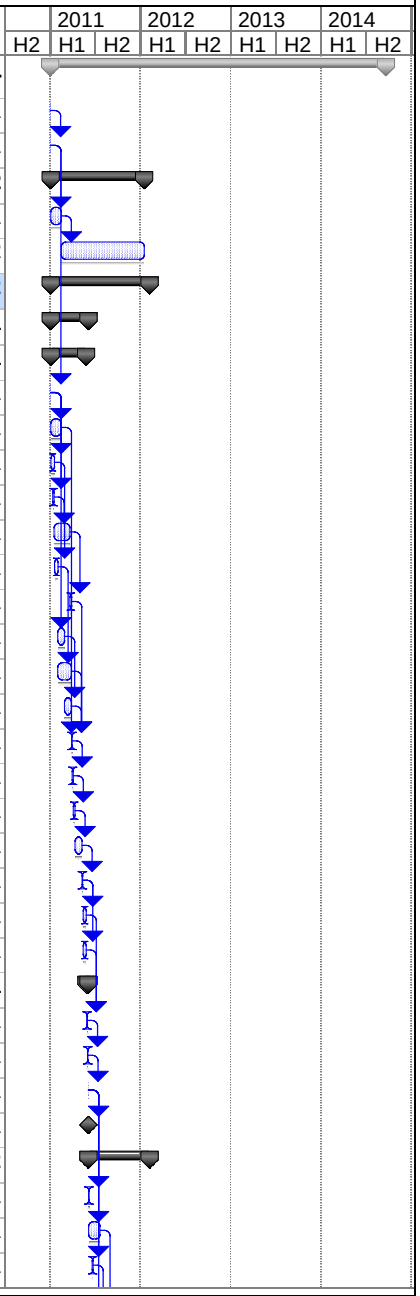


Figure 6-2
UHF P25 Implementation Schedule

ID	Task Name	Resource Names	Duration	Start	Finish
35	Addenda	AECOM	9 days	Mon 6/27/11	Thu 7/7/11
36	**Technical Evaluation**		**36 days**	**Mon 7/25/11**	**Mon 9/12/11**
37	Technical Proposal Opening	Marin	1 day	Mon 7/25/11	Mon 7/25/11
38	First Pass Evaluation	AECOM/Marin	15 days	Tue 7/26/11	Mon 8/15/11
39	Request Clarifications	AECOM	5 days	Tue 8/16/11	Mon 8/22/11
40	Clarification Response	Proposer	5 days	Tue 8/23/11	Mon 8/29/11
41	Final Technical Evaluation	AECOM/Marin	5 days	Tue 8/30/11	Mon 9/5/11
42	Evaluation Team Meeting	Meeting	5 days	Tue 9/6/11	Mon 9/12/11
43	Proposer Presentation	Proposer	5 days	Tue 9/6/11	Mon 9/12/11
44	**Cost Evaluation**		**6 days**	**Tue 9/13/11**	**Tue 9/20/11**
45	Cost Proposal Opening	Marin	1 day	Tue 9/13/11	Tue 9/13/11
46	Cost Evaluation	AECOM/Marin	5 days	Wed 9/14/11	Tue 9/20/11
47	Recommendations	AECOM	10 days	Wed 9/21/11	Tue 10/4/11
48	Executive Presentation	Meeting	1 day	Wed 10/5/11	Wed 10/5/11
49	Negotiations	Marin	45 days	Thu 10/6/11	Wed 12/7/11
50	Approve Contract	Marin	6 days	Thu 12/8/11	Wed 2/8/12
51	Contract Sign	Marin	6 days	Thu 12/8/11	Tue 2/7/12
52	End Phase 1 Radio Procurement		1 day	Wed 2/8/12	Wed 2/8/12
53	**Phase 2 Microwave**		**327.01 days**	**Tue 6/7/11**	**Thu 9/6/12**
54	**Microwave Specifications**		**250.01 days**	**Tue 6/7/11**	**Tue 5/22/12**
55	**Draft Specifications**		**81 days**	**Tue 6/7/11**	**Tue 9/27/11**
56	Microwave Specification	AECOM	53 days	Tue 6/7/11	Thu 8/18/11
57	MW Draft Assembly	AECOM	2 days	Fri 8/19/11	Mon 8/22/11
58	MW - PM Review	AECOM	3 days	Tue 8/23/11	Thu 8/25/11
59	MW Technical Edit	AECOM	5 days	Fri 8/26/11	Thu 9/1/11
60	MW Finalize Draft Specifications	AECOM	5 days	Fri 9/2/11	Thu 9/8/11
61	MW Publish Draft Specs	AECOM	3 days	Fri 9/9/11	Tue 9/13/11
62	MW - Client Review/Approval	Marin	10 days	Wed 9/14/11	Tue 9/27/11
63	**Final Specifications**		**164.01 days**	**Wed 10/5/11**	**Tue 5/22/12**
64	Finalize Microwave RFP	AECOM	55 days	Wed 10/5/11	Tue 12/20/11
65	Publish Final MW RFP	AECOM	9 days	Wed 12/21/11	Mon 3/5/12
66	Release RFP Microwave	Marin	4 days	Tue 3/6/12	Thu 5/17/12
67	End Phase 2 MW Specification		3 days	Thu 5/17/12	Tue 5/22/12
68	**Microwave Procurement**		**80 days**	**Thu 5/17/12**	**Thu 9/6/12**
69	MW Procurement Initial Letter	AECOM	11 days	Thu 5/17/12	Fri 6/1/12

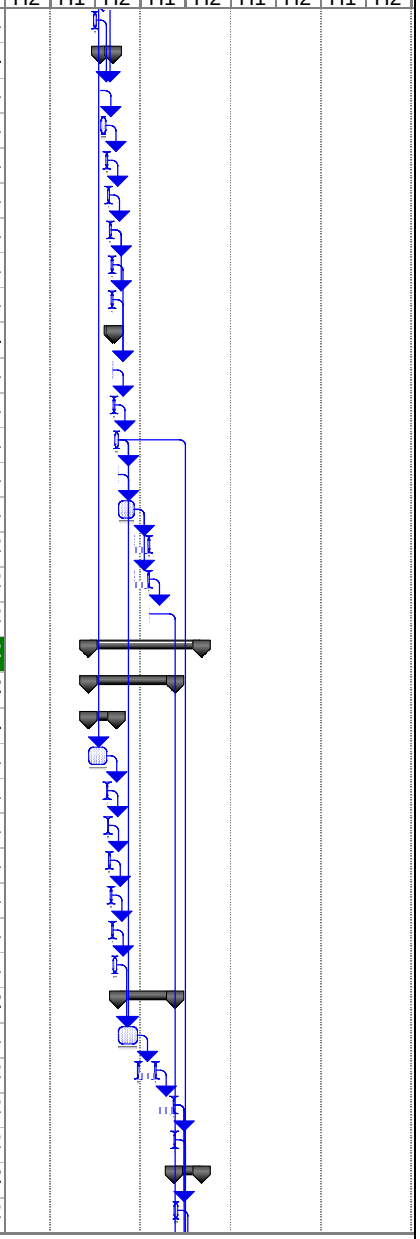


Figure 6-2
UHF P25 Implementation Schedule

ID	Task Name	Resource Names	Duration	Start	Finish
70	Proposal Prep	Microwave Vendor	29 days	Thu 5/17/12	Wed 6/27/12
71	MW Pre-Proposal Conference	AECOM/Marin	1 day	Fri 6/1/12	Mon 6/4/12
72	MW Addenda	AECOM	7 days	Mon 6/4/12	Wed 6/13/12
73	**Technical Evaluation**		**21 days**	**Wed 6/27/12**	**Thu 7/26/12**
74	MW Proposal Opening	Marin	1 day	Wed 6/27/12	Thu 6/28/12
75	Technical Evaluation	AECOM/Marin	15 days	Thu 6/28/12	Thu 7/19/12
76	Evaluation Team Meeting	Meeting	5 days	Thu 7/19/12	Thu 7/26/12
77	**Cost Evaluation**		**5 days**	**Thu 7/26/12**	**Thu 8/2/12**
78	Cost and Proposal Opening	Marin	1 day	Thu 7/26/12	Fri 7/27/12
79	Cost Evaluation	AECOM/Marin	5 days	Thu 7/26/12	Thu 8/2/12
80	Recommendations	AECOM	13 days	Thu 8/2/12	Tue 8/21/12
81	Negotiations	AECOM/Marin	10 days	Tue 8/21/12	Tue 9/4/12
82	Microwave Contract Sign	Marin	2 days	Tue 9/4/12	Thu 9/6/12
83	End Phase 2 MW Procurement		0 days	Thu 9/6/12	Thu 9/6/12
84	**Phase 3 Physical Facilities**		**116 days**	**Tue 5/22/12**	**Wed 10/31/12**
85	**Physical Facilities Specifications**		**116 days**	**Tue 5/22/12**	**Wed 10/31/12**
86	**Phy Fac Draft Specification**		**30 days**	**Tue 5/22/12**	**Tue 7/3/12**
87	Physical Facilities Specifications	AECOM	7 days	Tue 5/22/12	Thu 5/31/12
88	Phy Fac Draft Assembly	AECOM	2 days	Thu 5/31/12	Mon 6/4/12
89	Phy Fac PM Review	AECOM	2 days	Mon 6/4/12	Wed 6/6/12
90	Phy Fac Technical Edit	AECOM	3 days	Wed 6/6/12	Mon 6/11/12
91	Phy Fac Finalize Draft Specifications	AECOM	3 days	Mon 6/11/12	Thu 6/14/12
92	Phy Fac Publish Draft Specs	AECOM	3 days	Thu 6/14/12	Tue 6/19/12
93	Phy Fac - Client Review/Approval	Marin	10 days	Tue 6/19/12	Tue 7/3/12
94	**Phy Fac Final Specification**		**12 days**	**Tue 7/3/12**	**Thu 7/19/12**
95	Finalize Facility RFP	AECOM	10 days	Tue 7/3/12	Tue 7/17/12
96	Publish Final Facility Specs	AECOM	1 day	Tue 7/17/12	Wed 7/18/12
97	Release Facility RFP	Marin	1 day	Wed 7/18/12	Thu 7/19/12
98	End Phase 3 Phy Fac Specification		0 days	Wed 7/18/12	Wed 7/18/12
99	**Phy Fac- Procurement**		**36 days**	**Thu 7/19/12**	**Fri 9/7/12**
100	Procurement Initial Letter	AECOM	5 days	Thu 7/19/12	Thu 7/26/12
101	Proposal Prep	Facility Vendor	30 days	Thu 7/26/12	Thu 9/6/12
102	Pre-Proposal Conference	Meeting	10 days	Thu 7/19/12	Thu 8/2/12
103	Addenda	AECOM	10 days	Thu 8/2/12	Thu 8/16/12
104	Proposed Opening	Marin	1 day	Thu 9/6/12	Fri 9/7/12

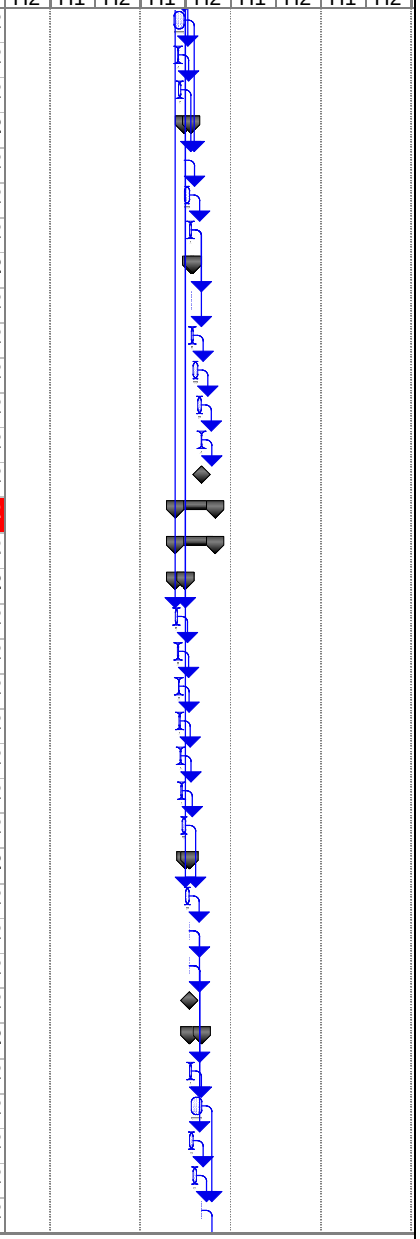


Figure 6-2
UHF P25 Implementation Schedule

ID	Task Name	Resource Names	Duration	Start	Finish
105	**Technical Evaluation**		**20 days**	**Fri 9/7/12**	**Fri 10/5/12**
106	Tech Evaluation	AECOM/Marin	15 days	Fri 9/7/12	Fri 9/28/12
107	Evaluation Team Meeting	Meeting	5 days	Fri 9/28/12	Fri 10/5/12
108	**Cost Evaluation**	**AECOM/Marin**	**1 day**	**Fri 10/5/12**	**Mon 10/8/12**
109	Cost Proposal Opening	Marin	1 day	Fri 10/5/12	Mon 10/8/12
110	Cost Evaluation	AECOM/Marin	1 day	Fri 10/5/12	Mon 10/8/12
111	Recommendations	AECOM	5 days	Mon 10/8/12	Mon 10/15/12
112	Negotiations	AECOM/Marin	10 days	Mon 10/15/12	Mon 10/29/12
113	Physical Facilities Contract Sign	Marin	2 days	Mon 10/29/12	Wed 10/31/12
114	End Phase 3 Phy Fac Procurement		0 days	Wed 10/31/12	Wed 10/31/12
115	**Phase 4 - Implementation & System Acceptance**		**493 days**	**Wed 10/31/12**	**Mon 9/22/14**
116	**DESIGN REVIEW**		**61 days**	**Wed 10/31/12**	**Thu 1/24/13**
117	Design Materials	Contractors	60 days	Wed 10/31/12	Wed 1/23/13
118	Implementation Plan	Contractors	10 days	Wed 10/31/12	Wed 11/14/12
119	Finalize Detailed Design	Marin/AECOM/Contractors	40 days	Wed 11/14/12	Wed 1/9/13
120	DDR Meeting	Marin/AECOM/Contractors	1 day	Wed 1/9/13	Thu 1/10/13
121	DDR Approval	AECOM/Marin	10 days	Thu 1/10/13	Thu 1/24/13
122	**TEST PLAN**		**230 days**	**Thu 1/24/13**	**Thu 12/12/13**
123	Staging Test Plan Submittal	Contractors	40 days	Thu 1/24/13	Thu 3/21/13
124	Staging Test Plans Approval	AECOM/Marin	20 days	Thu 3/21/13	Thu 4/18/13
125	Acceptance Test Plan Submittal	Contractors	40 days	Thu 8/22/13	Thu 10/17/13
126	Acceptance Test Plan Approval	AECOM/Marin	40 days	Thu 10/17/13	Thu 12/12/13
127	**RADIO**		**295 days**	**Thu 1/24/13**	**Thu 3/13/14**
128	Manufacture Radio System	Contractors	60 days	Thu 1/24/13	Thu 4/18/13
129	Stage Radio System	Marin/AECOM/Contractors	20 days	Thu 7/25/13	Thu 8/22/13
130	Ship Non-Fixed Equipment	Contractors	65 days	Thu 8/22/13	Thu 11/21/13
131	Ship Infrastructure	Contractors	10 days	Thu 11/21/13	Thu 12/5/13
132	Non-Fixed Equipment Installation	Contractors	75 days	Thu 11/21/13	Thu 3/6/14
133	Infrastructure Installation	Contractors	30 days	Thu 12/5/13	Thu 1/16/14
134	Final Inspection	AECOM	20 days	Thu 1/16/14	Thu 2/13/14
135	Optimization	Contractors	30 days	Thu 1/16/14	Thu 2/27/14
136	Telecom Test	Contractors	5 days	Thu 2/27/14	Thu 3/6/14
137	Punch List Update	AECOM	5 days	Thu 2/13/14	Thu 2/20/14
138	Pre-Test Punch List Resolution	Contractors	15 days	Thu 2/20/14	Thu 3/13/14
139	**MICROWAVE**		**120 days**	**Thu 1/24/13**	**Thu 7/11/13**

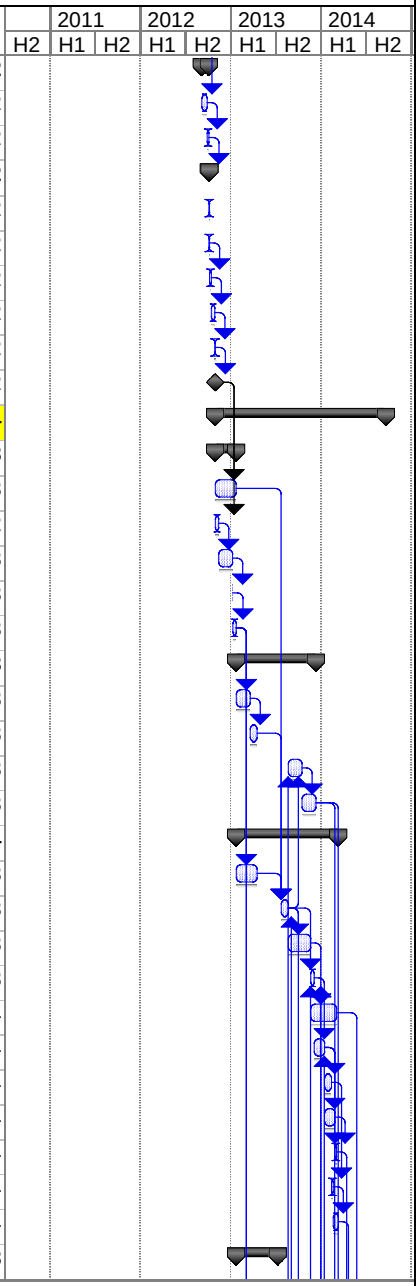
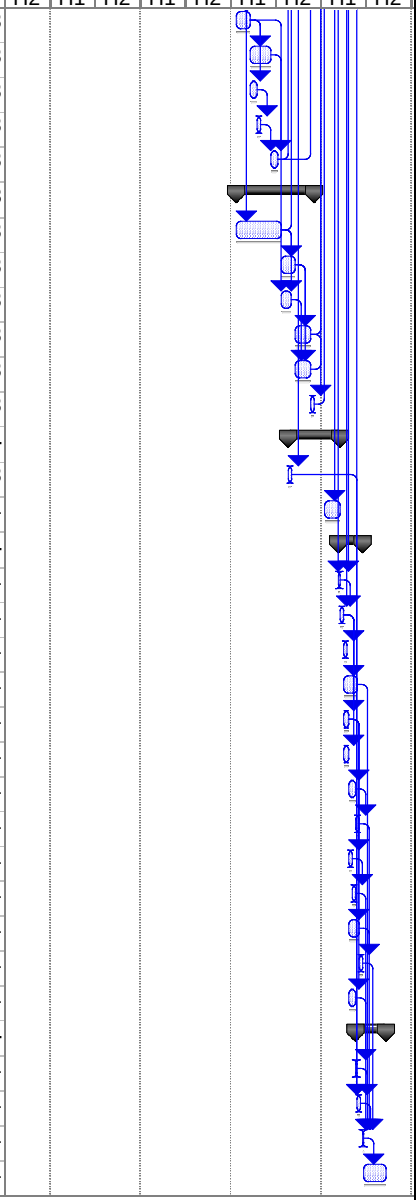


Figure 6-2
UHF P25 Implementation Schedule

ID	Task Name	Resource Names	Duration	Start	Finish
140	Microwave Path Survey	Contractors	40 days	Thu 1/24/13	Thu 3/21/13
141	Manufacture Microwave	Contractors	60 days	Thu 3/21/13	Thu 6/13/13
142	Microwave Staging Test Plan Submittal	Contractors	20 days	Thu 3/21/13	Thu 4/18/13
143	Microwave Staging Test Plan Approval	AECOM/Marin	10 days	Thu 4/18/13	Thu 5/2/13
144	Microwave Staging	Marin/AECOM/Contractors	20 days	Thu 6/13/13	Thu 7/11/13
145	**PHYSICAL FACILITIES**		**225 days**	**Thu 1/24/13**	**Thu 12/5/13**
146	Site Acquisition	Marin	130 days	Thu 1/24/13	Thu 7/25/13
147	Site Development	Contractors	40 days	Thu 7/25/13	Thu 9/19/13
148	Tower Procurement	Contractors	28 days	Thu 7/25/13	Tue 9/3/13
149	Building Implementation	Contractors	45 days	Thu 9/19/13	Thu 11/21/13
150	Tower Implementation	Contractors	45 days	Thu 9/19/13	Thu 11/21/13
151	Facility Inspection	AECOM	10 days	Thu 11/21/13	Thu 12/5/13
152	**TRAINING**		**150 days**	**Thu 8/22/13**	**Thu 3/20/14**
153	System Administrative Support Training	Contractors	10 days	Thu 8/22/13	Thu 9/5/13
154	Maintenance Training	Contractors	45 days	Thu 1/16/14	Thu 3/20/14
155	**FINAL TEST**		**70 days**	**Thu 3/13/14**	**Thu 6/19/14**
156	Interference Test	Contractors	5 days	Thu 3/13/14	Thu 3/20/14
157	Infrastructure Test	Contractors/AECOM	10 days	Thu 3/20/14	Thu 4/3/14
158	Operations Training	Contractors	10 days	Thu 4/3/14	Thu 4/17/14
159	Punch List Resolution	Contractors	40 days	Thu 4/3/14	Thu 5/29/14
160	Coverage Test	Contractors/AECOM	15 days	Thu 4/3/14	Thu 4/24/14
161	User Training	Contractors	15 days	Thu 4/3/14	Thu 4/24/14
162	Test Report Submittal	Contractors	20 days	Thu 4/24/14	Thu 5/22/14
163	Test Report Approval	AECOM	10 days	Thu 5/22/14	Thu 6/5/14
164	System Maintenance Manual Submittal	Contractors	10 days	Thu 4/24/14	Thu 5/8/14
165	System Maintenance Manual Review	AECOM	10 days	Thu 5/8/14	Thu 5/22/14
166	As Built Document Submittal	Contractors	30 days	Thu 4/24/14	Thu 6/5/14
167	As Built Document Review	AECOM	10 days	Thu 6/5/14	Thu 6/19/14
168	Burn In Test	Contractors	20 days	Thu 4/24/14	Thu 5/22/14
169	**CUTOVER**		**87 days**	**Thu 5/22/14**	**Mon 9/22/14**
170	Cutover Recommendation	AECOM	3 days	Thu 5/22/14	Tue 5/27/14
171	Cutover	Contractors	10 days	Tue 5/27/14	Tue 6/10/14
172	Final System Acceptance	AECOM	2 days	Thu 6/19/14	Mon 6/23/14
173	System Commissioning	Marin	65 days	Mon 6/23/14	Mon 9/22/14



7.0 Budgetary Cost and Potential Funding Mechanisms

This section provides an overview of Opinion of Probable costs for each viable option and discusses possible funding mechanisms that can be used to purchase the mobile and portable radios needed to implement each system design. In addition, we have included several case studies that provide an overview of how other agencies have funded radio system upgrades.

7.1 Radio Systems Cost Estimate

Estimates were developed for the major categories of equipment as they apply to each of the two viable Conceptual System Design for the Marin County Project that is described in this report. The various costs are compared and weighted in order to derive an average "list price" type of estimate. Estimates reflect expected list pricing.

7.1.1 Opinions of Probable Costs Voice System

Included in this section are tables reflecting AECOM's opinion of the probable costs of the project. These display tables contain elements and categories that drive the reflected cost estimate.

Elements and categories in these tables include:

List Estimate - Items and categories of equipment are applied to the List Costs database that AECOM has created.

Negotiated Estimate - We have adjusted the List Costs for the effect of negotiating with a sole source vendor or system integrator. The Lists Costs are reduced by the percentages that we have typically seen in this type procurement.

Competitive Estimate - Estimates are further reduced to reflect the cost reduction we have seen in highly competitive procurements. As stated earlier in this report, the P25 standard introduces competition into the process. These are the reductions we have seen when multiple vendors respond to an RFP.

7.1.2 Cost Element Categories

Cost Elements are categories of equipment that make up the system design and costs. Each of these costs elements are discussed further in this document.

A. Radio Infrastructure

The estimate display for Voice Infrastructure contains several cost elements. These are generally the fixed equipment contained at the transmission and control sites. This includes transmitters, receivers, repeaters, antennas, multicouplers and combiners, voters, and simulcast equipment.

The following assumptions and elements are included:

- The number of transmitters and other equipment is based on the number of channels expected to be in use in the expected overall system size for the Year 2025.
- Specialized equipment is included for the basic systems.

B. Microwave (Connectivity)

This includes microwave radios, microwave antennas, waveguide and other cabling, orderwire, loop and hot standby switches, and DC power supplies; as well as the equivalent costs expected for fiber connectivity.

All of the trunked tower sites are interconnected as a countywide communications network through a combination of microwave radio links and fiber optic paths.

The network backbone also interconnects the dispatch operations, mobile data system, radio system administration and maintenance functions, and the public safety information systems such as CAD and records.

The connectivity network is estimated to interconnect the voice and data transmit sites with the Dispatch center, and to various other dispatch centers within system as described to support dispatch consoles. This telecommunications subsystem will provide the latest state-of-the-art technology and allow for expansion to accommodate future needs.

C. Non Fixed Radio Equipment

The Non Fixed or subscriber equipment represents a large portion of the cost of the system. The estimates will include full warranty and maintenance for the first year of operation.

Since subscriber equipment represents a large portion of the cost of the system, we make the following assumptions:

- The estimate is for the number of portables and mobiles for Marin County with growth predictions of 100 radio users per year for 15 years and a 20% increase for outside agency responders. This will meet the needs through 2015, provided actual growth does not exceed predictions.
- High, Mid, and Basic Tier Mobiles & Portables are provided to all Public Safety Agencies. At this point the ratio of tiers for mobile radios is projected to be 5% High-Tier, 15% Mid-Tier, and 80% Basic-Tier. Due to the limited talkgroup capacity of portable radios the applied ratios is 5% High-Tier, 85% Mid-Tier, and 10% Basic Tier for Portable radios only. This ratio has been applied throughout the estimate for all agencies.
- Portable estimates are based on each radio being equipped with two batteries, a shoulder/lapel microphone, a desk rapid charger, and one multi-charger for every 40 portables purchased.

Subscriber radio equipment is divided by available features into the following three tiers:
Radio Tiers: Non-Fixed radio equipment is divided by available features into the following three tiers:

- **High – Tier Units** are full featured, public safety grade portable or mobile radios. These units typically provide features such as automatic telephone interconnect, private or single unit calling, and access to groups or subgroups necessary for administrative functions. This normally entails a free form DTMF keypad. High-Tier Units are typically assigned to administrative, command, or management personnel. This tier normally has a capacity of 512 talk groups/channels.
- **Mid – Tier Units** are public safety grade portable or mobile radios, which include those features necessary for fulfilling the particular mission of the public safety agency. These units typically provide features such as automatic telephone interconnect, private or single unit calling through list selection rather than free form dialing, and access to talk groups necessary for administrative functions. This tier normally has a capacity of 256 to 512 talk groups/channels.
- **Basic – Tier Units** have the same features of mid-tier radios with fewer talk groups accessible. Reliability is equivalent to the other Tier units. These units are limited to very basic features yet retain the public safety grade of reliability. This tier normally has a capacity of 256 to 512 talk groups/channels for mobiles and control stations and 48 talk group/channels for portables.

It is expected that High – Tier, Mid – Tier and Basic – Tier Units will be the same radio model, with the only differences being equipped features or options, and price. The intent is to allow one model/type of accessory, such as a microphone or antenna, to work on all three tiers of the radio.
Subscriber equipment requires certain features and conditions in order to accurately provide an estimate. In this case we have made several assumptions in order to proceed.
Estimates for subscriber radios include:

- The radio is estimated to be digital, P-25 in operation
- All units are estimated as non-encrypted

- All units are estimated as non-intrinsically safe
- Installation – assuming “normal” conditions
- Antennas – assuming “normal” conditions with cabling and antenna
- Programming – including the initial program
- Warranty – warranty service for one year

Subscriber Options

Intrinsically Safe Option

Certain portable radios can be designed for use in highly incendiary environments. These designs incorporate the safety feature of having no extreme temperature points and emitting no sparks. The critical areas are the Push-To-Talk button and the battery connections.

Generally, modern radios do not exceed these cautionary temperatures; however, vendors offer equipment that is “certified as intrinsically safe” by one of the agencies empowered to give this certification if required. In this case the radio, and particularly the batteries, are certified and marked indicating that they are intrinsically safe. This certification adds to the costs of the radio, and the batteries; and in some cases limits the design of shoulder microphones, etc.

These radios make particular sense for Haz/Mat Teams and other selected units. However, some departments may feel the need to issue intrinsically safe radios to all fire fighters. The estimate includes an optional line item for the Intrinsically Safe feature. This line item projects a need to provide intrinsically safe portables and batteries for all fire departments.

Encryption Option

The proposed system will be based on digital signaling formats thus; the encryption process normally involves a software upgrade rather than a hardware add-on. The estimate includes an optional line item for the Encryption feature. This estimates the addition of the encryption software package to all law enforcement radios.

D. Physical Facilities

This category is perhaps the most difficult to identify. Contained here are towers, foundations, geotechnical surveys, tower analysis, site clearing, access road paving, security fencing, lighting, shelters, generators, UPS power supplies, HVAC, solar power, utilities connections, and grounding.

The existing facilities at a number of tower site locations have been evaluated. The different sites are in various levels of readiness. The sites will require some development before they are ready to support a system of this complexity. Much of the system’s reliability will rely on the sites’ condition.

E. Environmental Studies

This category includes an opinion of probable cost for the environmental studies that must be completed for each site. AECOM is aware of the environmental concerns that changes to any site configuration will require and we have included these costs in Table 7-1.

F. Licensing Efforts

The licensing process typically requires several steps which include generating the license package, submitting the package to a frequency coordinator and interfacing with Regional Planning Committees and the FCC. Keep in mind that a transmit / receive frequency pair is two frequencies and is typically charged as two frequencies by the frequency coordinators.

G. Alerting System

This category includes the cost to upgrade the existing Fire Alerting system. The current system supports 35 Fire Stations and 6 sirens as well as a large number of Know Boxes throughout the County. The cost is based

on installing a single UHF TBand simulcast channel at all 15 sites in the System Design. Each site would be part of an analog UHF T-Band simulcast that would interface with the existing user equipment currently installed at the Fire Stations. We have assumed that the equipment at each fire station would remain the same and we have not included any costs for paging. Although the existing UHF T-Band repeaters could likely be used for this system, our costing assumed that they would not be used, since we cannot guarantee at least 15 of them would be available at the same time to implement the alerting solution.

H. Vendor Services

Purchasing a communications system is a complex and detailed process. Some of the effort on the part of a major radio retailer and/or a systems integrator would be to outsource those efforts not part of their core business. As would be expected in the outsourcing, the price for the service is escalated with pass through fees and administrative add-ons, as well as risk factors for unanticipated activities.

In the cost estimate there is a category for Vendor Services. This accounts for the expenses experienced by the Vendor to perform procedures for professional engineering, design, project management, and their own verification of performance for these elements to match your requirements.

I. IV&V

We have included an Independent Validation and Verification (IV&V) as part of the Opinion of Probable Cost. The idea is to have an independent consultant, like AECOM, assist the County in developing an RFP Specification and assist the County with the procurement process. We have found that the “value added” and cost savings in the eventual contract between the selected Vendor and the County for this type of service far exceeds this cost element.

J. Spares - Fixed

This cost element is a simple 1% factor of the value of the Fixed Infrastructure costs; including consoles.

K. Spares – Non Fixed

This cost element is a simple 1% factor of the value of the Non-Fixed (Subscriber).

L. Contingency

In a project of this size and complexity unexpected occurrences and expenditures will be required. All of the estimates and all of the proposals will be predicated on such terms as “normal soils conditions”, that there will be no zoning appeals and/or delays, suitable access will be available, and other such codicils. While successful and detailed negotiations can assist in protecting the implementation project; there will be the unexpected. In our experience, a viable cost element for contingencies set aside should be 10% of the project without the non-fixed element.

7.1.3 Radio System Cost Summaries

The following list of tables summarizes the Opinion of Probable Cost for Voice Infrastructure, Non-Fixed, and Connectivity system Opinion for the Countywide 700 MHz option and the Countywide UHF P25 Phase 2 system. Each of these options is discussed in detail in Section 5 of this report. The following tables provide a summary of the Opinion of Probable Cost. Because these two viable designs use the same architecture, site selections and have the same number of subscriber units, the cost for these two systems are the same. Vendors do not charge different amounts based on frequency band. In Order to reduce the complexity of this report, we have included one cost table that can be applied to both viable designs.

Table:	Description
Table 7-1	Opinion of Probable Cost for a Countywide P25 Phase 2 System The probable costs are based on an 11-site, 11 channel (20 talkpaths plus one control channel) simulcast (700 MHz or UHF T-Band) P25 Phase 2 trunking system. Four Stand-

Alone P25 Trunked sites are included to provide additional coverage. The “Non-Fixed” Cost element is shown by agency in Table 7-2.

Table 7-2 Opinion of Probable Cost for the Countywide Subscriber (Non-Fixed) Equipment

7.1.4 Radio System Cost Assumptions

The Opinion of probable cost includes the following assumptions:

1. Radio Infrastructure includes the eleven Simulcast Sites with 11 P25 Phase 2 channels plus the four fill in sites with 4 P25 Phase 2 channels and all associated equipment to include, repeaters, antenna systems, digital controllers, subsystem controllers, site controllers, simulcast equipment, system manager terminals, and consoles for dispatch centers.
2. Microwave costs include upgrade costs for existing microwave connections and cost to install the additional microwave hops.
3. Non-Fixed Equipment includes cost of all subscriber equipment needed for each agency, as shown in Table 7-2.
4. Physical facilities includes upgrade cost for moderate upgrades for all existing sites and costs to install Backup power, UPS, Site Grounding, tower analysis at four sites and two new towers.
5. Fire Alerting assumes reuse of existing equipment at Fire Stations.
6. Fire Alerting assumes new repeaters will be purchased to support the alerting simulcast.
7. Fire Alerting assumes 15 site single channel UHF T-Band analog simulcast.
8. EIR / EIS costs include an average of $22,000 per site, but will depend on many factors that cannot be determined at the time of this report.

7.1.5 UHF Phase 1 versus UHF Phase 2 Radio System Upgrade

Our initial thought was that upgrading to a P25 Phase 1 UHF system would be significantly more cost effective than upgrading to a P25 Phase 2 UHF system, because a Phase 2 system requires replacing all existing subscriber units. However, due to the increased number of channels in a Phase 1 system over a Phase 2 system (19 versus 11 in this case) the cost estimates for Phase 1 versus Phase 2 are within 3% of each other.

As a result, we have included several important factors that we used to determine that upgrading to P25 Phase 2 was the best long-term upgrade path:

1. Cost – Phase 1 upgrade will mean that the County must stay with the same vendor so that they can take advantage of the backward compatibility of the P25 equipment with the existing Motorola SmartZone MERA system. A sole source vendor means that the best pricing option would be a “Negotiated’ price. If the County were to upgrade to P25 Phase 2, they could develop an RFP Specification and encourage all vendors to participate in the process. Since the entire system would need to be replaced, the cost for the UHF P25 Phase 2 system would be essentially the same as the Countywide 700MHz Phase 2 system as shown in Table 7-1. A competitive process means that the best pricing option would be the “Competitive” price shown in Table 7-1. When we compared the P25 Phase 2 Competitive price with the Phase 1 Negotiated price, we noted that the difference was only 3%. This 3% difference provides the County with the current P25 Phase 2 technology, rather than P25 Phase 1 technology, which will soon be obsolete.
2. Maintenance – Since the Phase 1 system has more channels per site, the Phase 1 system would likely have a higher maintenance cost than the Phase 2 system. Although in the early years this cost difference would not be significant, as the equipment reached end of life the maintenance cost for the Phase 1 system would climb at a faster rate.

3. Future Upgrades – If the County ever needs additional channels, the first step will be to move from a Phase 1 system to a Phase 2 system. This would, at a minimum, require the replacement of all non-fixed equipment and will require replacing or upgrading all fixed components that are not P25 Phase 2 compliant.
4. Licensing - Since additional channels are required at each site, there would be a need to license more UHF channels for the Phase 1 solution than with the Phase 2 solution. Although our research indicates that the enough simulcast channels are available, it would ease the license criteria and lower the licensing fees if the system is upgraded to P25 Phase 2.
5. Site and Tower Considerations - Additional channels at each site presents many challenges to the existing site and tower configurations. Site surveys were beyond the scope of this project, and as a result we do not have detailed site information. However, if even one site is not able to support the additional tower loading and site shelter requirements for a 19 channel simulcast, then significant additional cost could result. A Phase 2 system would only have 11 channels at 11 sites, many of which already have 11 channels. A Phase 2 system would avoid many of the site and shelter considerations.

7.2 Funding Alternatives

This section discusses the different avenues available to public safety agencies to fund their communication system upgrades, and also examines a number of specific public safety organizations: statewide, County and City systems, and indicates which sources they utilized.

7.2.1 Bonds

The majority of AECOM clients have utilized bonds to fund their new radio systems. Often, they have bundled radio system upgrades with other improvement plans such as new jails and courthouses in order to bring the focus off the radio system.

7.2.2 Lease Purchase Agreements / Certificate of Participation (COPS)

As an alternative to bonds, lease purchase agreements and certificates of participation (COP) allow localities to raise funds through private investors. They each function similarly to a home mortgage in which a bank acts as a broker between the lessor (the vendor) and the lessee (the government authority) to secure the funding for the certificate from the investment community. COPs are usually tax-exempt, which attracts a larger investment base than other mechanisms available to local areas. Jurisdictions that use this funding mechanism often form public authorities or new governmental entities that can invite a private firm or vendor to negotiate the lease or purchase of radio equipment. Local public safety agencies within the City of Winston-Salem, North Carolina, City and County of San Francisco, and Maricopa County, Arizona, have used COPs. In these cases, the COPs cover the operations and maintenance costs for the communications systems and provide funding for upgrades to allow the local systems to become interoperable with larger, surrounding systems. At the end of the payment schedule, ownership of the radio system transfers to the jurisdiction.

7.2.3 Federal Grants

Federal grants provide targeted funding to advance nationwide goals and to assist in the equal distribution of government services. These grants are associated with many different government program areas, including education, transportation, and public safety. The Federal Government has created numerous grant programs specifically to promote criminal justice and public safety initiatives.

While these grants may seem large, sometimes reaching into the millions of dollars, they should in no way be considered sufficient to fund the construction of a new radio system. Generally, the grants should be viewed as supplementary – a contribution by the federal government. Typically, grant funding will not exceed about 10 to 20% of the total cost of the new system. For more detail, see the discussion on federal grants in Section 3.4 below.

7.2.4 Leasing/Selling of County Property

Funds can be raised by selling (or leasing) assets that have been deeded, donated, or forfeited to the jurisdictions from private individuals. We have seen jurisdictions sell land and buildings, lease right of ways and lease space on towers to fund their new systems.

7.2.5 Asset Forfeitures

Similar to the above, assets seized by public safety agencies as a result of criminal investigations are often utilized as a revenue source by auctioning the property. Proceeds from asset forfeitures are separate and distinct from traditional civil forfeitures, which are realized through property liens associated with delinquent taxes and are generally already included in budget revenue forecasts. As such, asset forfeiture proceeds from law enforcement activities are typically not included in the revenue forecasts.

7.2.6 Targeted Taxes

Many states collect revenue from motor-vehicle-related taxes and from targeted sales taxes to establish special revenue funds. Alternatively, it may be possible to redirect the revenue from an existing tax. Many jurisdictions in Virginia and Georgia have implemented local sales tax increases of 1% to pay for their communication system upgrades.

7.2.7 Surcharges for 911 and E9-1-1

E9-1-1 surcharges are typically used to pay for 9-1-1 system upgrades required in a jurisdiction to meet Federal Communications Commission requirements. However, once the system upgrades are paid for, the agencies can use the tax revenue to fund wireless networks. Currently, 13 states have specifically designated some monies from this revenue stream for the maintenance of their current wireless systems. The increase in wireless use by individuals is being realized by jurisdictions and many are actively looking for ways to bring those fees back to the cities and counties. Carlton B. Walls III, ENP, Project Analyst, Lancaster County-Wide Communications, PA: "We have learned that, for the first time, Lancaster County-Wide Communications has lost $400,000 in wire line revenues during calendar year 2004."

7.2.8 User Fees

Many joint-use, interoperable communication systems charge user fees to tenant agencies based on the number of radios used by the agency. Generally, this is done by the lead agency who funds the original procurement and installation of the infrastructure, then assesses the other participants based on their usage. This is particularly effective in funding long-term costs such as maintenance, software upgrades, etc.

7.2.9 Impact Fees

To avoid raising the rates of highly visible taxes, such as those levied on property and income, some local governments have employed impact fees to generate additional revenue. Impact fees typically take the form of a one-time charge per residential unit or per square foot for commercial development and are paid by land developers. In Prescott, Arizona, for example, the impact fee for each new residential unit constructed is $1,740.22. This fee is collected as part of a permit fee for new home construction.

7.2.10 Public/Private Partnerships or Fee for Service

Fee-for-service, as an alternative to the traditional approach of procuring a privately owned and operated land mobile radio (LMR) system, offers public safety agencies feature-rich LMR services with little capital expenditure. Ongoing costs for operations and maintenance (O&M) would be the responsibility of the LMR service supplier, and not of the user agencies. From the user perspective, several benefits can be associated with the fee-for-service approach, including acquisition cost savings, access to state-of-the-art technology, and the opportunity for outsourcing of non-core competencies. Here, the vendor will build and operate the public safety network with guaranteed performance parameters (service level agreements). For its part of the agreement, the participating government agency will pay an annual or monthly fee for the use of the network. Funding can be provided through the annual operating budget rather than through a one-time capital

expenditure plan. Motorola and the State of Illinois have developed this relationship under the STARCOM network.

7.3 Case Studies

7.3.1 Orange County, FL

Orange County primarily utilized impact fees to fund their radio system. They attached a $500 radio assessment fee to each single-family residential building permit in the County under the justification that it was the growth in the County that was causing the degradation of the system coverage and the need for an expanded radio system. The assessments are proportionally higher for larger commercial permits.

7.3.2 Cobb County, GA

Cobb County sold County owned property to finance the radio system upgrades. This property primarily came from the deaths of residents, as well as asset forfeitures under the RICO Act (where people convicted of certain acts forfeit all ill-gotten gains, including interest in any business gained through a pattern of "racketeering activity"). The County also added an impact fee of $15/ticket for traffic violations to fund the radio system.

7.3.3 San Bernardino County, CA

San Bernardino County is preparing to pursue a five-zone simulcast, P25 trunked and conventional radio system covering over 20,000 square miles. They are leaning towards a monthly user fee of between $50 and $75 per radio to fund acquisition, operation, and maintenance of their system.

7.3.4 Muskegon, MI

Muskegon charged local jurisdictions a monthly user fee based on a formula containing the jurisdiction population, the tax base, the number of radio users on the system, and the number of checks requested of the 911 center (for law enforcement agencies). They also utilized funds from the 911 surcharges. The initial financing for construction of the system was obtained through a lease/purchase program managed by a local bank. Tax-exempt financing was provided at 70% of the prime rate. A dedicated millage was subsequently enacted to provide for continuing technological updates.

7.3.5 Commonwealth of Virginia

The Commonwealth of Virginia is building a statewide network for the Virginia State Police and other state agencies called STARS. The system will have approximately 130 sites and initial cost estimates were $330 million. They received general legislature funding for system.

7.3.6 State of Illinois

The State of Illinois received an initial $25 million federal grant to purchase new radio equipment for their new 146 site, statewide system constructed, owned, and operated by Motorola through a public/private partnership. State and local jurisdictions lease airtime based on the number of radios approved for operation on the network.

7.3.7 Pima County, AZ

Pima County is planning to construct a wide-area, Project 25 (P25) trunked, simulcast 700/800 MHz two-way radio communications system covering over 10,000 square miles and designed to serve twenty fire departments and districts, eleven law enforcement agencies, and the Pima County Office of Emergency Management and Homeland Security. The County is utilizing a bond issued for the purpose, and already approved by the citizens through a special ballot. The County, in partnership with the City of Tucson, is also seeking supplemental funding through public grant programs from the U.S. Department of Homeland Security. The grant monies will be used to offset some of the acquisition costs, especially as they relate to specific equipment classifications covered by the federal grant.

7.3.8 Tomkins County, NY

Tomkins County is planning to build a ten (10) site, digital, trunked 800 MHz simulcast Land Mobile Radio (LMR) system with a connected microwave ring. This $15-20 million radio project will be primarily funded by local bonds. The infrastructure, such as towers, equipment shelters, and site work will be bonded for 20 years. Other types of equipment will be bonded for up to 10 years, commensurate with the expected useful lifespan of the technology and hardware. Two public safety grants relating to the project, of approximately $500,000 each, have been received through the efforts of local congressional representatives.

7.3.9 Allegany County, MD

Allegany County, MD, has found a way to provide its first response agencies with advanced telecommunications services, such as enhanced interoperability, mobile high-speed data terminals and more, by using an innovative public/private partnership.

The Allegany County Network, AllCoNet2, is a carrier class communication network that provides high quality communication services to public safety, government, educational, commercial, and residential users. AllCoNet2 was originally developed by the Allegany School System to bridge the "Digital Divide" in a cost effective manner to improve educational opportunities. As AllCoNet2 evolved over time, additional government agencies such as the libraries, City, and County government and public safety agencies adopted it as a cost-effective, reliable solution to the need for interoperable communications including voice, data, and video. Construction and operational costs are thus shared among a number of groups, rather than being borne entirely by Allegany County's public safety agencies.

Their outstanding public/private partnership received the ‘Smart Practice’ designation from the Federal Emergency Management Administration (FEMA) in 2006. This proven network has been the only municipal network to receive this designation and has been in operation since 2003. For more information on the principles behind their network, see the next section on Cambria County, which adopted a similar plan.

7.3.10 Cambria County, PA

Cambria County has initiated a project known as “Cambria Connected,” which will fund their radio system through a unique and creative way based on a proven example from Allegany County, MD. This project will allow Cambria County to offer some of the benefits of their public safety communications system upgrade to the community, by providing services such as high-speed internet, IP telephone, mobile data communications, and video monitoring to public safety agencies, local businesses, and even private citizens.

Costs for the initial radio and emergency center upgrades were estimated by the County at $4.5 million. Looking to avoid the bond and tax issues for funding, they decided to overbuild the network for approximately $10 million and develop a public/private cooperation to lease the excess capacity.

The County pursued the system through a no-bid, lease-purchase, tax-exempt plan financed through an area bank. The expectation is that the project will be able to pay off their 15 year, $10 million acquisition loan in approximately 7 years. Revenue potential is expected to reach the neighborhood of $300,000 per month.

They have actively sought out partners from around the County and State who could potentially receive benefit from their high capacity network. For example, the Commonwealth of Pennsylvania traded tower space with the County to reduce their fees for leased lines connecting the PENDOT road signs by over $10,000/month. The network will also provide free video monitoring and internet for Forestry and other State agencies.

Cambria County issued a contract to CONXX to build and maintain a high capacity (OC3 - 155.52 Mbps currently, with plans upgrade to OC12 - 622.08 Mbps) SONET ring network around the County. The ring

connects the 15 County radio sites, along with other commercial entities, to provide a telecommunication-grade infrastructure with advanced security features and architecture that enables the network to safely and effectively provide a variety of services to a diverse user community.

The CONXX Carrier Communication Platform™ is a telecommunication-grade infrastructure deployed wirelessly. It provides traditional T1 and frame relay connections for phone systems, data networks, and metropolitan LAN connections to link government and businesses across the County. It provides high-quality connections to tie the public safety two-way radio system together and mobile communications to provide high-speed networks between police, fire and other government agencies. Schools are able to connect at up to 20 times existing speeds allowing IP voice, high definition school security systems and "on-demand" multimedia access in classrooms.

The project involves a revenue sharing plan, with Cambria County and CONXX splitting the revenue from entities that join the network. Currently, the County receives 70% of the revenue and CONXX receives the other 30%. Those percentages will change over time, based on certain milestones, with a final ratio of 50/50 when the network is mature. The County owns the microwave network, but CONXX operates and maintains it for a negotiated annual fee of approximately $300,000. Since CONXX would like to expand its customer base (and hence, increase its revenue stream), they have taken responsibility for all marketing, advertising and sales activities.

The County commissioners also want to improve broadband Internet access for residents. To promote social inclusion, the network will provide high-speed broadband access to many areas of the County that previously had no access. The network includes plans for the deployment of metro Wi-Fi (with technology from Wavion) in several communities where traditional DSL and cable have not been available in the past. Where Wi-Fi will not be available, residential and business customers can still gain access to the network through fixed wireless connections.

The County will be able to eliminate most of its own monthly communication costs, and at the same time create opportunities for economic development and better government and public safety services. For instance, the new system is allowing the County to drop Verizon as their mobile data provider at a savings of over $150,000 per year. Internet service to the County is now available free from four local internet service providers, in exchange for access to the County network. For $30 per month, many Cambria County residents can obtain high-speed internet service, from which the County receives $5 per month in revenue. Additionally, because of the economics, the County has the ability to provide free (or at a very low cost) broadband access to the homes of children who qualify for subsidized lunch programs at school.

7.4 Grants-In-Aid

The usual approach when the need for increased funding is mentioned is to look for grants. There are a number of grant programs at both the state and federal levels. In addition, there are a large number of private sources of grants. In addition to private foundations such as the Bill and Melinda Gates Foundation or the Robert Wood Johnson Foundation, there are both corporate foundations and community foundations.

Corporate foundations, such as the Verizon Foundation make grants for a variety of purposes. Community Foundations are tax-exempt, non-profit, autonomous, publicly supported, non-sectarian philanthropic institutions with a long-term goal of building permanent, named component funds established by many separate donors for the broad-based charitable benefit of the residents of a defined geographic area. According to the Foundation Center, 64,843 private, corporate, and community foundations distributed $33,768,375,000 in 2002. Based on a sample of grants awarded by the 1,000 largest foundations, only a small portion of the grants awarded went to the categories classified as “Public Safety and Disaster Relief” or “Crime, Justice and Legal Services.” According to the Foundation Center, less than 2.5% of the grants awarded in 2002 went to either of those two classifications. That still amounted to

$318,139,000. Historically, education has consistently accounted for the largest share of grant dollars, while the human services category has represented the largest number of grants.2

Community Foundations

Community foundations are much like a private foundation. A community foundation's funds however are received from a variety of donors rather than a single source, as is usually the situation with a private or corporate foundation. Community foundations are usually classified as public charities and are subject to different rules and regulations than those, which govern private foundations. A community foundation is different from agencies such as the United Way in that the United Way campaign raises funds each year and distributes them to participating agencies. A community foundation, on the other hand, makes grants equal to a portion of its principal each year. Typically, a community foundation makes grants equal to five percent of its fund balance each year. Interest earned on the principal is usually more than that so the foundation continues to grow.

There are twenty-six federal grant-making agencies and over 900 separate federal grants-in-aid programs. There are fifteen (15) different types of federal assistance. These include seven financial types of assistance and eight non-financial types of assistance. The two most common of the seven types of financial assistance are Formula Grants and Project Grants. Formula grants allocate funds to states or local governments according to a distribution formula prescribed by federal law. The State Homeland Security Grant Program and the Law Enforcement Prevention of Terrorism grant program are two examples of formula grants. The amount appropriated by Congress is distributed to the states based on population. Other formula grant programs use more complex formulas to distribute the grants. Block grants are a subcategory of formula grants. Block grant programs often have a wide range of eligible activities typically covering a general problem area. Two examples of block grants are the Community Development Block Grant and the Byrne Memorial Justice Assistance Program. The COPS Interoperable Communications grant program is an example of a project grant program. Project grants are also referred to as discretionary grants. Funding is provided for specific projects for a fixed period of time. Often there is a competitive process among the grant applicants.

Most federal agencies provide three types of funding to state and local governments: formula or block grants, discretionary funding, and direct appropriations or earmarks. While there are examples of agencies successfully using other programs for funding of public safety communications projects, the most applicable Federal Government Grant Programs generally fall under two departments: the Department of Justice and the Department of Homeland Security.

With the increased emphasis on Homeland Security since 2001, Homeland Security grant programs are increasing and appropriations for Department of Justice Grant programs are decreasing. Another trend, especially with Homeland Security grants, is the increased use of block grants to the states rather than grants to individual communities. The states then must distribute 80 percent of the money received to local governments. An added trend in federal funding is the increase in the number of direct appropriations, or earmarks, in many of the appropriations bills and a corresponding decrease in the number of discretionary grants. In 1994 and 1995, there were no earmarks in the Federal Budget. The 2004 Federal Budget contained 7,931. The 2005 Omnibus Spending Bill passed by Congress in November contains over 11,000. A significant number of those earmarks are contained in the Department of Justice's budget. In both the 2004 and 2005 Federal Budgets, all of the appropriations for the Community Oriented Policing Services (COPS) Technology (327 earmarks) and the Byrne Discretionary Grant (241 earmarks) programs were earmarked in the appropriations bill. One additional trend is that, while the Department of Homeland Security's budget has increased over the past several years, the overall amount of assistance provide to

2 The Foundation Center, 2004, *Foundations Today, A Tutorial*. Retrieved December 20, 2004, from http://fdncenter.org/learn/classroom/ft_tutorial/ftt_part2_q6.html.

state and local governments has decreased, especially when the DHS and Department of Justice grant budgets are combined.

Table 7-1
Opinion of Probable Cost
Marin County, California
Countywide 700MHz Infrastructure & Non-Fixed Equipment

COST ELEMENT	LIST ESTIMATE		NEGOTIATED ESTIMATE		COMPETITIVE ESTIMATE	
RADIO INFRASTRUCTURE	100%	$ 20,035,100	85%	$ 17,029,800	75%	$ 15,026,300
MICROWAVE	100%	$ 4,185,400	90%	$ 3,766,900	90%	$ 3,766,900
NON FIXED EQUIPMENT	100%	$ 13,543,700	85%	$ 11,512,100	75%	$ 10,157,800
PHYSICAL FACILITIES	100%	$ 1,291,200	90%	$ 1,162,100	90%	$ 1,162,100
ENVIRONMENTAL STUDIES	100%	$ 338,800	100%	$ 338,800	100%	$ 338,800
LICENSING EFFORTS	100%	$ 125,200	100%	$ 125,200	100%	$ 125,200
ALERTING SYSTEM	100%	$ 702,800	100%	$ 702,800	100%	$ 702,800
VENDOR SERVICES	100%	$4,718,600	85%	$ 4,010,800	75%	$ 3,539,000
IV&V	100%	$ 580,000	100%	$ 580,000	100%	$ 580,000
SPARES - FIXED	100%	$262,200	100%	$ 262,200	100%	$ 262,200
SPARES - NON FIXED	100%	$ 135,400	100%	$ 135,400	100%	$ 135,400
CONTINGENCY	100%	$2,621,500	90%	$ 2,359,400	80%	$ 2,097,200
TOTAL		**$ 48,539,900**		**$ 41,985,500**		**$ 37,893,700**

Table 7-2
Opinion of Probable Cost
Marin County, California
Countywide 700MHz Non-Fixed Equipment

NON-FIXED EQUIPMENT AGENCY	LIST ESTIMATE		NEGOTIATED ESTIMATE		COMPETITIVE ESTIMATE	
AMR	100%	$ 50,400	85%	$ 42,800	75%	$ 37,800
B.A. AMER. RED CROSS	100%	$ 4,700	85%	$ 4,000	75%	$ 3,500
CA State Parks	100%	$ 33,400	85%	$ 28,400	75%	$ 25,100
CHP	100%	$ 52,500	85%	$ 44,600	75%	$ 39,400
GGNRA FIRE	100%	$ 43,500	85%	$ 37,000	75%	$ 32,600
GGNRA NPS LAW	100%	$ 18,900	85%	$ 16,100	75%	$ 14,200
PT.REYES NAT. SS	100%	$ 210,900	85%	$ 179,300	75%	$ 158,200
San Antonio VFD	100%	$ 82,200	85%	$ 69,900	75%	$ 61,700
Sonoma Co. SO	100%	$ 11,600	85%	$ 9,900	75%	$ 8,700
St. Joe's Ambulance Svc.	100%	$ 28,500	85%	$ 24,200	75%	$ 21,400
USCG CAMSPAC	100%	$ 19,100	85%	$ 16,200	75%	$ 14,300
XSN CA OES COMM	100%	$ 5,500	85%	$ 4,700	75%	$ 4,100
New Ambulance Company	100%	$ 21,100	85%	$ 17,900	75%	$ 15,800
Major Crimes TF	100%	$ 123,800	85%	$ 105,200	75%	$ 92,900
Humane Soc.	100%	$ 74,000	85%	$ 62,900	75%	$ 55,500
Belvedere PD	100%	$ 62,300	85%	$ 53,000	75%	$ 46,700
Belvedere PW	100%	$ 19,400	85%	$ 16,500	75%	$ 14,600
Bolinas FD	100%	$ 115,700	85%	$ 98,300	75%	$ 86,800
Corte Madera Fire	100%	$ 168,900	85%	$ 143,600	75%	$ 126,700
Corte Madera PW	100%	$ 125,300	85%	$ 106,500	75%	$ 94,000
Fairfax PD	100%	$ 125,600	85%	$ 106,800	75%	$ 94,200
Fairfax PW	100%	$ 41,400	85%	$ 35,200	75%	$ 31,100
Inverness FD	100%	$ 97,700	85%	$ 83,000	75%	$ 73,300
Kentfield FD	100%	$ 117,300	85%	$ 99,700	75%	$ 88,000
Larkspur Fire	100%	$ 168,800	85%	$ 143,500	75%	$ 126,600
Larkspur PW	100%	$ 99,600	85%	$ 84,700	75%	$ 74,700

Table 7-2 (Continued)
Opinion of Probable Cost
Marin County, California
Countywide 700MHz Non-Fixed Equipment

NON-FIXED EQUIPMENT AGENCY	LIST ESTIMATE			NEGOTIATED ESTIMATE			COMPETITIVE ESTIMATE		
Marin Comm. Coll. District	100%	$	70,200	85%	$	59,700	75%	$	52,700
Marin County Coroner	100%	$	14,700	85%	$	12,500	75%	$	11,000
Marin County Dist. Atty.	100%	$	53,800	85%	$	45,700	75%	$	40,400
Marin County DPW	100%	$	884,000	85%	$	751,400	75%	$	663,000
Marin County EMS	100%	$	92,700	85%	$	78,800	75%	$	69,500
Marin County Fair	100%	$	33,400	85%	$	28,400	75%	$	25,100
Marin County Fire	100%	$	806,500	85%	$	685,500	75%	$	604,900
Marin County H&HS	100%	$	37,500	85%	$	31,900	75%	$	28,100
Marin County Juvenile Hall	100%	$	29,300	85%	$	24,900	75%	$	22,000
Marin County Landscape	100%	$	41,400	85%	$	35,200	75%	$	31,100
Marin County Open Space	100%	$	178,200	85%	$	151,500	75%	$	133,700
Marin County Parks	100%	$	136,100	85%	$	115,700	75%	$	102,100
Marin County Probation	100%	$	50,400	85%	$	42,800	75%	$	37,800
Marin County SO - ADMIN	100%	$	126,100	85%	$	107,200	75%	$	94,600
Marin County SO - Air	100%	$	15,600	85%	$	13,300	75%	$	11,700
Marin County SO - Civil	100%	$	4,800	85%	$	4,100	75%	$	3,600
Marin County SO - COPE	100%	$	17,100	85%	$	14,500	75%	$	12,800
Marin County SO - Courts	100%	$	46,600	85%	$	39,600	75%	$	35,000
Marin County SO - DARE	100%	$	6,100	85%	$	5,200	75%	$	4,600
Marin County SO - Disp.	100%	$	139,100	85%	$	118,200	75%	$	104,300
Marin County SO - Dive/Rng	100%	$	17,100	85%	$	14,500	75%	$	12,800
Marin County SO - Invest	100%	$	149,300	85%	$	126,900	75%	$	112,000
Marin County SO - Jail	100%	$	117,600	85%	$	100,000	75%	$	88,200
Marin County SO - M.I.C.	100%	$	33,600	85%	$	28,600	75%	$	25,200
Marin County SO - MARINE	100%	$	17,100	85%	$	14,500	75%	$	12,800
Marin County SO - OES	100%	$	130,300	85%	$	110,800	75%	$	97,700

Table 7-2 (Continued)
Opinion of Probable Cost
Marin County, California
Countywide 700MHz Non-Fixed Equipment

NON-FIXED EQUIPMENT AGENCY	LIST ESTIMATE		NEGOTIATED ESTIMATE		COMPETITIVE ESTIMATE	
Marin County SO - Patrol	100%	$ 1,048,600	85%	$ 891,300	75%	$ 786,500
Marin County SO - Posse	100%	$ 28,300	85%	$ 24,100	75%	$ 21,200
Marin County SO - SAR	100%	$ 109,000	85%	$ 92,700	75%	$ 81,800
Marin County SO - SRT	100%	$ 91,700	85%	$ 77,900	75%	$ 68,800
Marin County Transit	100%	$ 349,900	85%	$ 297,400	75%	$ 262,400
Marin County Wgt&Msrs.	100%	$ 8,800	85%	$ 7,500	75%	$ 6,600
Marinwood FD/CSD	100%	$ 105,500	85%	$ 89,700	75%	$ 79,100
Mill Valley FD	100%	$ 157,500	85%	$ 133,900	75%	$ 118,100
Mill Valley PD	100%	$ 251,800	85%	$ 214,000	75%	$ 188,900
Mill Valley PW	100%	$ 145,900	85%	$ 124,000	75%	$ 109,400
MMWD Rangers	100%	$ 270,400	85%	$ 229,800	75%	$ 202,800
Muir Beach VFD	100%	$ 64,300	85%	$ 54,700	75%	$ 48,200
Nicasio VFD	100%	$ 35,300	85%	$ 30,000	75%	$ 26,500
Novato Fire District	100%	$ 626,700	85%	$ 532,700	75%	$ 470,000
Novato PD	100%	$ 637,700	85%	$ 542,000	75%	$ 478,300
Novato PW	100%	$ 270,800	85%	$ 230,200	75%	$ 203,100
Ross FD	100%	$ 72,500	85%	$ 61,600	75%	$ 54,400
Ross PD	100%	$ 78,000	85%	$ 66,300	75%	$ 58,500
Ross Valley FD	100%	$ 172,300	85%	$ 146,500	75%	$ 129,200
San Anselmo PD	100%	$ 201,600	85%	$ 171,400	75%	$ 151,200
San Anselmo PW	100%	$ 91,500	85%	$ 77,800	75%	$ 68,600
San Rafael FD	100%	$ 601,000	85%	$ 510,900	75%	$ 450,800
San Rafael PD	100%	$ 1,010,200	85%	$ 858,700	75%	$ 757,700
San Rafael PW	100%	$ 518,500	85%	$ 440,700	75%	$ 388,900

Table 7-2 (Continued)
Opinion of Probable Cost
Marin County, California
Countywide 700MHz Non-Fixed Equipment

NON-FIXED EQUIPMENT AGENCY	LIST ESTIMATE		NEGOTIATED ESTIMATE		COMPETITIVE ESTIMATE	
Sausalito PD	100%	$ 154,200	85%	$ 131,100	75%	$ 115,700
Sausalito PW	100%	$ 61,900	85%	$ 52,600	75%	$ 46,400
Skywalker FB	100%	$ 70,500	85%	$ 59,900	75%	$ 52,900
Southern Marin FD	100%	$ 333,000	85%	$ 283,100	75%	$ 249,800
Stinson Beach VFD	100%	$ 116,100	85%	$ 98,700	75%	$ 87,100
Tiburon Fire District	100%	$ 172,500	85%	$ 146,600	75%	$ 129,400
Tiburon PD	100%	$ 121,800	85%	$ 103,500	75%	$ 91,400
Tiburon PW	100%	$ 69,400	85%	$ 59,000	75%	$ 52,100
Tomales VFD	100%	$ 12,900	85%	$ 11,000	75%	$ 9,700
Twin Cities PD	100%	$ 312,900	85%	$ 266,000	75%	$ 234,700
TOTAL		**$ 13,543,700**		**$ 11,512,100**		**$ 10,157,800**

Appendix A Microwave Path Profiles and Calculations

Figure A - 1
Mount Tiburon to Wolfback Ridge

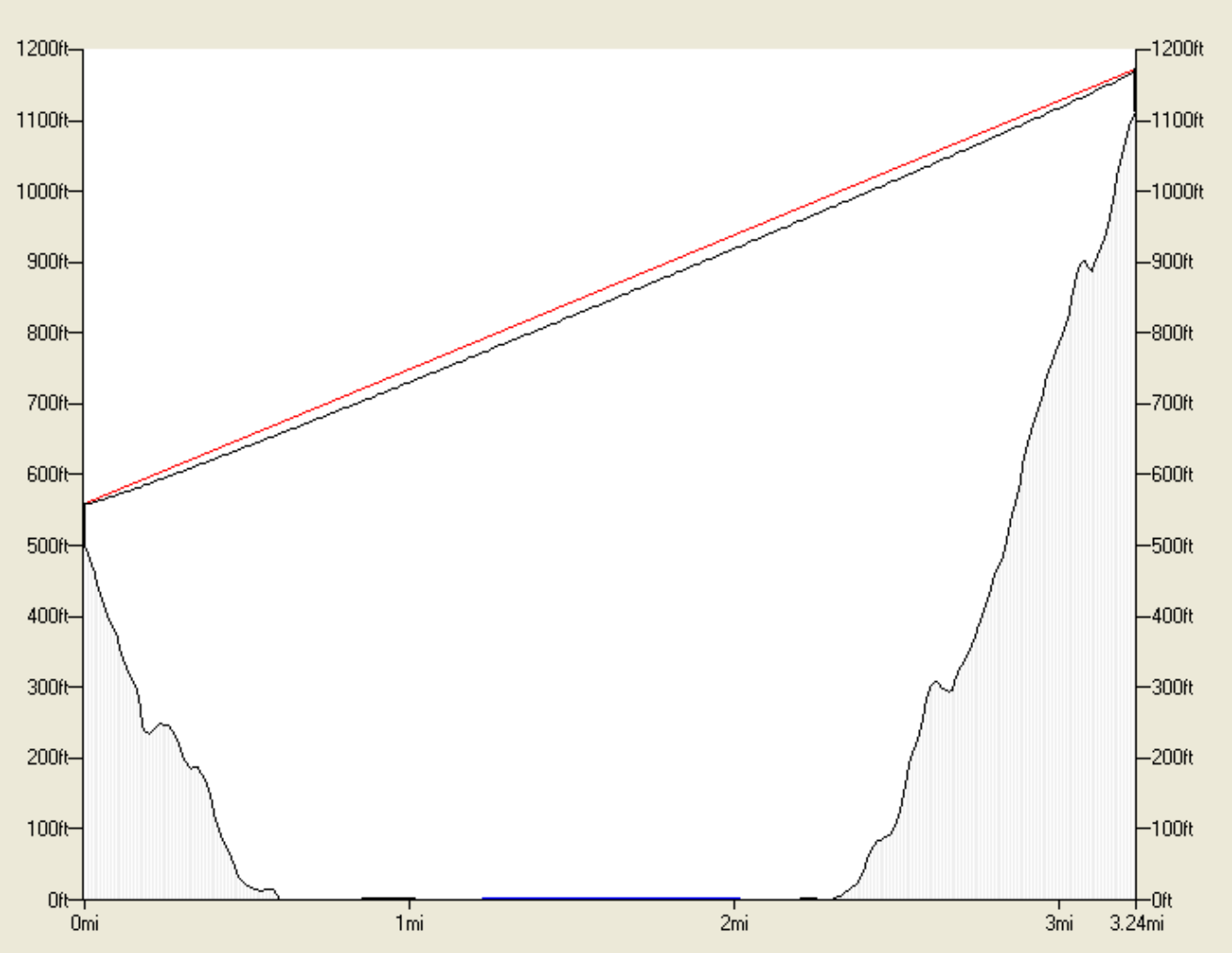
MT TIBURON

37 53 25.70 N
122 27 59.20 W
WGS 84
Elev: 499.24 ft MSL

TRANSMITTER:
FREQ: 10700.00000 MHz
ERP: 63.67 dBm

TX Antenna:
ANT HGT: 60.00 ft AGL
DESC: UXA 4 - 107 A (P)
GAIN: 40.40 dBi
ORIENT: 212.71

RX Antenna (Primary):
ANT HGT: 60.00 ft AGL
DESC: UXA 4 - 107 A (P)
GAIN: 40.40 dBi
ORIENT: 212.71



WOLFBACK RIDGE

37 51 3.52 N
122 29 54.36 W
WGS 84
Elev: 1112.54 ft MSL

TRANSMITTER:
FREQ: 10700.00000 MHz
ERP: 63.72 dBm

TX Antenna:
ANT HGT: 60.00 ft AGL
DESC: UXA 4 - 107 A (P)
GAIN: 40.40 dBi
ORIENT: 32.69

RX Antenna (Primary):
ANT HGT: 60.00 ft AGL
DESC: UXA 4 - 107 A (P)
GAIN: 40.40 dBi
ORIENT: 32.69

Effective Earth Curvature:
1.333

Fresnel Zone: 1.0 F1 at
10700.00000MHz

Azimuth 212.71°T Reverse
32.69°T

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Table A-1
Mount Tiburon to Wolfback Ridge

Site	MT TIBURON	WOLFBACK RIDGE
Latitude	37 53 25.70 N	37 51 3.52 N
Lat (Dec Degrees)	37.89047222	37.85097778
Longitude	122 27 59.20 W	122 29 54.36 W
Lon (Dec Degrees)	-122.4664444	-122.4984333
Site Elevation	499.24 ft	1112.54 ft
Antenna Center	60.00 ft AGL	60.00 ft AGL
Bearing (T)	212.71	32.69
Antenna Orientation	212.71	32.69
Path Angle	2.06	-2.06
Antenna Tilt		
Freq (MHz)	10700	10700
TX Power	1.000 W	
RX Threshold		-73.000 dBm
Antenna	UXA 4 - 107 A (P)	UXA 4 - 107 A (P)
(Ant File/ID)	AMSZ0030 Z003000526	AMSZ0030 Z003000526
Ant Gain (Major Lobe)	40.40 dBi	40.40 dBi
Ant Gain (Along Path)	40.40 dBi	40.40 dBi
Line 1	Andrew EWP90 Elliptical Waveguide_ 10.	Andrew EWP90 Elliptical Waveguide_ 10.
(Line1 File/ID)	LmsAND00 0120000024	LmsAND00 0120000024
Line1 Length	90.00 ft	90.00 ft
Line1 Loss	2.83 dB	2.83 dB
Circulator Loss	0.50 dB	0.50 dB
Connector Loss	0.25 dB	0.25 dB
Jumper Loss	0.50 dB	0.50 dB
Radome Loss	0.50 dB	0.50 dB
Bearing (T)	212.71	32.69
Distance	3.24 mi	3.24 mi
Absorption Loss		0.07 dB
Rain Loss		0.01 dB
Alignment Loss		0.00 dB
Other Loss		0.00 dB
Free Space Loss		127.39 dB
Total Gains dBm		110.8
Total Loss dB		136.63
Received Signal Level dBm		-25.83
Unfaded Fade Margin dB		47.17
Digital EIFM		0
Digital AIFM		0
Digital DFM		46
Composite Fade Margin		43.54
Terrain Factor (a)	0.756	
Climate Factor (b)	0.275	
Undp (TFM)		3.62E-09
Reliability (%)		99.99999964
Outage (sec/yr)		0

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Figure A - 2
Mount Tomales to Sonoma Mountain

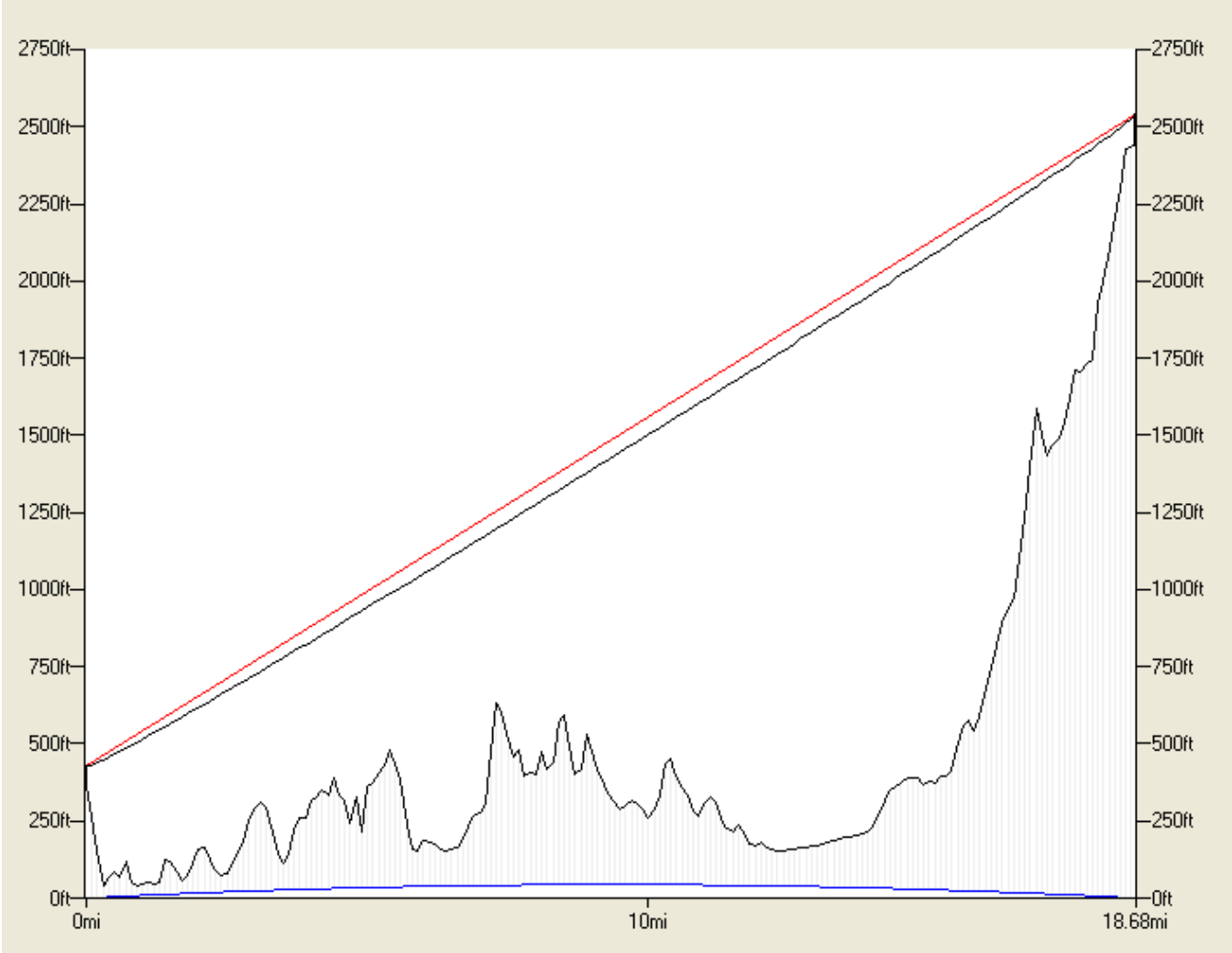
MT TOMALES

38 15 39.74 N
122 54 12.38 W
WGS 84
Elev: 369.08 ft MSL

TRANSMITTER:
FREQ: 6700.00000 MHz
ERP: 63.58 dBm

TX Antenna:
ANT HGT: 60.00 ft AGL
DESC: UXA 6 - 59 A
GAIN: 38.70 dBi
ORIENT: 71.08

RX Antenna (Primary):
ANT HGT: 60.00 ft AGL
DESC: UXA 6 - 59 A
GAIN: 38.70 dBi
ORIENT: 71.08



SONOMA MTN

38 20 54.30 N
122 34 41.33 W
WGS 84
Elev: 2442.36 ft MSL

TRANSMITTER:
FREQ: 6700.00000 MHz
ERP: 63.03 dBm

TX Antenna:
ANT HGT: 100.00 ft AGL
DESC: UXA 6 - 59 A
GAIN: 38.70 dBi
ORIENT: 251.28

RX Antenna (Primary):
ANT HGT: 100.00 ft AGL
DESC: UXA 6 - 59 A
GAIN: 38.70 dBi
ORIENT: 251.28

Effective Earth Curvature: 1.333

Fresnel Zone: 1.0 F1 at 6700.00000MHz

Azimuth 71.08°T Reverse 251.28°T

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Table A-2
Mount Tomales to Sonoma Mountain

Site	MT TOMALES	SONOMA MTN
Latitude	38 15 39.74 N	38 20 54.30 N
Lat (Dec Degrees)	38.26103889	38.34841667
Longitude	122 54 12.38 W	122 34 41.33 W
Lon (Dec Degrees)	-122.9034389	-122.5781472
Site Elevation	369.08 ft	2442.36 ft
Antenna Center	60.00 ft AGL	100.00 ft AGL
Bearing (T)	71.08	251.28
Antenna Orientation	71.08	251.28
Path Angle	1.23	-1.23
Antenna Tilt		
Freq (MHz)	6700	6700
TX Power	1.000 W	
RX Threshold		-73.000 dBm
Antenna	UXA 6 - 59 A	UXA 6 - 59 A
(Ant File/ID)	AMSZ0030 Z003000191	AMSZ0030 Z003000191
Ant Gain (Major Lobe)	38.70 dBi	38.70 dBi
Ant Gain (Along Path)	38.70 dBi	38.70 dBi
Line 1	Andrew EW63 Elliptical Waveguide_ 5.9	Andrew EW63 Elliptical Waveguide_ 5.9
(Line1 File/ID)	LmsAND00 0120000015	LmsAND00 0120000015
Line1 Length	90.00 ft	130.00 ft
Line1 Loss	1.22 dB	1.77 dB
Circulator Loss	0.50 dB	0.50 dB
Connector Loss	0.25 dB	0.25 dB
Jumper Loss	0.50 dB	0.50 dB
Radome Loss	0.50 dB	0.50 dB
Gain1		dB
Gain2		dB
Bearing (T)	71.08	251.28
Distance	18.68 mi	18.68 mi
Absorption Loss		0.07 dB
Rain Loss		0.01 dB
Alignment Loss		0.00 dB
Other Loss		0.00 dB
Free Space Loss		138.55 dB
Total Gains dBm		107.4
Total Loss dB		145.12
Received Signal Level dBm		-37.72
Unfaded Fade Margin dB		35.28
Digital EIFM		0
Digital AIFM		0
Digital DFM		46
Composite Fade Margin		34.93
Terrain Factor (a)	0.756	
Climate Factor (b)	0.275	
Undp (TFM)		6.73E-06
Reliability (%)		99.99932743
Outage (sec/yr)		212

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Figure A - 3
Point Reyes Coastal to Point Reyes Hill

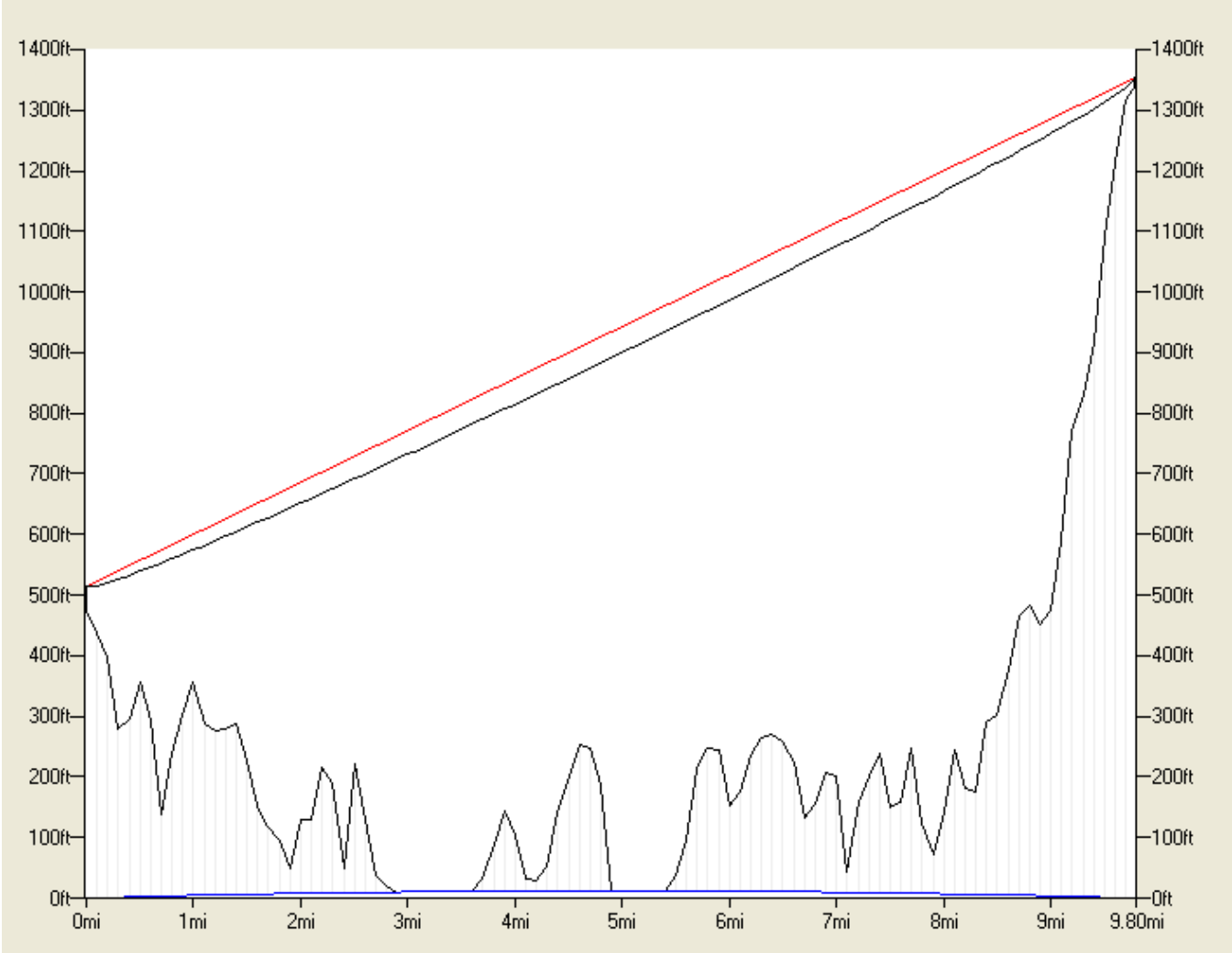
PT REYES COASTAL

37 59 47.70 N
123 00 49.00 W
WGS 84
Elev: 475.49 ft MSL

TRANSMITTER:
FREQ: 6700.00000 MHz
ERP: 66.45 dBm

TX Antenna:
ANT HGT: 40.00 ft AGL
DESC: UXA 8 - 59 A
GAIN: 41.30 dBi
ORIENT: 54.11

RX Antenna (Primary):
ANT HGT: 40.00 ft AGL
DESC: UXA 8 - 59 A
GAIN: 41.30 dBi
ORIENT: 54.11



PT REYES HILL

38 04 47.08 N
122 52 4.98 W
WGS 84
Elev: 1343.50 ft MSL

TRANSMITTER:
FREQ: 6700.00000 MHz
ERP: 66.86 dBm

TX Antenna:
ANT HGT: 10.00 ft AGL
DESC: UXA 8 - 59 A
GAIN: 41.30 dBi
ORIENT: 234.2

RX Antenna (Primary):
ANT HGT: 10.00 ft AGL
DESC: UXA 8 - 59 A
GAIN: 41.30 dBi
ORIENT: 234.2

Effective Earth Curvature: 1.333

Fresnel Zone: 1.0 F1 at 6700.00000MHz

Azimuth 54.11°T Reverse 234.20°T

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Table A-3
Point Reyes Coastal to Point Reyes Hill

Site	PT REYES COASTAL	PT REYES HILL
Latitude	37 59 47.70 N	38 04 47.08 N
Lat (Dec Degrees)	37.99658333	38.07974444
Longitude	123 00 49.00 W	122 52 4.98 W
Lon (Dec Degrees)	-123.0136111	-122.86805
Site Elevation	475.49 ft	1343.50 ft
Antenna Center	40.00 ft AGL	10.00 ft AGL
Bearing (T)	54.11	234.2
Antenna Orientation	54.11	234.2
Path Angle	0.93	-0.93
Antenna Tilt		
Freq (MHz)	6700	6700
TX Power	1.000 W	
RX Threshold		-73.000 dBm
Antenna	UXA 8 - 59 A	UXA 8 - 59 A
(Ant File/ID)	AMSZ0030 Z003000192	AMSZ0030 Z003000192
Ant Gain (Major Lobe)	41.30 dBi	41.30 dBi
Ant Gain (Along Path)	41.30 dBi	41.30 dBi
Line 1	Andrew EW63 Elliptical Waveguide_ 5.9	Andrew EW63 Elliptical Waveguide_ 5.9
(Line1 File/ID)	LmsAND00 0120000015	LmsAND00 0120000015
Line1 Length	70.00 ft	40.00 ft
Line1 Loss	0.95 dB	0.54 dB
Line 2		
(Line2 File/ID)		
Line2 Length	0.00 ft	0.00 ft
Line2 Loss	0.00 dB	0.00 dB
Circulator Loss	0.50 dB	0.50 dB
Connector Loss	0.25 dB	0.25 dB
Jumper Loss	0.50 dB	0.50 dB
Radome Loss	0.50 dB	0.50 dB
Bearing (T)	54.11	234.2
Distance	9.80 mi	9.80 mi
Absorption Loss		0.07 dB
Rain Loss		0.01 dB
Alignment Loss		0.00 dB
Other Loss		0.00 dB
Free Space Loss		132.94 dB
Total Gains dBm		112.6
Total Loss dB		138.01
Received Signal Level dBm		-25.41
Unfaded Fade Margin dB		47.59
Digital EIFM		0
Digital AIFM		0
Digital DFM		46
Composite Fade Margin		43.71
Terrain Factor (a)	0.756	
Climate Factor (b)	0.275	
Undp (TFM)		5.70E-08
Reliability (%)		99.9999943
Outage (sec/yr)		2

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Figure A - 4
Radar Tower to Wolfback Ridge

RADAR TOWER

37 49 13.31 N
122 31 51.00 W
WGS 84
Elev: 250.67 ft MSL

TRANSMITTER:
FREQ: 10700.00000 MHz
ERP: 57.47 dBm

TX Antenna:
ANT HGT: 60.00 ft AGL
DESC: SU 2 - 107 A
GAIN: 34.20 dBi
ORIENT: 40

RX Antenna (Primary):
ANT HGT: 60.00 ft AGL
DESC: SU 2 - 107 A
GAIN: 34.20 dBi
ORIENT: 40

WOLFBACK RIDGE

37 51 3.52 N
122 29 54.36 W
WGS 84
Elev: 1112.54 ft MSL

TRANSMITTER:
FREQ: 10700.00000 MHz
ERP: 57.47 dBm

TX Antenna:
ANT HGT: 60.00 ft AGL
DESC: SU 2 - 107 A
GAIN: 34.20 dBi
ORIENT: 220.02

RX Antenna (Primary):
ANT HGT: 60.00 ft AGL
DESC: SU 2 - 107 A
GAIN: 34.20 dBi
ORIENT: 220.02

Effective Earth Curvature:
1.333

Fresnel Zone: 1.0 F1 at
10700.00000MHz

Azimuth 40.00°T Reverse
220.02°T

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Table A-4
Radar Tower to Wolfback Ridge

Site	RADAR TOWER	WOLFBACK RIDGE
Latitude	37 49 13.31 N	37 51 3.52 N
Lat (Dec Degrees)	37.82036389	37.85097778
Longitude	122 31 51.00 W	122 29 54.36 W
Lon (Dec Degrees)	-122.5308333	-122.4984333
Site Elevation	250.67 ft	1112.54 ft
Antenna Center	60.00 ft AGL	60.00 ft AGL
Bearing (T)	40	220.02
Antenna Orientation	40	220.02
Path Angle	3.39	-3.39
Antenna Tilt		
Freq (MHz)	10700	10700
TX Power	1.000 W	
RX Threshold		-73.000 dBm
Antenna	SU 2 - 107 A	SU 2 - 107 A
(Ant File/ID)	AMSZ0030 Z003000512	AMSZ0030 Z003000512
Ant Gain (Major Lobe)	34.20 dBi	34.20 dBi
Ant Gain (Along Path)	34.20 dBi	34.20 dBi
Line 1	Andrew EWP90 Elliptical Waveguide_ 10.	Andrew EWP90 Elliptical Waveguide_ 10.
(Line1 File/ID)	LmsAND00 0120000024	LmsAND00 0120000024
Line1 Length	90.00 ft	90.00 ft
Line1 Loss	2.83 dB	2.83 dB
Circulator Loss	0.50 dB	0.50 dB
Connector Loss	0.25 dB	0.25 dB
Jumper Loss	0.50 dB	0.50 dB
Radome Loss	0.50 dB	0.50 dB
Bearing (T)	40	220.02
Distance	2.76 mi	2.76 mi
Absorption Loss		0.07 dB
Rain Loss		0.01 dB
Alignment Loss		0.00 dB
Other Loss		0.00 dB
Free Space Loss		126.00 dB
Total Gains dBm		98.4
Total Loss dB		135.24
Received Signal Level dBm		-36.84
Unfaded Fade Margin dB		36.16
Digital EIFM		0
Digital AIFM		0
Digital DFM		46
Composite Fade Margin		35.73
Terrain Factor (a)	0.756	
Climate Factor (b)	0.275	
Undp (TFM)		2.82E-08
Reliability (%)		99.99999718
Outage (sec/yr)		1

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Figure A-5
Mount Tiburon to Martha

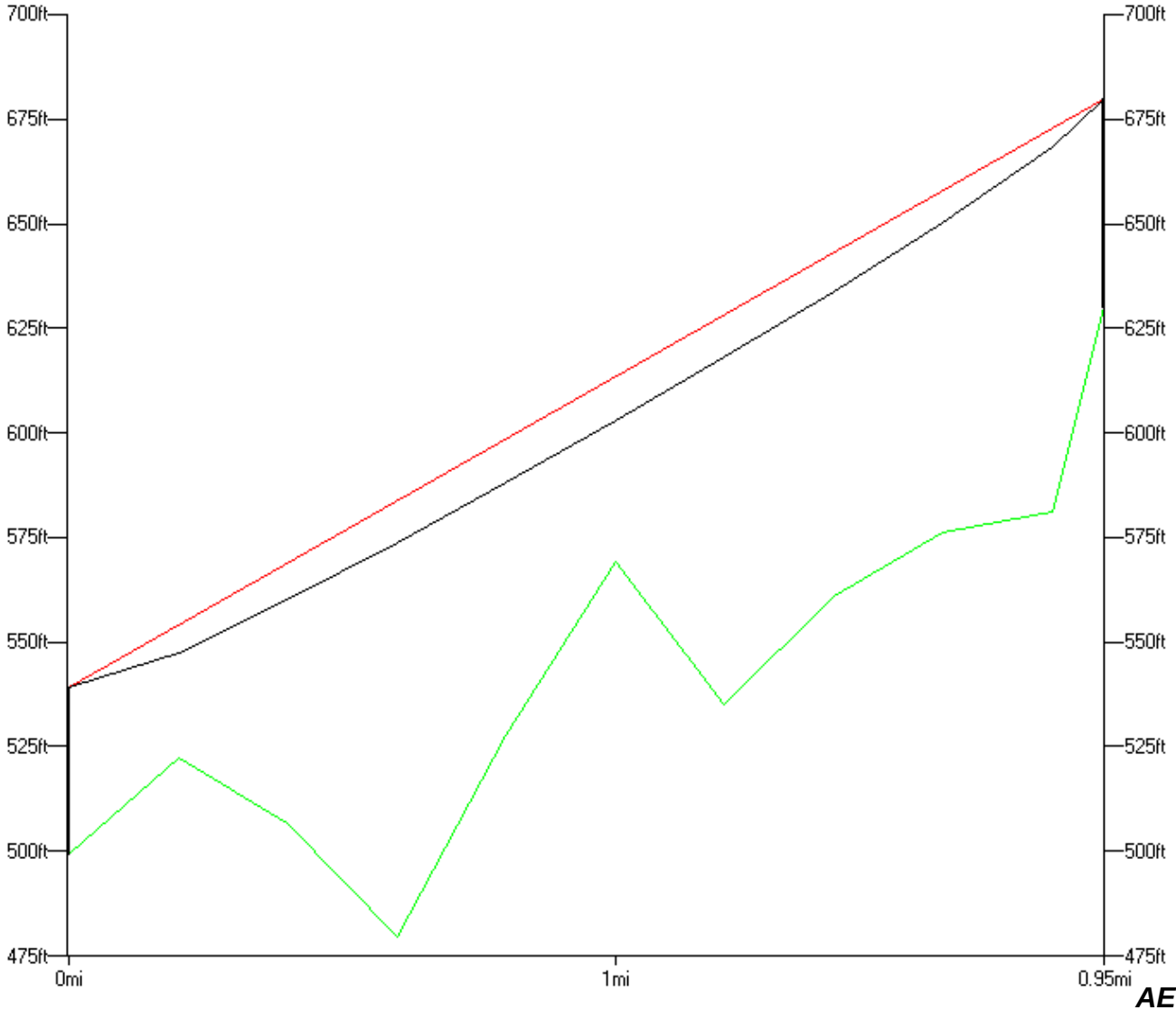
MT TIBURON

37 53 25.69 N
122 27 59.18 W
WGS 84
Elev: 499.24 ft MSL

TRANSMITTER:
FREQ: 10700.00000 MHz
ERP: 1.00 W

TX Antenna:
ANT HGT: 40.00 ft AGL
DESC: UXA 4 - 107 A (P)
GAIN: 40.40 dBi
ORIENT: 111.08

RX Antenna (Primary):
ANT HGT: 40.00 ft AGL
DESC: UXA 4 - 107 A (P)
GAIN: 40.40 dBi
ORIENT: 111.08



MARTHA

37 53 7.91 N
122 27 0.97 W
WGS 84
Elev: 630.00 ft MSL

TRANSMITTER:
FREQ: 10700.00000 MHz
ERP: 1.00 W

TX Antenna:
ANT HGT: 50.00 ft AGL
DESC: UXA 4 - 107 A (P)
GAIN: 40.40 dBi
ORIENT: 291.08

RX Antenna (Primary):
ANT HGT: 50.00 ft AGL
DESC: UXA 4 - 107 A (P)
GAIN: 40.40 dBi
ORIENT: 291.08

Effective Earth Curvature: 1.333

Fresnel Zone: 1.0 F1 at 10700.00000MHz

Azimuth 111.08°T Reverse 291.09°T

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Table A-5
Mount Tiburon to Martha

Site	MT TIBURON	MARTHA
Latitude	37 53 25.69 N	37 53 7.91 N
Lat (Dec Degrees)	37.89047	37.88553
Longitude	122 27 59.18 W	122 27 0.97 W
Lon (Dec Degrees)	-122.46644	-122.45027
Site Elevation	499.24 ft	630.00 ft
Antenna Center	40.00 ft AGL	50.00 ft AGL
Bearing (T)	111.08	291.09
Antenna Orientation	111.08	291.08
Path Angle	1.61	-1.61
Antenna Tilt		
Freq (MHz)	10700	10700
TX Power	0.000 W	
RX Threshold		-73.000 dBm
Antenna	UXA 4 - 107 A (P)	UXA 4 - 107 A (P)
(Ant File/ID)	Amsz0030 Z003000526	Amsz0030 Z003000526
Ant Gain (Major Lobe)	40.40 dBi	40.40 dBi
Ant Gain (Along Path)	40.40 dBi	40.40 dBi
Line 1	Andrew EWP90 Elliptical Waveguide_ 10.	Andrew EW90 Elliptical Waveguide_ 10.
(Line1 File/ID)	LmsAND00 0120000024	LmsAND00 0120000023
Line1 Length	70.00 ft	80.00 ft
Line1 Loss	2.20 dB	2.51 dB
Line 2		
(Line2 File/ID)		
Line2 Length	0.00 ft	0.00 ft
Line2 Loss	0.00 dB	0.00 dB
Circulator Loss	0.50 dB	0.50 dB
Connector Loss	0.25 dB	0.25 dB
Jumper Loss	0.50 dB	0.50 dB
Combiner Loss	0.00 dB	
Splitter Loss		0.00 dB
Misc1 Loss	0.00 dB	0.00 dB
Misc2 Loss	0.00 dB	0.00 dB
Radome Loss	0.50 dB	0.50 dB
Gain1		dB
Gain2		dB
Bearing (T)	111.08	291.09
Distance	0.95 mi	0.95 mi
Absorption Loss		0.01 dB
Rain Loss CRANE:		0.00 dB
Alignment Loss		0.00 dB
Other Loss		0.00 dB
Free Space Loss		116.72 dB
Total Gains dBm		76.48
Total Loss dB		124.94
Received Signal Level dBm		-48.45
Unfaded Fade Margin dB		24.55
Terrain Factor (a)	1	
Climate Factor (b)	0.275	
Undp (TFM)		2.20E-08
Reliability (%)		99.99999781
Outage (sec/yr)		1

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Appendix B MERA System Draft Questionnaire

Table of Contents

1.0 User Information - Questions

Is your primary radio system Trunked or Conventional?
Your radio system is trunked if you use talk groups. Your radio system is conventional if you use channels or frequencies. If you are using the MERA system, then you are using a trunked radio system. Note: If you have additional conventional channels that are used for mutual aid or interoperability, these channels will be covered later.

Trunked
Conventional

Please describe your user category with regards to the radio system?

Radio Users
Radio Maintenance personnel
Dispatchers
Policy Makers

What is your operational structure, Select the best choice?

City Police Department
County Sheriff
City Fire Department
County Fire Department
Fire District
Volunteer Fire Department
Emergency Medical Services
Ambulance Service
College / University Public Safety
School system
Public Transit
Public Works
County Parks / Open Space
CA State Parks (Fire)
CA State Parks (Law)
CHP

Rate the factors that will influence your preferred radio system solution?
Most Important / Least Important

5	4	3	2	1	Daily Operational Requirements
5	4	3	2	1	Financial and Cost Considerations
5	4	3	2	1	Conventional Radio System
5	4	3	2	1	P25 / Standards Based Radio System
5	4	3	2	1	Interoperability Needs
5	4	3	2	1	Centralized Control
5	4	3	2	1	Agency Centered Control

2.0 Current Systems Information

Current Voice Radio Systems Information

Conventional Voice Radio System Assessment

(This section is only filled out by those whose primary radio system is conventional.)

Possible Answers for Ratings Questions; Fill in the Blank with appropriate Rating:

0. No problem identified
1. Identified problem, currently not of concern
2. Occasionally a problem
3. Regularly a problem
4. Frequently a problem
5. Critical concern
6. Don't Know

_____ **Limited Coverage:** With your current radio system, do you experience dead spots or have limited coverage?
Limited Coverage -- Dead spots regularly occur, particularly between dispatcher and user.

_____ **Mobile to Mobile:** Can you talk more than a short distance in direct mobile to mobile mode (Talk Around)?
Mobile to Mobile (Talk Around) -- Users cannot talk between mobile units more than a short distance.

_____ **Channel Unavailable:** With your current radio system, do you have too many users on the channel so that you cannot gain access on the channel?
Channel Unavailable -- Too many users on the channel so that the user cannot gain access when the situation requires communications with other units or with the dispatcher.

_____ **Channel Congestion:** On your radio system, do you hear too much unrelated chatter from other users or agencies?
Channel Congestion -- Too many unrelated functions using the channel; user tends to turn volume down unless they specifically need to call someone, and thus cannot be reached.

_____ **Outdoor Portable Operation:** Can you use your portable radio reliably outdoors?
Outdoor Portable Operation -- Portable radios cannot reliably be used on the system, particularly outdoors.

_____ **Indoor Portable Operation:** Can you use your portable radio reliably indoors?
Portable Operation -- Portable radios cannot generally and reliably be used on the system, particularly indoors.

_____ **Interference:** Do other users, either from your own or from another locality, interfere and step on local users?
Interference – Users from your own or other localities interfere and step on the local users. This either overrides critical communications or forces messages to be repeated.

_____ **System Reliability:** How **r**eliable is your radio system; does it frequently breakdown?
System Reliability – There are frequent breakdowns of old or poorly maintained infrastructure equipment.

_____ **Interoperability:** Does your radio system allow you to communicate between agencies within your jurisdiction?
Interoperability -- The system does not allow users the ability to communicate between agencies within the jurisdiction.

_____ **Regional Interoperability:** Does your radio system allow you to communicate with agencies outside your jurisdiction?
Regional Interoperability -- The system does not allow users the ability to communicate between agencies outside of the jurisdiction.

Conventional Voice Radio System Assessment (continued)

Possible Answers for Ratings Questions, Fill in the Blank with appropriate Rating:

0. No problem identified
1. Identified problem, currently not of concern
2. Occasionally a problem
3. Regularly a problem
4. Frequently a problem
5. Critical concern
6. Don't Know

_____ **Capacity:** How readily can you access a channel during peak hours or emergency conditions?
Capacity -- The system has insufficient capacity to support traffic associated with peak or emergency conditions.

_____ **Complex Operation:** How difficult is it to operate your radio on the system?
Complex Operation -- The radio is complicated to operate or the radio user needs to know the characteristics of the system, which could cause difficulty if the user is in a high-pressure situation.

_____ **Dispatcher Access:** Can you gain access to the Dispatcher?
Dispatcher Access -- For whatever reason, the dispatcher or the user cannot gain access to each other on a routine basis. Either the user must compete for the dispatcher's time, or the dispatcher has no way to contact the user.

_____ **Equipment Maintainability:** Is maintenance on your user equipment adequate, or do you regularly need to get the same thing fixed?
Equipment Maintainability-- Maintenance is inadequate on user equipment (including consoles and desk top units) ;the user regularly needs to return to get the same thing fixed.

Trunked Voice Radio System Assessment

Possible Answers for Ratings Questions: Fill in the Blank with appropriate Rating.

0. No problem identified
1. Identified problem, currently not of concern
2. Occasionally a problem
3. Regularly a problem
4. Frequently a problem
5. Critical concern
6. Don't Know

_____ **Limited Coverage:** With your current radio system, do you experience dead spots or have limited coverage?
Limited Coverage -- Dead spots regularly occur, particularly between dispatcher and user.

_____ **System Busies**: With your current radio system, do you have to wait to gain access to the radio system or do you experience System Busies?
System Busies -- Too many users on the system; user cannot gain access to the system when the situation requires communications with other units or with the dispatcher.

_____ **Talk Group Congestion:** On your radio system, do you hear too much unrelated chatter from other users?
Talk Group Congestion -- Too many unrelated functions using the talk group; user tends to turn volume down unless they specifically need to call someone, and thus cannot be reached.

_____ **Outdoor Portable Operation:** Can you use your portable radio reliably outdoors?
Outdoor Portable Operation -- Portable radios cannot reliably be used on the system, particularly outdoors.

_____ **Indoor Portable Operation:** Can you use your portable radio reliably indoors?
Portable Operation -- Portable radios cannot generally and reliably be used on the system, particularly indoors.

Trunked Voice Radio System Assessment (Continued)

Possible Answers for Ratings Questions: Fill in the Blank with appropriate Rating.

0. No problem identified
1. Identified problem, currently not of concern
2. Occasionally a problem
3. Regularly a problem
4. Frequently a problem
5. Critical concern
6. Don't Know

_____ **Interference:** Do you encounter static, garbled transmissions or dead spots that appear to be interference related?
Interference – Users from your own or other localities interfere. This can be experienced as "static" or garbled transmission or dead spots. This either overrides critical communications or forces messages to be repeated.

_____ **System Reliability:** How reliable is your radio system; does it frequently breakdown?
System Reliability – There are frequent breakdowns of old or poorly maintained infrastructure equipment.

_____ **Interoperability:** Does your radio system allow you to communicate between agencies within your jurisdiction?
Lack of Interoperability -- The system does not allow users the ability to communicate between agencies within the jurisdiction.

_____ **Regional Interoperability:** Does your radio system allow you to communicate with agencies outside your jurisdiction?
Lack of Regional Interoperability -- The system does not allow users the ability to communicate between agencies outside of the jurisdiction.

_____ **Capacity:** How readily can you access the system during peak hours or emergency conditions? *Capacity -- The system has insufficient capacity to support traffic associated with peak or emergency conditions.*

_____ **Complex Operation:** How difficult is it to operate your radio on the system?
Complex Operation -- The radio is complicated to operate or the radio user needs to know the characteristics of the system in order to operate on it. This could cause difficulty if the user is in a high-pressure situation.

_____ **Dispatcher Access:** Can you gain access to the Dispatcher?
Dispatcher Access -- For whatever reason, the dispatcher or the user cannot gain access to each other on a routine basis. Either the user must compete for the dispatcher's time, or the configuration is such that the dispatcher has no way to contact the user.

_____ **Equipment Maintainability:** Is maintenance on your user equipment adequate, or do you regularly need to get the same thing fixed?
Equipment Maintainability -- Maintenance is inadequate on user equipment (including consoles and desk top units); the user regularly needs to return to get the same thing fixed.

Radio System Traffic

_____ ***When is your typical busy hour?***

Rate the following attributes concerning your radio usage:

Very Disciplined				Need Training	
5	4	3	2	1	Channel Discipline (Using appropriate channel or talkgroup for the appropriate operational situation)
5	4	3	2	1	Radio Users are brief and show a good understanding of succinct radio transmissions
5	4	3	2	1	Radio Users understand interoperability channel or talkgroup structure and frequently use them
5	4	3	2	1	Radios Users understand the Incident Command Structure
5	4	3	2	1	Radio Users understanding of Future Technologies and the direction Radio Communications is headed.

Dispatch Center Radio Related Operations

The following questions relate to the radio operations of the dispatch / communication center.

_____ ***What are the dimensions of your dispatch center?***

_____ ***Number of Call Taker Positions?***

_____ ***Number of Dispatch Positions?***

_____ ***Number of spare positions?***

_____ ***How many consoles do you have?***

How many incoming circuits do you have? Indicate type (MW, T1, etc) and number?

Type _____ *Number* _____

Type _____ *Number* _____

Type _____ *Number* _____

What is the manufacturer and model of your consoles?

Manufacturer _____ *Model* _____

What is the manufacturer and version of your CAD?

Manufacturer _____ *Version* _____

Describe the Central Electronics Equipment. This is the control unit that controls the LMR.

Manufacturer _____ *Model* _____

Describe any unique features / requirements and SOPs in place for the Dispatch Center?

Describe any existing interfaces with other radio systems and Dispatch Centers

Describe any additional Dispatch Center Radio Requirements and / or features:

Voice Radio Problems / Enhancements

The following questions relate to the Existing Radio System Problems.

What voice radio system Features or Technologies do you need that you don't have today?

Describe any existing radio interface problems.

List any coverage problem areas, please be specific and include street / building and type of problem.

Describe any leased facilities and how you use them for current communications.

Location _____ *Type of Facility* _____

Equipment at Location _____

Location _____ *Type of Facility* _____

Equipment at Location _____

Describe any potential locations that could be used to improve coverage or support current communications.

Location _____ *Type of Facility* _____

Owner _____

Location _____ *Type of Facility* _____

Owner _____

Describe the aspects of the Communications System which are working well today.

_____

_____

Which areas need the most improvement?

_____

_____

Voice Radio Problems / Enhancements

The following questions relate to the Existing Radio System Problems.

What is the impression or perception of the existing radio system in the following categories?

Needs Improvement				No Change Needed	
5	4	3	2	1	Channel Capacity
5	4	3	2	1	Radio Coverage
5	4	3	2	1	Interoperability
5	4	3	2	1	Governance Structure
5	4	3	2	1	Maintenance
5	4	3	2	1	Radio Features
5	4	3	2	1	Cost and Monthly Fees

Describe any Budget or Funding Provisions that limit Radio Upgrades and / or Maintenance

_____

_____

_____

Additional Radio System Comments

3.0 Equipment Quantities Assessment

Current Subscriber Equipment Quantities

For each equipment category, enter the total number of units you operate (not including spares) for each frequency band.

Equipment Type	Low Band	VHF	UHF	Dual Band 700 / 800 MHz	800 MHz	900 MHz
Mobiles						
Portables						
Desk Top or Control Stations						

For each equipment category, enter the total number of spare units you have in inventory for each frequency band.

Equipment Type	Low Band	VHF	UHF	Dual Band 700 / 800 MHz	800 MHz	900 MHz
Mobiles						
Portables						
Desk Top or Control Stations						

Immediate Subscriber Equipment Needs

Are the equipment quantities you entered in the previous section sufficient for your current staffing needs?

Yes
No

For each equipment category, enter the total number of units you need today for each frequency band.

Equipment Type	Low Band	VHF	UHF	Dual Band 700 / 800 MHz	800 MHz	900 MHz
Mobiles						
Spare Mobiles						
Portables						
Spare Portables						
Desk Top or Control Stations						
Spare Desk Top or Control Stations						

Future Subscriber Quantities

Enter the percentage increase in the quantities of subscriber equipment estimated to be needed 5, 10 and 15 years from now. For example, if you currently have 500 mobiles, 300 portables, and 20 desktop stations, and you enter 10 (percent), this means you would need 50 more mobiles, 30 more portables, and 2 more Desktop stations in 5 years. This is a rough estimate, and so will be applied across each radio type (mobiles, portables, control stations). Note that the range is 0% to 1000%, allowing for no increase to up to 10 times as many radios as currently in place. It would be unusual for increases over 50%, unless you are expecting significant growth, or planning consolidation with other Agencies on a shared system, for example

	5 Years	10 Years	15 Years
What percentage increase in equipment do you forecast for 5, 10 and 15 years out?			

Describe any population or other factors that may impact the number of Radios needed.

Describe any Growth factor Challenges.

4.0 Interoperability Information

SAFECOM Continuum

Governance

A common governing structure for solving interoperability issues will improve the policies, processes, and procedures of any major project by enhancing communication, coordination, and cooperation, establishing guidelines and principles, and reducing any internal jurisdictional conflicts. This group should consist of local, tribal, state, and federal entities as well as representatives from all pertinent public safety disciplines within the identified region. A formal governance structure is critical to the success of interoperability planning.

Possible Answers for Ratings Questions:
1- Individual Agencies Working Independently
2- Informal Coordination Between Agencies
3- Key Multi-Discipline Staff Collaboration on a Regular Basis
4- Regional Committee Working with a Statewide Communications Interoperability Plan Framework
5- Don't Know

_____ **Please select the response that best describes your interoperability governance structure with other disciplines within your own jurisdiction or locality.**

_____ **Please select the response that best describes your interoperability governance structure with other agencies outside your jurisdiction or locality.**

_____ **Please select the response that best describes your interoperability governance structure between state and local government.**

_____ **Please select the response that best describes your interoperability governance structure between federal and local government.**

Standard Operating Procedures

Standard Operating Procedures (SOPs) are formal written guidelines or instructions for incident response. SOPs typically have both operational and technical components. Established SOPs enable emergency responders to successfully coordinate an incident response across disciplines and jurisdictions. Clear and effective SOPs are essential in the development and deployment of any interoperable communications system.

Possible Answers for Ratings Questions:

1- Individual Agency SOPs
2- Joint SOPs for Planned Events
3- Joint SOPs for Emergencies
4- Regional Set of Communications SOPs
5- National Incident Management (NIMS) Integrated SOPs
6- Don't Know

_____ **Please select the response that best describes your Standard Operating Procedures for interoperability with other disciplines within your own jurisdiction or locality.**

_____ **Please select the response that best describes your Standard Operating Procedures for interoperability with agencies outside your jurisdiction or locality.**

_____ **Please select the response that best describes your Standard Operating Procedures for interoperability between state and local government.**

_____ **Please select the response that best describes your Standard Operating Procedures for interoperability between federal and local government.**

Technology - Voice

Although technology is a critical tool for improving Interoperability, it is not the sole driver of an optimal solution. Success in each of the other elements is essential to its proper use an implementation, and should drive technology procurement. Technology is highly dependent upon existing infrastructure within a region. Multiple technology solutions may be required to support large events.

Possible Answers for Ratings Questions:

1- Swap Radios
2- Gateway
3- Shared Channels
4- Proprietary Shared Systems
5- Standards-based Shared Systems
6- Don't Know

_____ **Please select the response that best describes the technology or your means of interoperability with other disciplines within your own jurisdiction or locality.**

_____ **Please select the response that best describes the technology or your means of interoperability with other agencies outside your own jurisdiction or locality.**

_____ **Please select the response that best describes the technology or your means of interoperability between state and local government.**

_____ **Please select the response that best describes your interoperability governance structure between federal and local government.**

Technology – Data

Although technology is a critical tool for improving Interoperability, it is not the sole driver of an optimal solution. Success in each of the other elements is essential to its proper use an implementation, and should drive technology procurement. Technology is highly dependent upon existing infrastructure within a region. Multiple technology solutions may be required to support large events.

Possible Answers for Ratings Questions:

1- Swap Files
2- Common Applications
3- Custom-Interfaced Applications
4- One-Way Standards-based Sharing
5- Two-Way Standards-based Sharing
6- Don't Know

_____ **Please select the response that best describes the technology or your means of data interoperability with other disciplines within your own jurisdiction or locality.**

_____ **Please select the response that best describes the technology or your means of data interoperability with other agencies outside your own jurisdiction or locality.**

_____ **Please select the response that best describes the technology or your means of data interoperability between state and local government.**

_____ **Please select the response that best describes the technology or your means of data interoperability between federal and local government.**

Training and Exercises

Proper training and regular exercises are critical to the implementation and maintenance of a successful interoperability solution. Implementing effective training and exercise programs to practice communications interoperability is essential for ensuring that the technology works and responders are able to effectively communicate during emergencies.

Possible Answers for Ratings Questions:

1- General Orientation on Equipment
2- Single Agency Tabletop Exercises for Key Field and Support Staff
3- Multi-agency Tabletop Exercises for Key Field and Support Staff
4- Multi-agency Full Functional Exercises Involving All Staff
5- Regular Comprehensive Regional Training and Exercises
6- Don't Know

_____ **Please select the response that best describes your interoperability training and exercises with other disciplines within your own jurisdiction or locality.**

_____ **Please select the response that best describes your training and exercises for interoperability with agencies outside of jurisdiction.**

_____ **Please select the response that best describes your training and exercises for interoperability between state and local government.**

_____ **Please select the response that best describes your training and exercises for interoperability between federal and local government.**

Usage

Usage refers to how often interoperable communications technologies are used. Success in this element is contingent upon progress and interplay among the other four elements on the Interoperability Continuum.

Possible Answers for Ratings Questions:
1- Planned Events
2- Localized Emergency Incidents
3- Regional Incident Management
4- Daily Use Throughout Region
5- Don't Know

_____ **Please select the response that best describes how often you use interoperability with other disciplines within your own jurisdiction or locality.**

_____ **Please select the response that best describes how often you use interoperability with other agencies outside your jurisdiction.**

_____ **Please select the response that best describes how often you use interoperability between state and local government.**

_____ **Please select the response that best describes how often you use interoperability between federal and local government.**

Voice Systems Interoperability Assessment

What disciplines within your jurisdiction do you currently have interoperability with?

Select all that apply – Disciplines within your jurisdiction that your Agency currently has interoperability with. If you do not have interoperability with any other disciplines, check "None".

☐ Law Enforcement - Sheriff
☐ Law Enforcement - Police
☐ Law Enforcement - Tribal
☐ Fire
☐ EMS
☐ Emergency Management

☐ Hospitals
☐ Correctional Facilities
☐ Local Public Works
☐ Other Local Government
☐ Other Tribal Government
☐ Other
☐ None

What disciplines outside your jurisdiction do you currently have interoperability with?

Select all that apply – Disciplines outside your jurisdiction that your Agency currently has interoperability with. If you do not have interoperability with any other disciplines, check "None".

☐ Law Enforcement - Sheriff
☐ Law Enforcement - Police
☐ Law Enforcement - Tribal
☐ Fire
☐ EMS
☐ Emergency Management
☐ Hospitals
☐ Correctional Facilities
☐ Local Public Works
☐ Other Local Government
☐ Other Tribal Government
☐ Other
☐ None

What State Agencies are you currently able to communicate with? (List must be customized for applicable state)
Select all that apply - State Agencies that your Agency communicates with. If you do not communicate with any State Agencies, check "None".

☐ State Police
☐ Fish and Game
☐ Homeland Security
☐ Dept. of Agriculture
☐ Dept. of Commerce
☐ Corrections
☐ Health
☐ Emergency Management
☐ Human Services
☐ Information Technologies
☐ National Guard
☐ Transportation Dept.
☐ Other
☐ None

What Federal Agencies are you currently able to communicate with?
Select all that apply - Federal Agencies that your agency communicates with. If you do not communicate with any Federal Agencies, check "None".

☐ Alcohol, Tobacco, and Firearms
☐ Bureau of Land Management
☐ Drug Enforcement Administration
☐ Dept of Interior
☐ Dept of Homeland Security
☐ Environmental Protection Agency
☐ Federal Bureau of Investigation
☐ National Parks Service
☐ Natural Resource Conservation Service
☐ Secret Service
☐ Transportation Security Agency
☐ US Dept of Agriculture
☐ US Forest Service
☐ US Fish and Wildlife Service
☐ US Marshals
☐ US Postal Service
☐ Other
☐ None

If you selected "Other" for having interoperability with any local, state or federal disciplines or agencies, please enter the agencies here.
List the specific disciplines that you have interoperability with that are not listed above.

_____

_____

What disciplines in your jurisdiction do you need to communicate with, but cannot?
Select all that apply – Disciplines that your Agency is not currently able to interoperate with. If you do not communicate with any other disciplines, check "None".

☐ Law Enforcement - Sheriff
☐ Law Enforcement - Police
☐ Law Enforcement - Tribal
☐ Fire
☐ EMS
☐ Emergency Management
☐ Hospitals
☐ Correctional Facilities
☐ Local Public Works
☐ Other Local Government
☐ Other Tribal Government
☐ Other
☐ None

What disciplines outside of your jurisdiction do you need to communicate with, but cannot?
Select all that apply – Disciplines that your Agency is not currently able to interoperate with. If you do not communicate with any other disciplines, check "None".

- ☐ Law Enforcement - Sheriff
- ☐ Law Enforcement - Police
- ☐ Law Enforcement - Tribal
- ☐ Fire
- ☐ EMS
- ☐ Emergency Management
- ☐ Hospitals
- ☐ Correctional Facilities
- ☐ Local Public Works
- ☐ Other Local Government
- ☐ Other Tribal Government
- ☐ Other
- ☐ None

What State Agencies or disciplines do you need to communicate with, but cannot? (List must be customized for applicable state)
Select all that apply - State Agencies that your Agency is not currently able to interoperate with. If you do not communicate with any other disciplines, check "None".

- ☐ California Highway Patrol
- ☐ Fish and Game
- ☐ Homeland Security
- ☐ Dept. of Agriculture
- ☐ Dept. of Commerce
- ☐ Corrections
- ☐ Health
- ☐ Emergency Management
- ☐ Human Services
- ☐ Information Technologies
- ☐ National Guard
- ☐ Transportation Dept.
- ☐ Other
- ☐ None

What Federal Agencies or disciplines do you need to communicate with, but cannot? (List must be customized for applicable state)
Select all that apply – Federal Agencies that your Agency is not currently able to interoperate with. If you do not communicate with any other disciplines, check "None".

- ☐ Alcohol, Tobacco, and Firearms
- ☐ Bureau of Land Management
- ☐ Drug Enforcement Administration
- ☐ Dept of Interior
- ☐ Dept of Homeland Security

- ☐ Environmental Protection Agency
- ☐ Federal Bureau of Investigation
- ☐ National Parks Service
- ☐ Natural Resource Conservation Service
- ☐ Secret Service
- ☐ Transportation Security Agency
- ☐ US Dept of Agriculture
- ☐ US Forest Service
- ☐ US Fish and Wildlife Service
- ☐ US Marshals
- ☐ US Postal Service
- ☐ Other
- ☐ None

If you selected "Other" for needing interoperability with any local, state or federal disciplines or agencies, please enter the agencies here.
List the specific Agencies that you communicate with (interoperations) that have not been selected above.

_____

_____

_____

Please list the agencies that you have mutual aid responsibilities with.

_____ _____

_____ _____

_____ _____

_____ _____

Please list any interagency communication requirements not already mentioned.

_____ _____

Please list the agencies that you have interoperable communications with. There is no need to list those agencies on the MERA system, since all agencies on this shared system have interoperable capabilities with one another.

_____ _____

_____ _____

_____ _____

_____ _____

Please Check the frequency bands that you use for Day to Day communications.

☐ Conventional VHF	☐ Conventional UHF	☐ Conventional VHF Lowband
☐ Trunked UHF (MERA)	☐ Other _____	

Please Check the frequency bands that you use for Interoperable communications.

☐ Conventional VHF	☐ Conventional UHF	☐ Conventional VHF Lowband
☐ Fairfield / Vacaville 800 MHz	☐ Sonoma County UHF	☐ Sonoma County VHF
☐ Richmond 800 MHz	☐ Oakland 800 MHz	☐ Alameda 800 MHz
☐ Contra Costa VHF	☐ Contra Costa UHF	☐ CHP Lowband
☐ CalFire VHF	☐ CLEMARS	☐ San Francisco County
☐ Trunked UHF (MERA)	☐ Other _____	

5.0 Future Systems Information

Voice Radio Systems Operations

Possible Answers for Ratings Questions:
0. Attribute is NOT IMPORTANT to the user.
1. Attribute is MINIMALLY IMPORTANT to the user.
2. Attribute is NICE TO HAVE, could enhance operations.
3. Attribute is USEFUL, will promote more efficient day to day operation.
4. QUITE IMPORTANT, lack could result in degradation of mission, injury, or loss of property.
5. CRITICAL, lack generally will result in injury, loss of property, or degradation of mission.
6. Don't Know, insufficient information available to answer this question.

_____ **Improved Voice Radio Coverage:** The system should provide radio coverage evenly distributed over the service area for all operational functions. The goal is for there to be no dead spots.
The system shall provide a signal availability of 95 percent to/from mobile radios, with coverage evenly distributed over the service area for all operational functions.

_____ **In-Building Coverage:** The radio system should provide in-building coverage in the metropolitan areas and in other areas where appropriate.
The system shall provide a signal availability of 95 percent to/from portables in building.

_____ **Minimize Interference:** The system should minimize or eliminate interference.

_____ **Increased Channel Capacity:** The system design shall include additional channels for current and future capacity. Additional channels are important to alleviate congestion on the dispatch and incident channels.

_____ **On-Scene Fireground/Tactical Communications Channels:** The system design should include licensed simplex frequencies for use by fire departments on-scene.
Direct radio-to-radio frequencies (firegrounds) enable local incident communications in-building, below grade, and in other situations where repeated channels do not offer solid coverage.

_____ **Monitored Firegrounds:** The system design should provide a means or routing fireground channels to dispatch. *Fireground communications must be available to be monitored by dispatch, command personnel, or recording.*

_____ **Emergency Alerting:** The radios and system shall provide an emergency function for alerting dispatch and supervisors to the need for assistance.

_____ **Workgroup Oriented Operation:** The system shall be organized with sufficient channels or talk groups to allow departmental workgroups to have their own channel or talk group.

_____ **Voice Security:** The system shall provide encrypted communications for users that need to prevent unauthorized interception of sensitive information.

_____ **Operational Boundary Transparency:** The radio system design shall utilize multiple tower sites, and to the extent possible, automatically switch to the correct site, transparent to the radio user.
System operation will be logical, with the focus on whom the user wants to call rather than where they are located. Changes in the user Agencies' operational boundaries shall be transparent to radio users. The radio system shall allow any group or department to operate with full communications capability within the service area.

_____ **One System Serves All Agencies:** One radio system shall support all Public Safety agencies including all Law Enforcement, Fire agencies and Emergency Medical Service agencies. It may also support Public Service agencies.
Convenient, same-radio communications is important between all Public Safety agencies within the Locality.

Possible Answers for Ratings Questions:
0. Attribute is NOT IMPORTANT to the user.
1. Attribute is MINIMALLY IMPORTANT to the user.
2. Attribute is NICE TO HAVE, could enhance operations.
3. Attribute is USEFUL, will promote more efficient day to day operation.
4. QUITE IMPORTANT, lack could result in degradation of mission, injury, or loss of property.
5. CRITICAL, lack generally will result in injury, loss of property, or degradation of mission.
6. Don't Know, insufficient information available to answer this question.

_____ **Interoperability through Dispatch:** The radio system shall provide a connection between all dispatch operations allowing dispatchers to facilitate information flow between agencies through dispatch and incident command, rather than at the user level.

_____ **Interoperability with Adjacent Localities:** The radio system design shall emphasize compatibility with radio systems in the adjacent localities to enable public safety users to assist in adjacent counties (and visa versa) and communicate with users from other Public Safety agencies using their assigned radios.

_____ **Interoperability with State Agencies:** The radio system design should emphasize compatibility with radio systems in use by the State to facilitate communications with State agencies.

_____ **Interoperability with Federal Agencies:** The radio system design shall emphasize compatibility with radio systems in use by the Federal agencies operating in the locality.
While local agencies cannot operate radio on Federal channels, compatible equipment would facilitate Federal/local cooperative efforts if Federal users could communicate over the locality infrastructure.

_____ **Person Location:** The radio system shall include radio location technology to map the location of user radios.
Dispatch can determine the location of a user (to his portable or mobile radio), useful for example when sending assistance.

_____ **System Control:** The Locality is significantly more comfortable with the high level of system control that comes with exclusive use and system ownership.

_____ **Text Messaging:** The mobiles and portable radios shall be capable of text messaging.

_____ **Dual Band Operation:** The user radios need to operate on both VHF and 700 / 800 MHz.

_____ **Recorder Operations:** The system design shall provide the capability of recording audio for all Public Safety agencies using the system.
Logged audio is important for all dispatch and incident communications.

_____ **Future Expansion:** The system shall be capable of future expansion in the number of channels and the number of users. *System design shall incorporate expansion to the level of usage predicted for the next 15 years with only the addition of equipment.*

_____ **Owner-Controlled Connectivity Network:** The system shall be interconnected using a dedicated interconnecting backbone network, such as microwave or fiber.
The goal is to maximize reliability, minimize use of leased carriers and associated costs, and maintain control of the network. Additionally, a dedicated, highly reliable network interconnecting all major radio locations is highly desired. This can be via microwave or fiber

_____ **Microwave Additional Capacity:** The network design shall include extra capacity, over and above the radio and mobile data needs, for other Locality uses.

_____ **Regional Connectivity:** The system design shall provide infrastructure connectivity to adjacent areas.

_____ **OTAP:** The system shall provide for Over-the-Air-Programming of radios.

Possible Answers for Ratings Questions:
0. Attribute is NOT IMPORTANT to the user.
1. Attribute is MINIMALLY IMPORTANT to the user.
2. Attribute is NICE TO HAVE, could enhance operations.
3. Attribute is USEFUL, will promote more efficient day to day operation.
4. QUITE IMPORTANT, lack could result in degradation of mission, injury, or loss of property.
5. CRITICAL, lack generally will result in injury, loss of property, or degradation of mission.
6. Don't Know, insufficient information available to answer this question.

_____ **OTAR:** The system shall provide for Over-the-Air-Rekeying of encrypted radios.

_____ **Over-the-Air-Reflash:** The system shall provide for over-the-air upgrades to operating software or new software versions for mobiles and portables.

_____ **Survivability:** The system shall be designed to survive in severe weather or emergency conditions.
If dispatch points are shifted from their primary to a backup location, radio control shall be available at the backup location to the same degree it was available at primary dispatch.

_____ **Reliability/Failure Hierarchy:** The radio system and equipment must be designed such that single-mode failures do not perceptibly impact the routine operations of the system.
The following requirements shall apply to failure conditions:

- *Channel failure: no operating impact due to failed voice channel.*
- *Site failure: no operating impact except reduced coverage area.*
- *Primary power failure: UPS backup shall be supplied for all communications equipment, and generator backup for the radio equipment.*
- *Console failures: Single console failure: use reserve console. Console common equipment failure: dispatchers operate co-located radio control station. Communications Center failure: Dispatch using radio control stations at a backup dispatch center.*

_____ **Single Points of Failure:** The system shall, as much as practical, minimize single points of failure.
This is accomplished through redundant equipment, multi-node network design, distributed processing, backup equipment, etc.

_____ **Power Backup:** All fixed radio equipment shall require backup power with automatic transfer, capable of handling 100 percent loading of radio equipment. An uninterruptible power system (UPS) shall be required for all communications equipment.

_____ **Staffing and Training:** The system vendor shall provide formal training for system administrators, supervisors, dispatchers, radio users, and maintenance technicians.

_____ **Centralized Maintenance:** The Locality / Agency prefers to centrally maintain and administer the radio system, dispatch systems, and user radios, either in-house or using a service shop.
Centralized maintenance provides consistent and coordinated services for all user departments.

_____ **Competitive Procurement Process:** The overall system concept shall be available from more than one vendor allowing a competitive procurement process.
Equipment shall be procured using open non-restrictive, competitive specifications. Award to be based on the most cost-effective system meeting the specified operational and functional requirements.

_____ **Commonality of Equipment:** A single vendor shall install and supply all required equipment; as much as possible, user equipment shall be similar in operation and maintenance requirements.
The goal is to minimize spare parts inventory and multiple vendor training requirements.

Possible Answers for Ratings Questions:

0. Attribute is NOT IMPORTANT to the user.
1. Attribute is MINIMALLY IMPORTANT to the user.
2. Attribute is NICE TO HAVE, could enhance operations.
3. Attribute is USEFUL, will promote more efficient day to day operation.
4. QUITE IMPORTANT, lack could result in degradation of mission, injury, or loss of property.
5. CRITICAL, lack generally will result in injury, loss of property, or degradation of mission.
6. Don't Know, insufficient information available to answer this question.

_____ **Multiple Sources:** Compatible user equipment shall be available from multiple vendors. Competitive procurement of user equipment is more important than equipment commonality.

_____ **Phased Implementation:** As much as possible, system procurement and implementation shall occur on a phased basis, allowing costs to be spread over several years. The radio system shall be designed to add user groups to the system over time.

_____ **Tiered Subscriber Cost:** High-, mid-, and low-tier radio equipment with feature sets and costs matched to the user group shall be provided.

The initial cost of user radios is a prime concern in the evaluation of proposed alternatives.

Appendix C Environmental Impact Analysis

1.0 Introduction and Objectives

AECOM assist the County of Marin Department of Public Works and the Marin Emergency Radio Authority (MERA) in their proposed project to expand emergency radio capability in Marin County through the addition of new antennas and related equipment at four locations, referred to throughout this document as the *MERA Project*.

The objectives of this document are to:

- Provide a summary of the *MERA Project* to aid future planning and environmental review efforts, including the preparation of a Request for Proposal (RFP) for consulting services;
- Provide relevant environmental setting information for each proposed location;
- Identify adopted regulatory plans applicable to the project;
- Identify potential environmental impacts; and
- Identify likely level of environmental documentation required for CEQA and NEPA compliance.

2.0 Project Description

The following describes the locations, land use designations, applicable land use plans, existing environmental conditions, and a description of the proposed project at each of the four locations: Wolfback Ridge, Point Reyes Coastal, Point Bonita Radar Tower, and Mount Tomales. All four sites contain existing telecommunications facilities with existing towers; however, there are currently no MERA facilities at these sites; therefore, for the purpose of this study, they are considered new sites. **Exhibit 1** illustrates the locations of the four proposed sites.

Location No. 1: Wolf Back Ridge
Assessor's Parcel No: 200-120-02
Owner: Sundial Broadcasting Corporation
Marin County Land Use Designation: Planned Residential (PR)
Marin County Zoning: Residential Multiple-Family, one unit per 20 acres maximum density (RMP-0.05)
Applicable Land Use Plans: *Marin Countywide Plan* and *Golden Gate National Recreation Area General Management Plan*

Environmental Setting [1]

The project site is an existing telecommunications facility located at the terminus of Sundial Road, approximately three-eighths of a mile west of U.S. 101 on Wolfback Ridge, west of the City of Sausalito in unincorporated Marin County. Although the site is privately owned by the Sundial Broadcasting Company, the one-half-acre property is located entirely within the Golden Gate National Recreation Area (GGNRA). Gated access through the GGNRA is provided over an approximately one-half-mile dirt road through a 30-foot wide road easement that extends from the end of Spencer Avenue to the site. The nearest occupied buildings are residences located approximately 830 feet to the east. **Exhibit 2** depicts the project site.

The project site contains existing telecommunications facilities, including a 100-foot high lattice tower, four equipment buildings, emergency electric power generators, and various ground-level equipment cabinets. The facility includes several FM stations and antennas / equipment for various wireless communication providers. The site is enclosed by a six-foot tall chain link fence topped with barbed wire.

This site is located approximately 1122 feet above MSL on the summit of Mt. Beacon. The site slopes gently (five percent) downslope to the southwest. The predominate vegetation type at the site is grassland. Mission Blue Butterfly habitat is known to occur near the project site. [2] No streams or other water features (e.g., wetlands) transect or exist at or adjacent to the project site. Additionally, there are no faults in the immediate vicinity but the area is subject to strong ground shaking from its proximity to the San Andreas and Hayward faults.

The site is within the jurisdiction of both the County of Marin and the National Park Service and is therefore subject to the *Marin Countywide Plan* and the *Golden Gate National Recreation Area General Management Plan*. **Section 3.0 Adopted Plans and Policies** describes policies relevant to the proposed project.

Proposed Project at Wolfback Ridge Site

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1 Information for this site was collected from *Staff Report to the Deputy Zoning Administrator, Sundial Broadcasting Corporation / Metro PCS Inc., Use Permit and Design Review*, Marin County Community Development Agency, October 10, 2002 and from Marin Map Data Viewer, accessed online at http://marinmap.org.

2 Mission Blue Butterfly is a federally-listed species and its protection has been an issue for previous telecommunications-related projects at this location. **Section 4.0 CEQA / NEPA Compliance** describes the ramifications of its presence in greater detail.

The proposed project would install (at a minimum) four (4), approximately two-inch diameter, 40-inch length omni antennas and two (2) approximately 24-inch diameter microwave dishes on the existing 100-foot high lattice tower. The exact location and height the antenna would be mounted at is not known at this time. It is assumed that any new equipment cabinets would be installed within an existing equipment building located within the existing fence line. No ground disturbance (i.e., grading) or tree removal is anticipated and the size of existing facility would not be expanded beyond its current footprint. [3]

Location No. 2: Point Bonita Radar Tower
Assessor's Parcel No: 200-150-07
Owner: United States of America
Marin County Land Use Designation: Coastal Open Space (C-OS)
Marin County Zoning: Coastal Open Area (C-OA)
Applicable Land Use Plans: *Marin Countywide Plan / Local Coastal Program (Unit I)* and *Golden Gate National Recreation Area General Management Plan.*

Environmental Setting [4]

This site is owned by the United States Coast Guard and is located within the Golden Gate National Recreation Area, approximately one-third of a mile north of the Point Bonita Lighthouse. The approximately 0.25-acre site is located approximately 600 feet southwest of Mendell Road near its intersection with Conzelman Road. The nearest occupied buildings include the YMCA / Hostelling International / Headlands Center for the Arts complex approximately 0.2 miles to the northeast and historic residences approximately 0.2 miles to the east.

The proposed site contains an existing 120-foot Vessel Traffic Service (VTS) radar tower. Approximately eight- to ten-foot, ground-level equipment cabinets are located downslope to the east and are connected to the tower pad by a staircase. The site is enclosed by an approximately eight-foot chain link fence topped with barbed wire. **Exhibit 3** illustrates the above features of the project site.

The site is adjacent to and accessed from the Bonita Ridge access road, an unpaved road in the vicinity of the radar site. Bonita Ridge is also used by hikers and other visitors of the Marin Headlands and Point Bonita Lighthouse. An historic stairs that ascend up to the original Coast Guard radar site is located adjacent to the radar site.

The existing tower is located 254 feet above MSL approximately 40 feet from a cliff above the Pacific Ocean. While the tower is located on a level pad, the site slopes approximately 25 percent from west to east. The predominant vegetation types within the vicinity of the Radar Tower site are native northern coastal scrub and mixed non-native woodland, which is dominated by planted Monterey cypress (Cupressus macrocarpa) and Monterey pine (Pinus radiata). No streams or other water resources (e.g., wetlands) transect or exist at or adjacent to the project site. Additionally, there are no faults in the immediate vicinity of the site, but the area is subject to strong ground shaking due to its proximity to the San Andreas and Hayward faults.

The Point Bonita Radar Tower site is visible from several potentially sensitive viewpoints, including some that experience a high degree of recreational use: the Point Bonita Lighthouse, the scenic-viewing area at the end of Mendell Road, west of Battery Mendell; Conzelman Road coming up from Rodeo Lagoon and the Nike Site just as it passes below Battery Wallace and before the entrance to the YMCA conference center; and the middle span of the Golden Gate Bridge (though the proposed antenna improvements [see below]would not likely be visible from distant views such as from the Golden Gate Bridge).

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[3] See assumptions in **Section 4.0 CEQA / NEPA Compliance**.

[4] Information for this site was collected from *Environmental Assessment for Replace/Relocate U.S. Coast Guard Vessel Traffic Service (VTS) Radar Tower at Point Bonita, Marin County, California,* Department of Homeland Security, June 2005, a site visit on March 20, 2010, and from Marin Map Data Viewer, accessed online at http://marinmap.org.

The site is within the jurisdiction of both the County of Marin and the National Park Service and is subject to the *Marin Countywide Plan / Local Coastal Program (Unit I)* and the *Golden Gate National Recreation Area General Management Plan*. However, the site itself is owned by the United States Coast Guard who maintains ultimate authority over the property. **Section 3.0 Adopted Plans and Policies** describes policies relevant to the proposed project.

Proposed Project at Point Bonita Radar Tower Site

The proposed project would install (at a minimum) two (2), approximately two-inch diameter, 40-inch length omni antennas and one (1) approximately 24-inch diameter microwave dish on the existing 120-foot high radar tower. The exact location and height the antenna would be mounted at is not known at this time. New equipment cabinets would be installed within the existing fence line. No ground disturbance (i.e., grading) or tree removal is anticipated and the size of the existing facility would not be expanded beyond its current footprint. [5]

Location No. 3: Point Reyes Coastal
Assessor's Parcel No: 109-270-07
Owner: Pacific Telephone & Telegraph Company
Marin County Land Use Designation: Coastal Agriculture 1 (C-AG1)
Marin County Zoning: Coastal Agriculture Residential Planned (C-ARP-60)
Applicable Land Use Plans: *Marin Countywide Plan / Local Coastal Program (Unit II)* and *Golden Gate National Recreation Area General Management Plan.*
Environmental Setting [6]

This 1.29-acre site is one-half mile east of the Point Reyes Lighthouse. Although located within the Point Reyes National Seashore, the parcel is privately owned by the Pacific Telephone and Telegraph Company. The site is located approximately 145 feet from Lighthouse Road, 450 feet from a parking lot used to access the lighthouse, and one-third of a mile to the nearest occupied building (i.e., Point Reyes Lighthouse Visitor Center).

The proposed site contains existing telecommunications facilities, including a 60-foot tower and ground-level equipment structure, which is adjacent to and accessed from an unpaved recreational path used by visitors going to the Point Reyes Lighthouse and Visitor's Center. The Point Reyes Coastal site is enclosed by an eight- to ten-foot tall chain link fence topped with barbed wire. A United States Coast Guard telecommunications facility is collocated at this site. A shorter tower and two smaller equipment buildings are located just outside the fence line. **Exhibit 4** illustrates the above features of the project site.

The existing facilities are located on relatively flat ground and the site slopes (approximately eight percent) from north to south. The predominant vegetation types within the vicinity of the Point Reyes Coastal site are native northern coastal scrub and mixed non-native woodland. No streams or other water features transect or exist near the project site. Additionally, there are no faults in the vicinity of the site. The site is remote and is mostly visible from the adjacent path that leads to the Point Reyes Lighthouse and Visitor's Center.

The site is within the jurisdiction of both the County of Marin and the National Park Service and is therefore subject to the *Marin Countywide Plan and Local Coastal Plan (Unit II)* and the *Point Reyes National Seashore General Management Plan*. **Section 3.0 Adopted Plans and Policies** describes policies relevant to the proposed project.

Proposed Project at Point Reyes Coastal Site

The proposed project would install (at a minimum) four (4), approximately two-inch diameter, 40-inch length omni antennas and one (1) approximately 24-inch diameter microwave dish on the existing 60-foot high tower. The exact

[5] See assumptions in **Section 4.0 CEQA / NEPA Compliance**.
[6] Information for this site was gathered from a site visit on March 20, 2010 and from Marin Map Data Viewer, accessed online at http://marinmap.org.

location and height the antenna would be mounted at is not known at this time. New equipment cabinets would be installed within the existing fence line. No ground disturbance (i.e., grading) or tree removal is anticipated, and the size of the existing facility would not be expanded beyond its current footprint. [7]

Location No. 4 Mount Tomales
Assessor's Parcel No: 100-050-42
Owner: Robert and Lois Parks
Marin County Land Use Designation: C-AG-1 (Coastal Agricultural, one unit per 31 to 60 acres)
Marin County Zoning: C-APZ-60 (Coastal, Agricultural Production Zone, one unit per 60 acres)
Applicable Land Use Plans: *Marin Countywide Plan, Local Coastal Program (Unit II)*

Environmental Setting [8]

The project site is an existing telecommunications facility located on a hillside approximately 400 feet west of Highway 1 half a mile north of the town of Tomales in unincorporated Marin County. The 179-acre, agriculturally-zoned parcel is privately owned by the Parks Ranch, which leases the 840-square foot facility to Verizon. The property is served by existing gravel ranch roads. The monopoles and equipment area maintain setbacks of over 400 feet from the nearest public roadway as well as residential uses.

The existing facility includes one 18-foot high, six-inch diameter monopole supporting two four-foot long panel antennas, and one 25-foot high, six-inch diameter monopole supporting four four-foot long panel antennas. Each monopole is surrounded by four-foot high cattle fencing. The site also contains a 240-square foot equipment shelter located within the 840-square foot lease area, which houses a 60-kilowatt diesel emergency stand-by generator.

This site is located approximately 380 feet above MSL. The site slopes gently too moderately and is dominated by grazed grasslands with stands of non-native eucalyptus trees. No streams or other water features (e.g., wetlands) transect or exist at or adjacent to the project site. Additionally, there are no faults in the immediate vicinity but the area is subject to strong ground shaking from its proximity to the San Andreas and Hayward faults.

The site is within the jurisdiction of the County of Marin and is subject to the *Marin Countywide Plan* and *Local Coastal Program (Unit II)*. In addition, the property is encumbered by an agricultural conservation easement granted to the Marin Agricultural Land Trust (MALT). **Section 3.0 Adopted Plans and Policies** describes policies relevant to the proposed project.

Due to the topography of the ranch as well as existing vegetation (including a large eucalyptus grove) on the subject and surrounding properties, the monopoles are only partially visible to northbound drivers from a short section of Highway 1 as it passes the subject property. Due to the orientation and elevation of the road in relation to the monopole, and the prevailing speed of traffic in this area, the visibility is very limited.

Proposed Project at Mount Tomales Site

The proposed project would install (at a minimum) two (2), approximately two-inch diameter, 40-inch length omni antennas and one (1) approximately 24-inch diameter microwave dish on the existing 25-foot high tower. The exact location and height the antenna would be mounted at is not known at this time. New equipment cabinets would be installed within the existing fence line. No ground disturbance (i.e., grading) or tree removal is anticipated, and the size of existing facility would not be expanded beyond its current footprint. [9]

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[7] See assumptions in **Section 4.0 CEQA / NEPA Compliance**.

[8] Information for this site was collected from a site visit on March 20, 2010, and *Staff Report to the Deputy Zoning Administrator, Robert and Lois Parks (Verizon Wireless) Use Permit and Design Review*, County of Marin Community Development Agency, June 2008 and from Marin Map Data Viewer, accessed online at http://marinmap.org.

[9] See assumptions in **Section 4.0 CEQA / NEPA Compliance**.

3.0 Adopted Plans and Policies

The installation of new telecommunications facilities at proposed sites would be subject to provisions of the following adopted plans:

Marin Countywide Plan and Local Coastal Program
The Marin Countywide Plan includes *Goal PFS-5 Minimization of Telecommunications Facilities and Related Impacts* to ensure that siting of telecommunications facilities 1) avoids their undue proliferation and 2) avoids or minimizes adverse health effects to people and / or environmental or visual quality. **Policy PFS-5.1** implements the *Telecommunications Facilities Policy Plan* which includes specific policies that provide for collocation or best alternative location, and visual impact avoidance and / or mitigation. The TFPP plan is summarized below.

In addition, the Point Bonita Radar Tower, Point Reyes Coastal and Mount Tomales sites are subject to provisions of the Marin County Local Coastal Program (LCP). The LCP functions in conjunction with the Countywide Plan and is the County's land use plan, zoning ordinance / map, and implementing actions that implement the provisions of the Coastal Act of 1976 at the local level. The Coastal Act was designed to protect and conserve the State's coastal resources and to maximize public use and enjoyment of them. While the LCP currently contains only general provisions to protect visual resources from development (including infrastructure and utility projects), the plan (originally drafted in 1980) is currently being updated by the County.

Marin County Telecommunications Facilities Policy Plan (TFPP)
The TFPP establishes policies to guide the development of telecommunications facilities while protecting the natural resources, communities, and other land uses in Marin County. Specifically, the policies include provisions to reduce environmental impacts associated with land use compatibly, aesthetics, and hazards from electromagnetic radiation. TFPP policies state that wireless telecommunications facilities should be sited to avoid or minimize potential land use conflicts. The TFPP policies establish preferences for the siting of new telecommunications facilities with industrial, commercial, and institutional properties most preferable over other land uses. TFPP standards also establish a strong preference for co-located or clustered telecommunications facilities. Visual and aesthetic compatibility policies contained in the TFPP specify that telecommunications facilities should be sited and designed to avoid or minimize adverse visual effects. The TFPP also requires that telecommunication facilities should be sited and designed to minimize potential health risks from electromagnetic radiation.

National Park Service (NPS) General Management Plans
Since the proposed *MERA Project* would collocate new equipment on existing telecommunications sites located within both the Point Reyes National Seashore and the Golden Gate National Recreation Area, it would be subject to the provisions of their respective General Management Plans. A General Management Plan is a strategic planning document that outlines the future management of a National Park Service site for the next 15 to 20 years.

Each plan provides for resource protection and visitor management within the authorized boundaries that include lands and waters that are not administered by the NPS but have joint management concerns (for example, Mount Tamalpais State Park), those federal lands within each park that have shared responsibilities by the PRNSS and the GGNRA (e.g., the area north of Bolinas-Fairfax Road), and those non-federal public lands for which GGNRA holds an easement with certain rights and responsibilities (23,000 acres of City of San Francisco Watershed lands), as well as non-federal lands for which the NPS has no jurisdiction or management responsibility (i.e., on private lands) but monitors their development and use. Both General Management Plans are currently being updated and are undergoing environmental review. [10] These plans will set the basic philosophy and broad guidance for management decisions that affect the park's resources and the visitor's experience. [11]

[10] The Draft Management Plans for both the Point Reyes National Seashore and the Golden Gate National Recreation Area along with their respective Environmental Impact Statement are nearing completion. Studies on historic structures, park

4.0 CEQA / NEPA Compliance

The following describes potential environmental impacts of the proposed project and outlines steps required to achieve compliance with both the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA). **The following information regarding the potential environmental impacts and anticipated level of environmental review required for the *MERA Project* is based the assumption that the proposed antennas and ground equipment would be co-located on existing towers and within existing equipment yards (i.e., within the existing facilities' footprints)**. If the project is revised to include construction of new towers or expansion of existing equipment yards, the type and extent of potential environmental impacts that would need to be considered could change, and additional analysis and documentation could be required in order to comply with CEQA and NEPA. In addition, if sites or equipment other than those assumed in this study are contemplated, additional analysis and documentation could be required.

Potential Environmental Impacts

Based on the above assumption and from our review of similar projects,[12] [13] potential impacts associated with sensitive visual resources (e.g., scenic views from national parks), biological resources (e.g., Mission Blue Butterfly habitat), land use compatibility, and hazards associated with electromagnetic radiation would need to be addressed by the lead agency. The following outlines the analysis conducted by County of Marin and the National Park Service for environmental impacts of previous similar projects, the level of environmental review required to achieve CEQA and NEPA compliance, and the actions of each agency on those projects. Based on this information, we provide conclusions for the likely level of environmental review and documentation required for the *MERA Project*, their respective costs, and estimates the time to complete the various processes in **Section 5.0 Conclusions**.

Evaluation of Similar Projects

Wolfback Ridge The Marin County Environmental Coordinator determined that a similar telecommunications project by Metro PCS[14] at the Wolfback Ridge site was Categorically Exempt from the requirements of the California Environmental Quality Act pursuant to Section 15303, Class 3 of the CEQA Guidelines. Similar to the proposed project, the Metro PCS project involved the installation of cellular antenna panels (larger than the proposed *MERA Project* antennas) on the existing 100-foot tall tower and related ground equipment within the existing fence line at the site. County staff determined this project to be exempt because it was consistent with the goals and policies of the Marin Countywide Plan and the Marin County Telecommunications Facilities Policy Plan as it involved the "installation and operation of an unstaffed co-located telecommunications facility that would not result in any grading, tree removal or other potentially significant impacts on the environment".

To make this determination, staff reviewed a report submitted by the applicant's consultant, which concluded that the proposed project would not result in any significant risks with respect to human exposure to radio frequency fields emitted from the proposed telecommunications facility given the distance of the site from residences. In addition, the applicant provided visual simulations showing that the antenna panels would not increase the overall height of the tower and their color would blend with the existing tower.

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economics, transportation, cultural landscapes, and other topics are now completed or being finalized. The plans are anticipated to be released in early 2010 for public review.

11 http://www.nps.gov/pore/parkmgmt/planning_gmp.htm, accessed April 20, 2010

12 *Environmental Assessment for Replace/Relocate U.S. Coast Guard Vessel Traffic Service (VTS) Radar Tower at Point Bonita, Marin County, California,* Department of Homeland Security, June 2005.

13 *Staff Report to the Deputy Zoning Administrator, Sundial Broadcasting Corporation / Metro PCS Inc., Use Permit and Design Review*, Marin County Community Development Agency, October 10, 2002.

14 *Ibid.*

Given the project site is located within the jurisdiction GGNRA, the County consulted with NPS staff. The GGNRA Project Review Committee reviewed the project and determined that it met the requirements for a Categorical Exclusion from the National Environmental Policy Act with the fulfillment of six conditions:

- Ensure that the project does not conflict with the GGNRA radio system;
- Provide advance notice regarding construction vehicle access to the site;
- Do not park on the shoulder of the fire road;
- Complete a biological survey along the access road for Mission Blue Butterfly habitat and ensure that the project results in no adverse impact to the habitat.
- Construct the project outside the rainy season.
- Provide notification when construction work stops for more than 24 hours, when construction work is complete, and when routine maintenance will be completed.

In addition, the County placed one additional condition on approval of the project to mitigate erosion problems experienced by the access road that were affecting GGNRA lands. The applicant was required submit and erosion and sedimentation control plan and contribute a fair-share contribution for road maintenance.

Mount Tomales Similar to the Wolfback Ridge project above, the Marin County Environmental Coordinator determined that Verizon's installation of new monopoles and related ground equipment was Categorically Exempt from the requirements of the California Environmental Quality Act pursuant to Section 15303, Class 3 of the CEQA Guidelines. This determination was made because the project entailed the installation and operation of a new telecommunications facility that did not result in grading, tree removal, or other potentially significant impacts on the environment. Additionally, a report prepared by its consultant concluded that the proposed project would not result in any significant risks with respect to human exposure to radio frequency fields emitted by the proposed and existing telecommunications facilities.

Comparison to MERA Project

All four proposed sites have existing telecommunications facilities where proposed *MERA Project* antennas would be collocated on existing towers and proposed equipment cabinets within existing fence lines. Three of the four proposed *MERA Project* sites are located on privately-owned parcels within NPS jurisdiction; the Mount Tomales site is located solely within the jurisdiction of the County of Marin. All four sites are isolated and located far from occupied buildings. The proposed *MERA Project* antennas would not increase the overall height of existing towers and their color would blend with existing setting. No ground disturbance would occur and the existing footprint would not be increased.

5.0 Conclusions

Based on the assumption outlined above (see **Section 4 CEQA /NEPA Compliance**), our evaluation of the potential environmental impacts, past action by County and NPS staffs, and the similarity of the proposed *MERA Project* to other telecommunications projects proposed at two of the proposed site locations, we reasonably conclude the potential for significant impacts to the environment resulting from implementation of the *MERA Project* is low. The project would likely be consistent with relevant adopted plans (refer to **Section 3.0 Adopted Plans and Policies**) to collocate on existing telecommunications facilities. In addition, given the size and location of proposed antennas and equipment, significant impacts to visual resources would not occur. In addition, the project would not result in a substantial hazard associated with electromagnetic radiation. Furthermore, impacts to biological resources are not anticipated, assuming that no ground disturbance would occur, and assuming that the existing facilities would not be expanded beyond their current footprint.

The following scenarios describe the likely level of CEQA and NEPA documentation depending on the evolution of the *MERA Project* description.

Scenario One

Assumption: *MERA Project* is proposed as assumed (i.e., collocated on existing facilities, within existing footprint, and results in no ground disturbance).
Result: CEQA – Categorical Exemption
NEPA – Categorical Exclusion
Cost: **$**10-30K
Duration: 1 to 2 months

Based on the assumptions outlined above, our evaluation of the potential environmental impacts, past action by County and NPS staffs, and the similarity of the proposed project to another project that occurred at one of the proposed locations, we assert the likely level of CEQA and NEPA documentation required is a Categorical Exemption (CEQA) and Categorical Exclusion (NEPA). While these determinations would exclude the project from a greater level of environmental review to achieve CEQA / NEPA compliance, some amount of field work, analysis and documentation would likely need to occur to demonstrate that the project would have no significant impacts to the environment. For example, the applicant could be required to:

- Submit photosimulations from key viewpoints to illustrate the impact of proposed antennas to sensitive visual resources;
- Submit reports quantifying electromagnetic radiation hazards;
- Conduct a biological evaluation to assess presence of listed species;
- Repair roads or perform other site improvements (e.g., erosion control plan); and / or
- Demonstrate that the project would not have an effect on federal telecommunications facilities.

Scenario Two

Assumption: *MERA Project* is revised and requires new or expanded facilities that could require grading or other ground-disturbing activities, or new towers that result in less-than-significant impacts
Result: CEQA – Initial Study and Negative or Mitigated Negative Declaration
NEPA – Categorical Exclusion or Environmental Assessment
Cost: CEQA **– $**50-75K
NEPA **–** $10-20K (Categorical Exclusion) or $60-85K (Environmental Assessment)
Duration: CEQA – 4 to 9 months
NEPA **–** 1 to 2 months (Categorical Exclusion) or 4 to 9 months (Environmental Assessment)

In the event that the assumption in **Section 4 CEQA / NEPA Compliance** is not met (i.e., requires new towers or expanded footprints) and the project would result in potentially significant impacts**,** additional analysis and documentation could be required. The scope of work to achieve CEQA / NEPA compliance would involve the preparation of an Initial Study to determine the level of anticipated impact. For CEQA, if such impacts (e.g., visual impacts from new towers from sensitive viewpoints) were determined to be less-than-significant or less-than significant with the incorporation of identified mitigation measures, then a Negative Declaration or Mitigated Negative Declaration would be the appropriate level of review and documentation. The estimated cost and duration of this process would be four to nine months and cost approximately $50-75K.

For compliance with NEPA, the project may still qualify for a Categorical Exclusion. In the event that additional analysis would be required, it is likely that an Environmental Assessment (EA) would be required. It is likely that this document would be prepared as part of joint CEQA / NEPA document and would result in a Finding of No Significant Impact (FONSI) as the NEPA determination. This would increase the cost to $65-90K.

Scenario Three

Assumption: *MERA Project* is revised and requires new or expanded facilities including ground disturbance or new towers that could result in a significant impact(s)
Result: CEQA – Environmental Impact Report
NEPA – Environmental Impact Study or Environmental Assessment / Finding of No Significant Impact
Cost: **$**100-250K
Duration: 9 to 18 months

Similar to Scenario 2, this scenario would involve a proposed *MERA Project* that would require either new facilities or expanded footprints or would result in potentially significant impacts**.** If during the preparation of an Initial Study the level of anticipated impact was determined to be significant, an Environmental Impact Report (EIR) (CEQA), Environmental Impact Study (EIS) (NEPA), or joint EIR/EIS would be required. While the estimated cost is difficult to quantify without information regarding the scope of environmental effects, it could cost between $100-250K depending on the number of issues that would need to be addressed. The process would likely take between nine and eighteen months to complete.

Exhibit 1
MERA Project Location Sites

Sources: Marin Map (http://marinmap.org) and USGS Database, 2010.

AECOM
Communications Technology
Building Engineering
20715 Timberlake Road, Suite 106
Lynchburg, VA 24502
(434) 239-9200 www.aecom.com

Exhibit 2
Wolfback Ridge Location
View from Wolfback Ridge Road East of Existing Facility

Source: AECOM Design + Planning site visit April, 2010.

AECOM
Communications Technology
Building Engineering
20715 Timberlake Road, Suite 106
Lynchburg, VA 24502
(434) 239-9200 www.aecom.com

Exhibit 3
Point Bonita Radar Tower Location
Existing Facility

Existing Radar Tower Detail

View from Path to
Point Bonita Lighthouse

Source: AECOM Design + Planning site visit March 20, 2010.

AECOM
Communications Technology
Building Engineering
20715 Timberlake Road, Suite 106
Lynchburg, VA 24502
(434) 239-9200 www.aecom.com

Exhibit 4
Point Reyes Coastal Location
View from Lighthouse Road

Source: AECOM Design + Planning site visit March 20, 2010.

AECOM
Communications Technology
Building Engineering
20715 Timberlake Road, Suite 106
Lynchburg, VA 24502
(434) 239-9200 www.aecom.com

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Communications Technology

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Lynchburg, Virginia 24502
www.aecom.com