

# Columbia 9-1-1 Communications District



## Radio System Alternatives Analysis and Recommendations Report

**FINAL**

August 19, 2021

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## Executive Summary

The Columbia 9-1-1 Communications District (District) operates a 20-year-old very high frequency (VHF) conventional simulcast system that provides services to 12 public safety agencies across Columbia County. The system has evolved and being updated over the years, but it is still suffering from aging equipment, and coverage gaps and interference that is adversely affecting the daily operations of the public safety personnel.

The District contracted with Federal Engineering, Inc. (*FE*) to assess their existing land mobile radio (LMR) system, analyze alternatives and present a recommendation to upgrade or replace the existing system to meet user agency needs.

*FE* performed the following tasks to assess the County's existing LMR system and gather stakeholder needs:

- Reviewed existing system documentation
- Conducted a requirements workshop with the District and key stakeholders to determine current and future radio system needs
- Evaluated the three proposals submitted in response to the District's Request For Information (RFI)
- Performed a remote coverage analysis of the District's system to provide a visual representation of current system radio coverage and to obtain stakeholder feedback to identify current coverage challenges

### System Requirements

Based on our review of existing system documentation and the output of the requirements workshop with the District, *FE* identified the following key functional requirements for the new system:

- New site repeaters, antenna systems, and dispatch consoles given the existing system components are at or near end-of-life with limited or no vendor support and spare parts
- A minimum 95% District-wide mobile radio coverage throughout the county with improved in building coverage in population centers
- A public-safety Grade of Service (GoS) less than or equal to 1%, meaning that less than 1% of all attempted calls would be queued or blocked







- 256-bit Advanced Encryption Standard (AES) encryption with Over-the-Air Rekeying (OTAR)

### **System Alternatives**

Per the direction of the District, **FE** developed four system alternatives for consideration for their new system:

- Build a standalone District-owned VHF system
- Build a standalone District-owned 700 MHz system
- Join the Clark Regional Emergency Services Agency (CRESA) 800 MHz System
- Join the Washington County Consolidated Communications Authority (WCCCA) 800 MHz System

### **System Alternatives Comparison**

Table ES1 summarizes the key differences between the four system alternatives, including ownership and control, technology, coverage in populated areas, features, interoperability, subscribers, and total cost of ownership.

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**Table ES1 – System Alternatives Comparison**

<b>System Alternatives Comparison</b>				
<b>Item</b>	<b>Alternative 1 VHF System</b>	<b>Alternative 2 700 MHz</b>	<b>Alternative 3 CRESA</b>	<b>Alternative 4 WCCCA</b>
<b>Ownership and control</b>	<ul style="list-style-type: none"> <li>District-owned</li> <li>Full control</li> </ul>	<ul style="list-style-type: none"> <li>District-owned</li> <li>Full control</li> </ul>	<ul style="list-style-type: none"> <li>CRESA-owned</li> <li>Shared control</li> </ul>	<ul style="list-style-type: none"> <li>WCCCA-owned</li> <li>Shared control</li> </ul>
<b>Technology</b>	<ul style="list-style-type: none"> <li>Analog</li> <li>Conventional</li> </ul>	<ul style="list-style-type: none"> <li>P25 Phase 1</li> <li>Conventional</li> </ul>	<ul style="list-style-type: none"> <li>P25 Phase 1</li> <li>Trunking</li> </ul>	<ul style="list-style-type: none"> <li>P25 Phase 2</li> <li>Trunking</li> </ul>
<b>Spectrum</b>	VHF	700 MHz	800 MHz	800 MHz
<b>Mobile radio coverage</b>	95%	99%	97%	98%
<b>In-building coverage of industrial, commercial, and residential areas</b>	15%	75%	60%	65%
<b>Features</b>	<ul style="list-style-type: none"> <li>No added features</li> </ul>	<ul style="list-style-type: none"> <li>P25 std. features</li> <li>AES encryption</li> </ul>	<ul style="list-style-type: none"> <li>P25 std. features</li> <li>AES encryption</li> <li>OTAR</li> <li>GPS</li> <li>Smartphone Integration</li> </ul>	<ul style="list-style-type: none"> <li>P25 std. features</li> <li>AES encryption</li> <li>OTAR</li> <li>OTAP</li> <li>GPS</li> <li>Smartphone Integration</li> </ul>
<b>Interoperability</b>	<ul style="list-style-type: none"> <li>No added capability</li> </ul>	<ul style="list-style-type: none"> <li>Analog</li> <li>Backwards compatible with VHF analog</li> <li>Interoperability with surrounding P25 systems</li> </ul>	<ul style="list-style-type: none"> <li>Analog</li> <li>Backwards compatible with VHF analog</li> <li>Direct interoperability with CRESA users</li> <li>Interoperability with State of Oregon</li> <li>Interoperability with surrounding P25 systems</li> <li>ISSI to Portland</li> </ul>	<ul style="list-style-type: none"> <li>Analog</li> <li>Backwards compatible with VHF analog</li> <li>Direct interoperability with WCCCA users</li> <li>Interoperability with surrounding P25 systems</li> <li>ISSI to Portland and State of Oregon</li> </ul>
<b>Subscriber units</b>	<ul style="list-style-type: none"> <li>Re-use existing VHF radios</li> </ul>	<ul style="list-style-type: none"> <li>New dual-band VHF/700MHz radios</li> </ul>	<ul style="list-style-type: none"> <li>New dual-band VHF/800MHz radios</li> </ul>	<ul style="list-style-type: none"> <li>New dual-band VHF/800MHz radios</li> </ul>
<b>Estimated 10-year cost to acquire and maintain</b>	<b>\$8,410,000</b>	<b>\$21,780,000</b>	<b>\$19,540,000</b>	<b>\$25,530,000</b>





### **Recommendation**

Based on our analysis of the existing radio, dispatch, and backhaul systems coupled with the District's stated needs and objectives, **FE** recommends Alternative 3, joining the CRESA system. This alternative addresses the stakeholder needs and requirements for improved coverage, features, and interoperability. Joining CRESA provides significant coverage and feature benefits over the VHF analog system, and it has a lower cost of entry than building a new 700 MHz system or joining the WCCCA 800 MHz system.

### **Next Steps**

**FE** recommends that the District consider the following steps for implementing the new radio and backhaul system:

1. Obtain approval and funding for the new system, subscribers, and consulting services.
2. Initiate the conversation with CRESA to begin the process to join the system.
3. Develop a detailed plan to migrate the users to the new system.
4. Develop functional specifications for the additional sites and capacity to enhance the CRESA system.
5. Procure the equipment and services for enhancing the CRESA system
6. Complete regulatory submittals for coordination of frequencies, FCC licenses, and any environmental (NEPA, SHPO, etc.) approvals, if applicable.
7. Monitor and supervise the vendor in implementing the system enhancement
8. Decommission or re-purpose the old systems

**FE** appreciates the opportunity to develop this *Radio System Alternatives Analysis and Recommendations Report* for the District and looks forward to supporting the District during the subsequent phases of this radio project.







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## 1. Introduction

### 1.1 Background

The Columbia 9-1-1 Communications District (District) has a 20-year-old VHF conventional simulcast system with equipment that is beyond end-of-life<sup>1</sup> and that is experiencing interference and noise issues. Recognizing the need to upgrade or replace the system, the District contracted with Federal Engineering, Inc. (FE) to assess the existing VHF system and analyze alternatives and present a solution to upgrade or replace the existing system to meet user agency needs and requirements.

### 1.2 Project Approach

FE performed the following tasks to produce this document, the Columbia 9-1-1 Communications District Radio System Alternatives Analysis and Recommendations Report:

- Reviewed previous LMR system requirements developed by the District and worked with the District to develop a final requirements list
- Assessed the District's existing LMR system, including a computer-based radio coverage analysis
- Assessed proposed vendor solutions which were submitted in response to the request for information (RFI) previously issued by the District
- Evaluated the following alternatives for the replacement of the District's VHF system:
  - Build a standalone District-owned VHF system
  - Build a standalone District-owned 700 MHz system
  - Join the Clark Regional Emergency Services Agency (CRESA) 800 MHz System
  - Join the Washington County Consolidated Communications Authority (WCCCA) 800 MHz System
- Recommended a solution that would best meet the District's needs
- Identified next steps required to implement the recommended solution

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<sup>1</sup> Equipment that has reached or exceeded the end of the product lifecycle, indicating that the product is at the end of its useful life. The vendor no longer supports the equipment and replacement parts become difficult to find.





## 2. Existing Systems

### 2.1 District VHF Radio System

#### 2.1.1 System Overview

The District has an eight-site Very High Frequency (VHF) analog conventional simulcast radio system, with the following channels (listed as repeater transmit/receive):

- F1 Dispatch, 154.1300 MHz transmit (Tx)/159.1500 MHz receive (Rx)
- F2 Mednet, 153.8750 MHz Tx/157.4925 MHz Rx
- F3 TAC 3, 153.1175 MHz Tx/156.0150 MHz Rx
- F4 TAC 4, 154.8750 MHz Tx/157.4775 MHz Rx
- L1 Ops, 154.7850 MHz Tx/158.9700 MHz Rx
- L2 Support, 154.7100 MHz Tx/158.8125 MHz Rx
- L3 Chat, 154.8300 MHz Tx/155.8650 MHz Rx
- L5/F5 Common, 154.3550 MHz Tx/158.8800 MHz Rx

One of the obstacles that the District faces is the availability of individual VHF frequencies. Pallans and Associates completed exhaustive searches in 2015 with Federal, State and Tribal agencies to find frequencies that were compatible for District use. This effort included extensive research and testing. The purpose of this work was to find frequencies that reduce interference from outside sources.

The District currently utilizes the following transmit (Tx)/receive (Rx) and Rx-only sites:

- |                                |                          |
|--------------------------------|--------------------------|
| • Bald Mountain – Rx           | • Green Mountain – Tx/Rx |
| • Clatskanie Mountain – Tx/Rx  | • Havens Acres – Rx      |
| • Columbia Heights – Tx/Rx     | • Meissner Lookout – Rx  |
| • Corey Hill – Tx/Rx           | • Scappoose PD – Rx      |
| • Courthouse (St. Helens) – Rx | • St. Helens – Tx/Rx     |

The District's VHF system was originally installed and operational in 2004. The Clatskanie Mountain site was added to the system in 2010 to replace the Benson Point site for improved coverage. The Green Mountain site was added in 2013 for improved coverage. The District added the Haven Acres receive-only site in 2015 and is available as a





potential new site. Installed receivers at the County Courthouse and Scappoose PD in 2018 to improve portable talk-in coverage in parts of St. Helens and Scappoose.

All primary frequencies are simulcast throughout the District. The District has simulcast control equipment at the Columbia Heights site, consisting of Harris Synchrocast3 for timing and launch delays. Received signals are sent via microwave from the sites to the Dispatch center in St. Helens where the JPS voters are located.

All radio system equipment (including Motorola MTR2000 repeaters, Harris Synchrocast3 controller, and JPS PSM-1 voters) have exceeded the end of their product lifecycle. The vendors no longer support the equipment and replacement parts are difficult to find.

### **2.1.2 Radio Coverage**

Radio coverage defines the ability of a radio system to send and receive intelligible signals to/from mobile and portable radios over a specified area and is a key aspect in the performance of any radio communications system. Identifying coverage problem areas and where additional radio coverage may be needed is the primary goal when analyzing an existing system. *FE's* analysis of existing District LMR system coverage is presented below.

*Note: The radio coverage portrayed by maps in this report may vary slightly from actual system coverage. Computer modeling cannot account for all variables that exist in the real world. Coverage differences exist due to many factors such as individual radio performance, terrain, foliage, noise floors, RF interference, and other variables.*

#### **2.1.2.1 Radio Coverage Prediction Software**

*FE* produced radio coverage studies using *FEPerformancePro*<sup>™</sup> and high-resolution elevation and land use/land cover data from the United States Geological Survey (USGS). *FEPerformancePro*<sup>™</sup> uses ATDI's ICS Telecom network planning software, the same software that has been used extensively by the Federal Government and validated via field tests. *FE* has calibrated this modeling tool and our methodology based on many years of experience and industry-accepted guidelines to deliver the most accurate view of radio coverage possible. The radio coverage prediction studies were conducted using technical information provided by the District, such as transmit power levels, antenna make/model, and antenna mounting heights.







### 2.1.2.2 Radio Coverage Parameters

*FE* used the technical parameters in Table 1 to model the coverage for the existing District LMR system.

**Table 1 – Coverage Study Parameters**

Parameter	Description
<b>System Type</b>	Conventional Analog
<b>Frequency Band</b>	VHF High band
<b>Channel Bandwidth</b>	12.5 kHz
<b>Reliability</b>	95%
<b>Minimum Performance</b>	Delivered Audio Quality (DAQ) – 3.4
<b>Talk Paths</b>	Mobile radio talk-out (from repeater to mobile) Mobile radio talk-in (from mobile to repeater) Portable radio talk-out, on-street (from repeater to a portable on the street) Portable radio talk-in, on-street (from portable on the street to repeater) Portable radio talk-out, in light/residential buildings (from repeater to portable inside buildings) Portable radio talk-in, in light/residential buildings (from portable inside buildings to repeater).

The coverage displayed on each map in this section indicates the areas predicted to have audio quality greater than or equal to Delivered Audio Quality (DAQ) 3.4. DAQ is a measure of audio quality over a transmission medium and is often used to quantify radio system audio quality. Table 2 contains definitions of DAQ levels.

**Table 2 – Delivered Audio Quality Definitions**

DAQ Level	Definition
<b>1.0</b>	Unusable. Speech present but not understandable
<b>2.0</b>	Speech understandable with considerable effort. Requires frequent repetition due to noise or distortion
<b>3.0</b>	Speech understandable with slight effort. Requires occasional repetition due to noise or distortion
<b>3.4</b>	Speech understandable without repetition. Some noise or distortion present. DAQ 3.4 is the minimum Channel Performance Criterion (CPC) used for public safety agencies.
<b>4.0</b>	Speech easily understandable. Little noise or distortion
<b>5.0</b>	Perfect. No distortion or noise discernible







Reliability is a measure of confidence in the reliability of signals in areas shown as covered on the maps and is based on recommendations from the Telecommunications Industry Association (TIA) TSB-882 suite of documents. In the case of public safety radio systems, TSB-88 recommends a 95% reliability level, which means that users should be able to transmit and receive audio at DAQ 3.4 or better in any area that is deemed "covered" at least 95% of the time.

### **2.1.2.3 Mobile and Portable Radio Parameters**

*FE* used the mobile and portable radio parameters in Table 3 to model radio coverage.

**Table 3 – Mobile and Portable Radio Parameters**

Parameter	Mobile	Portable
Transmit Power (watts)	50	5
Receive Sensitivity (dBm)	-119	-119
Antenna Location	Roof	Hip
Antenna Gain (dB)	0	0
Body Loss (dB)	N/A	22.8

### **2.1.2.4 Radio Coverage Analysis**

*FE* analyzed the coverage of the District's existing system and potential new sites using *FEPerformancePro*<sup>™</sup> and the parameters listed above, and then conducted a radio coverage workshop with the District to:

- Review *FE*'s analysis of existing system
- Identify areas where coverage is insufficient
- Look at the coverage that could be provided by new sites
- Identify a final set of sites that would best meet the District's coverage requirements

### **2.1.2.5 Radio Coverage Maps**

*FE*'s analysis of existing system coverage assumed the proper operation of all equipment (i.e., "Day 1" system coverage). During the coverage workshop, District stakeholders identified a discrepancy between the modeled coverage that *FE* initially displayed, and the performance experienced in the field. As a result, *FE* recalibrated its coverage model

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<sup>2</sup> TIA TSB-88 Wireless Communications Systems - Performance in Noise and Interference-Limited Situations





of the existing VHF radio system to better replicate the user experience. The lesser amount of coverage experienced in the field, when compared with the initial coverage modeling, may be due to system degradation from age, lack of proper system or equipment maintenance, interference present in the VHF band, or a combination of these factors.

Figure 1 and Figure 2 show composite mobile and portable (on-street and in-building) talk-out and talk-in coverage for all repeater sites using the recalibrated coverage model. The coverage maps use the following colors to model coverage that meets or exceeds an audio quality level of DAQ 3.4:

- Green - areas where users should be able to communicate using their portable radios when inside light-density and/or residential buildings. For these coverage prediction studies, **FE** used 13 dB to represent signal loss inside these types of buildings
- Yellow - areas where users should be able to communicate using their portable radios on the street (on-street portable coverage should also exist in all purple areas).
- Purple - areas where users should be able to communicate using their mobile radios (mobile coverage should also exist in all green and yellow areas).

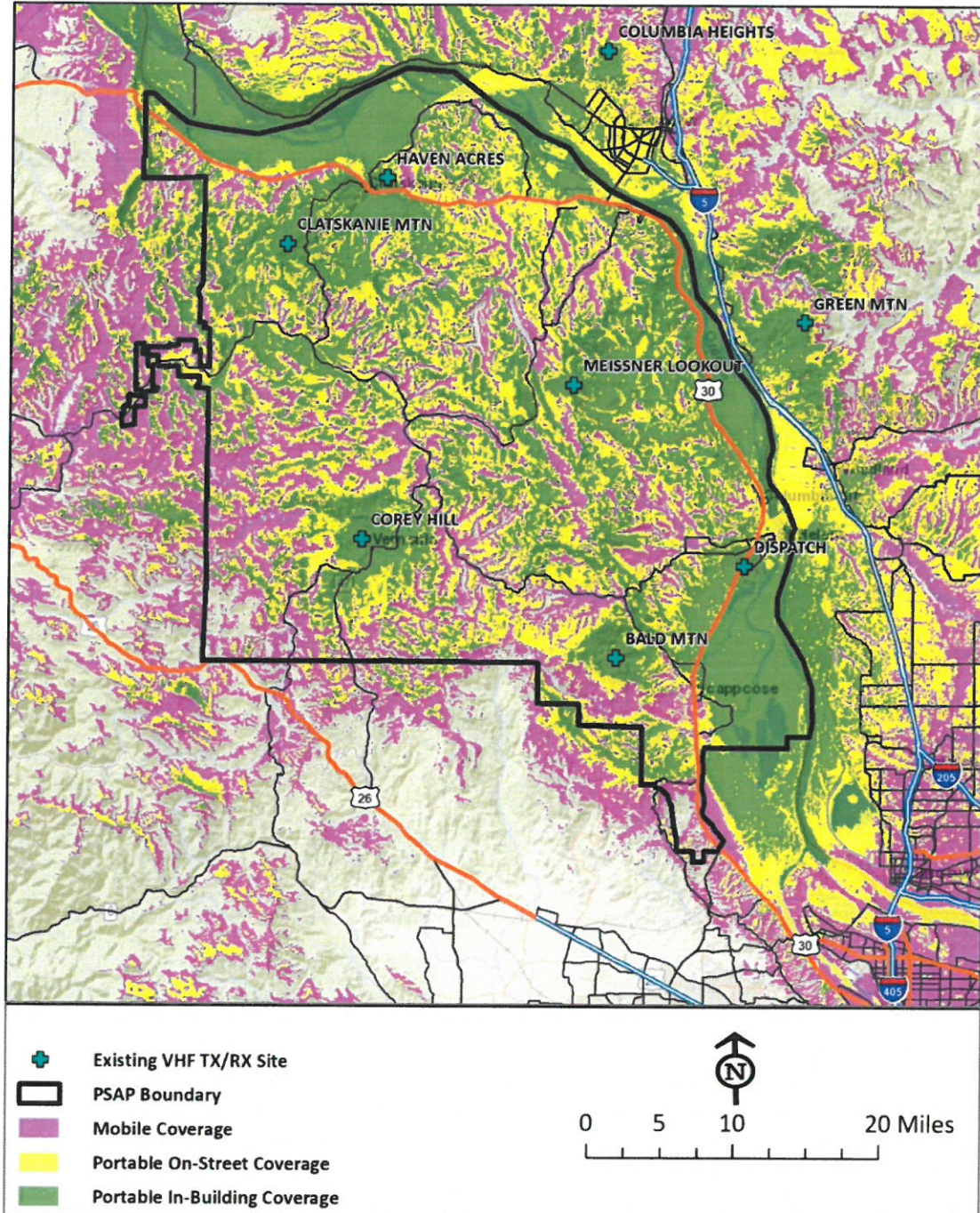
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**Columbia 911 Communications District - Existing LMR System**  
Analog VHF Voice Coverage  $\geq$  DAQ 3.4; Talk-Out (site to radio); 95% Reliability



**Figure 1 – Existing System Coverage – Talk-Out**







### Columbia 911 Communications District - Existing LMR System

Analog VHF Voice Coverage  $\geq$  DAQ 3.4; Talk-In (radio to site); 95% Reliability

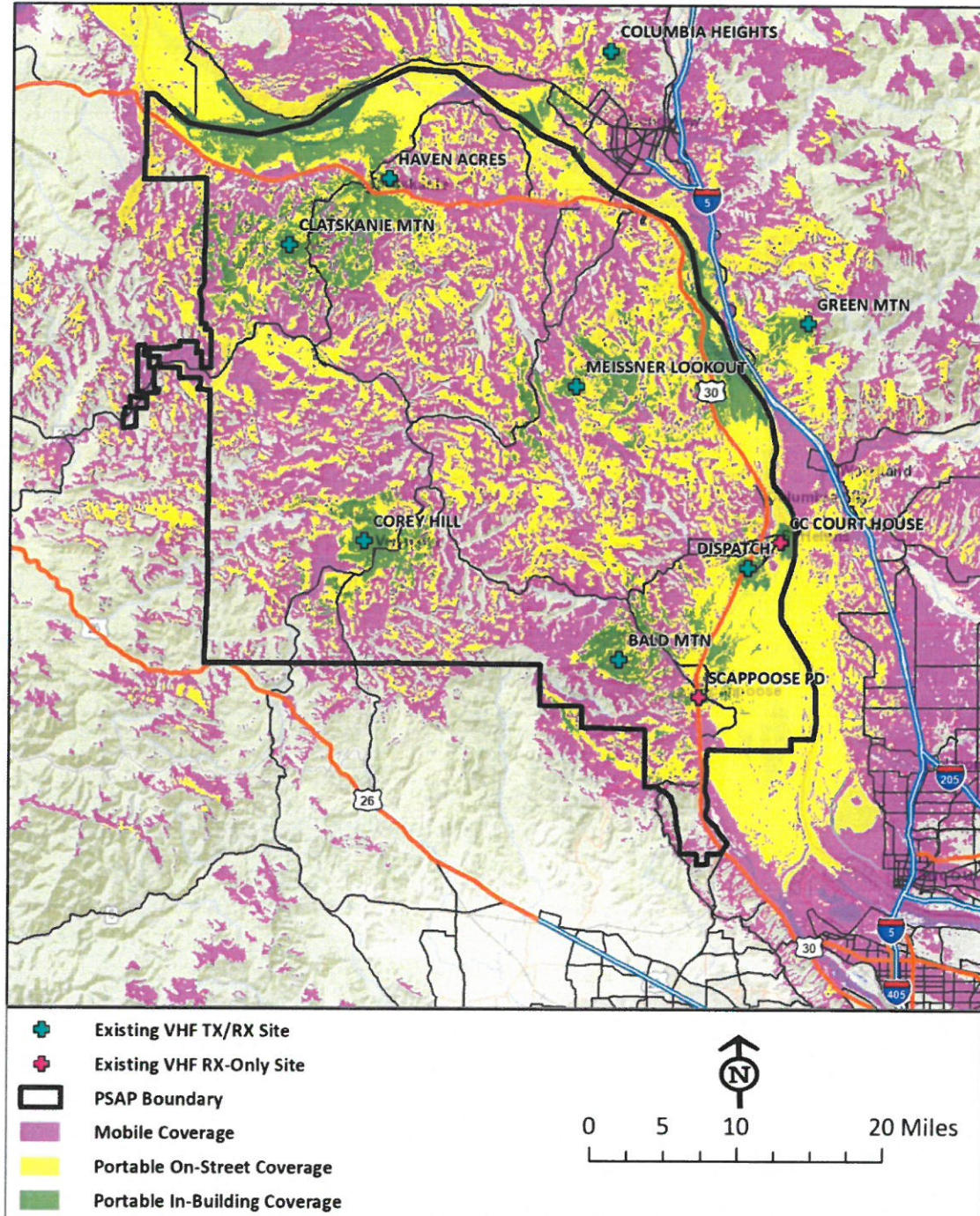


Figure 2 – Existing System Coverage – Talk-In







### 2.1.2.6 Radio Coverage Percentages

*FE* calculated the geographic percentages of radio coverage that the existing District system provides throughout the District boundary. In addition, *FE* calculated the geographic coverage percentage for portable “in-building” coverage throughout populated places. To make this determination, *FE* assessed the coverage over all areas which had a USGS clutter classification of either “residential”, “industrial”, or “commercial”. Table 4 displays the coverage percentages.

**Table 4 – Existing District LMR System Coverage Percentages**

Geographic Coverage %s of Columbia 9-1-1 Communications District						Coverage %s over Pop. Areas (Ind, Comm, Res) within District	
Mobile Talk-Out	Mobile Talk-In	Portable Talk-Out (On-Street)	Portable Talk-In (On-Street)	Portable Talk-Out (In Bldg.)	Portable Talk-In (In Bldg.)	Portable Talk-Out (In Bldg.)	Portable Talk-In (In Bldg.)
97	89	76	48	44	12	28	10

## 2.2 District Dispatch Center

The District Dispatch Center (Dispatch) in St. Helens is the sole Public Safety Answering Point (PSAP) and dispatch center for all public safety agencies in Columbia County, Oregon. The District also serves small adjacent portions of Clatsop and Multnomah Counties. The District provides 9-1-1 call-taking, dispatch services for the following law enforcement agencies, fire districts and ambulance services:

- Clatskanie Rural Fire Protection District
- Clatskanie Police Department
- Columbia Police Department
- Columbia River Fire and Rescue
- County Roads and Parks
- Department of Emergency Management
- Metro West Ambulance Services
- Mist-Birkenfeld Rural Fire Protection District
- Oregon State Police
- Oregon State Forestry
- Rainier Police Department
- Scappoose Rural Fire Protection District
- Scappoose Police Department
- Sheriff
- St. Helens Police Department
- Vernonia Rural Fire Protection District
- Vernonia Police Department





Dispatch is equipped with five Motorola Gold Elite consoles that are beyond the end of their product lifecycle. The vendor no longer supports the equipment and replacement parts are difficult to find.

## ***2.3 District Backhaul System***

The District's backhaul system consists primarily of licensed microwave hops between Dispatch and radio sites as follows:

- Dispatch to Bald Mountain (7.4-mile microwave hop)
- Dispatch to Green Mountain (12.1-mile microwave hop)
- Green Mountain to Clatskanie Mountain (24.7-mile microwave hop)
- Green Mountain to Columbia Heights (16.9-mile microwave hop)
- Clatskanie Mountain to Meissner Lookout (16.1-mile microwave hop)
- Clatskanie Mountain to Corey Hill (14.2-mile microwave hop)
- Clatskanie Mountain to Columbia Heights (17.7-mile microwave hop)
- Columbia Heights to Cowlitz County (microwave hop, distance unknown)
- Dispatch to Scappoose PD (leased T1 line)

Sites in the District radio system connect to each other and the Dispatch Center by an Alcatel microwave network. The network is essentially a point-to-point design with each site pointing to one or more sites in the system. The primary frequencies are in the 6 GHz range and 10 GHz range with the path from Meissner Lookout to Clatskanie Mountain being a Motorola "Canopy" 4.9 GHz link.

The existing microwave hop between Dispatch and Bald Mountain is potentially problematic: there are trees near the Bald Mountain site which have grown tall enough to obstruct the line of sight (LOS) required for this link. The District requested the site owner trim and/or cut the obstructing trees; however, to date the site owner has denied those requests.

The Scappoose satellite receiver location is connected to Dispatch via T-1 phone lines. There is an additional link from the Columbia Heights site to Cowlitz County's nearby







radio site. This provides for interoperability between both counties. On this same link there is an additional voting receiver for the District to improve L1 (police) coverage in Rainier. **FE** assumes that the Haven Acres and Columbia County Courthouse receiver sites also connect to Dispatch via leased T1 lines.

The equipment is Alcatel MDR series time division multiplexing (TDM) based equipment, of which most are 16 T1's, some less. The District is currently replacing some hops with MNI equipment that is capable of Ethernet and TDM. The Alcatel and Motorola equipment are beyond the end of their respective product lifecycles. The vendors no longer support the equipment and replacement parts are difficult to find.

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### 3. Shared Systems

Two shared systems in the region include Clark Regional Emergency Services Agency (CRESA) and the Washington County Consolidated Communications Agency (WCCCA), which are 800MHz Project 25 (P25) trunked systems that provide coverage within the District 911 boundary. The following sections provide a high-level summary of these systems as described to *FE* by their respective system managers.

#### 3.1 CRESA 800 MHz System

CRESA is a regional public safety agency that provides 9-1-1 dispatch, radio system services, and emergency management. The service area includes each of the seven cities within Clark County as well as the unincorporated areas of the county. There are 26 agencies currently on the system. C-TRAN is the bus service in Clark County that would be similar to the District with their own dispatch operation. Relatively small (mutual aid) agencies have joined. CRESA representatives' comment that no defined process is currently in place for joining the system or do not have service level agreement(s) they can share. They would need to evaluate the impact on the system should the District consider joining. However, they feel confident that the system has sufficient P25 Phase 1 capacity for current users but would consider moving to P25 Phase 2 if needed. A sample agreement is attached as Appendix D.

CRESA representatives state that system user fees are \$50 per unit per month for customer agencies and \$40 per unit per month for public safety agencies. The fee includes console connection, core provisioning, and radio programming with billing on a semi-annual or annual basis rather than monthly billing. CRESA did have subscriber unit purchases with the initial system contract, however volume discounts may have expired. The contract included a mix of purchase mechanisms (direct user payments, loans, reimbursements) for subscriber units. Any agency joining the system now is responsible for purchasing their own subscriber units. There is no list of approved subscriber units, but almost all system users have Motorola APX radios. CRESA would be open to other vendors as long as radios are P25 compliant and unique proprietary features are not required.

The current system design consists of a Motorola 800 MHz P25 Phase 1 Trunking system with 95% portable on street coverage. The system control equipment consists of a Motorola P25 Phase 1 Trunking core with geo-redundant locations. The core is currently on Release 7.19.2 with the next scheduled update for 2026, per the System Upgrade Agreement (SUA) in place. CRESA representatives state that the current core has capacity to support additional sites, channels, consoles, and radios that the District would







add to the system. The system has a single simulcast cell with nine sites and twelve channels per site. The system also has two ASTRO Standalone Repeater (ASR) Sites, Rainier Hill and Nicolai Ridge with five channels each. CRESA representatives do state that Rainier Hill is already getting system busies and may need additional channels. The Nicolai site has minimal traffic with no known capacity issues. Currently there is no formal coverage testing in Columbia County, and the District would be responsible for additional sites, including connectivity.

The system backhaul for the radio system consists of an all-microwave network from Aviat Networks. Bandwidth is available for additional traffic as only ¼ of maximum bandwidth is currently used in the loop. However, the bandwidth is close to maximum capacity (of T1) at the two ASR sites. CRESA prefers loop protection for new sites, but spur(s) would be acceptable with Monitored Hot Standby (MHSB) configuration.

Current features implemented and supported include P25 standard features, Advanced Encryption Standard (AES) encryption services, Over-the-Air Rekeying (OTAR) services, and Global Positioning System (GPS) location services. CRESA currently does not use the Over-the-Air Programming (OTAP) services. There is currently one Inter RF Subsystem Interface (ISSI) connection to Portland, and one port available but reserved for Washington County. The system does have smartphone integration with the Motorola WAVE push-to-talk (PTT) offering.

Regarding dispatch consoles, Motorola MCC7500 consoles currently operate on the system with no third-party consoles supported. Agencies like C-TRAN have their own logging recorder. CRESA would need to evaluate whether their two logging recorders have capacity to support the number of channels the District requires. If capacity is an issue, the District would be responsible for providing their own logging recorder system.

### **3.2 WCCCA 800 MHz System**

The WCCCA 800MHz system was constructed to support Law, Fire, and Medical for Washington County this included all County and City agencies as well as the 9-1-1 Call/Dispatch Center that supports them. In 2000 the C800 Group joined with WCCCA into a partnership and brought all Law, Fire, Medical on the system at that time. In 2007 the Cities of Newberg and Dundee Law and Fire (Yamhill County) joined the system. Along the way Public Works, Roads, and Schools have joined the system as well. WCCCA currently has over 7,000 users directly on the system and have partnerships with adjacent systems such as the State of Oregon system, City of Portland system, Clark Regional system (Clark County), and most recently the City of Salem system. These systems will be interconnected using ISSI as well as having their radios on the WCCCA







system to allow users to talk system to system and respond for mutual aid within a system. The current approximate number of radios on the system exceed 20,000 including all regional partner system members with whom WCCCA has system sharing agreements. As far as a documented process for the District to join the system, WCCCA states that generally there are several ways to leverage their system:

- Add new sites and additional capacity to existing sites as may be needed, add subscriber radios, and operate a self-supported system with autonomous support of users, sites, and related infrastructure. For instance, C800 pays for their system equipment and site leases.
- Join the system as a partner and have WCCCA provide infrastructure and subscriber support.
- Some other combination as might be appropriate. For instance, they have a fairly simple recipe that has worked for C800 Group and Newberg/Dundee that is a pretty simple model. For the most part, it depends upon how much or how little the District may want to support themselves as opposed to being supported.

A sample agreement is attached as Appendix D.

While there remains autonomy for each entity, their approach is somewhat uniform how WCCCA supports their dispatch center user community. Current cost percentages are based on number of users (6953 radios); WCCCA 60%, C800 (38%) pays for their own sites except for common sites, Newberg 1.3% (1 site), and overhead. The current system user fee is \$431.86 per radio per year (high case) which could decrease with the addition of District users. WCCCA representatives state that programming is built into the cost; however, user fees can vary annually to cover increased personnel and fuel costs. WCCCA would cover maintenance of backhaul once the District provides new microwave links. User fees would also cover connectivity of dispatch consoles to the system core.

It is important to note that WCCCA does not restrict coverage for users, allowing system-wide roaming within their coverage footprint. WCCCA advised that some users (no more than 500 radios) may roam onto the District system. They currently have two control channels per site, varying voice channels by site, one data channel for OTAR and OTAP, and one enhanced data channel for AVL, of which the latter two data channels would be desirable to have if roaming onto the District system.

The District would be responsible for purchasing their own subscriber units. However, joining the system gives them access to a radio purchase contract (minimum 30% off the list price). Additional support and programming costs may apply if radios other than Motorola are purchased for the system. Joining the system requires design review and





contract with Motorola (if adding sites to the system), determination of per radio costs based on WCCCA cost spreadsheet tool, Board review to present numbers and impact and get approval and executing partner or user agreement between WCCCA and District.

The current system consists of a Motorola 800 MHz P25 Phase 2 Trunking system, with dual cores at two geo-redundant sites (4 cores). The new system is primarily a TDMA (Phase 2) system with limited FDMA support for Fire/Medical interoperability on select talk groups. The system has Data prioritized channels for FDMA data (OTAR/OTAP) as well as Enhanced Data channels for location services. The current version is 7.17 but have an SUA for 10 years with updates every 2 years. WCCCA plans to update in Spring 2022 as the system will go live in September of 2021, if the schedule remains intact and the system is stable before kicking off the SUA process to bring them to current release.

The system currently has seven simulcast cells with differing number of physical sites that are appropriate to the area served. Prime sites (simulcast control equipment) are geo-redundant for simulcast sites. The system also has five ASR sites for large area coverage, and one ASR per each Jail (total of two), and one Site on Wheels for a total of eight ASR sites. The number of channels vary by the location and areas served. The smaller capacity sites (rural/forest) are eight channels, and the larger capacity sites are twelve channels (urban/suburban areas). The system is designed for 10 years of growth at an average rate of 3% per year for channel loading/capacity purposes. The Jail sites are purpose-built distributed antenna system (DAS) based trunked ASRs and have six multicast channels and the larger ASR's have eight to ten multicast channels, dependent upon areas served. The system has 100% microwave connectivity with 233 Mbps bandwidth, in a semi-mesh multi-protocol label switching (MPLS) routed configuration with very limited single points of failure.

Aside from P25 standard features, other features that WCCCA implemented include AES (256-bit encryption for law enforcement), OTAR, OTAP, and GPS. Dispatch centers that connect to the system include City of Newberg, City of Lake Oswego, Washington County, and Clackamas County. Dispatch consoles in all centers are Motorola MCC7500E. Logging recorders include Equature/DSS systems in redundant configuration with central archival, with local recording at each dispatch center. WCCCA has ISSI connections with the City of Portland and the State of Oregon. Once cutover, they will be connecting to CRESA (Vancouver/Clark County Washington, part of the UASI region) and the City of Salem (State Capitol). Smartphone integration is supported as WCCCA in the process of implementing Critical Connect and using the WAVE on Cloud application/services.







Regarding a list of approved subscriber units, WCCCA has qualified and recommends Motorola APX6000/6500 and APX8000/8500 radios as well as Kenwood/Johnson current models of P25 Phase 2 compliant radios. The State of Oregon will be using older generation Harris models on the WCCCA system (TDMA only). WCCCA also supports older Motorola XTL5000 radios for a few mutual aid fire agencies they work with infrequently.

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## 4. System Requirements

*FE* conducted a remote meeting with the District to discuss the District's functional requirements for a new system. Appendix A includes the full list of requirements as stated and approved by the District. *FE* provides the following summary of functional areas and requirements categorized as "Critical" or "Highly Desirable" by the District.

### 4.1 Backhaul

Redundant microwave backhaul connections shall be established between Dispatch, control, and RF sites. In addition to the LMR system requirements, the backhaul system shall have sufficient capacity to support the following additional applications:

- Video and alarms at sites (see below for video surveillance requirements)
- Potentially, automatic vehicle location (AVL)
- Potentially, body and vehicle dash camera video

All backhaul links shall have a minimum 99.999% availability (i.e., five 9's).

### 4.2 Capacity

Conventional system solutions shall have enough channels to meet current and future capacity requirements. Trunked system solutions shall provide sufficient capacity to provide a 1% Grade of Service (GoS) with a maximum one second hold time. The system channel capacity for trunked system solutions shall be calculated based on existing subscriber radio counts and a 1% annual subscriber unit growth rate for 10 years.

### 4.3 Coverage

The new system shall provide a minimum 95% District-wide mobile radio coverage with primary focus on population centers and highways, and a desired 95% District-wide on-street portable radio coverage (worn at hip) with primary focus on the following population centers and highways. In-building coverage shall include the following critical buildings:

1. Fred Meyer, Scappoose 51501 Columbia River Hwy, Scappoose, OR 97056
2. Cascade Tissue, Scappoose 52960 W Lane Rd, Scappoose, OR 97056
3. PCC, Scappoose, 33701 Charles T Parker Way, Scappoose, OR 97056
4. St. Helens new middle School 354 N 15th St, St Helens, OR 97051





5. 777 Port Ave, St. Helens, OR 97051(Unknown name of company)

*FE* (and eventually the awarded vendor) shall prioritize site RF site selection as follows:

1. Sites currently on the District system
2. Other existing public safety and/or government radio sites
3. Leased sites
4. Greenfield sites

#### **4.4 Dispatch**

System alternatives shall replace all existing console positions at Dispatch; currently there are five console positions and three control stations used for backup. Backup RF control stations shall be provided for all dispatch console positions at Dispatch and the backup dispatch center. A single console position shall be provided at Dispatch for use for training and maintenance.

#### **4.5 Interoperability**

Interoperability is required between all District agencies on the new system/solution, as well as the following agencies/systems:

- Portland Police Bureau (PPB) 700/800 MHz trunked system
- Oregon State Police (OSP)
- Oregon Department of Transportation (ODOT)
- Washington County Sheriff's Office (WCSO)
- Washington County Consolidated Communications Agency (WCCCA)
- Scappoose School District
- Portland Fire and Rescue (PF&R)
- AMR
- Tualatin Valley Fire and Rescue (TVF&R)
- Clatsop Fire agencies -
- Cowlitz Fire agencies
- United States Coast Guard (USCG)
- Oregon Department of Forestry (ODF)





- Clark Regional Emergency Services Agency (CRESA)
- Metro area hospitals
- Portland Bureau of Emergency Communications (BOEC)
- Multnomah County Sheriff's Office (MCSO)
- Clatsop County Sheriff's Office (CCSO)
- Cowlitz Sheriff's Office
- Vernonia Public Works
- State Search and Rescue
- Marine channels
- Medix
- Clatskanie Public Works
- Columbia Roads
- State Fire Marshall
- Life Flight
- Wakaikum County
- United States Forest Service (USFS)
- United States Bureau of Land Management (BLM)

#### **4.6 Maintenance**

The new system shall include a network management system (NMS) for alarm reporting and to remotely diagnose system outages and perform preventative maintenance activities. Each RF site shall include a small remote terminal unit (RTU) for monitoring/reporting of physical site alarms (i.e., intrusion, generator, etc.).

#### **4.7 Power**

LMR and microwave equipment at all RF sites shall operate on primary DC power with the ability for all equipment to operate for 8 - 10 hours upon failure of primary AC power. Backup generator required for all Dispatch, control (trunked and simulcast) and RF sites. Uninterruptible Power Supply (UPS) required at all sites for network equipment that will provide backup upon failure of utility AC power for 10 minutes.







## **4.8 Security**

Each RF site shall include three surveillance camera(s) and associated hardware and software to allow monitoring at Dispatch. Trunked system solutions shall be capable of encrypting radio traffic on desired talk groups.

## **4.9 Subscriber Units**

Current subscriber unit inventory for departments on the District system are as follows:

- Total Mobiles – 281
- Total Portables – 454
- Total Control Stations – 11
- Vehicular Repeaters – 4
- Total subscriber units – 750

Implementation of a VHF system would not require replacement of existing subscriber units. Implementation of a 700 MHz or 800 MHz system would require replacement of existing subscriber units. Replacement radios would likely be dual band units for primary communications on 700/800MHz with interoperable communications on VHF channels.

## **4.10 System**

New or upgraded system shall be designed to industry standards, in areas such as grounding, lightning protection and earthquake bracing. For budgetary purposes, the cost estimate shall assume all new LMR and microwave equipment. After contract award, the awarded vendor shall assess each site and recommend which equipment can be used on the new system.

The new system shall use existing District radio channels, where possible. The new system shall allow radio users to hear all radio traffic on a channel or talk group District-wide. Transmitter combiners and receiver multicouplers shall be used at all RF sites to minimize required tower space.

Trunked solutions shall be equipped and licensed for 256-bit Advanced Encryption Standard (AES) encryption services, Over-the-Air Rekeying (OTAR) services, and Over-the-Air Programming (OTAP) services. The new system shall provide paging, and Trunked solutions shall be capable of sending text messages.





## 5. Alternatives Analysis

Based on the system requirements documented in Section 4, *FE* developed and analyzed the following four alternatives to meet the District's radio coverage, channel capacity, interoperability, system reliability and operational needs:

- Build a standalone District-owned VHF analog conventional system
- Build a standalone District-owned 700 MHz P25 conventional system
- Join the Clark Regional Emergency Services Agency (CRESA) 800 MHz P25 Phase 1 Trunked System
- Join the Washington County Consolidated Communications Authority (WCCCA) 800 MHz P25 Phase 2 Trunked System

The following sections provide a detailed analysis of each alternative including coverage maps, capacity studies, and cost estimates.

### 5.1 Alternative 1 – District VHF System

Alternative 1 involves refreshing the District's existing VHF LMR system's radio infrastructure, including repeaters, transmit/receive antennas, and transmission lines at the existing radio sites. This alternative allows the District to continue to operate with its existing frequencies and analog subscriber equipment and minimizes the total investment in site infrastructure when compared with other alternatives that use different frequency bands and/or digital technology.

#### 5.1.1 Radio Coverage

*FE* modeled the coverage that a refresh of the District's existing analog LMR system can provide, using a methodology similar to that used when modeling the existing LMR system's coverage (see Section 2.2.2 for reference). Figure 3 and Figure 4 show the talk-out and talk-in coverage, respectively, for Alternative 1.

It is important to note that interference in the VHF band may not be sufficiently presented in the coverage maps. While a general interference amount is factored into the calculations, the amount may not be reflective of the actual level of interference each radio site is experiencing, which can vary from site to site.

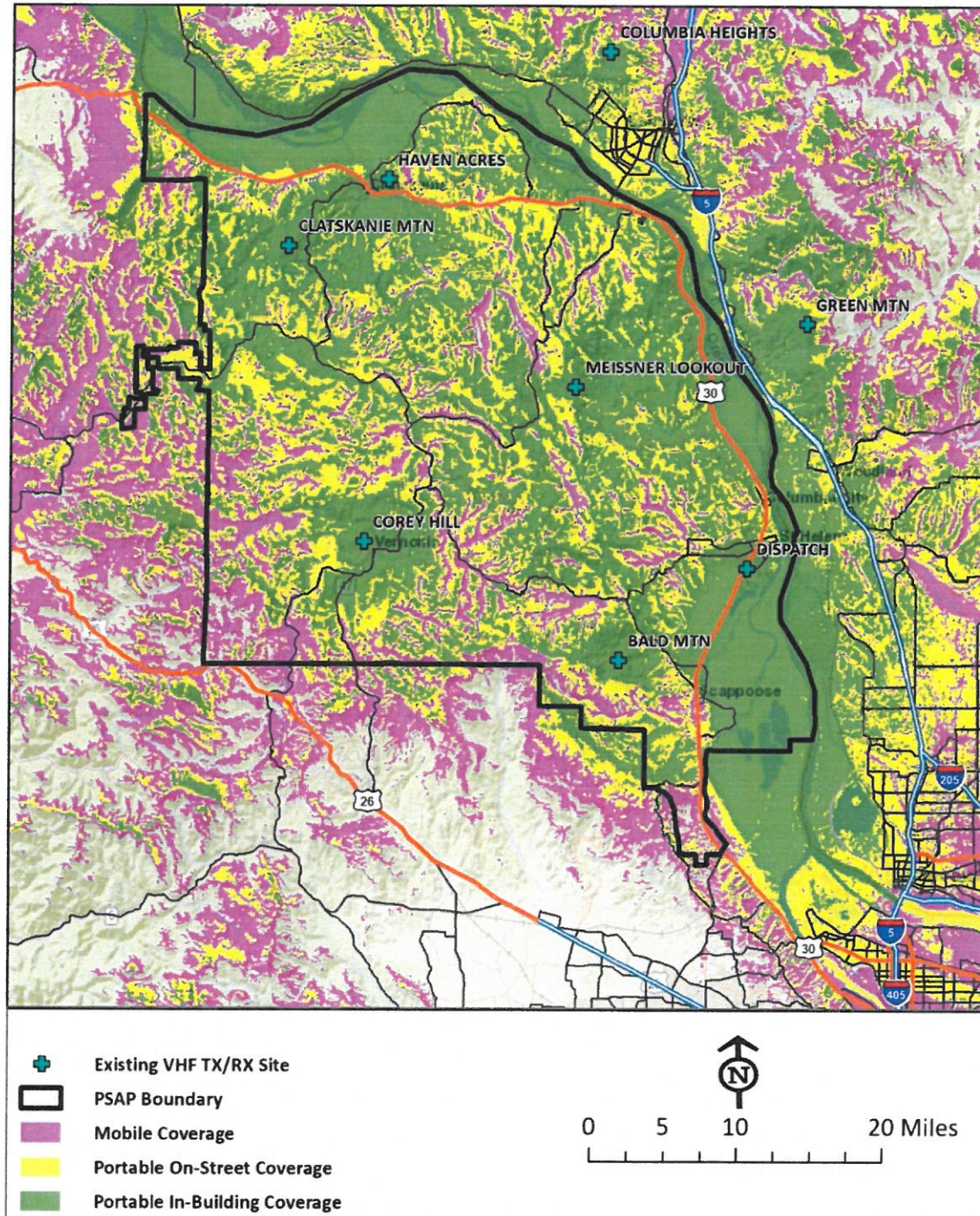






**Columbia 911 Communications District - Alternative 1 (Existing Refresh)**

Analog VHF Voice Coverage  $\geq$  DAQ 3.4; Talk-Out (site to radio); 95% Reliability



**Figure 3 – Alternative 1 Coverage – Talk-Out**

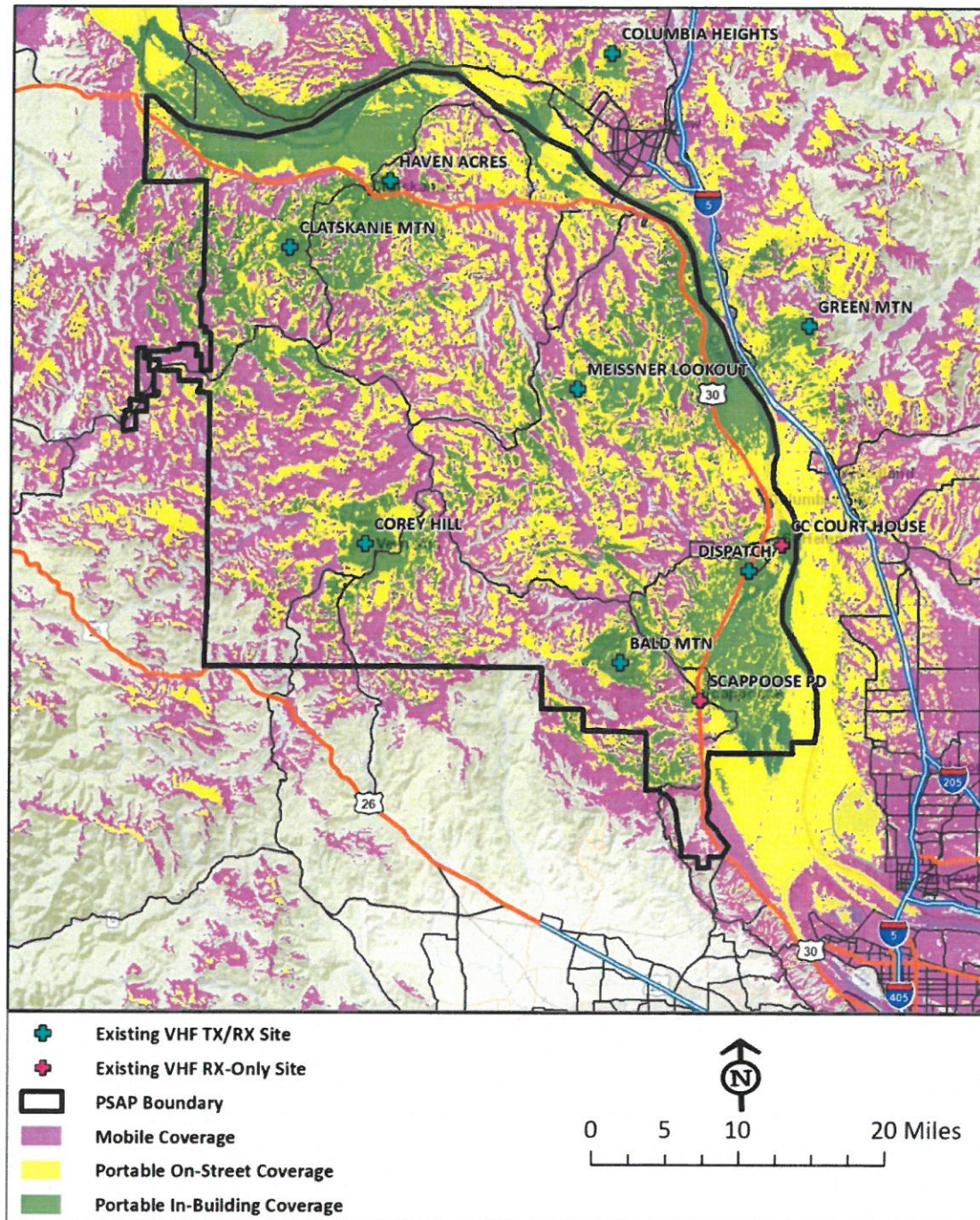






**Columbia 911 Communications District - Alternative 1 (Existing Refresh)**

Analog VHF Voice Coverage  $\geq$  DAQ 3.4; Talk-In (radio to site); 95% Reliability



**Figure 4 – Alternative 1 Coverage – Talk-In**







### 5.1.1.1 Radio Coverage Percentages

FE calculated the geographic percentages of radio coverage that Alternative 1 provides throughout the District boundary. Table 5 displays the coverage percentages.

**Table 5 – Alternative 1 Coverage Percentages**

Geographic Coverage %s of Columbia 9-1-1 Communications District						Coverage %s over Pop. Areas (Ind, Comm, Res) within District	
Mobile Talk-Out	Mobile Talk-In	Portable Talk-Out (On-Street)	Portable Talk-In (On-Street)	Portable Talk-Out (In Bldg.)	Portable Talk-In (In Bldg.)	Portable Talk-Out (In Bldg.)	Portable Talk-In (In Bldg.)
99	95	86	60	57	25	50	15

### 5.1.1.2 Site List

Table 6 presents a list of the radio sites used in Alternative 1.

**Table 6 – Alternative 1 Site List**

Site Name	Site Type	Lat (Dec)	Long (Dec)	Structure Type	Structure Height (ft)	TX Antenna Model	TX Antenna Height (ft)	RX Antenna Model	RX Antenna Height (ft)
Dispatch	Existing VHF TX/RX Site	45.846	-122.830	3 Leg Lattice	125	DB616-AB	72	DB616-AB	82
Columbia Heights	Existing VHF TX/RX Site	46.199	-122.968	3 Leg Lattice	80	SY250-SF2SNM	80	SY250-SF2SNM	80
Green Mtn	Existing VHF TX/RX Site	46.013	-122.772	4 Leg Lattice	120	SY250-SF2SNM	120	SY250-SF2SNM	120
Clatskanie Mtn	Existing VHF TX/RX Site	46.066	-123.283	3 Leg Lattice	190	DB616-AB	190	DB616-AB	190
Corey Hill	Existing VHF TX/RX Site	45.864	-123.208	3 Leg Lattice	130	DB616-AB	150	DB616-AB	150
Haven Acres	Existing VHF TX/RX Site	46.112	-123.186	3 Leg Lattice	250	DB616-AB	60	DB616-AB	70
Scappoose PD	Existing VHF RX Site	45.757	-122.877	Antenna Mount on Building Roof	30 (assumed)	N/A	N/A	DB616-AB	30
Columbia Co Court House	Existing VHF RX Site	45.864	-122.797	Antenna Mount on Building Roof	40 (assumed)	N/A	N/A	DB616-AB	40
Meissner Lookout	Existing VHF TX/RX Site	45.970	-123.000	3 Leg Lattice	45	DB616-AB	46	DB616-AB	46
Bald Mtn	Existing VHF TX/RX Site	45.783	-122.955	3 Leg Lattice	100	DB616-AB	100	DB616-AB	100

### 5.1.2 Channel Capacity

In Alternative 1, the refresh of the existing VHF site equipment involves a one-to-one replacement of the current amount of site repeaters at each radio site. As District stakeholders did not report issues with congestion with their current LMR system, Alternative 1 does not include additional repeaters at any of the radio sites.





### **5.1.3 System Description**

#### **5.1.3.1 Simulcast Control Equipment**

Alternative 1 includes new simulcast control and voting equipment for the eight-site simulcast cell and two receive-only sites. The simulcast control and voting equipment may reside at any of the sites, however, **FE** recommends installing it at sites that are easily accessible during the winter and have commercial AC power and UPS and/or generator backup. To mitigate single point of failure, the alternative includes redundant simulcast control and voting equipment at two geographically separated locations.

The simulcast control equipment maintains the frequency, phase, and amplitude stability of the VHF repeaters to minimize audio distortion for mobile and portable radios in areas where the transmit signals from multiple repeaters overlap. The voting comparator selects the highest quality audio from multiple sites and routes the selected audio to the simulcast control equipment and dispatch consoles. The simulcast control equipment then routes the audio to all repeater sites for retransmission. Audio from the dispatch consoles is routed to the simulcast control equipment for broadcast. The backhaul system would be used to transport audio between repeater sites, simulcast control and voting sites, and the dispatch consoles. Simulcast control and voting equipment sites would also include a Global Positioning System (GPS) receiver with a high-stability oscillator.

#### **5.1.3.2 Repeater Site Equipment**

Alternative 1 includes new repeater and receiver site equipment at the ten existing sites, Dispatch, Columbia Heights, Green Mountain, Clatskanie Mountain, Corey Hill, Haven Acres, Scappoose PD, Columbia County Courthouse, Meissner Lookout, and Bald Mountain. Based on the coverage and capacity analyses, these sites with eight channels (in simulcast mode) are needed to handle the District users. New District sites would consist of the following system components:

- Eight new VHF repeaters at TX/RX sites, licensed and configured to operate in Analog Simulcast mode.
- Eight new VHF receivers at RX-only sites, licensed and configured to operate in Analog Simulcast mode.
- New VHF transmit and receive antennas, radio frequency (RF) cable and lightning protection devices (i.e., lightning arrestors and feedline ground kits).
- New VHF transmitter combiner and receiver multicoupler to mitigate RF site interference and allow District repeaters to share the same transmit and receive antennas. All channels at a site would use the same transmit and







receive antennas, with the receive antenna at the top of the tower and the transmit antenna mounted below the receive antenna with maximum separation to help mitigate RF interference.

- New redundant routing and switching equipment to help mitigate a single point of failure.

#### ***5.1.3.3 Dispatch Console Equipment***

This alternative includes the replacement of the existing five dispatch consoles at the Columbia 911 District dispatch facility. In the requirements definition phase, the District expressed the need for a new console position at Dispatch for training and maintenance.

*FE* understands that the District has options for backup and redundancy

1. Three additional control stations installed in a different location of the same building that Dispatch is in (method currently used).
2. Establish a backup dispatch center at St. Helens PD, which is currently developing a new headquarters.
3. Establish a backup dispatch at the WCCCA facility.

The first option does not provide much redundancy as geographic separation is highly recommended for a backup dispatch center. While number of positions for the backup dispatch location is unknown at this time, the cost estimates reflect five new consoles. Therefore, the design includes a total of eleven new dispatch consoles. It is important to note that the cost estimates do not include any building construction, new tower or shelter, new console furniture, or new secondary power sources at the current or backup dispatch center.

Both locations require a highly reliable dispatch system with no single point of failure. Therefore, the design includes redundant networking equipment and backup RF control stations. The new console system would replace the existing backroom equipment with compact servers, routers, switches, and computers. Each console position would retain all functionality of the existing consoles, with the following additions:

- Radio systems talk group control
- Paging
- Fire station alerting
- Emergency alarms and calls
- Patching between talk groups and conventional stations





Each console position would have a backup control station for use in the event of a console or microwave hop failure to the core. These control stations would be multi-band units to allow for operation on analog or P25 digital systems on VHF, UHF and/or 700/800 MHz channels.

The District already has a logging recorder vendor that they are working with, which will be handled outside this project. Therefore, the cost estimates assume re-use of existing logging recorder with no need for replacement in this alternative. The estimates also do not include any potential hardware, software and/or licensing costs needed to record the voice traffic on the new radio system.

#### **5.1.3.4 Backhaul System Equipment**

Per direction from the District, this alternative assumes re-use of all existing backhaul equipment to the extent possible. Therefore, this alternative does not include costs for any new backhaul equipment for the radio system. The District is in the process of upgrading its current backhaul infrastructure. At the time of writing this report, it is not known whether the District will have the entire system updated prior to the new radio system build-out. It is impossible for *FE* to estimate costs for an unknown number of microwave hops that may remain at the time this upgrade starts. If all backhaul upgrades are not complete, the District should plan for an estimated \$200K per microwave hop as an incremental cost that needs to be added to the new radio system project.

#### **5.1.3.5 Network Management System**

Alternative 1 includes a new network management system (NMS) to remotely monitor the radio, microwave and network equipment performance and site alarms (i.e., rectifier failure, elevated temperature, and site intrusion), troubleshoot equipment outages, and manage their radio fleet. The district may have an existing platform that they want to leverage and integrate with the new equipment. For purpose of this conceptual design, the alternative assumes using a basic commercial off the shelf platform with the following components:

- A network management workstation
- Commercial off the shelf software for the repeater and backhaul equipment
- A remote terminal unit (RTU) for each site to monitor site alarms

This alternative includes two new network management terminals that can reside at any of the District sites that have connectivity to the backhaul network.







### 5.1.3.6 System Interoperability

Interoperability on the new system would remain the same as the existing system. Departments and other agencies using the District radio system would have the current channels of other agencies that they need to interoperate with programmed into their subscriber units and vice versa.

### 5.1.4 Site Improvements

Table 7 summarizes the radio site upgrades needed to support the Alternative 1 system implementation. The site modifications are based on site information provided by the District. An "X" in the table identifies available infrastructure and/or needed items per site that have been included in the cost estimates.

**Table 7 – Alternative 1 Site Improvement Assumptions**

Site Infrastructure and Improvements	Dispatch	Columbia Heights	Green Mtn.	Clatskanie Mtn.	Corey Hill	Haven Acres	Scappoose PD	Columbia Co. Courthouse	Meissner Lookout	Bald Mtn.
Existing Tower/Structure with Available Space	X	X	X	X	X	X	X	X		X
Tower Structural Analysis Needed	X	X		X	X	X	X	X		X
Existing Tower Mods Needed										
New Tower Structure Needed									X	
A&E, Environmental Compliance									X	
Existing Shelter/Bldg. with Available Space	X		X	X	X		X	X	X	
Site Grounding Updates Needed	X			X	X	X	X	X	X	X
Existing Shelter/Bldg. Mods Needed										
New Prefab Shelter Needed										X
New Outdoor Cabinet Needed		X				X				
Commercial AC Power Available	X	X	X	X	X	X	X	X	X	X
Solar/DC Site Upgrades Needed										
Backup Power Source(s) Available	X	X	X	X	X	X	X	X	X	X
New Generator Needed										
New UPS/Batteries Needed										





### 5.1.5 Subscriber Units

Table 8 provides the subscriber unit inventory of mobiles, portables, and control stations provided and validated by the District.

**Table 8 – Existing Subscriber Units Inventory**

Department	Manufacturer	Model	Type	Quantity
CRFPD	Motorola	DeskTrac	C	1
CRFPD	Motorola	CDM 1250	M	10
CRFPD	Kenwood	TK-5720	M	4
CRFPD	Motorola	GM300	M	2
CRFPD	Motorola	M1225	M	2
CRFPD	Motorola	HT1250	P	19
CRFPD	Motorola	MT2000	P	11
CRFPD	ICOM	FV-50	P	9
CCRD	Motorola	CM 300	M	78
CCRD	Motorola	EX 500	P	30
CRF&R	Motorola	HT1250	P	50
CRF&R	Motorola	CDM 1550 LS	M	30
CRF&R	Motorola	CDM 1550 LS	C	5
SRFD	Motorola	CDM1250	C	3
SRFD	Motorola	PM1500	C	2
SRFD	Motorola	CDM1250	M	3
SRFD	Motorola	PM1500	M	9
SRFD	Motorola	MCS2000	M	7
SRFD	Motorola	XTL5000	M	6
SRFD	Kenwood	TK5720	M	3
SRFD	Relm	M150	M	2
SRFD	Motorola	HT1000	P	58
SRFD	Motorola	HT1250	P	3
SRFD	Motorola	MTS2000	P	7
SRFD	Motorola	XTS5000	P	4
SRFD	Relm	P150	P	2
SRFD	Bendix King	DPHX5120x	P	5
St Helens Police	Motorola	CDM 1550-LS	M	15
St Helens Police	Motorola	MT1500	P	24
St Helens Police	Motorola	XLT500	M	8
St Helens Police	Motorola	XTS5000	P	7
Metro West Ambulance	Motorola	HTX1000	P	14
Metro West Ambulance	Motorola	CDM-300	M	2







Department	Manufacturer	Model	Type	Quantity
CCSO	Motorola	APX7000	P	13
CCSO	Motorola	APX7500	M	15
CCSO	Motorola	HT1250	P	90
CCSO	Motorola	CDM1250	M	25
CCSO	Motorola	XTS3000	P	4
Vernonia Fire	Unknown	Unknown	P	33
Vernonia Fire	Unknown	Unknown	M	17
Vernonia Fire	Unknown	Unknown	VR	3
Rainier Police	Unknown	Unknown	P	10
Rainier Police	Unknown	Unknown	M	6
Mist-Birkenfeld	Unknown	Unknown	P	39
Mist-Birkenfeld	Unknown	Unknown	M	27
Mist-Birkenfeld	Unknown	Unknown	VR	1
West Port Fire	Unknown	Unknown	P	16
West Port Fire	Unknown	Unknown	M	7
Columbia City PD	Unknown	Unknown	P	6
Columbia City PD	Unknown	Unknown	M	3
Total Mobiles				281
Total Portables				454
Total Control Stations				11
Total Vehicular Repeaters				4
Total Subscriber Units				750

Per direction from the District, this alternative assumes re-use of all existing subscriber units. Therefore, this alternative does not include any new mobiles, portables, or control stations for any of the departments that will operate on the refreshed system.

### 5.1.6 Cost Analysis

*FE* prepared high-level budgetary cost estimates using an in-house cost analysis tool for the new radio system, backhaul network, network management system, dispatch consoles, subscriber units, site improvements, and implementation services. The cost estimates are based on:

- Data collected from previous projects
- Our knowledge of existing systems and publicly available industry information





- Information collected specifically for this project
- *FE's* experience designing comparable radio systems

Actual system costs are highly dependent upon final system design choices as well as conditions in the land mobile and microwave radio markets during the system procurement phase.

*FE's* budgetary estimates are intentionally conservative. Typically, vendor proposal pricing is unlikely to exceed *FE's* estimate, based on a comparable design as outlined in our assumptions. Our cost estimates are based upon recent non-discounted pricing. Frequently, system vendors provide discounts for large system and subscriber unit purchases, however dynamics in the competitive systems market make it impractical to forecast the specific discounts vendors may offer at the time of proposal submission.

#### **5.1.6.1 Cost Assumptions**

Based on results from the coverage studies, analysis of existing inventory and feedback provided by the District, *FE* developed the following set of equipment- and services-related assumptions shown in Table 9 for the Alternative 1 cost estimates.

**Table 9 – Alternative 1 Cost Assumptions**

<b>Alternative 1 Assumptions</b>	<b>QTY</b>	<b>Notes</b>
<b><i>Simulcast Control Equipment</i></b>		
Simulcast Controller	2	New simulcast cell control equipment with geographically separated locations
GPS Frequency Standard	2	New simulcast cell frequency standard with geographically separated locations
Voting Equipment	6	New simulcast cell voting equipment (2 channels per chassis) with geographically separated locations
Networking Equipment	2	New simulcast cell networking equipment with geographically separated locations
<b><i>Repeater Site Equipment</i></b>		
VHF 8-CH TX/RX Analog Simulcast Equipment	8	New repeaters for the following sites: 6 Existing Columbia VHF sites (Dispatch, Columbia Heights, Green Mtn., Clatskanie Mtn., Corey Hill, Haven Acres, Meissner Lookout, and Bald Mtn.)
VHF 8-CH RX-only Analog Equipment	2	New receivers for the following sites: 2 Existing Columbia VHF sites (Scappoose PD and Columbia Co. Courthouse)
VHF TX/RX Antenna System	10	New 7/800 MHz Transmit/Receive antennas, transmission lines, combiners, multicouplers, and lightning protection
Site Networking Equipment	10	New, redundant routers and switches at each repeater site







Alternative 1 Assumptions	QTY	Notes
LMR FCC License	0	Re-use of existing sites and frequencies; assume no new licenses or modifications needed
LMR Frequency Coordination	0	Re-use of existing sites and frequencies; assume no new licenses or modifications needed
LMR Engineering Services	0	Re-use of existing sites and frequencies; assume no new licenses or modifications needed
<b>Primary Dispatch System Equipment</b>		
Logging Recorder	0	The District already has a logging recorder vendor that they are working with, which will be handled outside this project. Cost for a logging recorder is not needed for the conceptual design or RFP.
Dispatch Console	6	New dispatch consoles to replace five existing console positions, plus one new console position for training and maintenance.
Backup RF Control Station	6	New backup RF control station per console position
700/800 MHz TX/RX Antenna System	1	New Transmit/Receive Antenna, transmission line, control station combiner, and lightning protection
Conventional Channel Gateway	2	4-port gateways for interfacing to Mutual Aid conventional channels
Site Networking Equipment	1	New, redundant routers and switches
<b>Backup Dispatch System Equipment</b>		
Logging Recorder	0	The District already has a logging recorder vendor that they are working with, which will be handled outside this project. Cost for a logging recorder is not needed for the conceptual design or RFP.
Dispatch Console	5	New dispatch consoles to replace the five console positions the District currently has.
Backup RF Control Station	5	New backup RF control station per console position
700/800 MHz TX/RX Antenna System	1	New Transmit/Receive Antenna, transmission line, control station combiner, and lightning protection
Conventional Channel Gateway	2	4-port gateways for interfacing to Mutual Aid conventional channels
Site Networking Equipment	1	New, redundant routers and switches
<b>Microwave Backhaul Equipment</b>		
New Microwave Backhaul Equipment	0	Assume re-use of all existing microwave hops; upgrades currently in process; assume no new equipment needed
<b>Network Management System</b>		
Network Management Server	1	New NMS equipment to be housed at a P25 Phase 1 Core location
Network Management Terminal	2	New NMT equipment; can be located anywhere in the State with access to radio/backhaul network
Fault Management Server	1	New Alarms equipment to be housed at a P25 Phase 1 Core location
Fault Management Site	10	New Alarms equipment to be housed at each of the radio/backhaul sites plus enhancement sites
<b>Civil/Site Improvements</b>		
Existing Tower/Structure with Available Space	9	Based on information in District-provided documentation





Alternative 1 Assumptions	QTY	Notes
Tower Structural Analysis Needed	8	Based on information in District-provided documentation
Existing Tower Mods Needed	0	Based on information in District-provided documentation
New Tower Structure Needed	1	Based on information in District-provided documentation
A&E, Environmental Compliance	1	Based on information in District-provided documentation
Existing Shelter/Bldg. with Available Space	7	Based on information in District-provided documentation
Site Grounding Updates Needed	8	Based on information in District-provided documentation
Existing Shelter/Bldg. Mods Needed	0	Based on information in District-provided documentation
New Prefab Shelter Needed	1	Based on information in District-provided documentation
New Outdoor Cabinet Needed	2	Based on information in District-provided documentation
Commercial AC Power Available	10	Based on information in District-provided documentation
Solar/DC Site Upgrades Needed	0	Based on information in District-provided documentation
Backup Power Source(s) Available	10	Based on information in District-provided documentation
New Generator Needed	0	Based on information in District-provided documentation
New UPS/Batteries Needed	0	Based on information in District-provided documentation
<b><i>Subscriber Equipment</i></b>		
Total Mobiles	281	Re-use existing VHF mobiles; new radios not included in cost estimates
Total Portables	454	Re-use existing VHF portables; new radios not included in cost estimates
Total Control Stations	11	Re-use existing VHF control stations; new radios not included in cost estimates
Total Vehicular Repeaters	4	Re-use existing VHF vehicular repeaters; new radios not included in cost estimates
<b><i>Implementation Services</i></b>		
Spare / Test Equipment	5%	Based on <b>FE</b> historical / industry data
Project Management	10%	Based on <b>FE</b> historical / industry data
Installation	10%	Based on <b>FE</b> historical / industry data
Engineering	20%	Based on <b>FE</b> historical / industry data
Removal of Existing Equipment	2%	Based on <b>FE</b> historical / industry data
Training	1%	Based on <b>FE</b> historical / industry data
Staging	5%	Based on <b>FE</b> historical / industry data
Acceptance/Coverage Testing	1%	Based on <b>FE</b> historical / industry data
Documentation	1%	Based on <b>FE</b> historical / industry data
Sales Tax	0%	Oregon state sales tax rate is currently 0%







Alternative 1 Assumptions	QTY	Notes
Contingency	10%	Based on <b>FE</b> historical / industry data
<b>Operational Expenditures (OPEX)</b>		
System OPEX Period (years)	10	System lifecycle costs shown in 5-year increments
Manufacturer's Warranty (years)	1	Out-of-warranty supports begins in Year 2
Annual Inflation Rate	3%	Based on <b>FE</b> historical / industry data
System Remote Technical Support	1%	Percentage of total system equipment CAPEX in Year 1; annual inflation added Years 2 - 10
System Security/Information Assurance	2%	Percentage of total system equipment CAPEX in Year 1; annual inflation added Years 2 - 10
System Upgrades (Hardware/Software)	5%	Percentage of total system equipment CAPEX in Year 1; annual inflation added Years 2 - 10
System Onsite Support and Repair	3%	Percentage of total system equipment CAPEX in Year 1; annual inflation added Years 2 - 10

### 5.1.6.2 Radio System Cost

Table 10 summarizes the estimated costs for the LMR radio system upgrade equipment and services for Alternative 1.

**Table 10 – Alternative 1 Radio System Cost Estimate**

Alternative 1 Radio System Cost Estimate			
<b>Simulcast Site Equipment</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
Simulcast Controller	2	\$69,000	\$138,000
GPS Frequency Standard	2	\$37,000	\$74,000
Voting Equipment	6	\$23,000	\$138,000
Networking Equipment	2	\$37,000	\$74,000
Spare / Test Equipment	5%		\$22,000
<b>Subtotal - Repeater Site Equipment</b>			<b>\$446,000</b>
<b>Repeater Site Equipment</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
VHF 8-CH TX/RX Equipment	8	\$162,000	\$1,296,000
VHF 8-CH RX-only Equipment	2	\$53,000	\$106,000
VHF TX/RX Antenna System	10	\$34,000	\$340,000
Site Networking Equipment	10	\$13,000	\$130,000
Spare / Test Equipment	5%		\$94,000
<b>Subtotal - Repeater Site Equipment</b>			<b>\$1,966,000</b>
<b>Equipment Subtotal</b>			<b>\$2,412,000</b>
<b>FCC Licensing and Coordination</b>		<b>Unit Cost</b>	<b>Extended Cost</b>
LMR FCC License Fees	0	\$100	\$0
LMR Frequency Coordination Fees	0	\$300	\$0
LMR Engineering Services Fees	0	\$125	\$0
<b>Subtotal - FCC Licensing and Coordination (rounded)</b>			<b>\$0</b>
<b>Implementation Services</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
Project Management	10%		\$242,000
Installation	10%		\$242,000
Engineering	20%		\$483,000





Alternative 1 Radio System Cost Estimate			
Removal of Existing Equipment	2%		\$49,000
Training	1%		\$25,000
Staging	5%		\$121,000
Acceptance Testing	1%		\$25,000
Documentation	1%		\$25,000
<b>Subtotal - Implementation Services</b>			<b>\$1,212,000</b>
<b>Services Subtotal</b>			<b>\$1,212,000</b>
<b>TOTAL - EQUIPMENT &amp; SERVICES</b>			<b>\$3,624,000</b>
Sales Tax	0%		\$0
Contingency	10%		\$363,000
<b>TOTAL - EQUIPMENT &amp; SERVICES (with sales tax &amp; contingency), rounded</b>			<b>\$3,990,000</b>

### 5.1.6.3 Dispatch System Cost

Table 11 shows the estimated costs for the dispatch system equipment and services, common to all alternatives.

**Table 11 – Dispatch System Cost Estimate**

Dispatch System Cost Estimate			
<i><b>Primary Dispatch Equipment</b></i>	<i><b>Quantity</b></i>	<i><b>Unit Cost</b></i>	<i><b>Extended Cost</b></i>
Logging Recorder System	0	\$175,000	\$0
Dispatch Console Position	6	\$48,000	\$288,000
Backup RF Control Station	6	\$8,000	\$48,000
Control Station Antenna System	1	\$18,000	\$18,000
Conventional Channel Gateway	2	\$7,000	\$14,000
Networking Equipment	1	\$13,000	\$13,000
Spare / Test Equipment	5%		\$20,000
<b>Subtotal - Dispatch Equipment</b>			<b>\$401,000</b>
<i><b>Backup Dispatch Equipment</b></i>	<i><b>Quantity</b></i>	<i><b>Unit Cost</b></i>	<i><b>Extended Cost</b></i>
Logging Recorder System	0	\$175,000	\$0
Dispatch Console Position	5	\$48,000	\$240,000
Backup RF Control Station	5	\$8,000	\$40,000
Control Station Antenna System	1	\$18,000	\$18,000
Conventional Channel Gateway	2	\$7,000	\$14,000
Networking Equipment	1	\$13,000	\$13,000
Spare / Test Equipment	5%		\$17,000
<b>Subtotal - Dispatch Equipment</b>			<b>\$342,000</b>
<b>Equipment Subtotal</b>			<b>\$743,000</b>







<b>Implementation Services</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
Project Management	10%		\$75,000
Installation	10%		\$75,000
Engineering	20%		\$149,000
Removal of Existing Equipment	2%		\$15,000
Training	1%		\$8,000
Staging	5%		\$38,000
Acceptance Testing	1%		\$8,000
Documentation	1%		\$8,000
<b>Subtotal - Implementation Services</b>			<b>\$376,000</b>
<b>TOTAL - EQUIPMENT &amp; SERVICES</b>			<b>\$1,119,000</b>
Sales Tax	0%		\$0
Contingency	10%		\$112,000
<b>TOTAL - EQUIPMENT &amp; SERVICES (with sales tax &amp; contingency), rounded</b>			<b>\$1,240,000</b>

#### 5.1.6.4 Backhaul System Cost

Alternative 1 assumes re-use of all existing backhaul equipment, of which microwave upgrades are currently in process. Therefore, this alternative does not include any new backhaul equipment that will provide connectivity for the refreshed system.

#### 5.1.6.5 Network Management Cost

Table 12 summarizes the estimated costs for the NMS equipment and services for Alternative 1.

**Table 12 – Alternative 1 Network Management Cost Estimate**

<b>Alternative 1 Network Management Cost Estimate</b>			
<b>Network Management Equipment</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
Network Management Server	1	\$10,000	\$10,000
Network Management Terminal	2	\$5,000	\$10,000
Fault Management Server	1	\$10,000	\$10,000
Remote Terminal Unit	10	\$2,500	\$25,000
Spare / Test Equipment	5%		\$3,000
<b>Equipment Subtotal</b>			<b>\$58,000</b>
<b>Implementation Services</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
Project Management	10%		\$6,000
Installation	10%		\$6,000
Engineering	20%		\$12,000
Removal of Existing Equipment	2%		\$2,000
Training	1%		\$1,000
Staging	5%		\$3,000
Acceptance Testing	1%		\$1,000
Documentation	1%		\$1,000





Alternative 1 Network Management Cost Estimate			
Subtotal - Implementation Services			\$32,000
<b>TOTAL - EQUIPMENT &amp; SERVICES</b>			<b>\$90,000</b>
Sales Tax	0%		\$0
Contingency	10%		\$9,000
<b>TOTAL - EQUIPMENT &amp; SERVICES (with sales tax &amp; contingency), rounded</b>			<b>\$100,000</b>

#### 5.1.6.6 Site Improvements Cost

Table 13 summarizes the estimated costs for site improvements and services for Alternative 1.

**Table 13 – Alternative 1 Site Improvements Cost Estimate**

Alternative 1 Site Improvements Cost Estimate			
<i>Site Support Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Existing Tower/Structure with Available Space	9	\$0	\$0
Tower Structural Analysis Needed	8	\$5,000	\$40,000
Existing Tower Mods Needed	0	\$50,000	\$0
New Tower Structure Needed	1	\$283,000	\$283,000
A&E, Environmental Compliance	1	\$14,000	\$14,000
Existing Shelter/Bldg. with Available Space	7	\$0	\$0
Site Grounding Updates Needed	8	\$15,000	\$120,000
Existing Shelter/Bldg. Mods Needed	0	\$20,000	\$0
New Prefab Shelter Needed	1	\$109,000	\$109,000
New Outdoor Cabinet Needed	2	\$10,000	\$20,000
Commercial AC Power Available	10	\$0	\$0
Solar/DC Site Upgrades Needed	0	\$15,000	\$0
Backup Power Source(s) Available	10	\$0	\$0
New Generator Needed	0	\$30,000	\$0
New UPS/Batteries Needed	0	\$30,000	\$0
Spare / Test Equipment	5%		\$30,000
<b>Equipment Subtotal</b>			<b>\$616,000</b>







<b>Implementation Services</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
Project Management	10%		\$62,000
Installation	10%		\$62,000
Engineering	20%		\$124,000
Removal of Existing Equipment	2%		\$13,000
Training	1%		\$7,000
Staging	5%		\$31,000
Acceptance Testing	1%		\$7,000
Documentation	1%		\$7,000
<b>Subtotal - Implementation Services</b>			<b>\$313,000</b>
<b>TOTAL - EQUIPMENT &amp; SERVICES</b>			<b>\$929,000</b>
Sales Tax	0%		\$0
Contingency	10%		\$93,000
<b>TOTAL - EQUIPMENT &amp; SERVICES (with sales tax &amp; contingency), rounded</b>			<b>\$1,030,000</b>

#### 5.1.6.7 Subscriber Units Cost

Alternative 1 assumes re-use of all existing subscriber units, and therefore, does not include any new mobiles, portables, or control stations for any of the departments that will operate on the refreshed system.

#### 5.1.6.8 Total Cost Summary

Table 14 summarizes the total cost estimate for Alternative 1, including radio system, dispatch consoles, network management, site improvements, and system maintenance over 10 years.

**Table 14 – Alternative 1 Total Cost Estimate**

<b>Alternative 1 Total Cost Estimate</b>					
<i>Item</i>	<i>Equipment</i>	<i>Services</i>	<i>Sales Tax</i>	<i>Contingency</i>	<i>Total (rounded)</i>
Radio System	\$2,412,000	\$1,212,000	\$0	\$363,000	<b>\$3,990,000</b>
Dispatch System	\$743,000	\$376,000	\$0	\$112,000	<b>\$1,240,000</b>
Backhaul System	\$0	\$0	\$0	\$0	<b>\$0</b>
Network Management	\$58,000	\$32,000	\$0	\$9,000	<b>\$100,000</b>
Site Improvements	\$616,000	\$313,000	\$0	\$93,000	<b>\$1,030,000</b>
Subscriber Units	\$0	\$0	\$0	\$0	<b>\$0</b>
<b>Total</b>					<b>\$6,360,000</b>
<i>Lifecycle Costs</i>	<i>Equipment</i>	<i>Services</i>	<i>Sales Tax</i>	<i>Contingency</i>	<i>10-Year Total</i>
System Maintenance	\$0	\$2,050,000	\$0	\$0	<b>\$2,050,000</b>
<b>Total Capital and Recurring Costs over 10 Years</b>					<b>\$8,410,000</b>





## 6. Alternative 2 – District 700 MHz System

Alternative 2 involves the construction of a stand-alone, District-owned 700 MHz LMR system, operating on P25 conventional technology. This alternative allows the District to migrate to a frequency band that is less prone to interference (when compared with VHF), and also allows their users to operate on P25 technology.

### 6.1.1 Radio Coverage

*FE* modeled the coverage that a 700 MHz P25 LMR system can provide throughout the District. Throughout the course of the project, the District identified the following requirements with regards to coverage:

- Mobile coverage throughout 95% of the District's geographic boundary is required.
- Portable on-street coverage throughout 95% of the District's geographic boundary is highly desired.

*FE*, using a methodology similar to that used when modeling the existing LMR system's coverage (see Section 2.2.2 for reference), determined the optimal configuration of both existing radio sites and potential candidate sites to meet the coverage requirements. Table 15 and Table 16 present the coverage study parameters and the subscriber unit parameters, respectively, *FE* used to perform the coverage analysis.

**Table 15 – Coverage Study Parameters**

Parameter	Description
System Type	P25 Phase 1 conventional (FDMA)
Frequency Band	700 MHz
Channel Bandwidth	12.5 kHz
Reliability	95%
Minimum Performance	Delivered Audio Quality (DAQ) – 3.4
Talk Paths	Mobile radio talk-out (from repeater to mobile) Mobile radio talk-in (from mobile to repeater) Portable radio talk-out, on-street (from repeater to a portable on the street) Portable radio talk-in, on-street (from portable on the street to repeater) Portable radio talk-out, in light/residential buildings (from repeater to portable inside buildings) Portable radio talk-in, in light/residential buildings (from portable inside buildings to repeater).







**Table 16 – Subscriber Unit Parameters**

Parameter	Mobile	Portable
Transmit Power (watts)	35	2.5
Receive Sensitivity (dBm)	-119	-119
Antenna Location	Roof	Hip
Antenna Gain (dB)	3	0
Body Loss (dB)	N/A	14.3

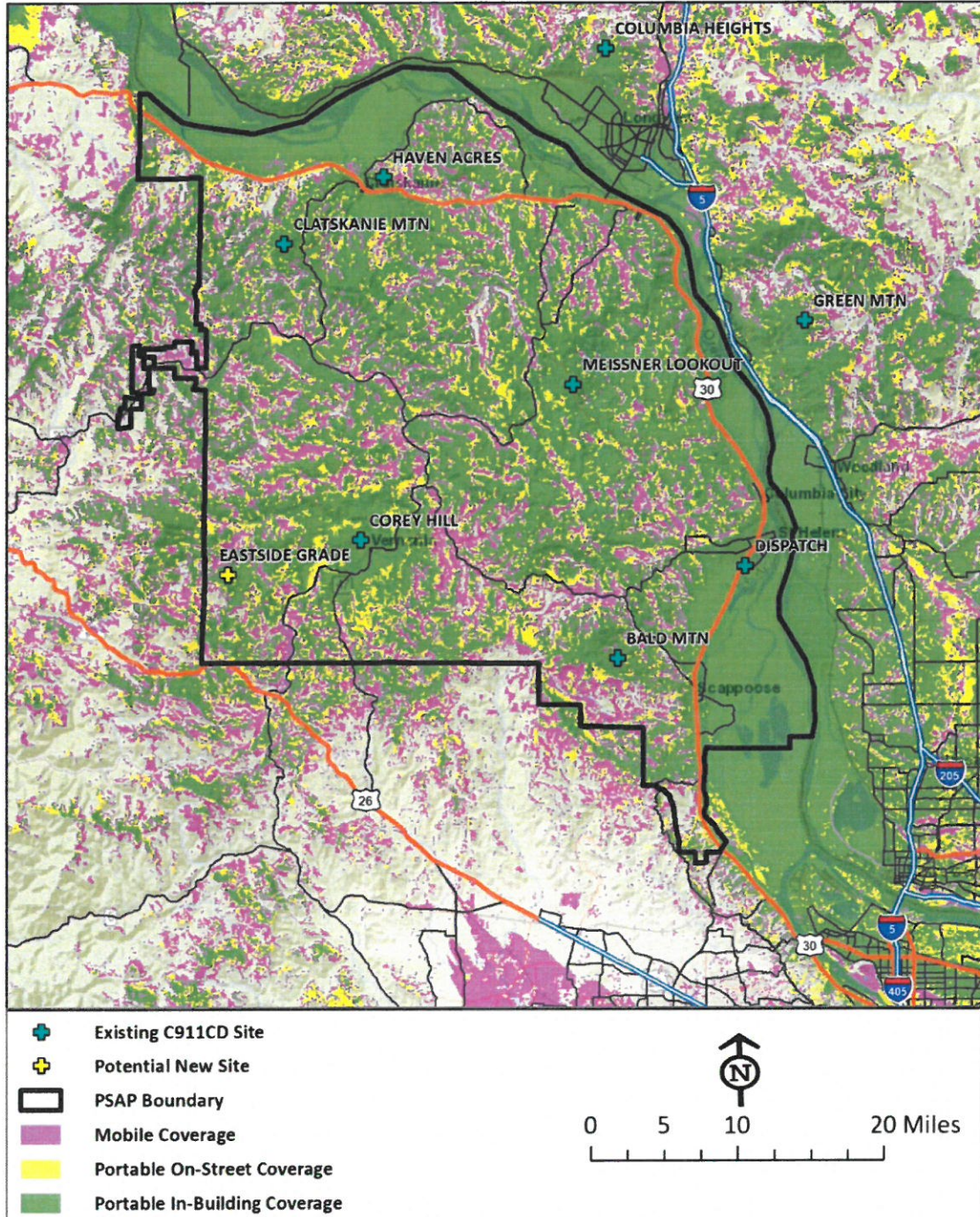
Figure 5 and Figure 6 show the Alternative 2 talk-out and talk-in coverage, respectively.

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**Columbia 911 Communications District - Alternative 2 (Stand-Alone)**  
700/800 MHz P25 Voice Coverage  $\geq$  DAQ 3.4; Talk-Out (site to radio); 95% Reliability



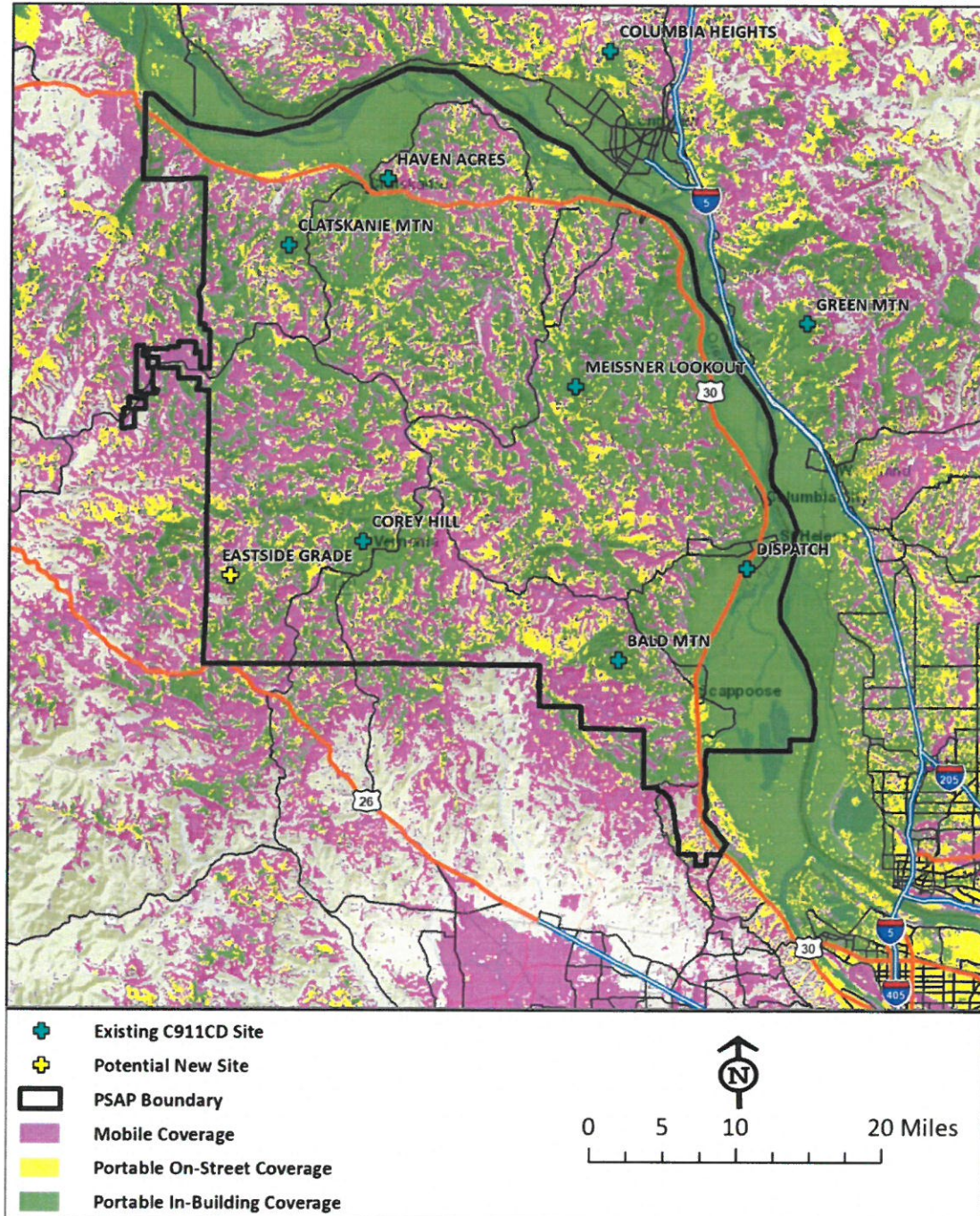
**Figure 5 – Alternative 2 Coverage – Talk-Out**







**Columbia 911 Communications District - Alternative 2 (Stand-Alone)**  
700/800 MHz P25 Voice Coverage >= DAQ 3.4; Talk-In (radio to site); 95% Reliability



**Figure 6 – Alternative 2 Coverage – Talk-In**







### 6.1.1.1 Radio Coverage Percentages

*FE* calculated the geographic percentages of radio coverage that Alternative 2 provides throughout the District boundary. Table 17 displays the coverage percentages.

**Table 17 – Alternative 2 Coverage Percentages**

Geographic Coverage %s of Columbia 9-1-1 Communications District						Coverage %s over Pop. Areas (Ind, Comm, Res) within District	
Mobile Talk-Out	Mobile Talk-In	Portable Talk-Out (On-Street)	Portable Talk-In (On-Street)	Portable Talk-Out (In Bldg.)	Portable Talk-In (In Bldg.)	Portable Talk-Out (In Bldg.)	Portable Talk-In (In Bldg.)
96	99	79	71	63	52	87	75

### 6.1.1.2 Site List

Table 18 presents a list the radio sites used in Alternative 2.

**Table 18 – Alternative 2 Site List**

Site Name	Site Type	Lat (Dec)	Long (Dec)	Structure Type	Structure Height (ft)	TX Antenna Model	TX Antenna Height (ft)	RX Antenna Model	RX Antenna Height (ft)
Dispatch	Existing C911CD Site	45.846	-122.830	3 Leg Lattice	125	SC469-HF1LDF	72	SC469-HF1LDF	82
Columbia Heights	Existing C911CD Site	46.199	-122.968	3 Leg Lattice	80	SP42F2X-HF1P65LDF	80	SP42F2X-HF1P65LDF	80
Green Mtn	Existing C911CD Site	46.013	-122.772	4 Leg Lattice	120	SP42F2X-HF1P65LDF	120	SP42F2X-HF1P65LDF	120
Clatskanie Mtn	Existing C911CD Site	46.066	-123.283	3 Leg Lattice	190	SC469-HF1LDF	190	SC469-HF1LDF	190
Corey Hill	Existing C911CD Site	45.864	-123.208	3 Leg Lattice	130	SC469-HF1LDF	150	SC469-HF1LDF	150
Haven Acres	Existing C911CD Site	46.112	-123.186	3 Leg Lattice	250	SC469-HF1LDF	60	SC469-HF1LDF	70
Meissner Lookout	Existing C911CD Site	45.970	-123.000	3 Leg Lattice	45	SC469-HF1LDF	46	SC469-HF1LDF	46
Bald Mtn	Existing C911CD Site	45.783	-122.955	3 Leg Lattice	100	SC469-HF1LDF	100	SC469-HF1LDF	100
Eastside Grade	Potential Candidate Site	45.840	-123.338	New SST	40	SC469-HF1LDF	40	SC469-HF1LDF	40

### 6.1.2 Channel Capacity

Alternative 2 is a conventional P25 system, which provides one talk path (i.e., voice conversation) per frequency. The typical rule of thumb for calculating necessary capacity for conventional systems is to provide one channel for every 100 radio users on the system. During the course of this project, the District conveyed to *FE* that there are currently 635 subscriber units on the existing LMR system, and that a 1% annual growth rate in subscriber units is anticipated over the next ten years. This results in a projected total of 701 subscriber units after ten years.







Using this projected total, *FE* believes seven conventional frequencies, simulcast throughout the radio sites in the stand-alone 700 MHz system, should provide sufficient capacity for the next ten years, based on the subscriber unit growth estimates.

### **6.1.3 System Description**

#### **6.1.3.1 System Control Equipment**

The new radio system would have a P25 conventional system control equipment that includes management, administration and networking components that are utilized for control of the new 700 MHz channels. The system control equipment could reside at the any of the repeater sites. However, *FE* recommends that the P25 system control equipment be installed at a site that is easily accessible during the winter and have commercial AC power and UPS or generator backup, such as the Dispatch Center. To mitigate single point of failure, the alternative includes redundant system control equipment at two geographically separated locations.

#### **6.1.3.2 Simulcast Control Equipment**

Refer to Section 5.1.3.1 for a description of simulcast control and voting equipment. Alternative 2 includes new simulcast control and voting equipment for the nine-site simulcast cell. The simulcast control and voting equipment may reside at any of the sites, however, *FE* recommends installing it at sites that are easily accessible during the winter and have commercial AC power and UPS and/or generator backup. To mitigate single point of failure, the alternative includes redundant simulcast control and voting equipment at two geographically separated locations.

#### **6.1.3.3 Repeater Site Equipment**

Alternative 2 includes new repeater site equipment at the nine identified candidate sites, Dispatch, Columbia Heights, Green Mountain, Clatskanie Mountain, Corey Hill, Haven Acres, Meissner Lookout, Bald Mountain, and Eastside Grade. Based on the coverage and capacity analyses, nine sites with seven channels (in simulcast mode) are needed to handle the District users. New District sites would consist of the following system components:

- Seven new 700/800 MHz digital repeaters, licensed and configured to operate in P25 Conventional Simulcast mode.





- New 700/800 MHz transmit and receive antennas, radio frequency (RF) cable and lightning protection devices (i.e., lightning arrestors and feedline ground kits).
- New 700/800 MHz transmitter combiner and receiver multicoupler to mitigate RF site interference and allow District repeaters to share the same transmit and receive antennas. All channels at a site would use the same transmit and receive antennas, with the receive antenna at the top of the tower and the transmit antenna mounted below the receive antenna with maximum separation to help mitigate RF interference.
- New redundant routing and switching equipment to help mitigate a single point of failure.

#### ***6.1.3.4 Dispatch Console Equipment***

Refer to Section 5.1.3.3 as the proposed dispatch console equipment is common to all four alternatives.

#### ***6.1.3.5 Backhaul System Equipment***

Alternative 2 assumes use of the following existing and new microwave hops to connect existing and new District sites on the new radio system.

- Existing District microwave hops
  - Dispatch to Green Mountain
  - Dispatch to Bald Mountain
  - Green Mountain to Clatskanie
  - Clatskanie to Meissner
  - Clatskanie to Columbia Heights
  - Clatskanie to Corey Hill
- New District microwave hops
  - Corey Hill to Eastside Grade (Greenfield site)
  - Clatskanie to Haven Acres (current RX-only site)

It is *FE's* understanding that the District has microwave system upgrades currently underway. At the time of writing this report, it is not known whether the District will have the entire system updated prior to the new radio system build-out. It is impossible for *FE* to estimate costs for an unknown number of microwave hops that may remain. If all







backhaul upgrades are not complete, the District should plan for an estimated \$200K per microwave hop to be a part of the new radio system project.

Except for Haven Acres, the design assumes that existing District microwave hops do not need replacement as part of this project. The cost estimates reflect only two new spur sites with Monitored Hot Standby (MHSB) configuration.

Because Eastside Grade is proposed as a Greenfield site, there is no existing microwave hop to connect it to an existing District site. Therefore, this alternative includes a new licensed microwave hop between Corey Hill and Eastside Grade (which appears to have a clear path profile).

The existing microwave hop between Dispatch and Bald Mountain is potentially problematic: there are trees near the Bald Mountain site which have grown tall enough to obstruct the line of sight (LOS) required for this link. The District requested the site owner trim and/or cut the obstructing trees; however, to date the site owner has denied those requests. While Alternative 2 includes Bald Mountain's existing link to Dispatch, the District may wish to evaluate an alternate method for connecting those two sites due to the issues with the current link.

The upgrade status of the Haven Acres backhaul equipment is unknown at the time of writing this report. Given it is currently an RX-only site, **FE** assumes that the existing microwave hop may not have enough bandwidth to support the number of transmit and receive channels required for this alternative. Therefore, this alternative includes a new licensed microwave hop between Clatskanie to Haven Acres (which appears to have a clear path profile).

**FE** recommends that new microwave hops be in a ring, unprotected (1+0) where possible, with spurs in monitored hot standby (1+1) configuration. New microwave hops shall have a minimum 99.999% availability (i.e., five 9's) and include all new radios, antennas, waveguide, dehydrator, accessories, and battery banks. Based on terrain, closing the ring with the new sites may not be feasible. Therefore, the design includes the above MHSB spurs.

**FE** analyzed potential new microwave paths to assess adequate clearance above terrain and obstructions. However, **FE** did not perform physical radio path surveys to identify the exact location and height of potential obstructions. The District should require the awarded vendor to perform final path and system design in their scope of work, including physical path surveys. It is important to note that actual frequencies for the new paths are unknown. Typically, new systems include frequencies between 6 and 23 GHz equipment





based on distance and line of site gathered through software tools and path surveys. For budgetary purposes, the cost estimates reflect 6 GHz radios, antennas, and waveguide.

Appendix B provides the path profile reports detailing estimated path availability for all new microwave links.

### **6.1.3.6 Network Management System**

Alternative 2 includes a new Network Management System (NMS) to:

- Remotely monitor radio, dispatch, and backhaul system and site performance and alarms (i.e., rectifier failure, elevated temperature, and intrusion)
- Troubleshoot system outages
- Administer and manage system security, functionality, and software licenses
- Page or send emails to report system alarms or outages to staff required to respond

The NMS software interface would identify the current operating status of the equipment and sites and would flag 'out of tolerance' conditions via an audio/visual indication. The indication would return to a normal indication after correction of the out of tolerance condition. The NMS would archive system data and would maintain a history of alarm events in a searchable database for a minimum of 180 days. Storage of alarm events enables root cause analysis on infrequent recurring events. Following is some of the events and functions that the NMS would monitor and manage:

- Transmitter low power output
- Antenna system high Voltage Standing Wave Ratio (VSWR)
- Transmitter power amplifier (PA) failure
- Base station power supply failure
- Tower top amplifier failure
- GPS frequency standard failure
- Router/switch failure
- Controller/gateway/server failure
- External interference detection
- Critical site path re-route alert
- IP network intrusion and security







- Configuration database changes

This alternative includes two new network management terminals that can reside at any of the District sites that have connectivity to the backhaul network.

#### **6.1.3.7 System Interoperability**

Most departments and agencies operating on the existing District radio system are able to interoperate by:

- VHF channel programming of other departments/agencies channels in their mobile and portable radios and vice versa
- Lending portable radios to other agencies responding to an incident
- Patching systems through dispatch consoles

With P25 radio systems (backwards compatible with analog), and with VHF and 700 MHz dual-band radios, the District would still be able to program other departments analog conventional channels in their mobile and portable radios and would be able to lend out portable radios, as needed. With use of gateways, P25 digital radio systems provide connectivity between the District's P25 system and other VHF analog conventional system(s).

P25 is the predominant standard for public safety in North America. Most U.S. Federal Government and state grants require use of P25 based equipment. The P25 standard supports both conventional and trunked operations, with over 1,800 conventional systems and over 1,000 trunked systems in operation throughout the United States.

There are currently 16 P25 Conventional and 15 P25 Trunked systems in the state of Oregon, and many other P25 systems in adjacent states. Migrating to a P25 system increases interoperability with surrounding P25 systems such as CRESA, WCCCA, City of Portland, and State of Oregon.

The use of P25 systems and subscribers provides the highest likelihood of achieving interoperability with other public safety users. P25 is a mature and robust standard, providing detailed specifications with a well-defined interface path for connecting with other P25 radio systems, even with potentially disparate manufacturers.

#### **6.1.4 Site Improvements**

Alternative 2 requires use of nine sites that serve different purposes as follows:





1. Dispatch - new P25 site, existing District site, use existing microwave to Bald Mtn. and Green Mtn.
2. Columbia Heights - new P25 site, existing District site with existing microwave to Clatskanie Mtn. and Green Mtn.
3. Green Mtn. - new P25 site, existing District site, use existing microwave to Clatskanie Mtn. and Dispatch
4. Clatskanie Mtn. – new P25 site, existing District site, use existing microwave to Corey Hill, Meissner Lookout, Green Mtn., and Columbia Heights
5. Corey Hill - new P25 site, existing District site with existing microwave to Clatskanie Mtn., new microwave link to Eastside Grade
6. Haven Acres – new P25 site, existing SBA site, new microwave hop to Clatskanie Mtn.
7. Meissner Lookout - new P25 site, existing District site with existing microwave to Clatskanie Mtn.
8. Bald Mtn. - new P25 site, existing District site with existing microwave to Dispatch
9. Eastside Grade - new P25 site, new tower and shelter, and new microwave link to Corey Hill

As stated previously, the existing microwave hop between Dispatch and Bald Mountain is potentially problematic due to trees obstructing the path. While Alternative 2 includes Bald Mountain's existing link to Dispatch, the District may wish to evaluate an alternate method for connecting those two sites due to the issues with the current link, or perhaps evaluate raising the microwave dish heights at the Bald Mountain site to account for the recent tree growth.

Table 19 summarizes the radio site upgrades needed to support the Alternative 2 system implementation. The site modifications are based on site information provided by the District. An "X" in the table identifies available infrastructure and/or needed items per site that have been included in the cost estimates.







**Table 19 – Alternative 2 Site Improvement Assumptions**

Site Infrastructure and Improvements	Dispatch	Columbia Heights	Green Mtn.	Clatskanie Mtn.	Corey Hill	Haven Acres	Meissner Lookout	Bald Mtn.	Eastside Grade
Existing Tower/Structure with Available Space	X	X	X	X	X	X		X	
Tower Structural Analysis Needed	X	X		X	X	X		X	
Existing Tower Mods Needed									
New Tower Structure Needed							X		X
A&E, Environmental Compliance							X		X
Existing Shelter/Bldg. with Available Space	X		X	X	X		X		
Site Grounding Updates Needed	X			X	X	X	X	X	
Existing Shelter/Bldg. Mods Needed									
New Prefab Shelter Needed								X	X
New Outdoor Cabinet Needed		X				X			
Commercial AC Power Available	X	X	X	X	X	X	X	X	X
Solar/DC Site Upgrades Needed									
Backup Power Source(s) Available	X	X	X	X	X	X	X	X	
New Generator Needed									X
New UPS/Batteries Needed									X

### 6.1.5 Subscriber Units

Section 5.1.5 provides the detailed inventory of the existing subscriber units. This alternative requires that the District replace existing VHF, analog-only and end-of-life subscriber units. Almost all existing subscriber units require replacement with 700/800 MHz radios equipped and licensed to operate on P25 Conventional mode. Only CCSO can re-use and re-program a portion of their fleet on the new system. These subscriber units consist of thirteen APX7000 portables and fifteen APX7500 mobiles that are dual band, assumed to operate on VHF and 700/800 MHz and licensed for P25 Conventional mode. The cost estimates do include re-programming of these subscriber units to operate on the new system.

Given the need to interoperate with agencies on VHF channels, the cost estimate includes the replacement of all other existing subscriber units with dual band (VHF and 700/800 MHz) radios. The use of these models provides a good average cost for budgetary purposes. Some departments may only purchase low-tier (single band) models, majority may purchase dual-band units, and others may purchase high-tier (all band) radios with





added features. As part of the RFP, the District could specify the quantity and tier requirements for each department, which would allow the vendors to provide a more accurate cost proposal.

## 6.1.6 Cost Analysis

### 6.1.6.1 Cost Assumptions

Based on results from the coverage studies, analysis of existing inventory and feedback provided by the District, **FE** developed the following set of equipment- and services-related assumptions shown in Table 20 for the Alternative 2 cost estimates.

**Table 20 – Alternative 2 Cost Assumptions**

<b>Alternative 2 Assumptions</b>	<b>QTY</b>	<b>Notes</b>
<b>System Control Equipment</b>		
P25 Phase 1 Core Equipment	2	New P25 Conventional Core with geographically separated locations
Core Networking Equipment	2	New redundant networking equipment to be housed at each P25 Core location
<b>Simulcast Control Equipment</b>		
Simulcast Controller	2	New simulcast cell control equipment with geographically separated locations
GPS Frequency Standard	2	New simulcast cell frequency standard with geographically separated locations
Voting Equipment	8	New simulcast cell voting equipment (2 channels per chassis) with geographically separated locations
Networking Equipment	2	New simulcast cell networking equipment with geographically separated locations
<b>Repeater Site Equipment</b>		
7-CH 7/800 MHz P25 Phase 1 Repeater Site (Conventional Simulcast configuration)	9	New P25 repeaters for the following sites: 8 Existing Columbia VHF sites (Dispatch, Columbia Heights, Green Mtn., Clatskanie Mtn., Corey Hill, Haven Acres, Meissner Lookout, and Bald Mtn.) 1 Potential new site at Eastside Grade
7-CH 7/800 MHz TX/RX Antenna System	9	New 7/800 MHz Transmit/Receive antennas, transmission lines, combiners, multicouplers, and lightning protection
Site Networking Equipment	9	New, redundant routers and switches at each repeater site
LMR FCC License	63	New LMR site application(s) and/or existing license modification(s) for Conceptual Design
LMR Frequency Coordination	63	New LMR site application(s) and/or existing license modification(s) for Conceptual Design
LMR Engineering Services	63	New LMR site application(s) and/or existing license modification(s) for Conceptual Design
<b>Primary Dispatch System Equipment</b>		







Alternative 2 Assumptions	QTY	Notes
Logging Recorder	0	The District already has a logging recorder vendor that they are working with, which will be handled outside this project. Cost for a logging recorder is not needed for the conceptual design or RFP.
Dispatch Console	6	New dispatch consoles to replace five existing console positions, plus one new console position for training and maintenance.
Backup RF Control Station	6	New backup RF control station per console position
700/800 MHz TX/RX Antenna System	1	New Transmit/Receive Antenna, transmission line, control station combiner, and lightning protection
Conventional Channel Gateway	2	4-port gateways for interfacing to Mutual Aid conventional channels
Site Networking Equipment	1	New, redundant routers and switches
<b>Backup Dispatch System Equipment</b>		
Logging Recorder	0	The District already has a logging recorder vendor that they are working with, which will be handled outside this project. Cost for a logging recorder is not needed for the conceptual design or RFP.
Dispatch Console	5	New dispatch consoles to replace the five console positions the District currently has.
Backup RF Control Station	5	New backup RF control station per console position
700/800 MHz TX/RX Antenna System	1	New Transmit/Receive Antenna, transmission line, control station combiner, and lightning protection
Conventional Channel Gateway	2	4-port gateways for interfacing to Mutual Aid conventional channels
Site Networking Equipment	1	New, redundant routers and switches
<b>Microwave Backhaul Equipment</b>		
Re-use of Existing Microwave Paths	6	Dispatch to Green Mountain Dispatch to Bald Mountain Green Mountain to Clatskanie Clatskanie to Meissner Clatskanie to Columbia Heights Clatskanie to Corey Hill
New Microwave Paths Needed	2	Corey Hill to Eastside Grade (Greenfield site) Clatskanie to Haven Acres (current RX-only site)
6 GHz Hot Standby Radio	4	New microwave radios for new sites
6 GHz - 6' Dual-Polarization	4	New 6 GHz - 6' Dual-Polarization microwave dish
Waveguide and Accessories	4	New Waveguide and Accessories
DC Plant	2	New Large DC Plant
Equipment Rack and Accessories	2	New Large Equipment Rack and Accessories
MPLS Router	2	New Large MPLS Router
Timing System	1	New Timing System
Dehydrator	2	New Dehydrator
MW FCC License	4	New MW site application(s) and/or existing license modification(s) for Conceptual Design
MW FCC License Coordination	2	New MW site application(s) and/or existing license modification(s) for Conceptual Design
<b>Network Management System</b>		
Network Management Server	1	New NMS equipment to be housed at a P25 Phase 1 Core location





Alternative 2 Assumptions	QTY	Notes
Network Management Terminal	2	New NMT equipment; can be located anywhere in the State with access to radio/backhaul network
Fault Management Server	1	New Alarms equipment to be housed at a P25 Phase 1 Core location
Fault Management Site	10	New Alarms equipment to be housed at each of the radio/backhaul sites plus enhancement sites
<b>Civil/Site Improvements</b>		
Existing Tower/Structure with Available Space	8	Based on information in District-provided documentation
Tower Structural Analysis Needed	7	Based on information in District-provided documentation
Existing Tower Mods Needed	0	Based on information in District-provided documentation
New Tower Structure Needed	2	Based on information in District-provided documentation
A&E, Environmental Compliance	2	Based on information in District-provided documentation
Existing Shelter/Bldg. with Available Space	6	Based on information in District-provided documentation
Site Grounding Updates Needed	7	Based on information in District-provided documentation
Existing Shelter/Bldg. Mods Needed	0	Based on information in District-provided documentation
New Prefab Shelter Needed	2	Based on information in District-provided documentation
New Outdoor Cabinet Needed	2	Based on information in District-provided documentation
Commercial AC Power Available	10	Based on information in District-provided documentation
Solar/DC Site Upgrades Needed	0	Based on information in District-provided documentation
Backup Power Source(s) Available	9	Based on information in District-provided documentation
New Generator Needed	1	Based on information in District-provided documentation
New UPS/Batteries Needed	1	Based on information in District-provided documentation
<b>Subscriber Equipment</b>		
Total Mobiles	281	Replace existing mobiles with new 700/800 MHz subscriber units (equipped and licensed for P25 Phase 1 Conventional operation); Re-use fifteen APX7500 mobiles for CCSO
Total Portables	454	Replace existing portables with new 700/800 MHz subscriber units (equipped and licensed for P25 Phase 1 Conventional operation); Re-use thirteen APX7000 portables for CCSO







Alternative 2 Assumptions	QTY	Notes
Total Control Stations	11	Replace existing control stations with new 700/800 MHz subscriber units (equipped and licensed for P25 Phase 1 Conventional operation)
Total Vehicular Repeaters	4	Replace existing vehicular repeaters with new 700/800 MHz units (equipped and licensed for P25 Phase 1 Conventional operation)
<b>Implementation Services</b>		
Spare / Test Equipment	5%	Based on <i>FE</i> historical / industry data
Project Management	10%	Based on <i>FE</i> historical / industry data
Installation	10%	Based on <i>FE</i> historical / industry data
Engineering	20%	Based on <i>FE</i> historical / industry data
Removal of Existing Equipment	2%	Based on <i>FE</i> historical / industry data
Training	1%	Based on <i>FE</i> historical / industry data
Staging	5%	Based on <i>FE</i> historical / industry data
Acceptance/Coverage Testing	1%	Based on <i>FE</i> historical / industry data
Documentation	1%	Based on <i>FE</i> historical / industry data
Sales Tax	0%	Oregon state sales tax rate is currently 0%
Contingency	10%	Based on <i>FE</i> historical / industry data
<b>Operational Expenditures (OPEX)</b>		
System OPEX Period (years)	10	System lifecycle costs shown in 5-year increments
Manufacturer's Warranty (years)	1	Out-of-warranty supports begins in Year 2
Annual Inflation Rate	3%	Based on <i>FE</i> historical / industry data
System Remote Technical Support	1%	Percentage of total system equipment CAPEX in Year 1; annual inflation added Years 2 - 10
System Security/Information Assurance	2%	Percentage of total system equipment CAPEX in Year 1; annual inflation added Years 2 - 10
System Upgrades (Hardware/Software)	5%	Percentage of total system equipment CAPEX in Year 1; annual inflation added Years 2 - 10
System Onsite Support and Repair	3%	Percentage of total system equipment CAPEX in Year 1; annual inflation added Years 2 - 10

### 6.1.6.2 Radio System Cost

Table 21 shows the estimated costs for the LMR radio system upgrade equipment and services for Alternative 2.

**Table 21 – Alternative 2 Radio System Cost Estimate**

Alternative 2 Radio System Cost Estimate			
Core Network Equipment	Quantity	Unit Cost	Extended Cost
P25 Phase 1 Core Equipment	2	\$521,000	\$1,042,000
Core Networking Equipment	2	\$147,000	\$294,000
Spare / Test Equipment	5%		\$67,000
<b>Subtotal - Core Network Equipment</b>			<b>\$1,403,000</b>
Simulcast Site Equipment	Quantity	Unit Cost	Extended Cost





Alternative 2 Radio System Cost Estimate			
Simulcast Controller	2	\$69,000	\$138,000
GPS Frequency Standard	2	\$37,000	\$74,000
Voting Equipment	8	\$30,000	\$240,000
Networking Equipment	2	\$73,000	\$146,000
Spare / Test Equipment	5%		\$30,000
<b>Subtotal - Repeater Site Equipment</b>			<b>\$628,000</b>
<b>Repeater Site Equipment</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
7/800 MHz 7-CH TX/RX Equipment	9	\$233,000	\$2,097,000
7/800 MHz TX/RX Antenna System	9	\$28,000	\$252,000
Site Networking Equipment	9	\$13,000	\$117,000
Spare / Test Equipment	5%		\$124,000
<b>Subtotal - Repeater Site Equipment</b>			<b>\$2,590,000</b>
<b>Equipment Subtotal</b>			<b>\$4,621,000</b>
<b>FCC Licensing and Coordination</b>		<b>Unit Cost</b>	<b>Extended Cost</b>
LMR FCC License Fees	63	\$100	\$6,300
LMR Frequency Coordination Fees	63	\$300	\$18,900
LMR Engineering Services Fees	63	\$125	\$7,875
<b>Subtotal - FCC Licensing and Coordination (rounded)</b>			<b>\$34,000</b>
<b>Implementation Services</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
Project Management	10%		\$463,000
Installation	10%		\$463,000
Engineering	20%		\$925,000
Removal of Existing Equipment	2%		\$93,000
Training	1%		\$47,000
Staging	5%		\$232,000
Acceptance Testing	1%		\$47,000
Documentation	1%		\$47,000
<b>Subtotal - Implementation Services</b>			<b>\$2,317,000</b>
<b>Services Subtotal</b>			<b>\$2,351,000</b>
<b>TOTAL - EQUIPMENT &amp; SERVICES</b>			<b>\$6,972,000</b>
Sales Tax	0%		\$0
Contingency	10%		\$698,000
<b>TOTAL - EQUIPMENT &amp; SERVICES (with sales tax &amp; contingency), rounded</b>			<b>\$7,670,000</b>

#### 6.1.6.3 Dispatch System Cost

Refer to Section 5.1.6.3 as the dispatch system cost of \$1,240,000 is common to all four alternatives.

#### 6.1.6.4 Backhaul System Cost

Table 22 provides the estimated costs for the new backhaul system equipment and services for Alternative 2.







**Table 22 – Alternative 2 Backhaul System Cost Estimate**

<b>Alternative 2 Backhaul System Cost Estimate</b>			
<b>Backhaul Site Equipment</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
6 GHz Hot Standby Radio	4	\$30,000	\$120,000
6 GHz - 6' Dual-Polarization	4	\$9,000	\$36,000
Waveguide and Accessories	4	\$5,000	\$20,000
DC Plant	2	\$19,000	\$38,000
Equipment Rack and Accessories	2	\$10,000	\$20,000
MPLS Router	2	\$20,000	\$40,000
Timing System	1	\$13,000	\$13,000
Dehydrator	2	\$4,000	\$8,000
Spare / Test Equipment	5%		\$15,000
<b>Equipment Subtotal</b>			<b>\$310,000</b>
<b>FCC Licensing and Coordination</b>		<b>Unit Cost</b>	<b>Extended Cost</b>
MW FCC License Fees	4	\$1,200	\$4,800
MW Frequency Coordination Fees	2	\$1,700	\$3,400
<b>Subtotal - FCC Licensing and Coordination (rounded)</b>			<b>\$9,000</b>
<b>Implementation Services</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
Project Management	10%		\$31,000
Installation	10%		\$31,000
Engineering	20%		\$62,000
Removal of Existing Equipment	2%		\$7,000
Training	1%		\$4,000
Staging	5%		\$16,000
Acceptance Testing	1%		\$4,000
Documentation	1%		\$4,000
<b>Subtotal - Implementation Services</b>			<b>\$168,000</b>
<b>TOTAL - EQUIPMENT &amp; SERVICES</b>			<b>\$478,000</b>
Sales Tax	0%		\$0
Contingency	10%		\$48,000
<b>TOTAL - EQUIPMENT &amp; SERVICES (with sales tax &amp; contingency), rounded</b>			<b>\$530,000</b>

#### 6.1.6.5 Network Management Cost

Table 23 summarizes the estimated costs for the network management equipment and services for Alternative 2.

**Table 23 – Alternative 2 Network Management Cost Estimate**

<b>Alternative 2 Network Management Cost Estimate</b>			
<b>Network Management Equipment</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
Network Management Server	1	\$212,000	\$212,000
Network Management Terminal	2	\$15,000	\$30,000
Fault Management Server	1	\$188,000	\$188,000
Fault Management Site	10	\$10,000	\$100,000





Alternative 2 Network Management Cost Estimate			
Spare / Test Equipment	5%		\$27,000
<b>Equipment Subtotal</b>			<b>\$557,000</b>
<b>Implementation Services</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
Project Management	10%		\$56,000
Installation	10%		\$56,000
Engineering	20%		\$112,000
Removal of Existing Equipment	2%		\$12,000
Training	1%		\$6,000
Staging	5%		\$28,000
Acceptance Testing	1%		\$6,000
Documentation	1%		\$6,000
<b>Subtotal - Implementation Services</b>			<b>\$282,000</b>
<b>TOTAL - EQUIPMENT &amp; SERVICES</b>			<b>\$839,000</b>
Sales Tax	0%		\$0
Contingency	10%		\$84,000
<b>TOTAL - EQUIPMENT &amp; SERVICES (with sales tax &amp; contingency), rounded</b>			<b>\$930,000</b>

#### 6.1.6.6 Site Improvements Cost

Table 24 includes the estimated costs for Alternative 2 site improvements and services.

**Table 24 – Alternative 2 Site Improvements Cost Estimate**

Alternative 2 Site Improvements Cost Estimate			
<b>Site Support Equipment</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
Existing Tower/Structure with Available Space	8	\$0	\$0
Tower Structural Analysis Needed	7	\$5,000	\$35,000
Existing Tower Mods Needed	0	\$50,000	\$0
New Tower Structure Needed	2	\$283,000	\$566,000
A&E, Environmental Compliance	2	\$14,000	\$28,000
Existing Shelter/Bldg. with Available Space	6	\$0	\$0
Site Grounding Updates Needed	7	\$15,000	\$105,000
Existing Shelter/Bldg. Mods Needed	0	\$20,000	\$0
New Prefab Shelter Needed	2	\$109,000	\$218,000
New Outdoor Cabinet Needed	2	\$10,000	\$20,000
Commercial AC Power Available	10	\$0	\$0
Solar/DC Site Upgrades Needed	0	\$15,000	\$0
Backup Power Source(s) Available	9	\$0	\$0
New Generator Needed	1	\$30,000	\$30,000
New UPS/Batteries Needed	1	\$30,000	\$30,000
Spare / Test Equipment	5%		\$52,000
<b>Equipment Subtotal</b>			<b>\$1,084,000</b>







<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Project Management	10%		\$109,000
Installation	10%		\$109,000
Engineering	20%		\$217,000
Removal of Existing Equipment	2%		\$22,000
Training	1%		\$11,000
Staging	5%		\$55,000
Acceptance Testing	1%		\$11,000
Documentation	1%		\$11,000
<b>Subtotal - Implementation Services</b>			<b>\$545,000</b>
<b>TOTAL - EQUIPMENT &amp; SERVICES</b>			<b>\$1,629,000</b>
Sales Tax	0%		\$0
Contingency	10%		\$163,000
<b>TOTAL - EQUIPMENT &amp; SERVICES (with sales tax &amp; contingency), rounded</b>			<b>\$1,800,000</b>

#### 6.1.6.7 Subscriber Units Cost

Table 25 provides a summary of the estimated costs for subscriber units and services for Alternative 2. Appendix C includes detailed cost estimates on a per department and per radio basis.

**Table 25 – Alternative 2 Total Cost Estimate**

<b>Alternative 2 Subscriber Cost Estimate</b>			
<i>Department/Agency</i>	<i>Equipment Cost</i>	<i>Services Cost</i>	<i>Total Cost</i>
CRFPD	\$326,000	\$32,000	\$358,000
CCRD	\$587,000	\$72,000	\$659,000
CRF&R	\$507,000	\$57,000	\$564,000
SRFD	\$667,000	\$68,000	\$735,000
St Helens Police	\$295,000	\$30,000	\$325,000
Metro West Ambulance	\$88,000	\$8,000	\$96,000
CCSO	\$652,000	\$58,000	\$710,000
Vernonia Fire	\$319,000	\$29,000	\$348,000
Rainier Police	\$88,000	\$9,000	\$97,000
Mist-Birkenfeld	\$376,000	\$37,000	\$413,000
West Port Fire	\$126,000	\$13,000	\$139,000
Columbia City PD	\$50,000	\$6,000	\$56,000
<b>Total (rounded)</b>	<b>\$4,081,000</b>	<b>\$419,000</b>	<b>\$4,500,000</b>





### 6.1.6.8 Total Cost Summary

Table 26 summarizes the total cost estimate for Alternative 2, including radio, dispatch, backhaul, network management, site improvements, subscriber units, and system maintenance over 10 years.

**Table 26 – Alternative 2 Total Cost Estimate**

<b>Alternative 2 Total Cost Estimate</b>					
<i>Item</i>	<i>Equipment</i>	<i>Services</i>	<i>Sales Tax</i>	<i>Contingency</i>	<i>Total (rounded)</i>
Radio System	\$4,621,000	\$2,317,000	\$0	\$698,000	<b>\$7,640,000</b>
Dispatch System	\$743,000	\$376,000	\$0	\$112,000	<b>\$1,240,000</b>
Backhaul System	\$310,000	\$168,000	\$0	\$48,000	<b>\$530,000</b>
Network Management	\$557,000	\$282,000	\$0	\$84,000	<b>\$930,000</b>
Site Improvements	\$1,084,000	\$545,000	\$0	\$163,000	<b>\$1,800,000</b>
Subscriber Units	\$4,081,000	\$419,000	\$0	\$0	<b>\$4,500,000</b>
<b>Total</b>					<b>\$16,640,000</b>
<i>Recurring Costs</i>		<i>Services</i>	<i>Sales Tax</i>		<i>10-Year Total</i>
System Maintenance	\$0	\$5,140,000	\$0	\$0	<b>\$5,140,000</b>
<b>Total Capital and Recurring Costs over 10 Years</b>					<b>\$21,780,000</b>

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## 7. Alternative 3 – CRESA 800 MHz System

Alternative 3 involves joining the Clark Regional Emergency Services Agency (CRESA) 800 MHz P25 Phase 1 trunked radio system. This alternative allows the District to leverage a substantial amount of system control equipment that CRESA already owns and operates (thus making the District's initial investment less) and also updates District users' radios to a modern digital LMR architecture, with all of the performance improvements and enhanced features that entails.

### 7.1.1 Radio Coverage

To assess the potential coverage for Alternative 3, *FE* analyzed existing radio coverage plots provided by CRESA personnel, and also communicated directly with CRESA personnel to obtain technical information about the system. Using this information, *FE* developed an optimal configuration of additional sites the District would need to add to the CRESA system in order to meet the District's coverage requirements. For reference, the District's requirements are:

- Mobile coverage throughout 95% of the District's geographic boundary is required.
- Portable on-street coverage throughout 95% of the District's geographic boundary is highly desired.

*FE*, using a methodology similar to that used when modeling the existing LMR system's coverage (see Section 2.2.2 for reference), determined the optimal configuration of both existing radio sites and potential candidate sites the District would need to add to the CRESA system to meet the coverage requirements. Table 27 and Table 28 present the coverage study parameters and the subscriber unit parameters, respectively, *FE* used to perform the coverage analysis.

**Table 27 – Coverage Study Parameters**

Parameter	Description
System Type	P25 Phase 1 trunking (FDMA)
Frequency Band	800 MHz
Channel Bandwidth	12.5 kHz
Reliability	95%
Minimum Performance	Delivered Audio Quality (DAQ) – 3.4





<b>Talk Paths</b>	Mobile radio talk-out (from repeater to mobile) Mobile radio talk-in (from mobile to repeater) Portable radio talk-out, on-street (from repeater to a portable on the street) Portable radio talk-in, on-street (from portable on the street to repeater) Portable radio talk-out, in light/residential buildings (from repeater to portable inside buildings) Portable radio talk-in, in light/residential buildings (from portable inside buildings to repeater).
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**Table 28 – Subscriber Unit Parameters**

Parameter	Mobile	Portable
Transmit Power (watts)	35	3
Receive Sensitivity (dBm)	-119	-119
Antenna Location	Roof	Hip
Antenna Gain (dB)	3	0
Body Loss (dB)	N/A	14.3

Figure 7 and Figure 8 show the Alternative 3 talk-out and talk-in coverage, respectively. In each coverage map, the predicted coverage from the existing CRESA system's simulcast cell in Clark County, as well as two ASR sites (Nicolai Ridge and Rainier Hill), is combined with the coverage from candidate radio sites that the District may potentially add to the system.

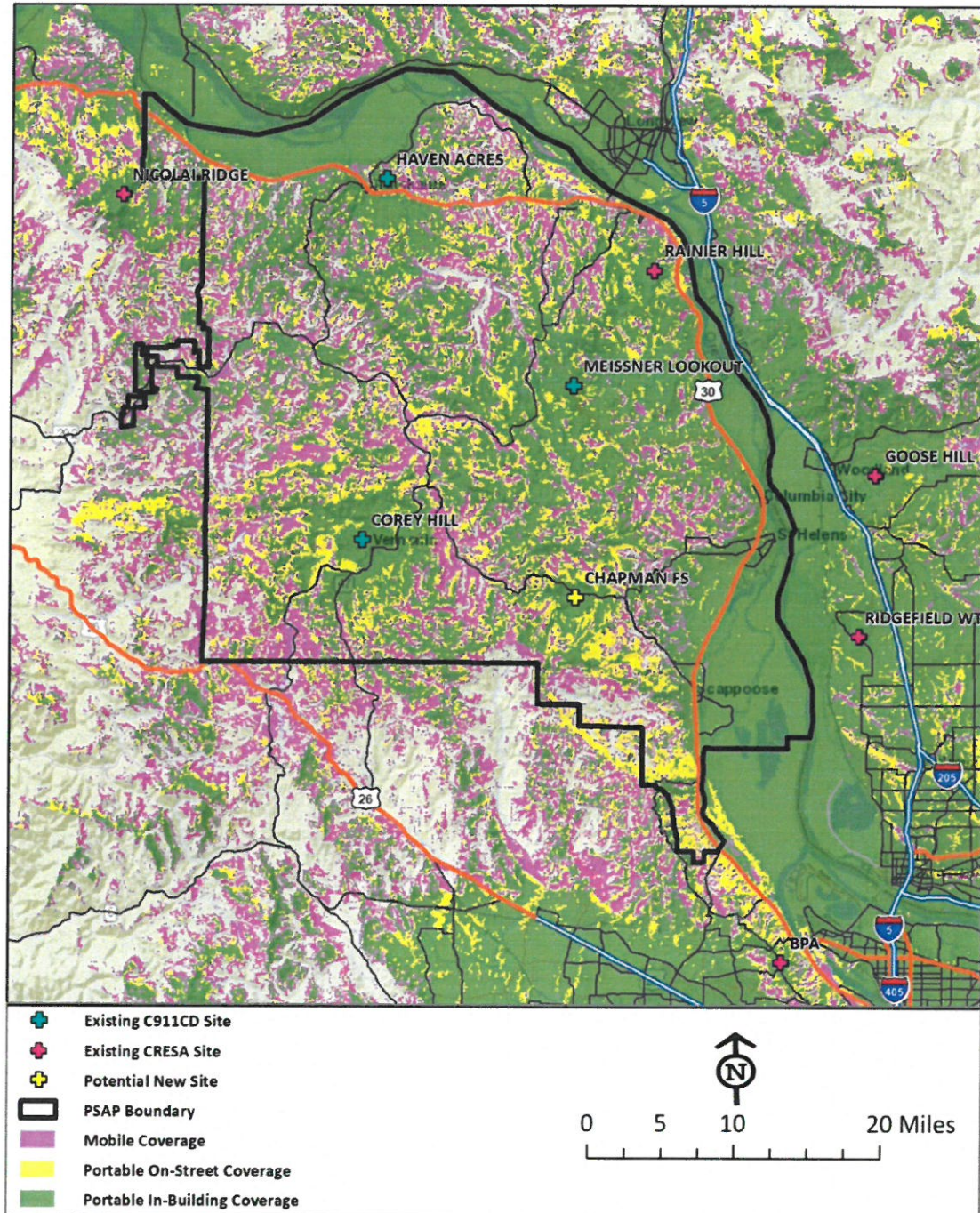
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**Columbia 911 Communications District - Alternative 3 (CRESA)**  
800 MHz P25 Voice Coverage  $\geq$  DAQ 3.4; Talk-Out (site to radio); 95% Reliability



**Figure 7 – Alternative 3 Coverage – Talk-Out**

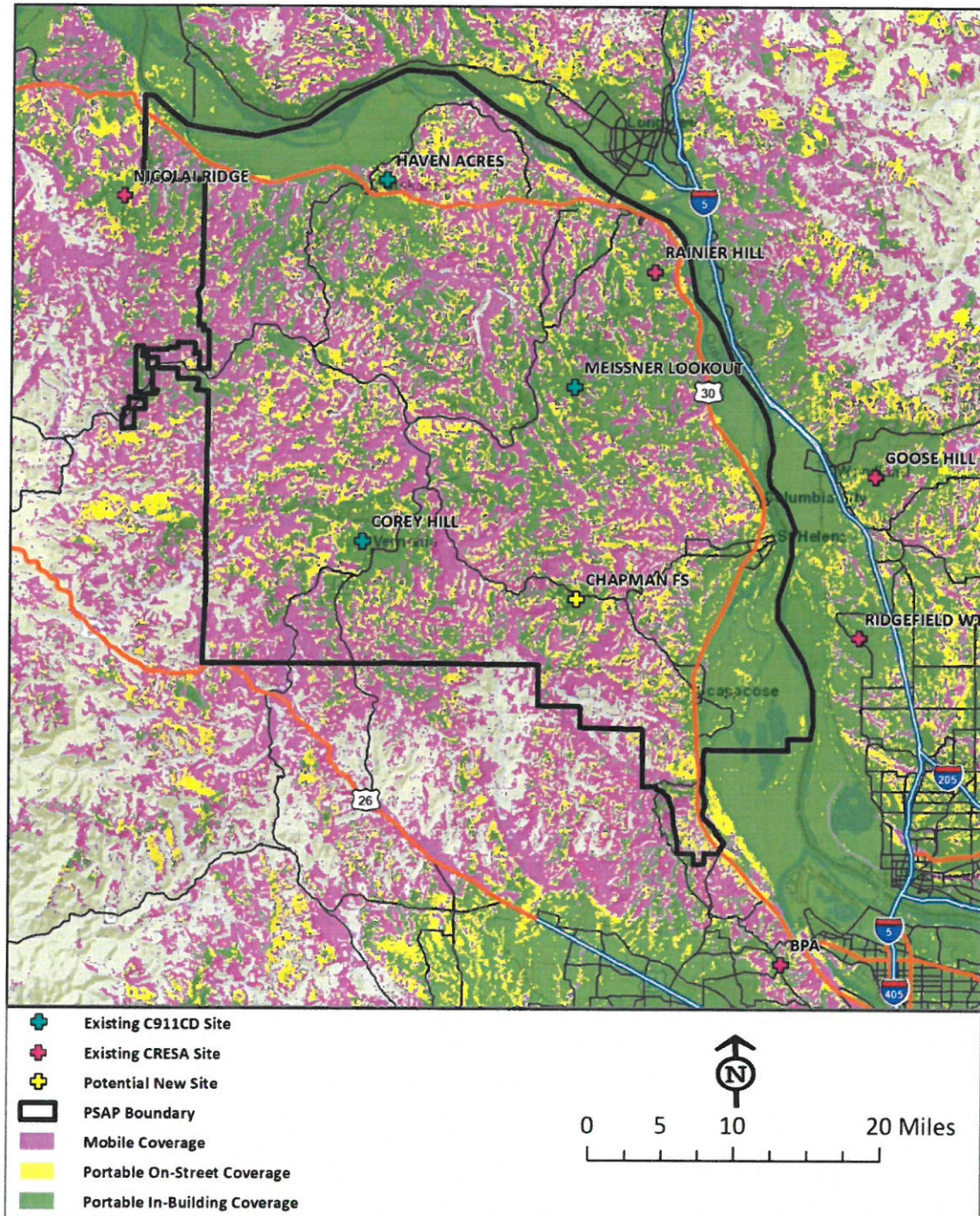






### Columbia 911 Communications District - Alternative 3 (CRESA)

800 MHz P25 Voice Coverage  $\geq$  DAQ 3.4; Talk-In (radio to site); 95% Reliability



**Figure 8 – Alternative 3 Coverage – Talk-In**







### 7.1.1.1 Radio Coverage Percentages

FE calculated the geographic percentages of radio coverage that Alternative 3 provides throughout the District boundary. Table 29 displays the coverage percentages.

**Table 29 – Alternative 3 Coverage Percentages**

Geographic Coverage %s of Columbia 9-1-1 Communications District						Coverage %s over Pop. Areas (Ind, Comm, Res) within District	
Mobile Talk-Out	Mobile Talk-In	Portable Talk-Out (On-Street)	Portable Talk-In (On-Street)	Portable Talk-Out (In Bldg.)	Portable Talk-In (In Bldg.)	Portable Talk-Out (In Bldg.)	Portable Talk-In (In Bldg.)
94	97	72	60	52	40	76	60

### 7.1.1.2 Site List

In addition to the coverage currently provided by both the existing CRESA simulcast cell in Clark County, as well as two CRESA ASR sites, Table 30 presents a list of the additional candidate radio sites used in Alternative 3.

**Table 30 – Alternative 3 Site List**

Site Name	Site Status	Lat (Dec)	Long (Dec)	Structure Type	Structure Height (ft)	TX Antenna Model	TX Antenna Height (ft)	RX Antenna Model	RX Antenna Height (ft)
Corey Hill	Existing C911CD Site	45.864	-123.208	3 Leg Lattice	130	BCR80609 3 Degree DT	150	BCR80609 3 Degree DT	150
Meissner Lookout	Existing C911CD Site	45.970	-123.000	3 Leg Lattice	45	BCR80609 3 Degree DT	46	BCR80609 3 Degree DT	46
Haven Acres	Existing C911CD Site	46.112	-123.186	3 Leg Lattice	250	BCR80609 3 Degree DT	60	BCR80609 3 Degree DT	70
Chapman Fire Station	Potential Candidate Site	45.825	-122.996	New Tower	80	BCR80609 3 Degree DT	70	BCR80609 3 Degree DT	80

### 7.1.2 Channel Capacity

The CRESA system is a P25 Phase 1 trunking system, which currently has a nine-site simulcast cell operating in Clark County, as well as a series of stand-alone ASR sites. In Alternative 3, it is envisioned that District users will be able to communicate on the simulcast cell when needed, however the majority of communications will likely occur on the two current ASR sites (Nicolai Ridge and Rainier Hill), as well as the additional four candidate sites. As a result, from a capacity standpoint, Alternative 3 adds sufficient channels to the four new candidate sites (as a new simulcast cell) and two existing ASRs to support District radio users but does not propose adding channels to the Clark County simulcast cell.





Analyzing required capacity in a trunking system involves different methods as opposed to a conventional system. *FE* used existing and projected District subscriber unit quantities to perform an Erlang-C trunked system loading analysis, which determines the required number of channels needed to meet the District system capacity needs. *FE* used the following design targets for the capacity analysis:

- The system would have a public-safety Grade of Service (GoS) less than or equal to 1%, meaning that less than 1% of all attempted calls would be queued or blocked.
- The system would support a subscriber unit growth factor of 1% per year for 10 years (for a projected subscriber unit total of 701 radios).

*FE* made the following assumptions regarding the capacity analysis for the Alternative 3:

- P25 Phase 1 would provide one voice path per radio licensed frequency pair using frequency division multiple access (FDMA) technology
- Due to a lack of existing traffic data, *FE* assumed projected push-to-talk (PTT) duration and PTTs per hour based on extensive experience analyzing public safety radio system traffic data
- The number of talk paths would support projected traffic in the Average Non-Busy Hour, as well as Busy Hour traffic scenarios

*FE* derived an Average Non-Busy Hour user traffic profile for the District by examining public safety traffic data obtained from other similar public safety radio projects. Based on evaluations by the Public Safety Wireless Advisory Committee (PSWAC)<sup>3</sup>, Busy Hour traffic is assumed to be 3 to 4 times the Average Non-Busy Hour traffic. *FE* used the Busy Hour traffic scenario as the minimum requirement for the channel capacity throughout the P25 system.

Based on the results of the Erlang-C analysis, **five P25 Phase 1 channels** would meet the GoS requirement during Busy Hour traffic scenarios. Five P25 Phase 1 channels would provide four talk paths (i.e., four distinct simultaneous conversations) and one trunking control channel. From a spectrum efficiency standpoint, creating a new five-channel simulcast cell composed of the four candidate sites provides the District with the most feasible path for obtaining required frequencies. At the current CRESA ASR sites (Nicolai Ridge and Rainier Hill), only four additional channels would be needed at each

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<sup>3</sup> Final Report of the Public Safety Wireless Advisory Committee to the Federal Communications Commission. September 11, 1996. <https://www.apcointl.org/doc/spectrum-management/173-public-safety-wireless-pdf/file.html>







site, as they currently each have a trunking control channel. This frequency plan involves the District obtaining **13 new 800 MHz channel pairs**.

### ***7.1.3 System Description***

#### ***7.1.3.1 System Control Equipment***

Alternative 3 assumes use of the existing CRESA system control equipment. The equipment consists of a Motorola P25 Phase 1 Trunking core with geo-redundant locations. The core is currently on Release 7.19.2 with the next scheduled update for 2026, per the System Upgrade Agreement (SUA) in place.

CRESA representatives state that the current core has capacity to support additional sites, channels, consoles, and radios that the District would add to the system. As such, the cost estimates do not include any new hardware, software, or licensing that may be needed at the core to support the additional load.

CRESA representatives state that the District would not incur any upfront capital costs for provisioning the new sites, channels, consoles, and radios on their system core. Similarly, District would not incur any upfront capital costs for programming of the radios to access the CRESA system. Therefore, the cost estimates do not include any costs for core provisioning or radio programming needed for the District to join the system.

#### ***7.1.3.2 Simulcast Control Equipment***

Refer to Section 5.1.3.1 for a description of simulcast control and voting equipment. Alternative 3 includes new simulcast control and voting equipment for the four-site simulcast cell. The simulcast control and voting equipment may reside at any of the sites, however, **FE** recommends installing it at sites that are easily accessible during the winter and have commercial AC power and UPS and/or generator backup. To mitigate single point of failure, the alternative includes redundant simulcast control and voting equipment at two geographically separated locations.

#### ***7.1.3.3 Repeater Site Equipment***

Alternative 3 includes new repeater site equipment at the four identified candidate sites, Chapman Fire Station, Corey Hill, Meissner Lookout, and Haven Acres. CRESA representatives state the District would be responsible for procuring and implementing additional sites and channels needed to support the District loading. Based on the





coverage and capacity analyses, four new sites with five channels are needed to handle the District users. New District sites would consist of the following system components:

- Five new 700/800 MHz digital repeaters, licensed and configured to operate in P25 Phase 1 Trunking mode.
- New 700/800 MHz transmit and receive antennas, radio frequency (RF) cable and lightning protection devices (i.e., lightning arrestors and feedline ground kits).
- New 700/800 MHz transmitter combiner and receiver multicoupler to mitigate RF site interference and allow District repeaters to share the same transmit and receive antennas. All channels at a site would use the same transmit and receive antennas, with the receive antenna at the top of the tower and the transmit antenna mounted below the receive antenna with maximum separation to help mitigate RF interference.
- New redundant routing and switching equipment to help mitigate a single point of failure.

To support the new District traffic, Alternative 3 includes a four-channel expansion at two CRESA ASR sites, Rainier Hill and Nicolai.

#### ***7.1.3.4 Dispatch Console Equipment***

Refer to Section 5.1.3.3 as the proposed dispatch console equipment is common to all four alternatives.

#### ***7.1.3.5 Backhaul System Equipment***

Alternative 3 assumes use of existing and new microwave hops to connect District sites to the existing CRESA backhaul network. It is **FE's** understanding that the existing District microwave system has upgrades in the process. At the time of writing this report, it is not known whether the District will have the entire system updated prior to the new radio system build-out. It is impossible for **FE** to estimate costs for an unknown number of microwave hops that may remain. If all backhaul upgrades are not complete, the District should plan for an estimated \$200K per microwave hop to be a part of the new radio system project.

The design assumes that existing District microwave do not need replacement as part of this project. The cost estimates reflect only the new spur sites with MHSB configuration, with only one new District site connecting to the CRESA backhaul network.

- Existing District microwave hops





- Dispatch to Green Mountain
- Dispatch to Bald Mountain
- Green Mountain to Clatskanie
- Clatskanie to Meissner
- Clatskanie to Corey Hill
- New microwave hops
  - Clatskanie to Rainier Hill (CRESA site)
  - Clatskanie to Haven Acres (current RX-only site)
  - Chapman Fire Station to Buck Mountain (microwave relay)
  - Buck Mountain to Bald Mountain (District site)

Terrain and line of site challenges require the use of a microwave relay site at Buck Mountain to connect the new Chapman Fire Station location. The District owns Buck Mountain, also known as Pisgah. The District advises that this site requires new tower, shelter, and generator. The Haven Acres sites is a non-District site owned by SBA. The design assumes that space is available on the tower and shelter, and that the site does not require any improvements or construction. It is important to note that recurring costs for collocating at Haven Acres are unknown at the time of writing this report. Therefore, the cost estimates do not reflect any potential site improvements and recurring costs that the District could incur at a later time.

The microwave path from Chapman Fire Station to Buck Mountain also assumes that microwave dishes can be placed at the 80' level at Chapman Fire Station and the 100' level at Buck Mountain. If these heights are not feasible, this link may lose reliability due to terrain and/or trees along the path. Should that occur, the District may wish to consider alternate options to connecting the Chapman Fire Station radio site such as leased lines, fiber, or other point-to-point wireless connections that may not be as robust as the microwave paths modeled in this report.

The existing microwave hop between Dispatch and Bald Mountain is potentially problematic: there are trees near the Bald Mountain site which have grown tall enough to obstruct the line of sight (LOS) required for this link. The District requested the site owner trim and/or cut the obstructing trees; however, to date the site owner has denied those requests. While Alternative 3 includes Bald Mountain's existing link to Dispatch, the District may wish to evaluate an alternate method for connecting those two sites due to the issues with the current link. In addition, Alternative 3 proposes a new link from Bald





Mountain to Buck Mountain. The District should consider the possibility that recent tree growth may impede the feasibility of this new link as well.

**FE** recommends that new microwave links be in a ring, unprotected (1+0) where possible, with spur links in monitored hot standby (1+1) configuration. New microwave links shall have a minimum 99.999% availability (i.e., five 9's) and include all new radios, antennas, waveguide, dehydrator, accessories, and battery banks. Based on terrain, closing the ring with the new sites may not be feasible. Therefore, the design includes the above MHSB spurs. CRESA representatives stated that spurs sites are acceptable, and that the current radio system consumes only about ¼ of the bandwidth in their microwave loop.

**FE** analyzed potential new microwave paths to assess adequate clearance above terrain and obstructions. However, **FE** did not perform physical radio path surveys to identify the exact location and height of potential obstructions. The District should require the awarded vendor to perform final path and system design in their scope of work, including physical path surveys. It is important to note that actual frequencies for the new paths are unknown. Typically, new systems include frequencies between 6 and 23 GHz equipment based on distance and line of site gathered through software tools and path surveys. For budgetary purposes, the cost estimates reflect 6 GHz radios, antennas, and waveguide. Appendix B provides the path profile reports detailing estimated path availability for all new microwave links.

#### **7.1.3.6 Network Management System**

This alternative assumes use of the existing CRESA network management system (NMS) that should reside at the Motorola P25 Phase 1 Trunking core location. This alternative includes two new network management terminal (NMT) units that can reside at District sites that will have connectivity to the CRESA network. Each NMT would allow District maintenance staff to manage their radio fleet, remotely monitor the radio, microwave and network equipment performance and site alarms (i.e., rectifier failure, elevated temperature, and site intrusion), and troubleshoot equipment outages using:

- A network management workstation
- Vendor proprietary software for the repeater and backhaul equipment
- A remote terminal unit (RTU) for each site to monitor site alarms

This alternative assumes that the CRESA NMS has licenses to support these two additional NMT units, and that CRESA would allow the District to monitor the new radio and microwave sites part of the system expansion.







### **7.1.3.7 System Interoperability**

Migrating to a P25 system increases interoperability with surrounding P25 systems such as CRESA, WCCCA, City of Portland, and State of Oregon. By joining CRESA, the District would have interoperability opportunities with other user(s) on the CRESA system. This would require approval, agreement(s), planning, and programming on the system and subscriber units, but the potential for increased interoperability is there. With dual-band radios (VHF and 800 MHz), the District can retain existing interoperability with agencies on VHF analog conventional systems.

### **7.1.4 Site Improvements**

This alternative requires use of ten sites that serve different purposes as follows:

1. Rainier Hill - existing CRESA site, new microwave hop to Clatskanie Mtn.
2. Chapman Fire Station - new CRESA site, new tower and shelter, and new microwave hop to Buck Mtn.
3. Corey Hill - new CRESA site, existing District site with existing microwave to Clatskanie Mtn.
4. Meissner Lookout - new CRESA site, existing District site with existing microwave to Clatskanie Mtn.
5. Buck Mtn. (Pisgah) - existing District site, new microwave-only relay site to Chapman Fire Station and Bald Mtn.
6. Bald Mtn. - existing District site, use existing microwave to Dispatch, new microwave hop to Buck Mtn.
7. Dispatch - existing District site, use existing microwave to Bald Mtn. and Green Mtn.
8. Green Mtn. - existing District site, use existing microwave to Clatskanie Mtn.
9. Clatskanie Mtn. - existing District site, use existing microwave to Corey Hill, Meissner Lookout, and Green Mtn., new microwave hop to Rainer Hill
10. Haven Acres – existing SBA site, new CRESA site, new microwave hop to Clatskanie Mtn.
11. Nicolai - existing CRESA site, channel expansion only

As stated previously, the existing microwave hop between Dispatch and Bald Mountain is potentially problematic due to trees obstructing the path. While Alternative 3 includes





Bald Mountain's existing link to Dispatch, the District may wish to evaluate an alternate method for connecting those two sites due to the issues with the current link, or perhaps evaluate raising the microwave dish heights at the Bald Mountain site to account for the recent tree growth. The District may also wish to consider alternate connectivity options for the new hop from Bald Mountain to Buck Mountain, should recent tree growth prevent a reliable microwave path.

Table 31 summarizes the radio site upgrades needed to support the Alternative 3 system implementation. The site modifications are based on site information provided by the District. An "X" in the table identifies available infrastructure and/or needed items per site that have been included in the cost estimates.

**Table 31 – Alternative 3 Site Improvement Assumptions**

Site Infrastructure and Improvements	Rainier Hill	Chapman Fire Station	Corey Hill	Meissner Lookout	Buck Mtn. (Pisgah)	Bald Mtn.	Dispatch	Green Mtn.	Clatskanie Mtn.	Haven Acres	Nicolai
Existing Tower/Structure with Available Space	X		X			X	X	X	X	X	X
Tower Structural Analysis Needed	X		X			X	X		X	X	X
Existing Tower Mods Needed											
New Tower Structure Needed		X		X	X						
A&E, Environmental Compliance		X		X	X						
Existing Shelter/Bldg. with Available Space	X		X	X			X	X	X		X
Site Grounding Updates Needed			X	X		X	X		X	X	
Existing Shelter/Bldg. Mods Needed											
New Prefab Shelter Needed		X			X	X					
New Outdoor Cabinet Needed										X	
Commercial AC Power Available	X	X	X	X	X	X	X	X	X	X	X
Solar/DC Site Upgrades Needed											
Backup Power Source(s) Available	X		X	X		X	X	X	X	X	X
New Generator Needed		X			X						
New UPS/Batteries Needed		X									

It is important to note that the Chapman Fire Station requires a new 40' self-supported tower. The design assumes that the Fire Department would be amenable to the District







constructing a structure there. Any potential upfront or recurring costs for collocating at this site are unknown at the time of writing this report. Therefore, the cost estimates do not reflect any recurring costs that the District could incur at a later time. It is unknown whether the Fire Department would have space available inside the Fire Station for housing the District's radio and backhaul equipment. Therefore, the cost estimates include a new prefabricated communications shelter, equipped with HVAC, generator, fuel tank, and UPS.

### **7.1.5 Subscriber Units**

Section 5.1.5 provides the detailed inventory of the existing subscriber units. This alternative requires that the District replace existing VHF, analog-only and end-of-life subscriber units. Almost all existing subscriber units require replacement with 700/800 MHz radios equipped and licensed to operate on P25 Phase 1 Trunking mode. Only CCSO can re-use and re-program a portion of their fleet on the new system. These subscriber units consist of thirteen APX7000 portables and fifteen APX7500 mobiles that are dual band, assumed to operate on VHF and 700/800 MHz and licensed for P25 Phase 1 Trunking mode. The cost estimates do not include any software upgrades but do include re-programming of these subscriber units to operate on the new system.

Given the need to interoperate with agencies on VHF channels, the cost estimate includes the replacement of all other existing subscriber units with dual band (VHF and 700/800 MHz) radios. The use of these models provides a good average cost for budgetary purposes. Some departments may only purchase low-tier (single band) models, majority may purchase dual-band units, and others may purchase high-tier (all band) radios with added features. As part of the RFP, the District could specify the quantity and tier requirements for each department, which would allow the vendors to provide a more accurate cost proposal.

### **7.1.6 Cost Analysis**

#### **7.1.6.1 Cost Assumptions**

Based on results from the coverage studies, analysis of existing inventory and feedback provided by the District, *FE* developed the following set of equipment- and services-related assumptions shown in Table 32 for the Alternative 3 cost estimates.

**Table 32 – Alternative 3 Cost Assumptions**

<b>Alternative 3 Assumptions</b>	<b>QTY</b>	<b>Notes</b>
<b><i>CRESA System Equipment</i></b>		





Alternative 3 Assumptions	QTY	Notes
P25 Phase 1 Core Equipment	1	Existing P25 Phase 1 Trunking Core with geo-redundant locations
Simulcast Control Equipment	1	Existing Simulcast Control Equipment with geo-redundant locations
Simulcast Cell Equipment	1	Existing single Simulcast Cell with nine RF sites and 12 channels per site
Multicast Site Equipment	2	Existing ASTRO Standalone Repeater (ASR) Site at Rainier and Nicolai, each with 5 channels per site
<b><i>Simulcast Control Equipment</i></b>		
Simulcast Controller	2	New simulcast cell control equipment with geographically separated locations
GPS Frequency Standard	2	New simulcast cell frequency standard with geographically separated locations
Voting Equipment	6	New simulcast cell voting equipment (2 channels per chassis) with geographically separated locations
Networking Equipment	2	New simulcast cell networking equipment with geographically separated locations
<b><i>Repeater Site Equipment</i></b>		
5-CH 7/800 MHz P25 Phase 1 Repeater Site (Trunked Simulcast configuration)	4	New P25 repeaters for the following sites: 3 Existing Columbia VHF sites (Corey Hill, Meissner Lookout, and Haven Acres) 1 Potential new site at Chapman Fire Station
5-CH 7/800 MHz TX/RX Antenna System	4	New 7/800 MHz Transmit/Receive antennas, transmission lines, combiners, multicouplers, and lightning protection
New Site Networking Equipment	4	New, redundant routers and switches per site
4-CH 7/800 MHz P25 Phase 1 Repeater Site (Trunked Multicast configuration)	2	New P25 repeaters for two CRESA ASR sites, Rainier Hill and Nicolai
LMR FCC License	28	New LMR site application(s) for new District sites and expansion of two CRESA ASR sites
LMR Frequency Coordination	28	New LMR site application(s) for new District sites and expansion of two CRESA ASR sites
LMR Engineering Services	28	New LMR site application(s) for new District sites and expansion of two CRESA ASR sites
<b><i>Primary Dispatch System Equipment</i></b>		
Logging Recorder	0	The District already has a logging recorder vendor that they are working with, which will be handled outside this project. Cost for a logging recorder is not needed for the conceptual design or RFP.
Dispatch Console	6	New dispatch consoles to replace five existing console positions, plus one new console position for training and maintenance.
Backup RF Control Station	6	New backup RF control station per console position







Alternative 3 Assumptions	QTY	Notes
700/800 MHz TX/RX Antenna System	1	New Transmit/Receive Antenna, transmission line, control station combiner, and lightning protection
Conventional Channel Gateway	2	New 4-port gateways for interfacing to Mutual Aid conventional channels
Site Networking Equipment	1	New, redundant routers and switches
<b>Backup Dispatch System Equipment</b>		
Logging Recorder	0	The District already has a logging recorder vendor that they are working with, which will be handled outside this project. Cost for a logging recorder is not needed for the conceptual design or RFP.
Dispatch Console	5	New dispatch consoles to replace the five console positions the District currently has.
Backup RF Control Station	5	New backup RF control station per console position
700/800 MHz TX/RX Antenna System	1	New Transmit/Receive Antenna, transmission line, control station combiner, and lightning protection
Conventional Channel Gateway	2	New 4-port gateways for interfacing to Mutual Aid conventional channels
Site Networking Equipment	1	New, redundant routers and switches
<b>Microwave Backhaul Equipment</b>		
Re-use of Existing Microwave Paths	4	Dispatch to Green Mountain Green Mountain to Clatskanie Clatskanie to Meissner Clatskanie to Corey Hill
New Microwave Paths Needed	4	Clatskanie to Rainier Hill (CRESA site) Clatskanie to Haven Acres (current RX-only site) Chapman Fire Station to Buck Mountain (microwave relay) Buck Mountain to Bald Mountain (District site)
6 GHz Hot Standby Radio	8	New microwave radios for new sites
6 GHz - 6' Dual-Polarization	8	New 6 GHz - 6' Dual-Polarization microwave dish
Waveguide and Accessories	8	New Waveguide and Accessories
DC Plant	6	New Large DC Plant
Equipment Rack and Accessories	6	New Large Equipment Rack and Accessories
MPLS Router	6	New Large MPLS Router
Timing System	1	New Timing System
Dehydrator	6	New Dehydrator
MW FCC License	8	New MW site application(s) and/or existing license modification(s) for Conceptual Design
MW FCC License Coordination	4	New MW site application(s) and/or existing license modification(s) for Conceptual Design
<b>Network Management System</b>		
Network Management Server	0	Existing CRESA server assumed to be housed at P25 Phase 1 Trunking Core location(s)
Network Management Terminal	2	New NMT equipment; can be located anywhere in the District with access to radio/backhaul network
Fault Management Server	0	Existing CRESA server assumed to be housed at P25 Phase 1 Trunking Core location(s)





Alternative 3 Assumptions	QTY	Notes
Fault Management Site	8	New Alarms equipment to be installed at each new radio and backhaul sites
<b>Civil/Site Improvements</b>		
Existing Tower/Structure with Available Space	8	Based on information in District-provided documentation
Tower Structural Analysis Needed	7	Based on information in District-provided documentation
Existing Tower Mods Needed	0	Based on information in District-provided documentation
New Tower Structure Needed	3	Based on information in District-provided documentation
A&E, Environmental Compliance	3	Based on information in District-provided documentation
Existing Shelter/Bldg. with Available Space	8	Based on information in District-provided documentation
Site Grounding Updates Needed	6	Based on information in District-provided documentation
Existing Shelter/Bldg. Mods Needed	0	Based on information in District-provided documentation
New Prefab Shelter Needed	2	Based on information in District-provided documentation
New Outdoor Cabinet Needed	1	Based on information in District-provided documentation
Commercial AC Power Available	11	Based on information in District-provided documentation
Solar/DC Site Upgrades Needed	0	Based on information in District-provided documentation
Backup Power Source(s) Available	9	Based on information in District-provided documentation
New Generator Needed	2	Based on information in District-provided documentation
New UPS/Batteries Needed	1	Based on information in District-provided documentation
<b>Subscriber Equipment</b>		
Total Mobiles	281	Replace existing mobiles with new 700/800 MHz subscriber units (equipped and licensed for P25 Phase 1 Trunking operation); Re-use fifteen APX7500 mobiles for CCSO
Total Portables	454	Replace existing portables with new 700/800 MHz subscriber units (equipped and licensed for P25 Phase 1 Trunking operation); Re-use thirteen APX7000 portables for CCSO
Total Control Stations	11	Replace existing control stations with new 700/800 MHz subscriber units (equipped and licensed for P25 Phase 1 Trunking operation)
Total Vehicular Repeaters	4	Replace existing vehicular repeaters with new 700/800 MHz units (equipped and licensed for P25 Phase 1 Trunking operation)







Alternative 3 Assumptions	QTY	Notes
<b>Implementation Services</b>		
Spare / Test Equipment	5%	Based on <b>FE</b> historical / industry data
Project Management	10%	Based on <b>FE</b> historical / industry data
Installation	10%	Based on <b>FE</b> historical / industry data
Engineering	20%	Based on <b>FE</b> historical / industry data
Removal of Existing Equipment	2%	Based on <b>FE</b> historical / industry data
Training	1%	Based on <b>FE</b> historical / industry data
Staging	5%	Based on <b>FE</b> historical / industry data
Acceptance/Coverage Testing	1%	Based on <b>FE</b> historical / industry data
Documentation	1%	Based on <b>FE</b> historical / industry data
Sales Tax	0%	Oregon state sales tax rate is currently 0%
Contingency	10%	Based on <b>FE</b> historical / industry data
CRESA Monthly Recurring User Fee	\$40.00	Per subscriber unit per month cost, includes provisioning and programming; billing is semi- or annual basis
<b>Operational Expenditures (OPEX)</b>		
System OPEX Period (years)	10	System lifecycle costs shown in 5-year increments
Manufacturer's Warranty (years)	1	Out-of-warranty supports begins in Year 2
Annual Inflation Rate	3%	Based on <b>FE</b> historical / industry data
System Remote Technical Support	1%	Percentage of total system equipment CAPEX in Year 1; annual inflation added Years 2 - 10
System Security/Information Assurance	2%	Percentage of total system equipment CAPEX in Year 1; annual inflation added Years 2 - 10
System Upgrades (Hardware/Software)	5%	Percentage of total system equipment CAPEX in Year 1; annual inflation added Years 2 - 10
System Onsite Support and Repair	3%	Percentage of total system equipment CAPEX in Year 1; annual inflation added Years 2 - 10

### 7.1.6.2 Radio System Cost

Table 33 outlines the estimated costs for the radio system equipment and services for Alternative 3.

**Table 33 – Alternative 3 Radio System Cost Estimate**

Alternative 3 Radio System Cost Estimate			
<b>Core Network Equipment</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
P25 Phase 1 Core Equipment	0	\$521,000	\$0
Core Networking Equipment	0	\$147,000	\$0
Spare / Test Equipment	5%		\$0
<b>Subtotal - Core Network Equipment</b>			<b>\$0</b>
<b>Simulcast Site Equipment</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
Simulcast Controller	2	\$69,000	\$138,000
GPS Frequency Standard	2	\$37,000	\$74,000
Voting Equipment	6	\$32,000	\$192,000





Alternative 3 Radio System Cost Estimate			
Networking Equipment	2	\$73,000	\$146,000
Spare / Test Equipment	5%		\$28,000
<b>Subtotal - Repeater Site Equipment</b>			<b>\$578,000</b>
<b>Repeater Site Equipment</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
7/800 MHz 5-CH TX/RX Equipment	4	\$209,000	\$836,000
7/800 MHz TX/RX Antenna System	4	\$28,000	\$112,000
Site Networking Equipment	4	\$13,000	\$52,000
7/800 MHz 4-CH TX/RX Equipment (CRESA)	2	\$151,000	\$302,000
Spare / Test Equipment	5%		\$66,000
<b>Subtotal - Repeater Site Equipment</b>			<b>\$1,368,000</b>
<b>Equipment Subtotal</b>			<b>\$1,946,000</b>
<b>FCC Licensing and Coordination</b>		<b>Unit Cost</b>	<b>Extended Cost</b>
LMR FCC License Fees	28	\$100	\$2,800
LMR Frequency Coordination Fees	28	\$300	\$8,400
LMR Engineering Services Fees	28	\$125	\$3,500
<b>Subtotal - FCC Licensing and Coordination (rounded)</b>			<b>\$15,000</b>
<b>Implementation Services</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
Project Management	10%		\$195,000
Installation	10%		\$195,000
Engineering	20%		\$390,000
Removal of Existing Equipment	2%		\$39,000
Training	1%		\$20,000
Staging	5%		\$98,000
Acceptance Testing	1%		\$20,000
Documentation	1%		\$20,000
<b>Subtotal - Implementation Services</b>			<b>\$977,000</b>
<b>Services Subtotal</b>			<b>\$992,000</b>
<b>TOTAL - EQUIPMENT &amp; SERVICES</b>			<b>\$2,938,000</b>
Sales Tax	0%		\$0
Contingency	10%		\$294,000
<b>TOTAL - EQUIPMENT &amp; SERVICES (with sales tax &amp; contingency), rounded</b>			<b>\$3,240,000</b>

### 7.1.6.3 Dispatch System Cost

Refer to Section 5.1.6.3 as the dispatch system cost of \$1,240,000 is common to all four alternatives.

### 7.1.6.4 Backhaul System Cost

Table 34 provides the estimated costs for the new backhaul system equipment and services for Alternative 3.







**Table 34 – Alternative 3 Backhaul System Cost Estimate**

Alternative 3 Backhaul System Cost Estimate			
<i>Backhaul Site Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
6 GHz Hot Standby Radio	8	\$30,000	\$240,000
6 GHz - 6' Dual-Polarization	8	\$9,000	\$72,000
Waveguide and Accessories	8	\$5,000	\$40,000
DC Plant	6	\$19,000	\$114,000
Equipment Rack and Accessories	6	\$10,000	\$60,000
MPLS Router	6	\$20,000	\$120,000
Timing System	1	\$13,000	\$13,000
Dehydrator	6	\$4,000	\$24,000
Spare / Test Equipment	5%		\$35,000
<b>Equipment Subtotal</b>			<b>\$718,000</b>
<i>FCC Licensing and Coordination</i>		<i>Unit Cost</i>	<i>Extended Cost</i>
MW FCC License Fees	8	\$1,200	\$9,600
MW Frequency Coordination Fees	4	\$1,700	\$6,800
<b>Subtotal - FCC Licensing and Coordination (rounded)</b>			<b>\$17,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Project Management	10%		\$72,000
Installation	10%		\$72,000
Engineering	20%		\$144,000
Removal of Existing Equipment	2%		\$15,000
Training	1%		\$8,000
Staging	5%		\$36,000
Acceptance Testing	1%		\$8,000
Documentation	1%		\$8,000
<b>Subtotal - Implementation Services</b>			<b>\$380,000</b>
<b>TOTAL - EQUIPMENT &amp; SERVICES</b>			<b>\$1,098,000</b>
Sales Tax	0%		\$0
Contingency	10%		\$110,000
<b>TOTAL - EQUIPMENT &amp; SERVICES (with sales tax &amp; contingency), rounded</b>			<b>\$1,210,000</b>

#### 7.1.6.5 Network Management Cost

Table 35 summarizes the estimated costs for the network management equipment and services for Alternative 3.

**Table 35 – Alternative 3 Network Management Cost Estimate**

Alternative 3 Network Management Cost Estimate			
<i>Network Management Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Network Management Server	0	\$212,000	\$0
Network Management Terminal	2	\$15,000	\$30,000
Fault Management Server	0	\$188,000	\$0
Fault Management Site	8	\$10,000	\$80,000





Alternative 3 Network Management Cost Estimate			
Spare / Test Equipment	5%		\$6,000
<b>Equipment Subtotal</b>			<b>\$116,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Project Management	10%		\$12,000
Installation	10%		\$12,000
Engineering	20%		\$24,000
Removal of Existing Equipment	2%		\$3,000
Training	1%		\$2,000
Staging	5%		\$6,000
Acceptance Testing	1%		\$2,000
Documentation	1%		\$2,000
<b>Subtotal - Implementation Services</b>			<b>\$63,000</b>
<b>TOTAL - EQUIPMENT &amp; SERVICES</b>			<b>\$179,000</b>
Sales Tax	0%		\$0
Contingency	10%		\$18,000
<b>TOTAL - EQUIPMENT &amp; SERVICES (with sales tax &amp; contingency), rounded</b>			<b>\$200,000</b>

#### 7.1.6.6 Site Improvements Cost

Table 36 provides a breakdown of the estimated costs for site improvements and services for Alternative 3.

**Table 36 – Alternative 3 Site Improvements Cost Estimate**

Alternative 3 Site Improvements Cost Estimate			
<i>Site Support Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Existing Tower/Structure with Available Space	8	\$0	\$0
Tower Structural Analysis Needed	7	\$5,000	\$35,000
Existing Tower Mods Needed	0	\$50,000	\$0
New Tower Structure Needed	3	\$283,000	\$849,000
A&E, Environmental Compliance	3	\$14,000	\$42,000
Existing Shelter/Bldg. with Available Space	8	\$0	\$0
Site Grounding Updates Needed	6	\$15,000	\$90,000
Existing Shelter/Bldg. Mods Needed	0	\$20,000	\$0
New Prefab Shelter Needed	2	\$109,000	\$218,000
New Outdoor Cabinet Needed	1	\$10,000	\$10,000
Commercial AC Power Available	11	\$0	\$0
Solar/DC Site Upgrades Needed	0	\$15,000	\$0
Backup Power Source(s) Available	9	\$0	\$0
New Generator Needed	2	\$30,000	\$60,000
New UPS/Batteries Needed	1	\$30,000	\$30,000
Spare / Test Equipment	5%		\$67,000
<b>Equipment Subtotal</b>			<b>\$1,401,000</b>







<b>Implementation Services</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
Project Management	10%		\$141,000
Installation	10%		\$141,000
Engineering	20%		\$281,000
Removal of Existing Equipment	2%		\$29,000
Training	1%		\$15,000
Staging	5%		\$71,000
Acceptance Testing	1%		\$15,000
Documentation	1%		\$15,000
<b>Subtotal - Implementation Services</b>			<b>\$708,000</b>
<b>TOTAL - EQUIPMENT &amp; SERVICES</b>			<b>\$2,109,000</b>
Sales Tax	0%		\$0
Contingency	10%		\$211,000
<b>TOTAL - EQUIPMENT &amp; SERVICES (with sales tax &amp; contingency), rounded</b>			<b>\$2,320,000</b>

#### 7.1.6.7 Subscriber Units Cost

Table 37 provides a summary of the estimated costs for subscriber units and services for Alternative 3. Appendix C includes detailed cost estimates on a per department and per radio basis.

**Table 37 – Alternative 3 Subscriber Unit Cost Estimate**

<b>Alternative 3 Subscriber Cost Estimate</b>			
<i>Department/Agency</i>	<i>Equipment Cost</i>	<i>Services Cost</i>	<i>Total Cost</i>
CRFPD	\$343,000	\$33,000	\$376,000
CCRD	\$619,000	\$73,000	\$692,000
CRF&R	\$531,000	\$58,000	\$589,000
SRFD	\$700,000	\$69,000	\$769,000
St Helens Police	\$311,000	\$31,000	\$342,000
Metro West Ambulance	\$93,000	\$8,000	\$101,000
CCSO	\$688,000	\$60,000	\$748,000
Vernonia Fire	\$343,000	\$37,000	\$380,000
Rainier Police	\$93,000	\$9,000	\$102,000
Mist-Birkenfeld	\$396,000	\$38,000	\$434,000
West Port Fire	\$133,000	\$13,000	\$146,000
Columbia City PD	\$52,000	\$6,000	\$58,000
<b>Total (rounded)</b>	<b>\$4,302,000</b>	<b>\$435,000</b>	<b>\$4,740,000</b>





### 7.1.6.8 Total Cost Summary

Table 38 summarizes the total cost estimate for Alternative 3, including radio, dispatch, backhaul, network management, site improvements, subscriber units, and recurring CRESA user fees over 10 years.

**Table 38 – Alternative 3 Total Cost Estimate**

Alternative 3 Total Cost Estimate					
<i>Capital Costs</i>	<i>Equipment</i>	<i>Services</i>	<i>Sales Tax</i>	<i>Contingency</i>	<i>Total (rounded)</i>
Radio System	\$1,946,000	\$992,000	\$0	\$294,000	<b>\$3,240,000</b>
Dispatch System	\$743,000	\$376,000	\$0	\$112,000	<b>\$1,240,000</b>
Backhaul System	\$718,000	\$380,000	\$0	\$110,000	<b>\$1,210,000</b>
Network Management	\$116,000	\$63,000	\$0	\$18,000	<b>\$200,000</b>
Site Improvements	\$1,401,000	\$708,000	\$0	\$211,000	<b>\$2,320,000</b>
Subscriber Units	\$4,302,000	\$435,000	\$0	\$0	<b>\$4,740,000</b>
<b>Total Capital Costs for Joining CRESA</b>					<b>\$12,950,000</b>
<i>Lifecycle Costs</i>	<i>Equipment</i>	<i>Services</i>	<i>Sales Tax</i>	<i>Contingency</i>	<i>10-Year Total</i>
System Maintenance	\$0	\$2,990,000	\$0	\$0	<b>\$2,990,000</b>
<i>Recurring Costs</i>	<i>Monthly Fee</i>	<i>Yearly Fee</i>	<i>No. of Users</i>	<i>1-Year Total</i>	<i>10-Year Total</i>
CRESA User Fees	\$40	\$480	750	\$360,000	<b>\$3,600,000</b>
<b>Total Capital and Recurring Costs over 10 Years</b>					<b>\$19,540,000</b>

Based on discussions with CRESA representatives, the current user fee for public safety agencies joining the system is \$40 per unit per month. The fee includes console connection, core provisioning, and radio programming. CRESA representatives state that billing is on a semi-annual or annual basis rather than monthly billing. Based on a rounded number of District users at 750 (including radios and consoles), the estimated annual fee for operating on CRESA is \$360,000. Assuming the access fee does not change, and the District does not add more users, the estimated 10-year cost for using CRESA is \$3.60M. Alternative 3 has an estimated 10-year total cost of ownership for expanding and using CRESA is \$19.53M.

The District would be looking for CRESA to monitor and maintain the system in its entirety. The District would be interested in developing an agreement based on a hybrid support model where the District own and maintain their sites, shelters, HVAC and fuel, and CRESA would be responsible for towers, radio equipment, microwave system, and subscriber units. At the time of writing this report, it is unknown whether CRESA would take on full responsibility for maintenance of the new equipment and towers. The 10-year total cost of ownership already reflects the estimated maintenance costs; however, determining who performs the work and where the dollars are assigned, requires careful planning and negotiating.







## 8. Alternative 4 - WCCCA 800 MHz System

Alternative 4 involves joining the Washington County Consolidated Communications Authority (WCCCA) 800 MHz P25 Phase 2 Trunked System. This alternative allows the District to leverage a substantial amount of system control equipment that the WCCCA system already owns and operates (thus making the District's initial investment less) and also updates District users' radios to a modern digital LMR architecture, with all of the performance improvements and enhanced features that entails.

### 8.1.1 Radio Coverage

To assess the potential coverage for Alternative 4, *FE* analyzed existing radio coverage plots provided by WCCCA personnel, and also made some assumptions regarding technical site parameters using Federal Communications Commission (FCC) licenses. Using this information, *FE* developed an optimal configuration of additional sites the District would need to add to the WCCCA system in order to meet the District's coverage requirements. For reference, the District's requirements are:

- Mobile coverage throughout 95% of the District's geographic boundary is required.
- Portable on-street coverage throughout 95% of the District's geographic boundary is highly desired.

*FE*, using a methodology similar to that used when modeling the existing LMR system's coverage (see Section 2.2.2 for reference), determined the optimal configuration of both existing radio sites and potential candidate sites the District would need to add to the WCCCA system to meet the coverage requirements. Table 39 and Table 40 present the coverage study parameters and the subscriber unit parameters, respectively, *FE* used to perform the coverage analysis.

**Table 39 – Coverage Study Parameters**

Parameter	Description
System Type	P25 Phase 2 trunking (TDMA)
Frequency Band	800 MHz
Channel Bandwidth	12.5 kHz
Reliability	95%
Minimum Performance	Delivered Audio Quality (DAQ) – 3.4





<b>Talk Paths</b>	Mobile radio talk-out (from repeater to mobile) Mobile radio talk-in (from mobile to repeater) Portable radio talk-out, on-street (from repeater to a portable on the street) Portable radio talk-in, on-street (from portable on the street to repeater) Portable radio talk-out, in light/residential buildings (from repeater to portable inside buildings) Portable radio talk-in, in light/residential buildings (from portable inside buildings to repeater).
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**Table 40 – Subscriber Unit Parameters**

Parameter	Mobile	Portable
Transmit Power (watts)	35	3
Receive Sensitivity (dBm)	-119	-119
Antenna Location	Roof	Hip
Antenna Gain (dB)	3	0
Body Loss (dB)	N/A	14.3

Figure 9 and Figure 10 show the talk-out and talk-in coverage, respectively, for Alternative 4. In each coverage map, the predicted coverage from the existing WCCCA system's simulcast cells in Washington County, as well as ASR sites which provide usable coverage into the District, is combined with the coverage from candidate radio sites that the District may potentially add to the system.

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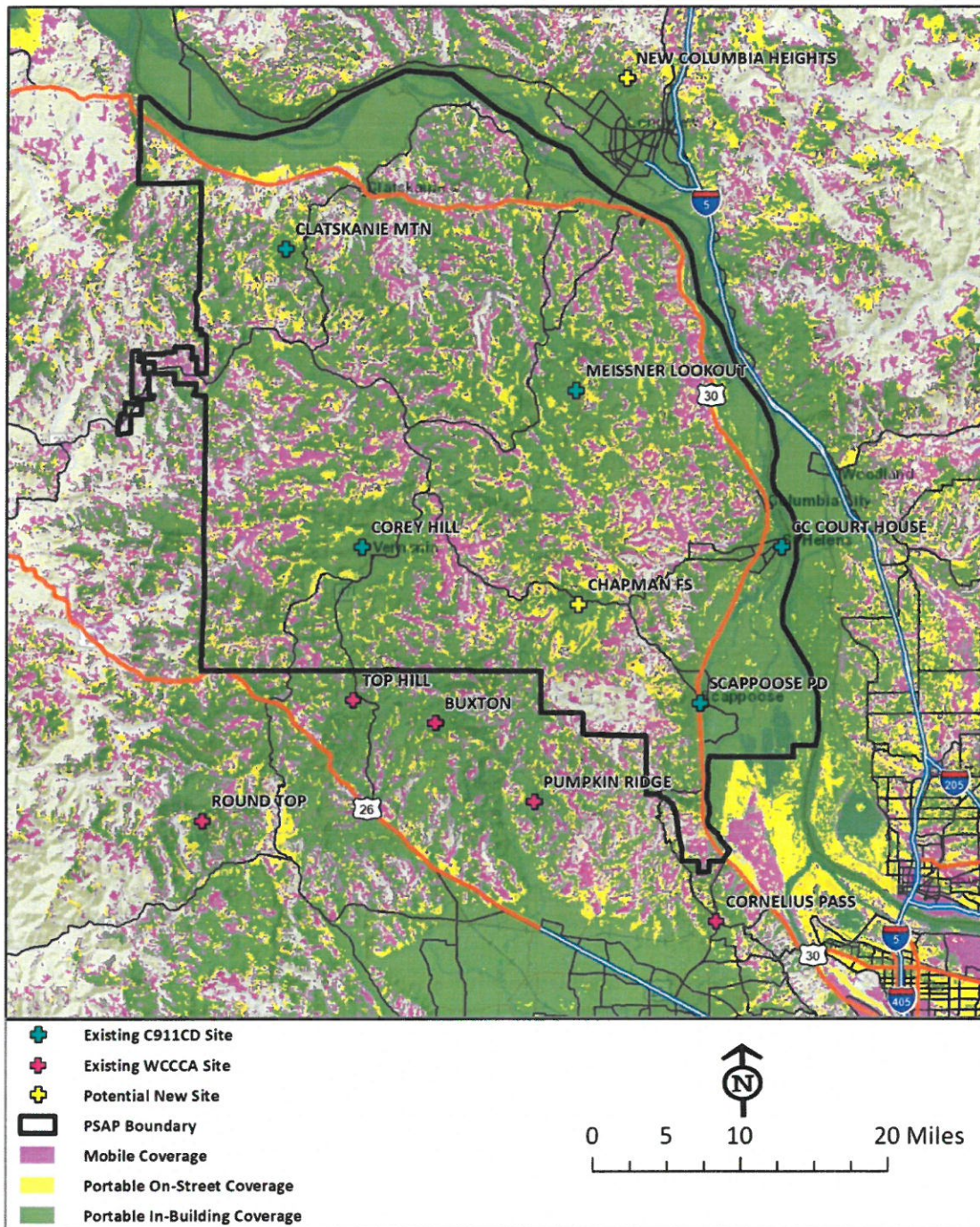






**Columbia 911 Communications District - Alternative 4 (WCCCA)**

800 MHz P25 Voice Coverage  $\geq$  DAQ 3.4; Talk-Out (site to radio); 95% Reliability



**Figure 9 – Alternative 4 Coverage – Talk-Out**

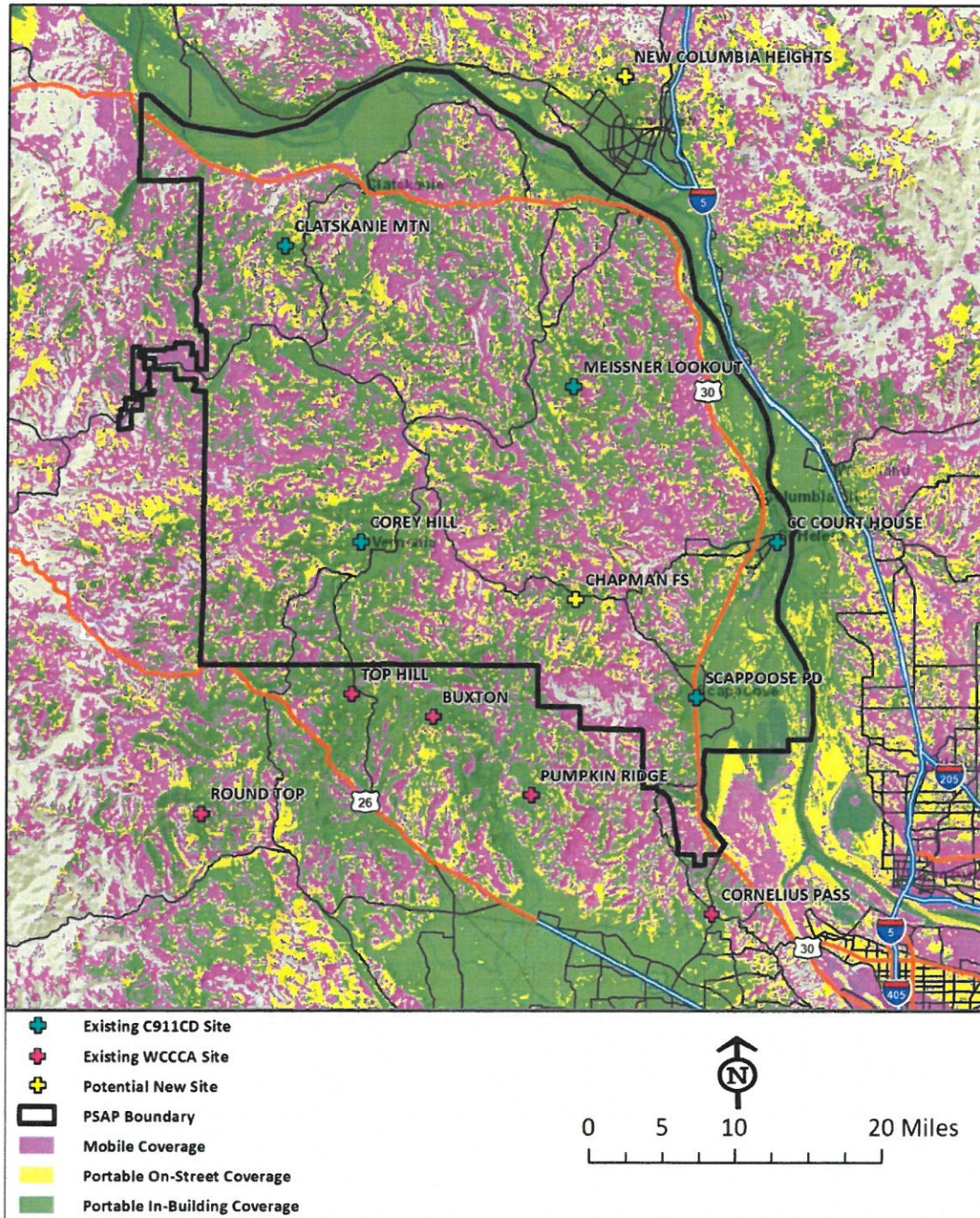






**Columbia 911 Communications District - Alternative 4 (WCCCA)**

800 MHz P25 Voice Coverage  $\geq$  DAQ 3.4; Talk-In (radio to site); 95% Reliability



**Figure 10 – Alternative 4 Coverage – Talk-In**







### 8.1.1.1 Radio Coverage Percentages

FE calculated the geographic percentages of radio coverage that Alternative 4 provides throughout the District boundary. Table 41 displays the coverage percentages.

**Table 41 – Alternative 4 Coverage Percentages**

Geographic Coverage %s of Columbia 9-1-1 Communications District						Coverage %s over Pop. Areas (Ind, Comm, Res) within District	
Mobile Talk-Out	Mobile Talk-In	Portable Talk-Out (On-Street)	Portable Talk-In (On-Street)	Portable Talk-Out (In Bldg.)	Portable Talk-In (In Bldg.)	Portable Talk-Out (In Bldg.)	Portable Talk-In (In Bldg.)
94	98	74	65	56	46	80	65

### 8.1.1.2 Site List

In addition to the coverage currently provided by WCCCA sites into the District, Table 42 presents a list of the additional candidate radio sites used in Alternative 4.

**Table 42 – Alternative 4 Site List**

Site Name	Site Status	Lat (Dec)	Long (Dec)	Structure Type	Structure Height (ft)	TX Antenna Model	TX Antenna Height (ft)	RX Antenna Model	RX Antenna Height (ft)
Clatskanie Mtn	Existing C911CD Site	46.066	-123.283	3 Leg Lattice	190	DB809	190	DB809	190
Meissner Lookout	Existing C911CD Site	45.970	-123.000	3 Leg Lattice	45	DB809	46	DB809	46
New Columbia Heights	Potential Candidate Site	46.182	-122.951	SST (assumed)	80 (assumed)	DB809	70	DB809	80
Chapman Fire Station	Potential Candidate Site	45.825	-122.996	New Tower	80	DB809	70	DB809	80
Columbia Co Court House	Existing C911CD Site	45.864	-122.797	Antenna Mount on Building Roof	40 (assumed)	DB809	40	DB809	40
Scappoose PD	Existing C911CD Site	45.757	-122.877	Antenna Mount on Building Roof	30 (assumed)	DB809	30	DB809	30
Corey Hill	Existing C911CD Site	45.864	-123.208	3 Leg Lattice	130	DB809	150	DB809	150

### 8.1.2 Channel Capacity

The WCCCA system is a P25 Phase 2 trunking system, which currently simulcast cells in neighboring counties, as well as a series of stand-alone ASR sites. In Alternative 4, it is envisioned that District users will be able to communicate on the existing WCCCA simulcast cells and existing ASR sites when needed, however the majority of communications will likely occur on the additional seven candidate sites. As a result, from a capacity standpoint, Alternative 4 adds sufficient channels to the new candidate sites





to support District radio users but does not propose adding channels to any existing WCCCA site.

As with Alternative 3, *FE* used existing and projected District subscriber unit quantities to perform an Erlang-C trunked system loading analysis to determine the required number of channels needed to meet the District's capacity needs for Alternative 4. *FE* used the following design targets for the capacity analysis:

- The system would have a public-safety Grade of Service (GoS) less than or equal to 1%, meaning that less than 1% of all attempted calls would be queued or blocked.
- The system would support a subscriber unit growth factor of 1% per year for 10 years (for a projected subscriber unit total of 701 radios).
- WCCCA advised that sufficient capacity at radio sites must support District users as well as an additional 500 radios. Therefore, the capacity must meet the projected District total of 701 radios plus 500 additional radios, for a total of 1201 radios.

*FE* made the following assumptions regarding the capacity analysis for the Alternative 4:

- P25 Phase 2 would provide two voice paths per radio licensed frequency pair using time division multiple access (TDMA) technology
- Due to a lack of existing traffic data, *FE* assumed projected push-to-talk (PTT) duration and PTTs per hour based on extensive experience analyzing public safety radio system traffic data
- The number of talk paths would support projected traffic in the Average Non-Busy Hour, as well as Busy Hour traffic scenarios

Based on the results of the Erlang-C analysis, **four P25 Phase 2 channels** would meet the GoS requirement during Busy Hour traffic scenarios. Four P25 Phase 2 channels would provide six talk paths (i.e., six distinct simultaneous conversations) and one dedicated trunking control channel. To make the most efficient use of spectrum, and to ease the burden of needing to obtain additional frequency licenses, *FE* evaluated the possibility of combining the seven sites into a single simulcast cell. After performing this analysis, *FE* determined that a simulcast cell can likely be created with six of the seven sites; however, the Clatskanie Mountain site will be difficult to include as a simulcast site due to the possibility of intra-cell interference. As a result, *FE* proposes that Clatskanie Mountain be a stand-alone ASR site in this Alternative.

WCCCA conveyed to the District that any new sites brought into the system will require two additional data channels for the purposes of OTAP, OTAR, and AVL use. As a result,







Alternative 4 involves the development of a six-site, six-channel simulcast cell (four voice channels, two data channels), and a single, six-channel ASR site at Clatskanie Mountain. This frequency plan involves the District obtaining **12 new 800 MHz channel pairs**.

### ***8.1.3 System Description***

#### ***8.1.3.1 System Control Equipment***

This alternative assumes use of the existing WCCCA system control equipment. The equipment consists of dual Motorola P25 Phase 2 Trunking cores with two geo-redundant locations. The cores are currently on Release 7.17 but there is an SUA in place for 10 years with updates every two years.

WCCCA representatives state that the current core has capacity to support additional sites, channels, consoles, and radios that the District would add to the system. As such, the cost estimates do not include any new hardware, software, or licensing that may be needed at the core to support the additional load.

WCCCA representatives state that the District would not incur any upfront capital costs for provisioning the new sites, channels, consoles, and radios on their system core. Similarly, District would not incur any upfront capital costs for programming of the radios to access the WCCCA system. Therefore, the cost estimates do not include any costs for core provisioning or radio programming needed for the District to join the system.

#### ***8.1.3.2 Simulcast Control Equipment***

Refer to Section 5.1.3.1 for a description of simulcast control and voting equipment. Alternative 4 includes new simulcast control and voting equipment for the six-site simulcast cell. The simulcast control and voting equipment may reside at any of the sites, however, **FE** recommends installing it at sites that are easily accessible during the winter and have commercial AC power and UPS and/or generator backup. To mitigate single point of failure, the alternative includes redundant simulcast control and voting equipment at two geographically separated locations.

#### ***8.1.3.3 Repeater Site Equipment***

This alternative includes new repeater site equipment at seven candidate sites, Clatskanie Mtn, Meissner Lookout, New Columbia Heights, Chapman Fire Station, Columbia Co Court House, Scappoose PD, and Corey Hill. WCCCA representatives state the District would be responsible for procuring and implementing additional sites and



channels needed to support the District loading and up to 500 roaming WCCCA users. Based on the coverage and capacity analyses, seven new sites with six channels are needed to handle the District users, roaming WCCCA users, and two data channels. New sites would consist of the following system components:

- Six new 700/800 MHz digital repeaters, licensed and configured to operate in P25 Phase 2 Trunking mode.
- New 700/800 MHz transmit and receive antennas, radio frequency (RF) cable and lightning protection devices (i.e., lightning arrestors and feedline ground kits).
- New 700/800 MHz transmitter combiner and receiver multicoupler to mitigate RF site interference and allow District repeaters to share the same transmit and receive antennas. All channels at a site would use the same transmit and receive antennas, with the receive antenna at the top of the tower and the transmit antenna mounted below the receive antenna with maximum separation to help mitigate RF interference.
- New redundant routing and switching equipment to help mitigate a single point of failure.

#### ***8.1.3.4 Dispatch Console Equipment***

Refer to Section 5.1.3.3 as the proposed dispatch console equipment is common to all four alternatives.

#### ***8.1.3.5 Backhaul System Equipment***

Alternative 4 assumes use of existing and new microwave hops to connect District sites to the existing WCCCA backhaul network. It is **FE's** understanding that the existing District microwave system has upgrades in the process. At the time of writing this report, it is unknown whether the District will have the entire system updated prior to the new radio system build-out. It is impossible for **FE** to estimate costs for an unknown number of microwave hops that may remain. If all backhaul upgrades are not complete, the District should plan for an estimated \$200K per microwave hop to be a part of the new radio system project.

The design assumes that existing District microwave do not need replacement as part of this project. The cost estimates reflect only the new spur sites with MHSB configuration, with only one new District site connecting to the WCCCA backhaul network.

- Existing District microwave hops







- Dispatch to Green Mountain
- Dispatch to Bald Mountain
- Green Mountain to Clatskanie
- Clatskanie to Meissner
- Clatskanie to Columbia Heights
- Clatskanie to Corey Hill
- New microwave hops
  - Corey Hill to Buxton (WCCCA site)
  - Chapman Fire Station to Buck Mountain (microwave relay)
  - Buck Mountain to Bald Mountain (District site)
  - Scappoose PD to Dispatch (replace T1)
  - Dispatch to Columbia County Courthouse (assume no fiber in place)
  - Columbia Heights to New Columbia Heights

Terrain and line of site challenges require the use of a microwave relay site at Buck Mountain to connect the new Chapman Fire Station location. The District owns the Buck Mountain site also known as Pisgah. Per discussion with the District, the design assumes that the site requires construction of a new tower and shelter. Therefore, the cost estimates reflect implementation of a new tower, shelter, and generator at this site.

The microwave path from Chapman Fire Station to Buck Mountain also assumes that microwave dishes can be placed at the 80' level at Chapman Fire Station and the 100' level at Buck Mountain. If these heights are not feasible, this link may lose reliability due to terrain and/or trees along the path. Should that occur, the District may wish to consider alternate options to connecting the Chapman Fire Station radio site such as leased lines, fiber, or other point-to-point wireless connections that may not be as robust as the microwave paths modeled in this report.

The existing microwave hop between Dispatch and Bald Mountain is potentially problematic: there are trees near the Bald Mountain site which have grown tall enough to obstruct the line of sight (LOS) required for this link. The District requested the site owner trim and/or cut the obstructing trees; however, to date the site owner has denied those requests. While Alternative 4 includes Bald Mountain's existing link to Dispatch, the District may wish to evaluate an alternate method for connecting those two sites due to the issues with the current link. In addition, Alternative 4 proposes a new link from Bald





Mountain to Buck Mountain. The District should consider the possibility that recent tree growth may impede the feasibility of this new link as well.

For the microwave path from Columbia County Courthouse to Dispatch, it is assumed that the height of the dish at the Courthouse can be elevated to the 65' level (above ground). If this is not feasible, and the dish must be mounted at a lower level, the reliability of the path may suffer. If this is not acceptable, the District may wish to consider the construction of a tower at the Courthouse, or perhaps an alternative to microwave connectivity (e.g., fiber) at this location.

**FE** recommends that new microwave links be in a ring, unprotected (1+0) where possible, with spur links in monitored hot standby (1+1) configuration. New microwave links shall have a minimum 99.999% availability (i.e., five 9's) and include all new radios, antennas, waveguide, dehydrator, accessories, and battery banks. Based on terrain, closing the ring with the new sites may not be feasible. Therefore, the design includes the above MHSB spurs. WCCCA representatives stated that spurs sites are acceptable, and that they have 100% microwave connectivity in a semi-mesh MPLS routed configuration with very limited single points of failure.

**FE** analyzed potential new microwave paths to assess adequate clearance above terrain and obstructions. However, **FE** did not perform physical radio path surveys to identify the exact location and height of potential obstructions. The District should require the awarded vendor to perform final path and system design in their scope of work, including physical path surveys. It is important to note that actual frequencies for the new paths are unknown. Typically, new systems include frequencies between 6 and 23 GHz equipment based on distance and line of site gathered through software tools and path surveys. For budgetary purposes, the cost estimates reflect 6 GHz radios, antennas, and waveguide.

Appendix B provides the path profile reports detailing estimated path availability for all new microwave links.

#### **8.1.3.6 Network Management System**

This alternative assumes use of the existing WCCCA NMS that should reside at the Motorola P25 Phase 2 Trunking core location(s). This alternative include two new NMT units that can reside at District sites that will have connectivity to the WCCCA network. Each NMT would allow District maintenance staff to manage their radio fleet, remotely monitor the radio, microwave and network equipment performance and site alarms (i.e., rectifier failure, elevated temperature, and site intrusion), and troubleshoot equipment outages using:







- A network management workstation
- Vendor proprietary software for the repeater and backhaul equipment
- A remote terminal unit (RTU) for each site to monitor site alarms

This alternative assumes that the WCCCA NMS has licenses to support these two additional NMT units, and that WCCCA would allow the District to monitor the new radio and microwave sites part of the system expansion.

#### ***8.1.3.7 System Interoperability***

Migrating to a P25 system increases interoperability with surrounding P25 systems such as CRESA, WCCCA, City of Portland, and State of Oregon. By joining CRESA, the District would have interoperability opportunities with other user(s) on the WCCCA system. This would require approval, agreement(s), planning, and programming on the system and subscriber units, but the potential for increased interoperability is there. With dual-band radios (VHF and 800 MHz), the District can retain existing interoperability with agencies on VHF analog conventional system.

#### ***8.1.4 Site Improvements***

Alternative 4 requires use of nine sites that serve different purposes as follows:

1. Buxton - existing WCCCA site, new microwave hop to Corey Hill
2. Chapman Fire Station - new WCCCA site, new tower and shelter, and new microwave hop to Buck Mtn.
3. Corey Hill - new WCCCA site, existing District site with existing microwave to Clatskanie Mtn., new microwave hop to Buxton
4. Meissner Lookout - new WCCCA site, existing District site with existing microwave to Clatskanie Mtn.
5. Clatskanie Mtn. – new WCCCA site existing District site, use existing microwave to Corey Hill, Meissner Lookout, Green Mtn., and Columbia Heights
6. New Columbia Heights - new WCCCA site, New District site with existing microwave to Clatskanie Mtn.
7. Columbia County Courthouse - new WCCCA site, existing District site with new microwave to Dispatch (assume no fiber in place)
8. Scappoose PD - new WCCCA site, existing District site with new microwave to Dispatch (replace existing T1)





9. Buck Mtn. (Pisgah) - existing District site, new microwave-only relay site to Chapman Fire Station and Bald Mtn.
10. Bald Mtn. - existing District site, use existing microwave to Dispatch, new microwave hop to Buck Mtn.
11. Dispatch - existing District site, use existing microwave to Bald Mtn. and Green Mtn., new microwave hops to Columbia County Courthouse and Scappoose PD (replace existing T1)
12. Green Mtn. - existing District site, use existing microwave to Clatskanie Mtn. and Dispatch

As stated previously, the existing microwave hop between Dispatch and Bald Mountain is potentially problematic due to trees obstructing the path. While Alternative 4 includes Bald Mountain's existing link to Dispatch, the District may wish to evaluate an alternate method for connecting those two sites due to the issues with the current link, or perhaps evaluate raising the microwave dish heights at the Bald Mountain site to account for the recent tree growth. The District may also wish to consider alternate connectivity options for the new hop from Bald Mountain to Buck Mountain, should recent tree growth prevent a reliable microwave path.

Table 43 summarizes the radio site upgrades needed to support the Alternative 4 system implementation. The site modifications are based on site information provided by the District. An "X" in the table identifies available infrastructure and/or needed items per site that have been included in the cost estimates.

**Table 43 – Alternative 4 Site Improvement Assumptions**

Site Infrastructure and Improvements	Buxton	Chapman Fire Station	Corey Hill	Meissner Lookout	Clatskanie Mtn.	New Columbia Heights	Columbia Co. Courthouse	Scappoose PD	Buck Mtn. (Pisgah)	Bald Mtn.	Dispatch	Green Mtn.
Existing Tower/Structure with Available Space	X		X		X		X	X		X	X	X
Tower Structural Analysis Needed	X		X		X		X	X		X	X	
Existing Tower Mods Needed												
New Tower Structure Needed		X		X		X			X			







Site Infrastructure and Improvements	Buxton	Chapman Fire Station	Corey Hill	Meissner Lookout	Clatskanie Mtn.	New Columbia Heights	Columbia Co. Courthouse	Scappoose PD	Buck Mtn. (Pisgah)	Bald Mtn.	Dispatch	Green Mtn.
A&E, Environmental Compliance		X		X		X			X			
Existing Shelter/Bldg. with Available Space	X		X	X	X		X	X		X	X	X
Site Grounding Updates Needed			X	X	X		X	X		X	X	
Existing Shelter/Bldg. Mods Needed												
New Prefab Shelter Needed		X				X			X			
New Outdoor Cabinet Needed												
Commercial AC Power Available	X	X	X	X	X	X	X	X	X	X	X	X
Solar/DC Site Upgrades Needed												
Backup Power Source(s) Available	X		X	X	X		X	X		X	X	X
New Generator Needed		X				X			X			
New UPS/Batteries Needed		X				X						

Alternative 4 assumes that Chapman Fire Station and New Columbia Heights require new self-supported tower structures. The design assumes that the site owners would be amenable to the District constructing structures there. Any potential upfront or recurring costs for collocating at the sites are unknown at the time of writing this report. Therefore, the cost estimates do not reflect any recurring costs that the District could incur at a later time. It is unknown whether the sites would have space available inside existing buildings for housing the District's radio and backhaul equipment. Therefore, the cost estimates include new prefabricated communications shelters, equipped with HVAC, generator, fuel tank, and UPS.

### 8.1.5 Subscriber Units

Section 5.1.5 provides the detailed inventory of the existing subscriber units. This alternative requires that the District replace existing VHF, analog-only and end-of-life subscriber units. Almost all existing subscriber units require replacement with 700/800 MHz radios equipped and licensed to operate on P25 Phase 2 Trunking mode. Only





CCSO can re-use and re-program a portion of their fleet on the new system. These subscriber units consist of thirteen APX7000 portables and fifteen APX7500 mobiles that are dual band, assumed to operate on VHF and 700/800 MHz and licensed for P25 Phase 2 Trunking mode. Therefore, the cost estimates do not include any software upgrades but do include re-programming of these subscriber units to operate on the new system.

Given the need to interoperate with agencies on VHF channels, the cost estimate includes the replacement of all other existing subscriber units with dual band (VHF and 700/800 MHz) radios. The use of these models provides a good average cost for budgetary purposes. Some departments may only purchase low-tier (single band) models, majority may purchase dual-band units, and others may purchase high-tier (all band) radios with added features. As part of the RFP, the District could specify the quantity and tier requirements for each department, which would allow the vendors to provide a more accurate cost proposal.

### 8.1.6 Cost Analysis

#### 8.1.6.1 Cost Assumptions

Based on results from the coverage studies, analysis of existing inventory and feedback provided by the District, **FE** developed the following set of equipment- and services-related assumptions shown in Table 44 for the Alternative 4 cost estimates.

**Table 44 – Alternative 4 Cost Assumptions**

Alternative 4 Assumptions	QTY	Notes
<b>WCCCA System Equipment</b>		
P25 Phase 2 Core Equipment	2	Existing Dual P25 Phase 2 Trunking Cores with geo-redundant locations (4 core cores)
Simulcast Control Equipment	7	Existing Simulcast Control Equipment with geo-redundant locations
Simulcast Cell Equipment	7	Existing Simulcast Cells with varying sites and channels per cell
Multicast Site Equipment	8	Existing 5 ASR sites for large area coverage, and one ASR per each Jail (total of two) and one Site on Wheels for a total of 8 ASR sites
<b>Simulcast Control Equipment</b>		
Simulcast Controller	2	New simulcast cell control equipment with geographically separated locations
GPS Frequency Standard	2	New simulcast cell frequency standard with geographically separated locations
Voting Equipment	6	New simulcast cell voting equipment (2 channels per chassis) with geographically separated locations







Alternative 4 Assumptions	QTY	Notes
Networking Equipment	2	New simulcast cell networking equipment with geographically separated locations
<b>Repeater Site Equipment</b>		
6-CH 7/800 MHz P25 Phase 2 Repeater Site (Trunked Simulcast configuration)	6	New P25 repeaters for the following sites: 5 Existing Columbia VHF sites (Corey Hill, Meissner Lookout, New Columbia Heights, Columbia Co. Courthouse, and Scappoose PD) 1 Potential new site at Chapman Fire Station
6-CH 7/800 MHz P25 Phase 2 Repeater Site (Trunked Multicast configuration)	1	New P25 repeaters at 1 Existing Columbia VHF site (Clatskanie Mtn.)
6-CH 7/800 MHz TX/RX Antenna System	7	New 7/800 MHz Transmit/Receive antennas, transmission lines, combiners, multicouplers, and lightning protection
Site Networking Equipment	7	New, redundant routers and switches
LMR FCC License	42	New LMR site application(s) for new RF sites included in the Conceptual Design
LMR Frequency Coordination	42	New LMR site application(s) for new RF sites included in the Conceptual Design
LMR Engineering Services	42	New LMR site application(s) for new RF sites included in the Conceptual Design
<b>Primary Dispatch System Equipment</b>		
Logging Recorder	0	The District already has a logging recorder vendor that they are working with, which will be handled outside this project. Therefore, the cost for a logging recorder is not needed for the conceptual design or RFP.
Dispatch Console	6	New dispatch consoles to replace five existing console positions, plus one new console position for training and maintenance.
Backup RF Control Station	6	New backup RF control station per console position
700/800 MHz TX/RX Antenna System	1	New Transmit/Receive Antenna, transmission line, control station combiner, and lightning protection
Conventional Channel Gateway	2	4-port gateways for interfacing to Mutual Aid conventional channels
Site Networking Equipment	1	New, redundant routers and switches
<b>Backup Dispatch System Equipment</b>		
Logging Recorder	0	The District already has a logging recorder vendor that they are working with, which will be handled outside this project. Therefore, the cost for a logging recorder is not needed for the conceptual design or RFP.
Dispatch Console	5	New dispatch consoles to replace the five console positions the District currently has.
Backup RF Control Station	5	New backup RF control station per console position





Alternative 4 Assumptions	QTY	Notes
700/800 MHz TX/RX Antenna System	1	New Transmit/Receive Antenna, transmission line, control station combiner, and lightning protection
Conventional Channel Gateway	2	New 4-port gateways for interfacing to Mutual Aid conventional channels
Site Networking Equipment	1	New, redundant routers and switches
<b>Microwave Backhaul Equipment</b>		
Re-use of Existing Microwave Paths	6	Dispatch to Green Mountain Dispatch to Bald Mountain Green Mountain to Clatskanie Clatskanie to Meissner Clatskanie to Columbia Heights Clatskanie to Corey Hill
New Microwave Paths Needed	6	Corey Hill to Buxton (WCCCA site) Chapman Fire Station to Buck Mountain (microwave relay) Buck Mountain to Bald Mountain (District site) Scappoose PD to Dispatch (replace T1) Dispatch to Columbia County Courthouse (assume no fiber in place) Columbia Heights to New Columbia Heights
6 GHz Hot Standby Radio	12	New microwave radios for new sites
6 GHz - 6' Dual-Polarization	12	New 6 GHz - 6' Dual-Polarization microwave dish
Waveguide and Accessories	12	New Waveguide and Accessories
DC Plant	10	New Large DC Plant
Equipment Rack and Accessories	10	New Large Equipment Rack and Accessories
MPLS Router	10	New Large MPLS Router
Timing System	1	New Timing System
Dehydrator	10	New Dehydrator
MW FCC License	12	New MW site application(s) and/or existing license modification(s) for Conceptual Design
MW FCC License Coordination	6	New MW site application(s) and/or existing license modification(s) for Conceptual Design
<b>Network Management System</b>		
Network Management Server	0	Existing WCCCA server assumed to be housed at P25 Phase 2 Trunking Core location(s)
Network Management Terminal	2	New NMT equipment; can be located anywhere in the District with access to radio/backhaul network
Fault Management Server	0	Existing WCCCA server assumed to be housed at P25 Phase 2 Trunking Core location(s)
Fault Management Site	11	New Alarms equipment to be installed at each new radio and backhaul sites
<b>Civil/Site Improvements</b>		
Existing Tower/Structure with Available Space	8	Based on information in District-provided documentation
Tower Structural Analysis Needed	7	Based on information in District-provided documentation
Existing Tower Mods Needed	0	Based on information in District-provided documentation







Alternative 4 Assumptions	QTY	Notes
New Tower Structure Needed	3	Based on information in District-provided documentation
A&E, Environmental Compliance	3	Based on information in District-provided documentation
Existing Shelter/Bldg. with Available Space	8	Based on information in District-provided documentation
Site Grounding Updates Needed	6	Based on information in District-provided documentation
Existing Shelter/Bldg. Mods Needed	0	Based on information in District-provided documentation
New Prefab Shelter Needed	2	Based on information in District-provided documentation
New Outdoor Cabinet Needed	1	Based on information in District-provided documentation
Commercial AC Power Available	11	Based on information in District-provided documentation
Solar/DC Site Upgrades Needed	0	Based on information in District-provided documentation
Backup Power Source(s) Available	9	Based on information in District-provided documentation
New Generator Needed	2	Based on information in District-provided documentation
New UPS/Batteries Needed	1	Based on information in District-provided documentation
<b>Subscriber Equipment</b>		
Total Mobiles	281	Replace existing mobiles with new 700/800 MHz subscriber units (equipped and licensed for P25 Phase 2 Trunking operation); Re-use fifteen APX7500 mobiles for CCSO
Total Portables	454	Replace existing portables with new 700/800 MHz subscriber units (equipped and licensed for P25 Phase 2 Trunking operation); Re-use thirteen APX7000 portables for CCSO
Total Control Stations	11	Replace existing control stations with new 700/800 MHz subscriber units (equipped and licensed for P25 Phase 2 Trunking operation)
Vehicular Repeaters	4	Replace existing vehicular repeaters with new 700/800 MHz units (equipped and licensed for P25 Phase 2 Trunking operation)
<b>Implementation Services</b>		
Spare / Test Equipment	5%	Based on <b>FE</b> historical / industry data
Project Management	10%	Based on <b>FE</b> historical / industry data
Installation	10%	Based on <b>FE</b> historical / industry data
Engineering	20%	Based on <b>FE</b> historical / industry data
Removal of Existing Equipment	2%	Based on <b>FE</b> historical / industry data
Training	1%	Based on <b>FE</b> historical / industry data
Staging	5%	Based on <b>FE</b> historical / industry data
Acceptance/Coverage Testing	1%	Based on <b>FE</b> historical / industry data





Alternative 4 Assumptions	QTY	Notes
Documentation	1%	Based on <i>FE</i> historical / industry data
Sales Tax	0%	Oregon state sales tax rate is currently 0%
Contingency	10%	Based on <i>FE</i> historical / industry data
WCCCA Annual Recurring User Fee	\$431.86	Per subscriber unit per year cost, includes provisioning and programming
<b>Operational Expenditures (OPEX)</b>		
System OPEX Period (years)	10	System lifecycle costs shown in 5-year increments
Manufacturer's Warranty (years)	1	Out-of-warranty supports begins in Year 2
Annual Inflation Rate	3%	Based on <i>FE</i> historical / industry data
System Remote Technical Support	1%	Percentage of total system equipment CAPEX in Year 1; annual inflation added Years 2 - 10
System Security/Information Assurance	2%	Percentage of total system equipment CAPEX in Year 1; annual inflation added Years 2 - 10
System Upgrades (Hardware/Software)	5%	Percentage of total system equipment CAPEX in Year 1; annual inflation added Years 2 - 10
System Onsite Support and Repair	3%	Percentage of total system equipment CAPEX in Year 1; annual inflation added Years 2 - 10

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### 8.1.6.2 Radio System Cost

Table 45 outlines the estimated costs for the radio system equipment and services for Alternative 4.

**Table 45 – Alternative 4 Radio System Cost Estimate**

Alternative 4 Radio System Cost Estimate			
<b>Core Network Equipment</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
P25 Phase 2 Core Equipment	0	\$1,372,000	\$0
Core Networking Equipment	0	\$147,000	\$0
Spare / Test Equipment	5%		\$0
<b>Subtotal - Core Network Equipment</b>			<b>\$0</b>
<b>Simulcast Site Equipment</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
Simulcast Controller	2	\$69,000	\$138,000
GPS Frequency Standard	2	\$37,000	\$74,000
Voting Equipment	6	\$64,000	\$384,000
Networking Equipment	2	\$73,000	\$146,000
Spare / Test Equipment	5%		\$38,000
<b>Subtotal - Repeater Site Equipment</b>			<b>\$780,000</b>
<b>Repeater Site Equipment</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
7/800 MHz 6-CH TX/RX Simulcast Equipment	6	\$340,000	\$2,040,000
7/800 MHz 6-CH TX/RX Multicast Equipment	1	\$299,000	\$299,000
7/800 MHz TX/RX Antenna System	7	\$28,000	\$196,000
Site Networking Equipment	7	\$13,000	\$91,000
Spare / Test Equipment	5%		\$132,000
<b>Subtotal - Repeater Site Equipment</b>			<b>\$2,758,000</b>
<b>Equipment Subtotal</b>			<b>\$3,538,000</b>
<b>FCC Licensing and Coordination</b>		<b>Unit Cost</b>	<b>Extended Cost</b>
LMR FCC License Fees	42	\$100	\$4,200
LMR Frequency Coordination Fees	42	\$300	\$12,600
LMR Engineering Services Fees	42	\$125	\$5,250
<b>Subtotal - FCC Licensing and Coordination (rounded)</b>			<b>\$23,000</b>





<b>Implementation Services</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
Project Management	10%		\$354,000
Installation	10%		\$354,000
Engineering	20%		\$708,000
Removal of Existing Equipment	2%		\$71,000
Training	1%		\$36,000
Staging	5%		\$177,000
Acceptance Testing	1%		\$36,000
Documentation	1%		\$36,000
<b>Subtotal - Implementation Services</b>			<b>\$1,772,000</b>
<b>Services Subtotal</b>			<b>\$1,795,000</b>
<b>TOTAL - EQUIPMENT &amp; SERVICES</b>			<b>\$5,333,000</b>
Sales Tax	0%		\$0
Contingency	10%		\$534,000
<b>TOTAL - EQUIPMENT &amp; SERVICES (with sales tax &amp; contingency), rounded</b>			<b>\$5,870,000</b>

#### 8.1.6.3 Dispatch System Cost

Refer to Section 5.1.6.3 as the dispatch system cost of \$1,240,000 is common to all four alternatives.

#### 8.1.6.4 Backhaul System Cost

Table 46 provides the estimated costs for the new backhaul system equipment and services for Alternative 4.

**Table 46 – Alternative 4 Backhaul System Cost Estimate**

<b>Alternative 4 Backhaul System Cost Estimate</b>			
<b>Backhaul Site Equipment</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
6 GHz Hot Standby Radio	12	\$30,000	\$360,000
6 GHz - 6' Dual-Polarization	12	\$9,000	\$108,000
Waveguide and Accessories	12	\$5,000	\$60,000
DC Plant	10	\$19,000	\$190,000
Equipment Rack and Accessories	10	\$10,000	\$100,000
MPLS Router	10	\$20,000	\$200,000
Timing System	1	\$13,000	\$13,000
Dehydrator	10	\$4,000	\$40,000
Spare / Test Equipment	5%		\$54,000
<b>Equipment Subtotal</b>			<b>\$1,125,000</b>
<b>FCC Licensing and Coordination</b>		<b>Unit Cost</b>	<b>Extended Cost</b>
MW FCC License Fees	12	\$1,200	\$14,400
MW Frequency Coordination Fees	6	\$1,700	\$10,200
<b>Subtotal - FCC Licensing and Coordination (rounded)</b>			<b>\$25,000</b>







<b>Implementation Services</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
Project Management	10%		\$113,000
Installation	10%		\$113,000
Engineering	20%		\$225,000
Removal of Existing Equipment	2%		\$23,000
Training	1%		\$12,000
Staging	5%		\$57,000
Acceptance Testing	1%		\$12,000
Documentation	1%		\$12,000
<b>Subtotal - Implementation Services</b>			<b>\$592,000</b>
<b>TOTAL - EQUIPMENT &amp; SERVICES</b>			<b>\$1,717,000</b>
Sales Tax	0%		\$0
Contingency	10%		\$172,000
<b>TOTAL - EQUIPMENT &amp; SERVICES (with sales tax &amp; contingency), rounded</b>			<b>\$1,890,000</b>

#### 8.1.6.5 Network Management Cost

Table 47 summarizes the estimated costs for the network management equipment and services for Alternative 4.

**Table 47 – Alternative 4 Network Management Cost Estimate**

<b>Alternative 4 Network Management Cost Estimate</b>			
<b>Network Management Equipment</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
Network Management Server	0	\$212,000	\$0
Network Management Terminal	2	\$15,000	\$30,000
Fault Management Server	0	\$188,000	\$0
Fault Management Site	11	\$10,000	\$110,000
Spare / Test Equipment	5%		\$7,000
<b>Equipment Subtotal</b>			<b>\$147,000</b>
<b>Implementation Services</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Extended Cost</b>
Project Management	10%		\$15,000
Installation	10%		\$15,000
Engineering	20%		\$30,000
Removal of Existing Equipment	2%		\$3,000
Training	1%		\$2,000
Staging	5%		\$8,000
Acceptance Testing	1%		\$2,000
Documentation	1%		\$2,000
<b>Subtotal - Implementation Services</b>			<b>\$77,000</b>
<b>TOTAL - EQUIPMENT &amp; SERVICES</b>			<b>\$224,000</b>
Sales Tax	0%		\$0
Contingency	10%		\$23,000
<b>TOTAL - EQUIPMENT &amp; SERVICES (with sales tax &amp; contingency), rounded</b>			<b>\$250,000</b>





### 8.1.6.6 Site Improvements Cost

Table 48 provides a breakdown of the estimated costs for site improvements and services for Alternative 4.

**Table 48 – Alternative 4 Site Improvements Cost Estimate**

Alternative 4 Site Improvements Cost Estimate			
<i>Site Support Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Existing Tower/Structure with Available Space	8	\$0	\$0
Tower Structural Analysis Needed	7	\$5,000	\$35,000
Existing Tower Mods Needed	0	\$50,000	\$0
New Tower Structure Needed	4	\$283,000	\$1,132,000
A&E, Environmental Compliance	4	\$14,000	\$56,000
Existing Shelter/Bldg. with Available Space	9	\$0	\$0
Site Grounding Updates Needed	7	\$15,000	\$105,000
Existing Shelter/Bldg. Mods Needed	0	\$20,000	\$0
New Prefab Shelter Needed	3	\$109,000	\$327,000
New Outdoor Cabinet Needed	0	\$10,000	\$0
Commercial AC Power Available	12	\$0	\$0
Solar/DC Site Upgrades Needed	0	\$15,000	\$0
Backup Power Source(s) Available	9	\$0	\$0
New Generator Needed	3	\$30,000	\$90,000
New UPS/Batteries Needed	2	\$30,000	\$60,000
Spare / Test Equipment	5%		\$91,000
<b>Equipment Subtotal</b>			<b>\$1,896,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Project Management	10%		\$190,000
Installation	10%		\$190,000
Engineering	20%		\$380,000
Removal of Existing Equipment	2%		\$38,000
Training	1%		\$19,000
Staging	5%		\$95,000
Acceptance Testing	1%		\$19,000
Documentation	1%		\$19,000
<b>Subtotal - Implementation Services</b>			<b>\$950,000</b>
<b>TOTAL - EQUIPMENT &amp; SERVICES</b>			<b>\$2,846,000</b>
Sales Tax	0%		\$0
Contingency	10%		\$285,000
<b>TOTAL - EQUIPMENT &amp; SERVICES (with sales tax &amp; contingency), rounded</b>			<b>\$3,140,000</b>







### 8.1.6.7 Subscriber Units Cost

Table 49 provides a summary of the estimated costs for subscriber units and services for Alternative 4. Appendix C includes detailed cost estimates on a per department and per radio basis.

**Table 49 – Alternative 4 Subscriber Unit Cost Estimate**

Alternative 4 Subscriber Cost Estimate			
Department/Agency	Equipment Cost	Services Cost	Total Cost
CRFPD	\$385,000	\$35,000	\$420,000
CCRD	\$702,000	\$78,000	\$780,000
CRF&R	\$590,000	\$61,000	\$651,000
SRFD	\$779,000	\$73,000	\$852,000
St Helens Police	\$351,000	\$33,000	\$384,000
Metro West Ambulance	\$104,000	\$9,000	\$113,000
CCSO	\$774,000	\$64,000	\$838,000
Vernonia Fire	\$379,000	\$38,000	\$417,000
Rainier Police	\$104,000	\$10,000	\$114,000
Mist-Birkenfeld	\$444,000	\$41,000	\$485,000
West Port Fire	\$150,000	\$14,000	\$164,000
Columbia City PD	\$59,000	\$6,000	\$65,000
<b>Total (rounded)</b>	<b>\$4,821,000</b>	<b>\$462,000</b>	<b>\$5,290,000</b>

### 8.1.6.8 Total Cost Summary

Table 50 summarizes the total cost estimate for Alternative 4, including radio, dispatch, backhaul, network management, site improvements, subscriber units, and recurring WCCCA user fees over 10 years.





**Table 50 – Alternative 4 Total Cost Estimate**

<b>Alternative 4 Total Cost Estimate</b>					
<i>Item</i>	<i>Equipment</i>	<i>Services</i>	<i>Sales Tax</i>	<i>Contingency</i>	<i>Total (rounded)</i>
Radio System	\$3,538,000	\$1,795,000	\$0	\$534,000	<b>\$5,870,000</b>
Dispatch System	\$743,000	\$376,000	\$0	\$112,000	<b>\$1,240,000</b>
Backhaul System	\$1,125,000	\$592,000	\$0	\$172,000	<b>\$1,890,000</b>
Network Management	\$147,000	\$77,000	\$0	\$23,000	<b>\$250,000</b>
Site Improvements	\$1,896,000	\$950,000	\$0	\$285,000	<b>\$3,140,000</b>
Subscriber Units	\$4,821,000	\$462,000	\$0	\$0	<b>\$5,290,000</b>
<b>Total Capital Costs for Joining WCCCA</b>					<b>\$17,680,000</b>
<i>Lifecycle Costs</i>	<i>Equipment</i>	<i>Services</i>	<i>Sales Tax</i>	<i>Contingency</i>	<i>10-Year Total</i>
System Maintenance	\$0	\$4,610,000	\$0	\$0	<b>\$4,610,000</b>
<i>Recurring Costs</i>	<i>Monthly Fee</i>	<i>Yearly Fee</i>	<i>No. of Users</i>	<i>1-Year Total</i>	<i>10-Year Total</i>
WCCCA User Fees		\$432	750	\$324,000	<b>\$3,240,000</b>
<b>Total Capital and Recurring Costs over 10 Years</b>					<b>\$25,530,000</b>

Based on discussions with WCCCA representatives, the current average user fee for agencies on the system is \$431.86 per radio per year which could decrease with addition of the District users. The fee includes console connection, core provisioning, and radio programming. WCCCA representatives state that annual fees to changes to cover increases in personnel costs, fuel, and other overhead items. Based on a rounded number of District users at 750 (including radios and consoles), the estimated annual fee for operating on WCCCA is \$324,000. Assuming the access fee does not change, and the District does not add more users, the estimated 10-year cost for using WCCCA is \$3.24M. Therefore, the estimated 10-year total cost of ownership for expanding and using WCCCA is \$25.53M.







## 9. Proposed Vendor Solutions

The District asked **FE** to conduct an independent, unbiased review of the CODAN, Communications Northwest/Tait, and Motorola proposals submitted to the District. We evaluated each proposal for technical compliance to the requirements verified with Columbia 9-1-1 stakeholders. We assessed the designs and vendor proposed costs in comparison to **FE's** alternatives analysis, documenting the relative strengths and weaknesses of each response. The following sections provide a summary of our findings for the District to consider when evaluating their options.

### 9.1 Codan Radio Communications

The proposal from Codan Radio Communications consists of multiple 30-100W P25 and Analog Voting + Simulcast LMR infrastructure sites situated throughout the District to improve coverage while maintaining radio spectrum efficiency. Equipment would utilize the various law and fire VHF frequencies and be deployed at select sites throughout the District service area. Infrastructure includes 8-channel simulcast transmit voted receive site at six locations, and 8-channel voted receive only sites at three locations.

Estimated budgetary price is \$1.9M with Codan only providing LMR repeaters, system design, and coverage studies. Codan's response does not include a 10-year total cost of ownership like Motorola. The District would be responsible for filtering, antennas, consoles, mobile and portable radios, and backhaul network. It is unclear whether the "Third Party Partner" installation costs are included in Codan's budgetary price.

Codan's proposal provides the lowest cost solution for the District, but it is not as strong as the proposals from the other vendors. The only benefit to the District is that operations remain the same, with no steep learning curve, and no new backhaul equipment, dispatch consoles, or subscriber units.

### 9.2 Communications Northwest/Tait

The response we reviewed from Communications Northwest/Tait appears to be a scanned copy of the submitted proposal, making it difficult to view certain graphics, especially coverage maps. Tait's proposal includes new Tait AS-IP Simulcast system, new DragonWave Microwave Backhaul, and new Zetron MAX dispatch consoles. However, spectrum is not specified; only "what if" scenarios provided if District stays on VHF or moves to 700MHz or 800MHz.





Technology consists of Tait conventional simulcast TB9400 base stations with IP connectivity and voting capabilities. While the base station is P25 Phase 1 and Phase 2 capable, it is used in analog mode for this design.

Similar to CODAN, it appears that the Tait solution is a refresh of existing VHF system with new hardware. It is not clear as to exact sites and channels that are proposed. Tait does include new backhaul and consoles. In addition to VHF, Tait provides 700 and 800 MHz coverage maps, but we cannot analyze in their current PDF format. Coverage maps provided in Google Earth format do have coverage layers added for each frequency band, talk-in/talk-out, and mobile/portable configurations.

Tait does provide microwave system overview, including path profiles. However, link details graphic (showing sites proposed) is difficult to see. Tait also provides dispatch console overview, including components description, gateways, interfaces, bundles, and features.

Tait's grand total is ~\$2.1M which include new RF hardware, microwave system, and dispatch consoles. The estimate does include services but does not include 10-year total cost of ownership. The estimate assumes re-use of existing radios, but Tait provides single-unit for different portable and mobile packages.

Pricing in Tait's proposal was more in line with CODAN offering. Tait's proposal included a supplemental workbook that provides detailed pricing sheets for different configurations and equipment not included in their proposal. However, the ~\$4.7M (capital costs only) in the workbook is more in line with Motorola, providing a new P25 system, microwave, consoles, subscribers, and services.

Tait's proposal is better than CODAN's but not as strong as Motorola's proposals for CRESA and WCCCA. In some areas, Tait provides much more information than CODAN (such as product info and pricing), but in other areas it is very generic with not much District-specific design considerations like Motorola provided.

### **9.3 Motorola Solutions**

Motorola Solutions' proposal includes three alternate radio system designs:

- 6 Site VHF Analog Conventional Simulcast Cell and 4 Receive only Sites with 6 Analog and 1 Digital Channel
- 3 Site P25 Trunking 700/800 MHz Simulcast Cell with 5 Channels and 2 P25 Repeater Sites with 4 Channels connected to CRESA P25 Core







- 4 Site P25 Trunking 700/800 Simulcast Cell and 2 Receive only Sites with 6 Channels connected to the WCN (previously WCCCA/C800) P25 Core

The Executive Summary provides clear and concise understanding of District needs, system design options, scope of work, and proposed system advantages.

Design 1 is essentially a refresh of existing VHF system with same sites, channels, subscribers, and technology. The new system also includes a K2 core, five MCC7500 consoles, and a Microwave Networks, Inc. (MNI) backhaul system.

Design 2 is a new 700/800 MHz Digital Trunked Simulcast Network/Radio Site Repeaters with connection to CRESA's P25 Core. The new system includes three simulcast sites with five channels each, two standalone sites with 4 channels each, and offers same digital features as WCCCA.

Design 3 is a new 700/800MHz Trunked Simulcast network leveraging WCCCA's Trunked P25 Core and RF sites. The new system includes six sites (two are RX-only), six-channel configuration with digital enhancements like GPS location services, OTAP, OTAR, and encryption.

Motorola's TCO estimates range from lowest (~\$8.7M) to highest (~\$9.1M) for Designs 1 to 3, respectively. At the time of proposal review, there were many unknowns on core configurations, potential fees, and maintenance agreements. Motorola took an initiative to attempt estimating the cost to use CRESA and WCCCA cores. However, discussions with CRESA and WCCCA representatives revealed that the \$140,000 per year for use of either core is extremely low.

It is important to note that all coverage maps were based on DAQ 3.0, and that cost estimates do not include providing required frequency pairs, licensing, sites, site upgrades, civil work, logging, and subscribers. Overall, Motorola's response is a strong proposal with point-by-point response to the RFI, multiple design options, detailed product information, and 10-Year TCO estimates. Motorola's presentation provides step-by-step view of decision tree, leading up to design options with high-level descriptions of proposal content, and comparison of options vs. RFI goals.





## 10. Comparison and Recommendation

Based on an in-depth analysis of District needs and requirements, coverage and capacity studies, and budgetary cost estimates, *FE* provides the following comparison of alternatives, comparison to vendor proposals, and our recommended solution.

### 10.1 Comparison of Alternatives

*FE* calculated the geographic percentages of radio coverage throughout the District for the existing LMR system and each of the four alternatives. In addition, *FE* calculated the geographic coverage percentage for portable “in-building” coverage throughout populated places. To make this determination, *FE* assessed the coverage over all areas which had a USGS clutter classification of either “residential”, “industrial”, or “commercial”. Table 51 provides a comparison of the coverage percentages of existing system and the four alternatives.

**Table 51 – Coverage Percentages for the Existing System and Alternatives**

System Evaluated	Geographic Coverage %s of Columbia 9-1-1 Communications District						Coverage %s over Pop. Areas (Ind, Comm, Res) within District	
	Mobile Talk-Out	Mobile Talk-In	Portable Talk-Out (On-Street)	Portable Talk-In (On-Street)	Portable Talk-Out (In Bldg.)	Portable Talk-In (In Bldg.)	Portable Talk-Out (In Bldg.)	Portable Talk-In (In Bldg.)
Existing System	97	89	76	48	44	12	28	10
Alternative 1 - Existing System "Refresh"	99	95	86	60	57	25	50	15
Alternative 2 - Stand-alone 700 MHz System	96	99	79	71	63	52	87	75
Alternative 3 - Join CRESA 800 MHz System	94	97	72	60	52	40	76	60
Alternative 4 - Join WCCCA 800 MHz System	94	98	74	65	56	46	80	65

Table 52 presents a summary of site and channel counts for each of the alternatives presented in this report.





**Table 52 – Site / Channel Summary by Alternative**

Alternative	Number of Existing C911CD Radio Sites	Number of New "Greenfield" Sites	Frequency Band	Number of Additional Channel Pairs Needed
Alternative 1 - Existing System "Refresh"	10	0	VHF	0
Alternative 2 - Stand-alone 700 MHz System	8	1	700 MHz	7
Alternative 3 - Join CRESA 800 MHz System	3	1	800 MHz	13
Alternative 4 - Join WCCCA 800 MHz System	5	2	800 MHz	12

Table 53 provides a side-by-side cost comparison of the four alternatives, including a breakdown of subsystem items, total capital cost, 10-year system maintenance, 10-year system user fees (where applicable), and total cost of ownership.

**Table 53 – Alternatives Cost Estimate Comparison**

Alternatives Cost Estimate Comparison				
Item	Alternative 1 (District VHF)	Alternative 2 (District 700)	Alternative 3 (CRESA)	Alternative 4 (WCCCA)
Radio System	\$3,990,000	\$7,640,000	\$3,240,000	\$5,870,000
Dispatch System	\$1,240,000	\$1,240,000	\$1,240,000	\$1,240,000
Backhaul System	\$0	\$530,000	\$1,210,000	\$1,890,000
Network Management	\$100,000	\$930,000	\$200,000	\$250,000
Site Improvements	\$1,030,000	\$1,800,000	\$2,320,000	\$3,140,000
Subscriber Units	\$0	\$4,500,000	\$4,740,000	\$5,290,000
<b>Total Capital Cost</b>	<b>\$6,360,000</b>	<b>\$16,640,000</b>	<b>\$12,950,000</b>	<b>\$17,680,000</b>
10-Year System Maintenance	\$2,050,000	\$5,140,000	\$2,990,000	\$4,610,000
10-Year System User Fees	N/A	N/A	\$3,600,000	\$3,240,000
<b>Total Cost of Ownership</b>	<b>\$8,410,000</b>	<b>\$21,780,000</b>	<b>\$19,540,000</b>	<b>\$25,530,000</b>

Table 54 summarizes the key differences between the four system alternatives, including ownership and control, technology, coverage in populated areas, features, interoperability, subscribers, and total cost of ownership.





**Table 54 – System Alternatives Comparison**

System Alternatives Comparison				
<i>Item</i>	<i>Alternative 1</i>	<i>Alternative 2</i>	<i>Alternative 3</i>	<i>Alternative 4</i>
System Ownership and Control	District-owned (full control)	District-owned (full control)	CRESA-owned (limited control)	WCCCA-owned (limited control)
System Technology	Analog Conventional	P25 Conventional	P25 Phase 1 Trunking	P25 Phase 2 Trunking
System Spectrum	VHF	700 MHz	800 MHz	800 MHz
System Coverage (portable talk-In in-bldg.) in populated areas within the District	15%	75%	60%	65%
System Features	Retain existing; no added features	P25 standard features and AES encryption	P25 standard features, AES encryption, OTAR, GPS, and Smartphone Integration	P25 standard features, AES encryption, OTAR, OTAP, GPS, and Smartphone Integration
System Interoperability	Retain existing; no added capability	Analog backwards compatible and interoperability with other P25 systems	Analog backwards compatible, interoperability with CRESA users and State of Oregon, and ISSI to Portland	Analog backwards compatible, interoperability with WCCCA users, and ISSI to Portland and State of Oregon
Subscriber Units	Re-use existing VHF radios	New dual-band radios (VHF and 700MHz)	New dual-band radios (VHF and 800MHz)	New dual-band radios (VHF and 800MHz)
<b>Total Cost of Ownership</b>	<b>\$8,410,000</b>	<b>\$21,780,000</b>	<b>\$19,540,000</b>	<b>\$25,530,000</b>

Based on our analysis of the four system alternatives, **FE** provides the following key findings between them:

- Alternative 1 is the lowest cost solution; however, it does not solve current spectrum issues or provide improved features, and interoperability that the other three alternatives provide.
- Alternative 1 assumes that existing mobiles, portables, and control stations are in good condition, performing within specifications, and currently supported by manufacturers, and therefore do not need replacement.
- Alternatives 2, 3, and 4 provide better in-building coverage in population centers with 700/800 MHz versus VHF.







- Alternatives 1 and 2 provide full system control and governance whereas Alternatives 3 and 4 provide limited control of systems owned by others.
- Alternative 4 is the most expensive option due to higher site counts, number of channels, P25 Phase 2 trunking software (system and subscribers), and system maintenance costs.
- Adding P25 Phase 2 trunking capability to Alternative 2 would increase total cost of ownership and may exceed cost of Alternative 4.
- Alternative 3 is a lower cost option than Alternative 4 and offers P25 Trunking features that Alternative 2 does not provide.
- Additional site(s) can be added to Alternative 3 to improve portable on-street talk-in coverage in populated areas within the District.

## **10.2 Comparison to Vendor Proposals**

*FE* assessed vendor proposed designs and costs in comparison to *FE*'s alternatives analysis. *FE* provides the following summary of key findings including strengths and weaknesses of each response.

### **FE Alternative 1 vs. Codan Radio Communications**

The only strength about Codan's proposal is that it is the lowest cost solution since technology and operations remain the same. Compared to *FE*'s Alternative 1, Codan's proposal has the following weaknesses:

- Codan does not include new dispatch consoles (for primary or backup dispatch centers).
- Codan does not include a new network management system and remote terminal units.
- Codan does not include new antenna systems (transmit/receive antennas, transmission lines, combiners, multicouplers, and lightning protection).
- Codan does not include any cost estimates for potential site improvements.
- Codan does not include costs for spare equipment, contingency, and system maintenance (over 10 years).

### **FE Alternative 1 vs. Motorola Solutions**

Similar to *FE*'s Alternative 1, Motorola's proposal has the following strengths:

- Motorola provides a refreshed VHF Conventional Simulcast network utilizing the same sites as today's design and existing subscriber units.





- Motorola provides coverage maps with layers added for each frequency band, talk-in/talk-out, and mobile/portable configurations.
- Motorola includes new dispatch consoles for the primary dispatch center.
  - *FE* includes consoles for a backup dispatch center.
- Motorola includes a new microwave backhaul to support the new system.
- Motorola's Design 1 (VHF) cost estimates are lower than their CRESA and WCCCA options.

Compared to *FE*'s Alternative 1, Motorola's proposal has the following weaknesses:

- Motorola's coverage maps are based on DAQ 3.0, not DAQ 3.4 as recommended for public safety grade radio systems.
- Motorola's cost proposal states that "C911CD is responsible for providing required frequency pairs, licensing, sites, site upgrades, civil work, logging and subscribers."
- Motorola does not appear to include any cost estimates for spare equipment or contingency.

#### **FE Alternative 2 vs. Communications Northwest/Tait**

Similar to *FE*'s Alternative 2, Tait's proposal has the following strengths:

- Tait provides coverage maps with layers added for each frequency band, talk-in/talk-out, and mobile/portable configurations.
- Tait provides a 700/800MHz option as an alternative should consider the District decide to move away from VHF.
- Tait includes new dispatch consoles for the primary dispatch center.
  - *FE* includes consoles for a backup dispatch center.
- Tait includes a new microwave backhaul to support the new system
- Tait's cost estimates (both VHF and 700/800MHz options) are lower than Motorola for CRESA and WCCCA options.

Compared to *FE*'s Alternative 1, Tait's proposal has the following weaknesses:

- Tait's baseline proposal consists of a VHF analog simulcast solution.
- Tait provides repeaters that are upgradeable to P25 but not initially equipped, configured, and priced to do so.
- Tait assumes re-use of existing VHF radios, and only provides single-unit for different portable and mobile packages.







- Tait does not include any cost estimates for potential site improvements.
- Tait does not include any cost estimates for spare equipment, contingency, or system maintenance (over 10 years).

### **FE Alternative 3 vs. Motorola Solutions for CRESA**

Similar to *FE's* Alternative 3, Motorola's proposal has the following strengths:

- Motorola provides a new 800MHz District subsystem (simulcast/multicast hybrid), leveraging the existing CRESA cores and RF sites.
- Motorola's proposed design provides the District with P25 Phase 1 trunking technology, enhanced coverage, and improved interoperability.
- Motorola provides coverage maps with layers added for each frequency band, talk-in/talk-out, and mobile/portable configurations.
- Motorola includes new dispatch consoles for the primary dispatch center.
  - *FE* includes consoles for a backup dispatch center.
- Motorola includes a new microwave backhaul to support the new system.
- Motorola provides a 10-year TCO estimates including equipment and implementation services, maintenance and lifecycle services, and operating expenses (as applicable) for each design.
- Motorola's CRESA cost estimates are lower than their WCCCA option.

Compared to *FE's* Alternative 3, Motorola's proposal has the following weaknesses:

- Motorola's coverage maps are based on DAQ 3.0, not DAQ 3.4 as recommended for public safety grade radio systems.
- Motorola's cost proposal states that "C911CD is responsible for providing required frequency pairs, licensing, sites, site upgrades, civil work, logging and subscribers."
- Motorola does not provide cost estimates for FCC licensing and coordination, subscriber units, site upgrades, or contingency, and therefore, their TCO is much lower than Alternative 3.
- Motorola's cost estimate of \$140K per year for use of the CRESA core is \$220K per year less than the actual cost of \$360K per year, and therefore, their TCO is much lower than Alternative 3.





### **FE Alternative 4 vs. Motorola Solutions for WCCCA**

Similar to *FE*'s Alternative 4, Motorola's proposal has the following strengths:

- Motorola provides a new 800MHz District subsystem (simulcast/multicast hybrid), leveraging the existing WCCCA cores and RF sites.
- Motorola's proposed design provides the District with P25 Phase 2 trunking technology, enhanced coverage, and improved interoperability.
- Motorola provides coverage maps with layers added for each frequency band, talk-in/talk-out, and mobile/portable configurations.
- Motorola includes new dispatch consoles for the primary dispatch center.
  - *FE* includes consoles for a backup dispatch center.
- Motorola includes a new microwave backhaul to support the new system.
- Motorola provides a 10-year TCO estimates including equipment and implementation services, maintenance and lifecycle services, and operating expenses (as applicable) for each design.

Compared to *FE*'s Alternative 4, Motorola's proposal has the following weaknesses:

- Motorola's coverage maps are based on DAQ 3.0, not DAQ 3.4 as recommended for public safety grade radio systems.
- Motorola's cost proposal states that "C911CD is responsible for providing required frequency pairs, licensing, sites, site upgrades, civil work, logging and subscribers."
- Motorola does not provide cost estimates for FCC licensing and coordination, subscriber units, site upgrades, or contingency, and therefore, their TCO is much lower than Alternative 4.
- Motorola's cost estimate of \$140K per year for use of the WCCCA core is \$184K per year less than the actual cost of \$324K per year, and therefore, their TCO is much lower than Alternative 4.

## **10.3 Recommended Solution**

Based on our analysis of the existing radio, dispatch, and backhaul systems coupled with the District's stated needs and objectives, *FE* recommends Alternative 3, joining the CRESA system. This alternative addresses the stakeholder needs and requirements for improved coverage, features, and interoperability. Joining CRESA provides significant coverage and feature benefits over the VHF analog system, and it has a lower cost of entry than building a new 700 MHz system or joining the WCCCA 800 MHz system.







## 11. Next Steps

Based on the recommendation of Alternative 3, **FE** recommends that the District consider the following steps for implementing the new system:

1. Obtain approval and funding for the new system, subscribers, and consulting services.
2. Initiate the conversation with CRESA to begin the process to join the system.
3. Develop a detailed plan to migrate the users to the new system.
4. Develop functional specifications for the additional sites and capacity to enhance the CRESA system.
5. Procure the equipment and services for enhancing the CRESA system
6. Complete regulatory submittals for coordination of frequencies, FCC licenses, and any environmental (NEPA, SHPO, etc.) approvals, if applicable.
7. Monitor and supervise the vendor in implementing the system enhancement, including the following steps:
  - a. Review, revise, and approve a detailed system design submitted by the vendor.
  - a. Prepare a cut-over plan with the cooperation of the vendor.
  - b. Approve the acceptance testing plans for all components and for coverage verification.
  - c. Approve equipment manufacturing and witness factory acceptance test.
  - d. Prepare the sites by completing site improvements.
  - e. Install the system and subscriber equipment, including base stations, antenna systems, backhaul components, and mobile radios.
  - f. Program subscriber equipment, including mobile radios, portable radios, and control stations that will access the system.
  - g. Testing the new system; perform acceptance testing and coverage testing.
  - h. Complete all technical and operator training as close to cutover as possible.





- i. Execute cutover and move groups of users onto the new system by department.

8. Decommission or re-purpose the old systems.

If requested, **FE** can work with the District to develop the detailed migration plan with CRESA, and functional specifications. The detailed design of the system will be the responsibility of the vendor to allow for a creative approach and to ensure they remain responsible for system performance in accordance with the specifications.





## Appendix A - Requirements Tracking Matrix

ID #	Function	Technical or Functional Requirement	Critical / Mandatory	Highly Desirable	Desirable	N/A or Unknown
BACK-01	Backhaul	Redundant microwave backhaul connections shall be established between Dispatch, control, and RF sites.	X			
BACK-02	Backhaul	In addition to the LMR system requirements, the backhaul system shall have sufficient capacity to support the following additional applications: <ul style="list-style-type: none"> <li>• Video and alarms at sites (see below for video surveillance requirements)</li> <li>• Potentially, automatic vehicle location (AVL)</li> <li>• Potentially, body and vehicle dash camera video</li> </ul>	X			
BACK-03	Backhaul	All backhaul links shall have a minimum 99.999% availability (i.e., five 9's).	X			
BACK-04	Backhaul	The backhaul system shall utilize Carrier Ethernet technology.		X		
BACK-05	Backhaul	Microwave backhaul links on a ring shall be unprotected (1+0) and spur links shall be monitored hot standby (1+1).		X		
BACK-06	Backhaul	District fiber can be utilized to replace microwave links and/or to establish path redundancy.				X
BACK-07	Backhaul	Microwave backhaul links shall utilize licensed bands.	X			
BACK-08	Backhaul	Licensed 900 MHz links shall be used for receive-only sites.		X		





ID #	Function	Technical or Functional Requirement	Critical / Mandatory	Highly Desirable	Desirable	N/A or Unknown
BACK-09	Backhaul	Unlicensed 900 MHz links are acceptable for receive-only sites.			X	
CAP-01	Capacity	Conventional system solutions shall have enough channels to meet current and future capacity requirements.	X			
CAP-02	Capacity	Trunked system solutions shall provide sufficient capacity to provide a 1% grade of service (GoS) with a maximum one second hold time.	X			
CAP-03	Capacity	The system channel capacity for trunked system solutions shall be calculated based on existing subscriber radio counts and a 1% annual subscriber unit growth rate for 10 years.	X			
COV-01	Coverage	Minimum 95% Districtwide mobile radio coverage with primary focus on population centers and highways.	X			
COV-02	Coverage	Minimum 95% Districtwide on-street portable radio coverage (worn at hip) with primary focus on the following population centers and highways: • Main roads and highways added to the coverage maps during the coverage workshop and approved by the District		X		
COV-03	Coverage	Vehicular repeaters shall be used to supplement portable radio coverage but not to meet the primary coverage requirements.			X	
COV-04	Coverage	Minimum 95% in-building portable		X		







ID #	Function	Technical or Functional Requirement	Critical / Mandatory	Highly Desirable	Desirable	N/A or Unknown
		coverage in residential buildings and population centers.				
COV-05	Coverage	In-building coverage shall be provided for the following critical buildings: 1. Fred Meyer, Scappoose 51501 Columbia River Hwy, Scappoose, OR 97056 2. Cascade Tissue, Scappoose 52960 W Lane Rd, Scappoose, OR 97056 3. PCC, Scappoose, 33701 Charles T Parker Way, Scappoose, OR 97056 4. St. Helens new middle School 354 N 15th St, St Helens, OR 97051 5. 777 Port Ave St. Helens (Unknown name of company)		X		
COV-06	Coverage	Prioritize site RF site selection as follows: 1. Sites currently on the District system 2. Other existing public safety and/or government radio sites 3. Leased sites 4. Greenfield sites	X			
DISP-01	Dispatch	Replace all existing console positions at Dispatch.	X			
DISP-02	Dispatch	Establish a backup dispatch center.		X		
DISP-03	Dispatch	Backup RF control stations shall be provided for all dispatch console positions at Dispatch and the backup dispatch center.	X			
DISP-04	Dispatch	A single console position shall be provided at Dispatch for use for training and maintenance.	X			





ID #	Function	Technical or Functional Requirement	Critical / Mandatory	Highly Desirable	Desirable	N/A or Unknown
DISP-05	Dispatch	The District already has a logging recorder vendor that they are working with, which will be handled outside this project. Therefore, the cost for a logging recorder is not needed for the conceptual design or RFP.				X
INT-01	Interoperability	Interoperability required between all District agencies on the new system and also with: <ul style="list-style-type: none"> <li>• Portland Police Bureau (PPB) - 700/800 MHz trunked system</li> <li>• Oregon State Police (Oregon State Police) -</li> <li>• Oregon Department of Transportation (ODOT) -</li> <li>• Washington County Sheriff's Office (WCSO) -</li> <li>• Washington County Consolidated Communications Agency (WCCCA) -</li> <li>• Scappoose School District -</li> <li>• Portland Fire and Rescue (PF&amp;R) -</li> <li>• AMR</li> <li>• Tualatin Valley Fire and Rescue (TVF&amp;R) -</li> <li>• Clatsop Fire agencies -</li> <li>• Cowlitz Fire agencies -</li> <li>• United States Coast Guard (USCG) -</li> <li>• Oregon Department of Forestry (ODF) -</li> <li>• Clark Regional Emergency Services Agency (CRESA) -</li> <li>• Metro area hospitals -</li> <li>• Portland Bureau of</li> </ul>	X			







ID #	Function	Technical or Functional Requirement	Critical / Mandatory	Highly Desirable	Desirable	N/A or Unknown
		Emergency Communications (BOEC) - • Multnomah County Sheriff's Office (MCSO) - • Clatsop County Sheriff's Office (CCSO) - • Cowlitz Sheriff's Office - • Vernonia Public Works - • State Search and Rescue - • Marine channels - • Medix - • Clatskanie Public Works - • Columbia Roads - • State Fire Marshall - • Life Flight - • Wakaikum County - • United States Forest Service (USFS) - • United States Bureau of Land Management (BLM) -				
INT-02	Interoperability	For District-owned P25 trunked solution, Inter RF Subsystem Interface (ISSI) connection(s) shall provide interoperability with other P25 system(s).	X			
INT-03	Interoperability	Trunked solutions shall include conventional gateways for interoperability with conventional systems.	X			
MAINT-01	Maintenance	The new system shall include an NMS for alarm reporting and to remotely diagnose system outages and perform preventative maintenance activities.	X			





ID #	Function	Technical or Functional Requirement	Critical / Mandatory	Highly Desirable	Desirable	N/A or Unknown
MAINT-02	Maintenance	Each RF site shall include a small remote terminal unit (RTU) for monitoring/reporting of physical site alarms (i.e., intrusion, generator, etc.).	X			
MAINT-03	Maintenance	District owned solutions will be maintained by the District. Depending on the solution there may be a long-term maintenance option with the selected vendor.	X			
PWR-01	Power	LMR and microwave equipment at all RF sites shall operate on primary DC power with the ability for all equipment to operate for 8 - 10 hours upon failure of primary AC power.	X			
PWR-02	Power	Backup generator required for all Dispatch, control (trunked and simulcast) and RF sites.	X			
PWR-03	Power	Uninterruptible Power Supply (UPS) required at all sites for network equipment that will provide backup upon failure of utility AC power for 10 minutes.	X			
SEC-01	Security	Each RF site shall include three surveillance camera(s) and associated hardware and software to allow monitoring at Dispatch.	X			
SEC-02	Security	Conventional system solutions shall be capable of encrypting radio traffic on the Law channels.		X		
SEC-03	Security	Trunked system solutions shall be capable of encrypting	X			







ID #	Function	Technical or Functional Requirement	Critical / Mandatory	Highly Desirable	Desirable	N/A or Unknown
		radio traffic on desired talkgroups.				
SUB-01	Subscriber Units	For a VHF system alternative, the District requires re-use of the following subscriber unit counts: Total Mobiles - 234 Total Portables - 390 Total Control Stations - 11	X			
SUB-02	Subscriber Units	For a 700MHz system alternative, the District requires replacement of existing subscriber units with new dual band radios that operate on P25 and conventional systems and VHF and 700MHz frequency bands. CCSO can re-use 13 APX7000 portables and 15 APX7500 mobiles.	X			
SUB-03	Subscriber Units	For an 800MHz system alternative, the District requires replacement of existing subscriber units with new dual band radios that operate on P25 and conventional systems and VHF and 800MHz frequency bands. CCSO can re-use 13 APX7000 portables and 15 APX7500 mobiles.	X			
SYS-01	System	New or upgraded system shall be designed to industry standards, in areas such as grounding, lightning protection and earthquake bracing.	X			
SYS-02	System	Trunked solutions shall have geo-redundant system controllers, either via centralized or distributed control.				X





ID #	Function	Technical or Functional Requirement	Critical / Mandatory	Highly Desirable	Desirable	N/A or Unknown
SYS-03	System	New system shall allow radio users to hear all radio traffic on a channel or talkgroup Districtwide.	X			
SYS-04	System	For budgetary purposes, the cost estimate shall assume all new LMR and microwave equipment. After contract award, the awarded vendor shall assess each site and recommend which equipment can be used on the new system.	X			
SYS-05	System	Simulcast systems shall have geo-redundant control/voting sites.				X
SYS-06	System	The new system shall utilize existing District radio channels, where possible.	X			
SYS-07	System	Transmitter combiners and receiver multicouplers shall be used at all RF sites to minimize required tower space.	X			
SYS-08	System	Trunked solutions shall be equipped and licensed for Global Positioning System (GPS) based unit location services.		X		
SYS-09	System	Trunked solutions shall be equipped and licensed for 256-bit Advanced Encryption Standard (AES) encryption services.	X			
SYS-10	System	Trunked solutions shall be equipped and licensed for Over-the-Air Rekeying (OTAR) services.	X			
SYS-11	System	Trunked solutions shall be equipped and licensed for Over-the-Air Programming (OTAP) services.	X			







ID #	Function	Technical or Functional Requirement	Critical / Mandatory	Highly Desirable	Desirable	N/A or Unknown
SYS-12	System	Trunked solutions shall be capable of sending text messages.	X			
SYS-13	System	The new system shall provide paging.	X			
SYS-14	System	New system shall provide a Site on Wheels (SOW) for use during planned or emergency events, disaster recovery, or site transition or outage scenarios.				X
SYS-15	System	New system shall provide a smartphone/broadband device integration solution that integrates voice and data communications between District P25 radio system users and District users with broadband devices and/or smartphone applications.				X



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## **Appendix B - New Microwave Path Profile Reports**

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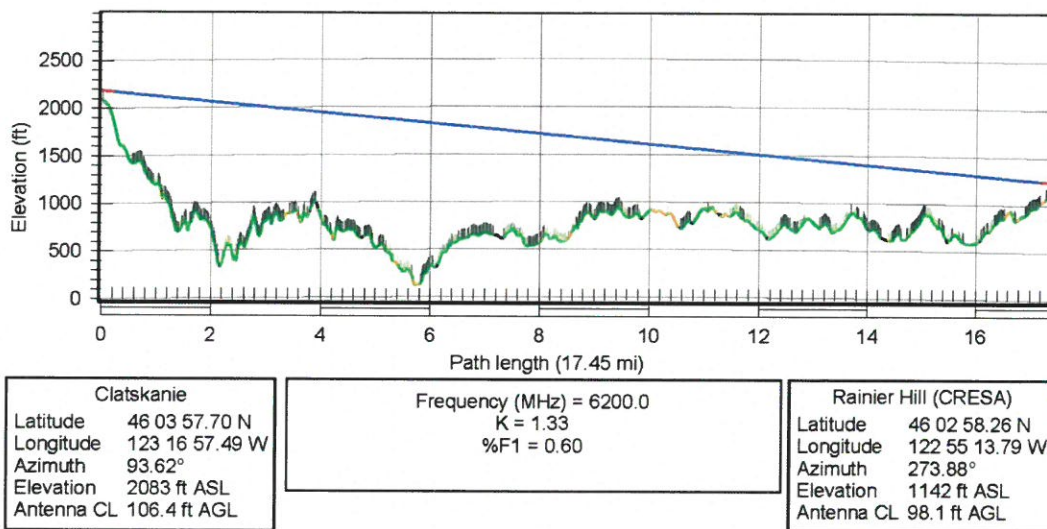






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Transmission details (Clatskanie-Rainier Hill (CRESA).pl5)

	Clatskanie	Rainier Hill (CRESA)
Latitude	46 03 57.70 N	46 02 58.26 N
Longitude	123 16 57.49 W	122 55 13.79 W
True azimuth (°)	93.62	273.88
Vertical angle (°)	-0.69	0.50
Elevation (ft)	2082.93	1141.70
Tower height (ft)	190.00	150.00
Antenna model	PAD6-W57BC (TR)	PAD6-W57BC (TR)
Antenna file name	pad6-w57bc	pad6-w57bc
Antenna gain (dBi)	38.90	38.90
Antenna height (ft)	106.37	98.11
Orientation loss (dB)	0.00	0.00
TX line model	EW63	EW63
TX line unit loss (dB/100 ft)	1.43	1.43
TX line length (ft)	137.00	129.00
TX line loss (dB)	1.96	1.85
Connector loss (dB)	0.50	0.50
Miscellaneous loss (dB)	1.00	1.00
Frequency (MHz)	6200.00	
Polarization	Vertical	
Path length (mi)	17.45	
Free space loss (dB)	137.29	
Atmospheric absorption loss (dB)	0.24	
Net path loss (dB)	66.54	66.54
Radio model	IRU 600 - L6 GHz - Max SG - Std Pwr	IRU 600 - L6 GHz - Max SG - Std Pwr
Radio file name	iru 600 - l6 ghz - max sg - std pwr	iru 600 - l6 ghz - max sg - std pwr
TX power (dBm)	28.00	28.00
Emission designator	30M0D7W	30M0D7W
EIRP (dBm)	63.44	63.55
RX threshold criteria	From Spec	From Spec
RX threshold level (dBm)	-68.50	-68.50
Receive signal (dBm)	-38.54	-38.54
Thermal fade margin (dB)	29.96	29.96
Dispersive fade margin (dB)	46.00	46.00
Dispersive fade occurrence factor	1.00	

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	Clatskanie	Rainier Hill (CRESA)
Effective fade margin (dB)	29.85	29.85
Climatic factor	1.00	
Terrain roughness (ft)	140.00	
C factor	0.26	
Average annual temperature (°F)	10.00	
Fade occurrence factor (Po)	2.161E-002	
Worst month multipath availability (%)	99.99777	99.99777
Worst month multipath unavailability (sec)	58.73	58.73
Annual multipath availability (%)	99.99961	99.99961
Annual multipath unavailability (sec)	123.32	123.32
Annual 2 way multipath availability (%)	99.99922	
Annual 2 way multipath unavailability (sec)	246.65	

Multipath fading method - Vigants - Barnett

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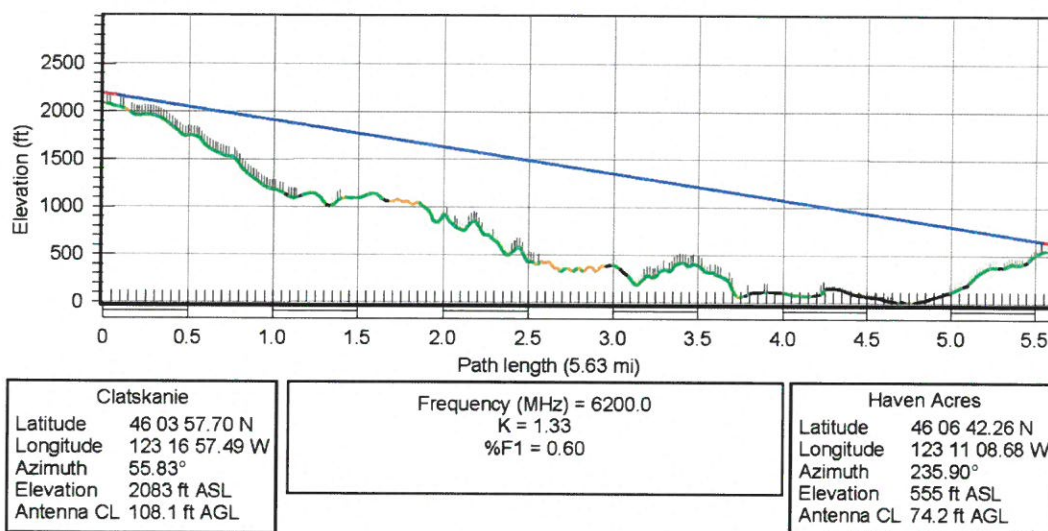
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Transmission details (Clatskanie-Haven Acres.pl5)

	Clatskanie	Haven Acres
Latitude	46 03 57.70 N	46 06 42.26 N
Longitude	123 16 57.49 W	123 11 08.68 W
True azimuth (°)	55.83	235.90
Vertical angle (°)	-3.04	2.98
Elevation (ft)	2082.93	554.71
Tower height (ft)	190.00	250.00
Antenna model	PAD6-W57BC (TR)	PAD6-W57BC (TR)
Antenna file name	pad6-w57bc	pad6-w57bc
Antenna gain (dBi)	38.90	38.90
Antenna height (ft)	108.11	74.21
Orientation loss (dB)	0.00	0.00
TX line model	EW63	EW63
TX line unit loss (dB/100 ft)	1.38	1.38
TX line length (ft)	140.00	104.00
TX line loss (dB)	1.94	1.44
Connector loss (dB)	0.50	0.50
Miscellaneous loss (dB)	1.00	1.00
Frequency (MHz)	6200.00	
Polarization	Vertical	
Path length (mi)	5.63	
Free space loss (dB)	127.46	
Atmospheric absorption loss (dB)	0.08	
Net path loss (dB)	56.12	56.12
Radio model	IRU 600 - L6 GHz - Max SG - Std Pwr	IRU 600 - L6 GHz - Max SG - Std Pwr
Radio file name	iru 600 - l6 ghz - max sg - std pwr	iru 600 - l6 ghz - max sg - std pwr
TX power (dBm)	28.00	28.00
Emission designator	30M0D7W	30M0D7W
EIRP (dBm)	63.46	63.96
TX channel assignments	6500.00V	6500.00V
RX threshold criteria	From Spec	From Spec
RX threshold level (dBm)	-68.50	-68.50
Receive signal (dBm)	-28.12	-28.12
Thermal fade margin (dB)	40.38	40.38
Dispersive fade margin (dB)	46.00	46.00

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	Clatskanie	Haven Acres
Dispersive fade occurrence factor	1.00	
Effective fade margin (dB)	39.33	39.33
Climatic factor	1.00	
Terrain roughness (ft)	140.00	
C factor	0.26	
Average annual temperature (°F)	10.00	
Fade occurrence factor (Po)	7.269E-004	
Worst month multipath availability (%)	99.99999	99.99999
Worst month multipath unavailability (sec)	0.22	0.22
Annual multipath availability (%)	100.00000	100.00000
Annual multipath unavailability (sec)	0.47	0.47
Annual 2 way multipath availability (%)	100.00000	
Annual 2 way multipath unavailability (sec)	0.94	

Multipath fading method - Vigants - Barnett

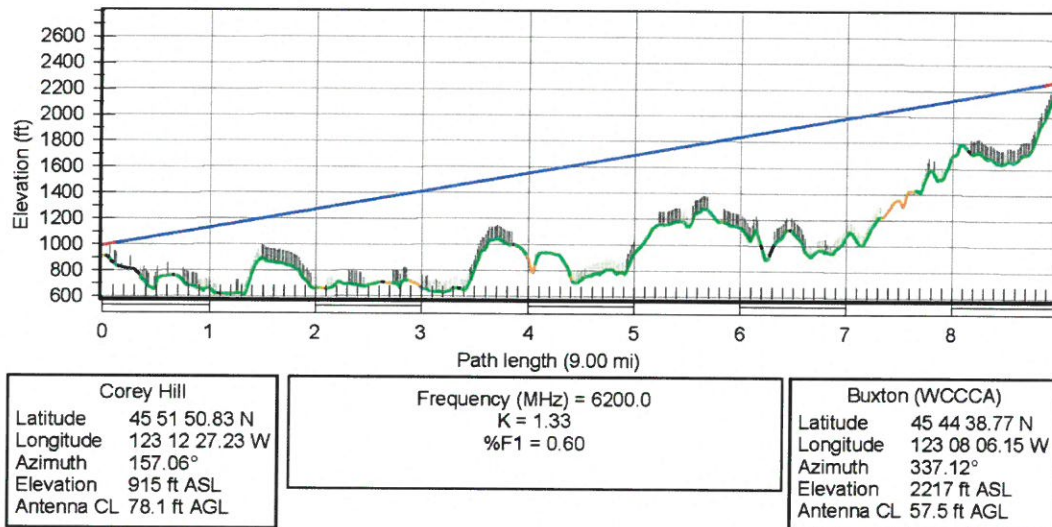






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Transmission details (Corey Hill-Buxton (WCCCA).pl5)

	Corey Hill	Buxton (WCCCA)
Latitude	45 51 50.83 N	45 44 38.77 N
Longitude	123 12 27.23 W	123 08 06.15 W
True azimuth (°)	157.06	337.12
Vertical angle (°)	1.50	-1.59
Elevation (ft)	915.35	2217.32
Tower height (ft)	130.00	80.00
Antenna model	PAD6-W57BC (TR)	PAD6-W57BC (TR)
Antenna file name	pad6-w57bc	pad6-w57bc
Antenna gain (dBi)	38.90	38.90
Antenna height (ft)	78.12	57.52
Orientation loss (dB)	0.00	0.00
TX line model	EW63	EW63
TX line unit loss (dB/100 ft)	1.43	1.43
TX line length (ft)	109.00	88.00
TX line loss (dB)	1.56	1.26
Connector loss (dB)	0.50	0.50
Miscellaneous loss (dB)	1.00	1.00
Frequency (MHz)	6200.00	
Polarization	Vertical	
Path length (mi)	9.00	
Free space loss (dB)	131.54	
Atmospheric absorption loss (dB)	0.13	
Net path loss (dB)	59.68	59.68
Radio model	IRU 600 - L6 GHz - Max SG - Std Pwr	IRU 600 - L6 GHz - Max SG - Std Pwr
Radio file name	iru 600 - l6 ghz - max sg - std pwr	iru 600 - l6 ghz - max sg - std pwr
TX power (dBm)	28.00	28.00
Emission designator	30M0D7W	30M0D7W
EIRP (dBm)	63.84	64.14
RX threshold criteria	From Spec	From Spec
RX threshold level (dBm)	-68.50	-68.50
Receive signal (dBm)	-31.68	-31.68
Thermal fade margin (dB)	36.82	36.82
Dispersive fade margin (dB)	46.00	46.00
Dispersive fade occurrence factor	1.00	

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	Corey Hill	Buxton (WCCCA)
Effective fade margin (dB)	36.32	36.32
Climatic factor	1.00	
Terrain roughness (ft)	133.13	
C factor	0.28	
Average annual temperature (°F)	10.00	
Fade occurrence factor (Po)	3.166E-003	
Worst month multipath availability (%)	99.99993	99.99993
Worst month multipath unavailability (sec)	1.94	1.94
Annual multipath availability (%)	99.99999	99.99999
Annual multipath unavailability (sec)	4.08	4.08
Annual 2 way multipath availability (%)	99.99997	
Annual 2 way multipath unavailability (sec)	8.15	

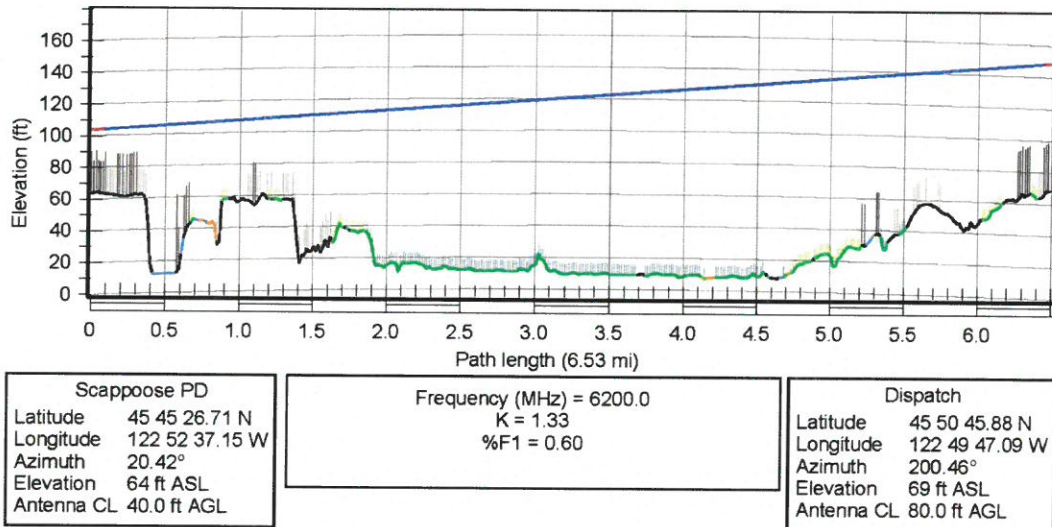
Multipath fading method - Vigants - Barnett





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Transmission details (Scappoose PD-Dispatch.pl5)

	Scappoose PD	Dispatch
Latitude	45 45 26.71 N	45 50 45.88 N
Longitude	122 52 37.15 W	122 49 47.09 W
True azimuth (°)	20.42	200.46
Vertical angle (°)	0.04	-0.11
Elevation (ft)	63.81	69.20
Tower height (ft)	30.00	125.00
Antenna model	PAD6-W57BC (TR)	PAD6-W57BC (TR)
Antenna file name	pad6-w57bc	pad6-w57bc
Antenna gain (dBi)	38.90	38.90
Antenna height (ft)	40.00	80.00
Orientation loss (dB)	0.00	0.00
TX line model	EW63	EW63
TX line unit loss (dB/100 ft)	1.43	1.43
TX line length (ft)	70.00	110.00
TX line loss (dB)	1.00	1.58
Connector loss (dB)	0.50	0.50
Miscellaneous loss (dB)	1.00	1.00
Frequency (MHz)	6200.00	
Polarization	Vertical	
Path length (mi)	6.53	
Free space loss (dB)	128.75	
Atmospheric absorption loss (dB)	0.09	
Net path loss (dB)	56.62	56.62
Radio model	IRU 600 - L6 GHz - Max SG - Std Pwr	IRU 600 - L6 GHz - Max SG - Std Pwr
Radio file name	iru 600 - l6 ghz - max sg - std pwr	iru 600 - l6 ghz - max sg - std pwr
TX power (dBm)	28.00	28.00
Emission designator	30M0D7W	30M0D7W
EIRP (dBm)	64.40	63.82
RX threshold criteria	From Spec	From Spec
RX threshold level (dBm)	-68.50	-68.50
Receive signal (dBm)	-28.62	-28.62
Thermal fade margin (dB)	39.88	39.88
Dispersive fade margin (dB)	46.00	46.00
Dispersive fade occurrence factor	1.00	

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	Scappoose PD	Dispatch
Effective fade margin (dB)	38.93	38.93
Climatic factor	1.00	
Terrain roughness (ft)	20.00	
C factor	3.29	
Average annual temperature (°F)	10.00	
Fade occurrence factor (Po)	1.423E-002	
Worst month multipath availability (%)	99.99982	99.99982
Worst month multipath unavailability (sec)	4.79	4.79
Annual multipath availability (%)	99.99997	99.99997
Annual multipath unavailability (sec)	10.05	10.05
Annual 2 way multipath availability (%)	99.99994	
Annual 2 way multipath unavailability (sec)	20.11	

Multipath fading method - Vigants - Barnett

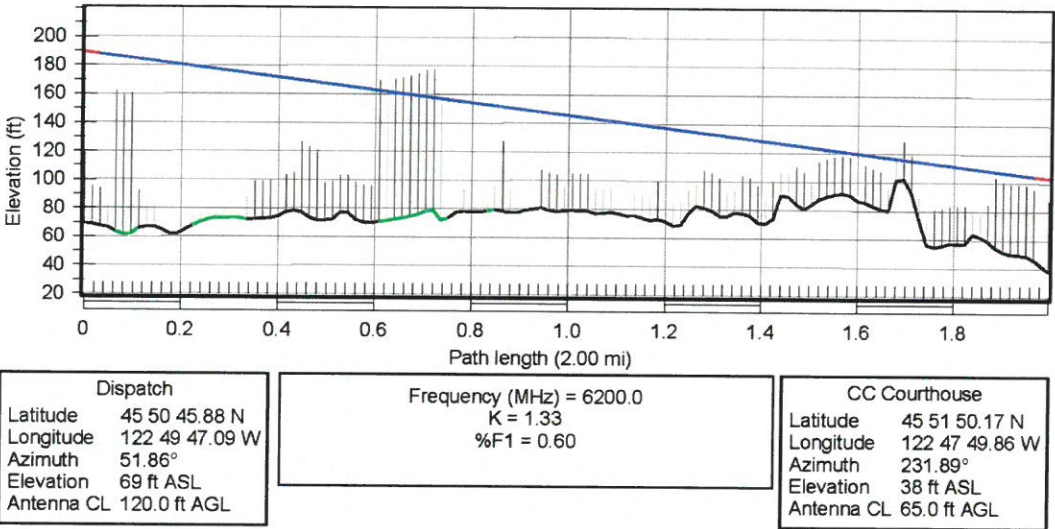






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Transmission details (Dispatch-CC Courthouse.pl5)

	Dispatch	CC Courthouse
Latitude	45 50 45.88 N	45 51 50.17 N
Longitude	122 49 47.09 W	122 47 49.86 W
True azimuth (°)	51.86	231.89
Vertical angle (°)	-0.48	0.46
Elevation (ft)	69.20	38.30
Tower height (ft)	125.00	40.00
Antenna model	PAD6-W57BC (TR)	PAD6-W57BC (TR)
Antenna file name	pad6-w57bc	pad6-w57bc
Antenna gain (dBi)	38.90	38.90
Antenna height (ft)	120.00	65.00
Orientation loss (dB)	0.00	0.00
TX line model	EW63	EW63
TX line unit loss (dB/100 ft)	1.43	1.43
TX line length (ft)	150.00	95.00
TX line loss (dB)	2.15	1.36
Connector loss (dB)	0.50	0.50
Miscellaneous loss (dB)	1.00	1.00
Frequency (MHz)	6200.00	
Polarization	Vertical	
Path length (mi)	2.00	
Free space loss (dB)	118.46	
Atmospheric absorption loss (dB)	0.03	
Diffraction loss	26.86	
Net path loss (dB)	74.06	74.06
Radio model	IRU 600 - L6 GHz - Max SG - Std Pwr	IRU 600 - L6 GHz - Max SG - Std Pwr
Radio file name	iru 600 - l6 ghz - max sg - std pwr	iru 600 - l6 ghz - max sg - std pwr
TX power (dBm)	28.00	28.00
Emission designator	30M0D7W	30M0D7W
EIRP (dBm)	63.25	64.04
RX threshold criteria	From Spec	From Spec
RX threshold level (dBm)	-68.50	-68.50
Receive signal (dBm)	-46.06	-46.06
Thermal fade margin (dB)	22.44	22.44
Dispersive fade margin (dB)	46.00	46.00

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	Dispatch	CC Courthouse
Dispersive fade occurrence factor	1.00	
Effective fade margin (dB)	22.42	22.42
Climatic factor	1.00	
Terrain roughness (ft)	20.00	
C factor	3.29	
Average annual temperature (°F)	10.00	
Fade occurrence factor (Po)	4.068E-004	
Worst month multipath availability (%)	99.99977	99.99977
Worst month multipath unavailability (sec)	6.12	6.12
Annual multipath availability (%)	99.99996	99.99996
Annual multipath unavailability (sec)	12.86	12.86
Annual 2 way multipath availability (%)	99.99992	
Annual 2 way multipath unavailability (sec)	25.72	

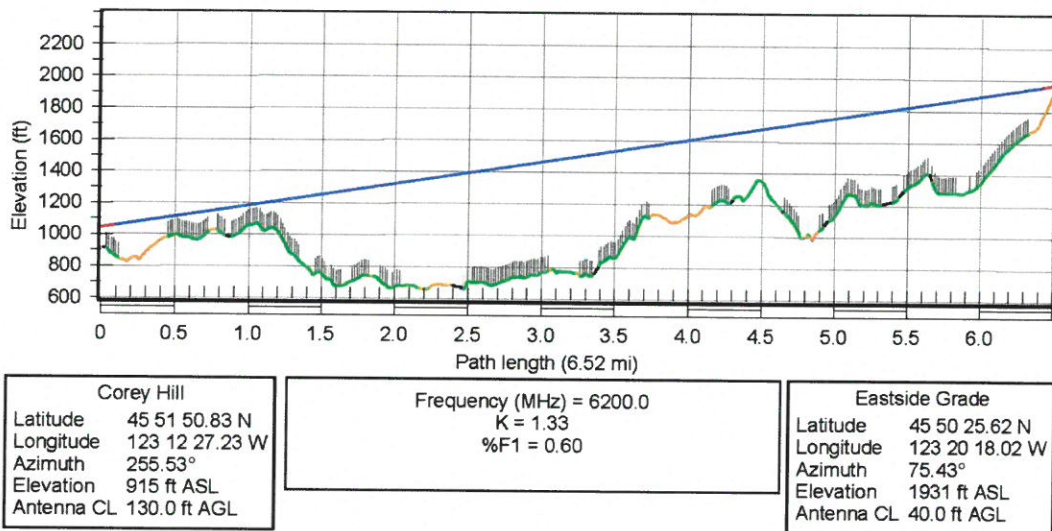
Multipath fading method - Vigants - Barnett





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Transmission details (Corey Hill-Eastside Grade.pl5)

	Corey Hill	Eastside Grade
Latitude	45 51 50.83 N	45 50 25.62 N
Longitude	123 12 27.23 W	123 20 18.02 W
True azimuth (°)	255.53	75.43
Vertical angle (°)	1.51	-1.58
Elevation (ft)	915.35	1931.13
Tower height (ft)	130.00	40.00
Antenna model	PAD6-W57BC (TR)	PAD6-W57BC (TR)
Antenna file name	pad6-w57bc	pad6-w57bc
Antenna gain (dBi)	38.90	38.90
Antenna height (ft)	130.00	40.00
Orientation loss (dB)	0.00	0.00
TX line model	EW63	EW63
TX line unit loss (dB/100 ft)	1.43	1.43
TX line length (ft)	160.00	70.00
TX line loss (dB)	2.29	1.00
Connector loss (dB)	0.50	0.50
Miscellaneous loss (dB)	1.00	1.00
Frequency (MHz)	6200.00	
Polarization	Vertical	
Path length (mi)	6.52	
Free space loss (dB)	128.74	
Atmospheric absorption loss (dB)	0.09	
Net path loss (dB)	57.32	57.32
Radio model	IRU 600 - L6 GHz - Max SG - Std Pwr	IRU 600 - L6 GHz - Max SG - Std Pwr
Radio file name	iru 600 - l6 ghz - max sg - std pwr	iru 600 - l6 ghz - max sg - std pwr
TX power (dBm)	28.00	28.00
Emission designator	30M0D7W	30M0D7W
EIRP (dBm)	63.11	64.40
RX threshold criteria	From Spec	From Spec
RX threshold level (dBm)	-68.50	-68.50
Receive signal (dBm)	-29.32	-29.32
Thermal fade margin (dB)	39.18	39.18
Dispersive fade margin (dB)	46.00	46.00
Dispersive fade occurrence factor	1.00	

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	Corey Hill	Eastside Grade
Effective fade margin (dB)	38.36	38.36
Climatic factor	1.00	
Terrain roughness (ft)	140.00	
C factor	0.26	
Average annual temperature (°F)	10.00	
Fade occurrence factor (Po)	1.128E-003	
Worst month multipath availability (%)	99.99998	99.99998
Worst month multipath unavailability (sec)	0.43	0.43
Annual multipath availability (%)	100.00000	100.00000
Annual multipath unavailability (sec)	0.91	0.91
Annual 2 way multipath availability (%)	99.99999	
Annual 2 way multipath unavailability (sec)	1.82	

Multipath fading method - Vigants - Barnett

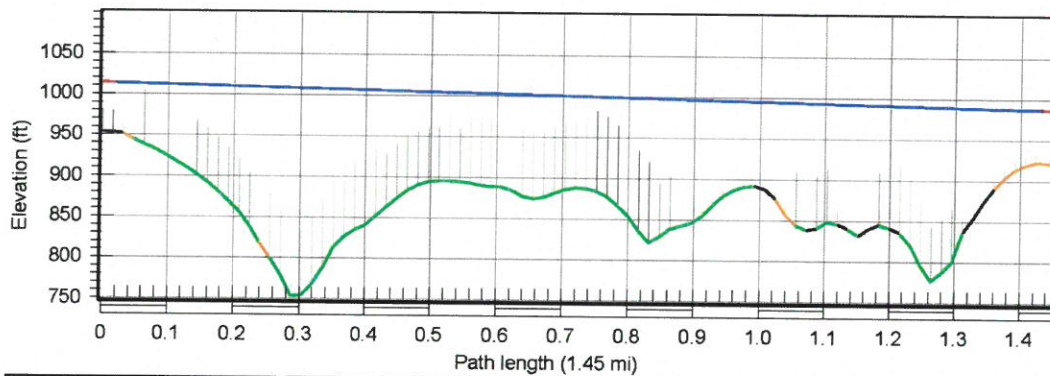






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Columbia Heights	
Latitude	46 11 56.72 N
Longitude	122 58 05.17 W
Azimuth	145.24°
Elevation	953 ft ASL
Antenna CL	60.7 ft AGL

Frequency (MHz) = 6200.0
K = 1.33
%F1 = 0.60

New Columbia Heights	
Latitude	46 10 54.48 N
Longitude	122 57 03.00 W
Azimuth	325.26°
Elevation	922 ft ASL
Antenna CL	65.1 ft AGL



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Transmission details (Columbia Heights-New Columbia Heights.pl5)

	Columbia Heights	New Columbia Heights
Latitude	46 11 56.72 N	46 10 54.48 N
Longitude	122 58 05.17 W	122 57 03.00 W
True azimuth (°)	145.24	325.26
Vertical angle (°)	-0.21	0.20
Elevation (ft)	953.46	921.64
Tower height (ft)	80.00	80.00
Antenna model	PAD6-W57BC (TR)	PAD6-W57BC (TR)
Antenna file name	pad6-w57bc	pad6-w57bc
Antenna gain (dBi)	38.90	38.90
Antenna height (ft)	60.68	65.07
Orientation loss (dB)	0.00	0.00
TX line model	EW63	EW63
TX line unit loss (dB/100 ft)	1.43	1.43
TX line length (ft)	91.00	86.00
TX line loss (dB)	1.30	1.23
Connector loss (dB)	0.50	0.50
Miscellaneous loss (dB)	1.00	1.00
Frequency (MHz)	6200.00	
Polarization	Vertical	
Path length (mi)	1.45	
Free space loss (dB)	115.70	
Atmospheric absorption loss (dB)	0.02	
Net path loss (dB)	43.45	43.45
Radio model	IRU 600 - L6 GHz - Max SG - Std Pwr	IRU 600 - L6 GHz - Max SG - Std Pwr
Radio file name	iru 600 - l6 ghz - max sg - std pwr	iru 600 - l6 ghz - max sg - std pwr
TX power (dBm)	28.00	28.00
Emission designator	30M0D7W	30M0D7W
EIRP (dBm)	64.10	64.17
RX threshold criteria	From Spec	From Spec
RX threshold level (dBm)	-68.50	-68.50
Receive signal (dBm)	-15.45	-15.45
Thermal fade margin (dB)	53.05	53.05
Dispersive fade margin (dB)	46.00	46.00
Dispersive fade occurrence factor	1.00	

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	Columbia Heights	New Columbia Heights
Effective fade margin (dB)	45.22	45.22
Climatic factor	1.00	
Terrain roughness (ft)	35.13	
C factor	1.58	
Average annual temperature (°F)	10.00	
Fade occurrence factor (Po)	7.529E-005	
Worst month multipath availability (%)	100.00000	100.00000
Worst month multipath unavailability (sec)	0.01	0.01
Annual multipath availability (%)	100.00000	100.00000
Annual multipath unavailability (sec)	0.01	0.01
Annual 2 way multipath availability (%)	100.00000	
Annual 2 way multipath unavailability (sec)	0.02	

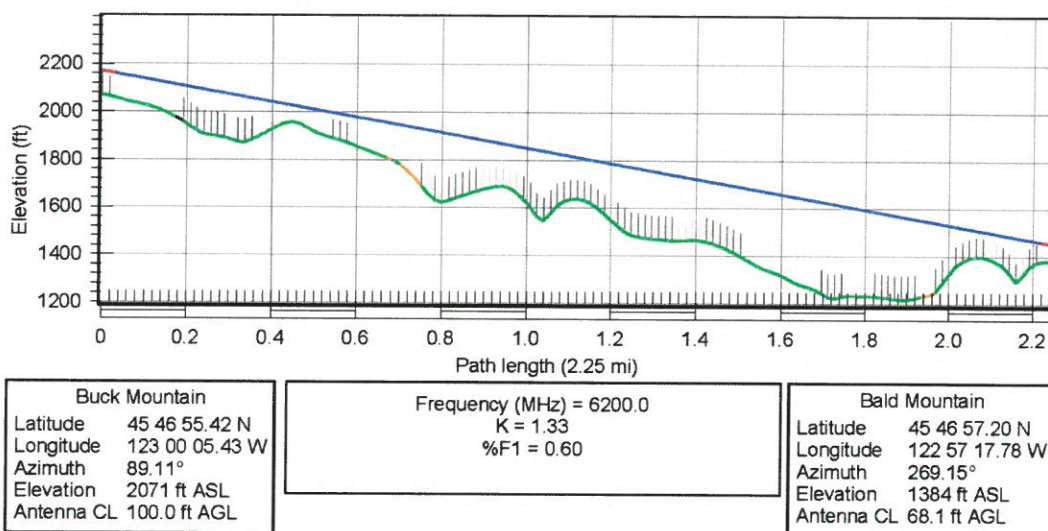
Multipath fading method - Vigants - Barnett





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Transmission details (Buck Mountain-Bald Mountain.pl5)

	Buck Mountain	Bald Mountain
Latitude	45 46 55.42 N	45 46 57.20 N
Longitude	123 00 05.43 W	122 57 17.78 W
True azimuth (°)	89.11	269.15
Vertical angle (°)	-3.47	3.45
Elevation (ft)	2070.92	1383.76
Tower height (ft)	40.00	100.00
Antenna model	PAD6-W57BC (TR)	PAD6-W57BC (TR)
Antenna file name	pad6-w57bc	pad6-w57bc
Antenna gain (dBi)	38.90	38.90
Antenna height (ft)	100.00	68.09
Orientation loss (dB)	0.00	0.00
TX line model	EW63	EW63
TX line unit loss (dB/100 ft)	1.43	1.43
TX line length (ft)	136.00	99.00
TX line loss (dB)	1.95	1.42
Connector loss (dB)	0.50	0.50
Miscellaneous loss (dB)	1.00	1.00
Frequency (MHz)	6200.00	
Polarization	Vertical	
Path length (mi)	2.25	
Free space loss (dB)	119.51	
Atmospheric absorption loss (dB)	0.03	
Net path loss (dB)	48.11	48.11
Radio model	IRU 600 - L6 GHz - Max SG - Std Pwr	IRU 600 - L6 GHz - Max SG - Std Pwr
Radio file name	iru 600 - l6 ghz - max sg - std pwr	iru 600 - l6 ghz - max sg - std pwr
TX power (dBm)	28.00	28.00
Emission designator	30M0D7W	30M0D7W
EIRP (dBm)	63.45	63.98
RX threshold criteria	From Spec	From Spec
RX threshold level (dBm)	-68.50	-68.50
Receive signal (dBm)	-20.11	-20.11
Thermal fade margin (dB)	48.39	48.39
Dispersive fade margin (dB)	46.00	46.00
Dispersive fade occurrence factor	1.00	

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	Buck Mountain	Bald Mountain
Effective fade margin (dB)	44.02	44.02
Climatic factor	1.00	
Terrain roughness (ft)	83.37	
C factor	0.51	
Average annual temperature (°F)	10.00	
Fade occurrence factor (Po)	9.143E-005	
Worst month multipath availability (%)	100.00000	100.00000
Worst month multipath unavailability (sec)	0.01	0.01
Annual multipath availability (%)	100.00000	100.00000
Annual multipath unavailability (sec)	0.02	0.02
Annual 2 way multipath availability (%)	100.00000	
Annual 2 way multipath unavailability (sec)	0.04	

Multipath fading method - Vigants - Barnett

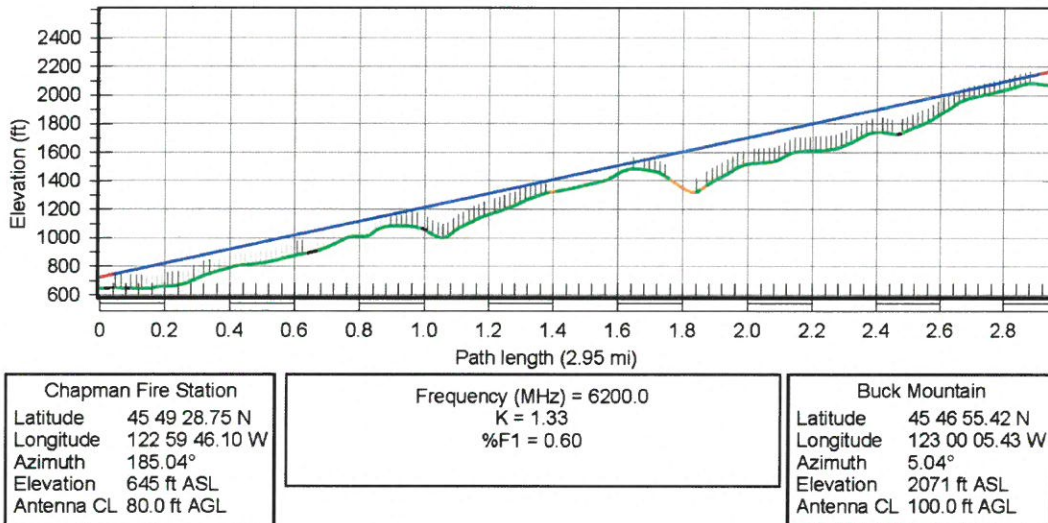






C911CD

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C911CD

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Transmission details (Chapman Fire Station-Buck Mountain.pl5)

	Chapman Fire Station	Buck Mountain
Latitude	45 49 28.75 N	45 46 55.42 N
Longitude	122 59 46.10 W	123 00 05.43 W
True azimuth (°)	185.04	5.04
Vertical angle (°)	5.28	-5.31
Elevation (ft)	645.32	2070.92
Tower height (ft)	80.00	40.00
Antenna model	PAD6-W57BC (TR)	PAD6-W57BC (TR)
Antenna file name	pad6-w57bc	pad6-w57bc
Antenna gain (dBi)	38.90	38.90
Antenna height (ft)	80.00	100.00
Orientation loss (dB)	0.00	0.00
TX line model	EW63	EW63
TX line unit loss (dB/100 ft)	1.43	1.43
TX line length (ft)	110.00	130.00
TX line loss (dB)	1.58	1.86
Connector loss (dB)	0.50	0.50
Miscellaneous loss (dB)	1.00	1.00
Frequency (MHz)	6200.00	
Polarization	Vertical	
Path length (mi)	2.97	
Free space loss (dB)	121.89	
Atmospheric absorption loss (dB)	0.04	
Diffraction loss	33.51	
Net path loss (dB)	84.08	84.08
Radio model	IRU 600 - L6 GHz - Max SG - Std Pwr	IRU 600 - L6 GHz - Max SG - Std Pwr
Radio file name	iru 600 - l6 ghz - max sg - std pwr	iru 600 - l6 ghz - max sg - std pwr
TX power (dBm)	28.00	28.00
Emission designator	30M0D7W	30M0D7W
EIRP (dBm)	63.82	63.54
RX threshold criteria	From Spec	From Spec
RX threshold level (dBm)	-68.50	-68.50
Receive signal (dBm)	-56.08	-56.08
Thermal fade margin (dB)	12.42	12.42
Dispersive fade margin (dB)	46.00	46.00

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	Chapman Fire Station	Buck Mountain
Dispersive fade occurrence factor	1.00	
Effective fade margin (dB)	12.42	12.42
Climatic factor	1.00	
Terrain roughness (ft)	52.17	
C factor	0.95	
Average annual temperature (°F)	10.00	
Fade occurrence factor (Po)	3.827E-004	
Worst month multipath availability (%)	99.99781	99.99781
Worst month multipath unavailability (sec)	57.57	57.57
Annual multipath availability (%)	99.99962	99.99962
Annual multipath unavailability (sec)	120.90	120.90
Annual 2 way multipath availability (%)	99.99923	
Annual 2 way multipath unavailability (sec)	241.81	

Multipath fading method - Vigants - Barnett





## Appendix C - Detailed Subscriber Unit Costs

Table C.1 – Alternative 2 Subscriber Unit Cost Estimates

CRFPD Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	18	\$5,400	\$97,200
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	39	\$5,500	\$214,500
New Base/Control Stations	1	\$11,000	\$11,000
Control Station Antenna System	1	\$3,000	\$3,000
<b>Equipment Subtotal (rounded)</b>			<b>\$326,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	58	\$100	\$5,800
Mobile Radio Installation	18	\$400	\$7,200
Control Station Installation	1	\$2,000	\$2,000
Sales Tax	0%		\$0
Spares	5%		\$17,000
<b>Services Subtotal (rounded)</b>			<b>\$32,000</b>
<b>Total Equipment and Services</b>			<b>\$358,000</b>

CCRD Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	78	\$5,400	\$421,200
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	30	\$5,500	\$165,000
New Base/Control Stations	0	\$11,000	\$0
Control Station Antenna System	0	\$3,000	\$0
<b>Equipment Subtotal (rounded)</b>			<b>\$587,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	108	\$100	\$10,800
Mobile Radio Installation	78	\$400	\$31,200
Control Station Installation	0	\$2,000	\$0
Sales Tax	0%		\$0
Spares	5%		\$30,000
<b>Services Subtotal (rounded)</b>			<b>\$72,000</b>
<b>Total Equipment and Services</b>			<b>\$659,000</b>







CRF&R Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	30	\$5,400	\$162,000
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	50	\$5,500	\$275,000
New Base/Control Stations	5	\$11,000	\$55,000
Control Station Antenna System	5	\$3,000	\$15,000
<b>Equipment Subtotal (rounded)</b>			<b>\$507,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	85	\$100	\$8,500
Mobile Radio Installation	30	\$400	\$12,000
Control Station Installation	5	\$2,000	\$10,000
Sales Tax	0%		\$0
Spares	5%		\$26,000
<b>Services Subtotal (rounded)</b>			<b>\$57,000</b>
<b>Total Equipment and Services</b>			<b>\$564,000</b>

SRFD Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	30	\$5,400	\$162,000
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	79	\$5,500	\$434,500
New Base/Control Stations	5	\$11,000	\$55,000
Control Station Antenna System	5	\$3,000	\$15,000
<b>Equipment Subtotal (rounded)</b>			<b>\$667,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	114	\$100	\$11,400
Mobile Radio Installation	30	\$400	\$12,000
Control Station Installation	5	\$2,000	\$10,000
Sales Tax	0%		\$0
Spares	5%		\$34,000
<b>Services Subtotal (rounded)</b>			<b>\$68,000</b>
<b>Total Equipment and Services</b>			<b>\$735,000</b>





St Helens Police Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	23	\$5,400	\$124,200
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	31	\$5,500	\$170,500
New Base/Control Stations	0	\$11,000	\$0
Control Station Antenna System	0	\$3,000	\$0
<b>Equipment Subtotal (rounded)</b>			<b>\$295,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	54	\$100	\$5,400
Mobile Radio Installation	23	\$400	\$9,200
Control Station Installation	0	\$2,000	\$0
Sales Tax	0%		\$0
Spares	5%		\$15,000
<b>Services Subtotal (rounded)</b>			<b>\$30,000</b>
<b>Total Equipment and Services</b>			<b>\$325,000</b>

Metro West Ambulance Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	2	\$5,400	\$10,800
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	14	\$5,500	\$77,000
New Base/Control Stations	0	\$11,000	\$0
Control Station Antenna System	0	\$3,000	\$0
<b>Equipment Subtotal (rounded)</b>			<b>\$88,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	16	\$100	\$1,600
Mobile Radio Installation	2	\$400	\$800
Control Station Installation	0	\$2,000	\$0
Sales Tax	0%		\$0
Spares	5%		\$5,000
<b>Services Subtotal (rounded)</b>			<b>\$8,000</b>
<b>Total Equipment and Services</b>			<b>\$96,000</b>







CCSO Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	15	\$0	\$0
New Mobile Radios	25	\$5,400	\$135,000
Re-use Portable Radios	13	\$0	\$0
New Portable Radios	94	\$5,500	\$517,000
New Base/Control Stations	0	\$11,000	\$0
Control Station Antenna System	0	\$3,000	\$0
<b>Equipment Subtotal (rounded)</b>			<b>\$652,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	147	\$100	\$14,700
Mobile Radio Installation	25	\$400	\$10,000
Control Station Installation	0	\$2,000	\$0
Sales Tax	0%		\$0
Spares	5%		\$33,000
<b>Services Subtotal (rounded)</b>			<b>\$58,000</b>
<b>Total Equipment and Services</b>			<b>\$710,000</b>

Vernonia Fire Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	17	\$5,400	\$91,800
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	33	\$5,500	\$181,500
New Vehicular Repeater	3	\$15,000	\$45,000
Control Station Antenna System	0	\$3,000	\$0
<b>Equipment Subtotal (rounded)</b>			<b>\$319,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	53	\$100	\$5,300
Mobile Radio Installation	17	\$400	\$6,800
Control Station Installation	0	\$2,000	\$0
Sales Tax	0%		\$0
Spares	5%		\$16,000
<b>Services Subtotal (rounded)</b>			<b>\$29,000</b>
<b>Total Equipment and Services</b>			<b>\$348,000</b>





Rainier Police Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	6	\$5,400	\$32,400
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	10	\$5,500	\$55,000
New Base/Control Stations	0	\$11,000	\$0
Control Station Antenna System	0	\$3,000	\$0
<b>Equipment Subtotal (rounded)</b>			<b>\$88,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	16	\$100	\$1,600
Mobile Radio Installation	6	\$400	\$2,400
Control Station Installation	0	\$2,000	\$0
Sales Tax	0%		\$0
Spares	5%		\$5,000
<b>Services Subtotal (rounded)</b>			<b>\$9,000</b>
<b>Total Equipment and Services</b>			<b>\$97,000</b>

Mist-Birkenfeld Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	27	\$5,400	\$145,800
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	39	\$5,500	\$214,500
New Vehicular Repeater	1	\$15,000	\$15,000
Control Station Antenna System	0	\$3,000	\$0
<b>Equipment Subtotal (rounded)</b>			<b>\$376,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	67	\$100	\$6,700
Mobile Radio Installation	27	\$400	\$10,800
Control Station Installation	0	\$2,000	\$0
Sales Tax	0%		\$0
Spares	5%		\$19,000
<b>Services Subtotal (rounded)</b>			<b>\$37,000</b>
<b>Total Equipment and Services</b>			<b>\$413,000</b>







West Port Fire Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	7	\$5,400	\$37,800
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	16	\$5,500	\$88,000
New Base/Control Stations	0	\$11,000	\$0
Control Station Antenna System	0	\$3,000	\$0
<b>Equipment Subtotal (rounded)</b>			<b>\$126,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	23	\$100	\$2,300
Mobile Radio Installation	7	\$400	\$2,800
Control Station Installation	0	\$2,000	\$0
Sales Tax	0%		\$0
Spares	5%		\$7,000
<b>Services Subtotal (rounded)</b>			<b>\$13,000</b>
<b>Total Equipment and Services</b>			<b>\$139,000</b>

Columbia City PD Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	3	\$5,400	\$16,200
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	6	\$5,500	\$33,000
New Base/Control Stations	0	\$11,000	\$0
Control Station Antenna System	0	\$3,000	\$0
<b>Equipment Subtotal (rounded)</b>			<b>\$50,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	9	\$100	\$900
Mobile Radio Installation	3	\$400	\$1,200
Control Station Installation	0	\$2,000	\$0
Sales Tax	0%		\$0
Spares	5%		\$3,000
<b>Services Subtotal (rounded)</b>			<b>\$6,000</b>
<b>Total Equipment and Services</b>			<b>\$56,000</b>





**Table C.2 – Alternative 3 Subscriber Unit Cost Estimates**

<b>CRFPD Subscriber Equipment Cost Estimate</b>			
<i><b>Subscriber Equipment</b></i>	<i><b>Quantity</b></i>	<i><b>Unit Cost</b></i>	<i><b>Extended Cost</b></i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	18	\$5,700	\$102,600
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	39	\$5,800	\$226,200
New Base/Control Stations	1	\$11,000	\$11,000
Control Station Antenna System	1	\$3,000	\$3,000
<b>Equipment Subtotal (rounded)</b>			<b>\$343,000</b>
<i><b>Implementation Services</b></i>	<i><b>Quantity</b></i>	<i><b>Unit Cost</b></i>	<i><b>Extended Cost</b></i>
Radio Programming	58	\$100	\$5,800
Mobile Radio Installation	18	\$400	\$7,200
Control Station Installation	1	\$2,000	\$2,000
Sales Tax	0%		\$0
Spares	5%		\$18,000
<b>Services Subtotal (rounded)</b>			<b>\$33,000</b>
<b>Total Equipment and Services</b>			<b>\$376,000</b>

<b>CCRD Subscriber Equipment Cost Estimate</b>			
<i><b>Subscriber Equipment</b></i>	<i><b>Quantity</b></i>	<i><b>Unit Cost</b></i>	<i><b>Extended Cost</b></i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	78	\$5,700	\$444,600
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	30	\$5,800	\$174,000
New Base/Control Stations	0	\$11,000	\$0
Control Station Antenna System	0	\$3,000	\$0
<b>Equipment Subtotal (rounded)</b>			<b>\$619,000</b>
<i><b>Implementation Services</b></i>	<i><b>Quantity</b></i>	<i><b>Unit Cost</b></i>	<i><b>Extended Cost</b></i>
Radio Programming	108	\$100	\$10,800
Mobile Radio Installation	78	\$400	\$31,200
Control Station Installation	0	\$2,000	\$0
Sales Tax	0%		\$0
Spares	5%		\$31,000
<b>Services Subtotal (rounded)</b>			<b>\$73,000</b>
<b>Total Equipment and Services</b>			<b>\$692,000</b>







CRF&R Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	30	\$5,700	\$171,000
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	50	\$5,800	\$290,000
New Base/Control Stations	5	\$11,000	\$55,000
Control Station Antenna System	5	\$3,000	\$15,000
<b>Equipment Subtotal (rounded)</b>			<b>\$531,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	85	\$100	\$8,500
Mobile Radio Installation	30	\$400	\$12,000
Control Station Installation	5	\$2,000	\$10,000
Sales Tax	0%		\$0
Spares	5%		\$27,000
<b>Services Subtotal (rounded)</b>			<b>\$58,000</b>
<b>Total Equipment and Services</b>			<b>\$589,000</b>

SRFD Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	30	\$5,700	\$171,000
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	79	\$5,800	\$458,200
New Base/Control Stations	5	\$11,000	\$55,000
Control Station Antenna System	5	\$3,000	\$15,000
<b>Equipment Subtotal (rounded)</b>			<b>\$700,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	114	\$100	\$11,400
Mobile Radio Installation	30	\$400	\$12,000
Control Station Installation	5	\$2,000	\$10,000
Sales Tax	0%		\$0
Spares	5%		\$35,000
<b>Services Subtotal (rounded)</b>			<b>\$69,000</b>
<b>Total Equipment and Services</b>			<b>\$769,000</b>





St Helens Police Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	23	\$5,700	\$131,100
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	31	\$5,800	\$179,800
New Base/Control Stations	0	\$11,000	\$0
Control Station Antenna System	0	\$3,000	\$0
<b>Equipment Subtotal (rounded)</b>			<b>\$311,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	54	\$100	\$5,400
Mobile Radio Installation	23	\$400	\$9,200
Control Station Installation	0	\$2,000	\$0
Sales Tax	0%		\$0
Spares	5%		\$16,000
<b>Services Subtotal (rounded)</b>			<b>\$31,000</b>
<b>Total Equipment and Services</b>			<b>\$342,000</b>

Metro West Ambulance Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	2	\$5,700	\$11,400
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	14	\$5,800	\$81,200
New Base/Control Stations	0	\$11,000	\$0
Control Station Antenna System	0	\$3,000	\$0
<b>Equipment Subtotal (rounded)</b>			<b>\$93,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	16	\$100	\$1,600
Mobile Radio Installation	2	\$400	\$800
Control Station Installation	0	\$2,000	\$0
Sales Tax	0%		\$0
Spares	5%		\$5,000
<b>Services Subtotal (rounded)</b>			<b>\$8,000</b>
<b>Total Equipment and Services</b>			<b>\$101,000</b>







CCSO Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	15	\$0	\$0
New Mobile Radios	25	\$5,700	\$142,500
Re-use Portable Radios	13	\$0	\$0
New Portable Radios	94	\$5,800	\$545,200
New Base/Control Stations	0	\$11,000	\$0
Control Station Antenna System	0	\$3,000	\$0
<b>Equipment Subtotal (rounded)</b>			<b>\$688,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	147	\$100	\$14,700
Mobile Radio Installation	25	\$400	\$10,000
Control Station Installation	0	\$2,000	\$0
Sales Tax	0%		\$0
Spares	5%		\$35,000
<b>Services Subtotal (rounded)</b>			<b>\$60,000</b>
<b>Total Equipment and Services</b>			<b>\$748,000</b>

Vernonia Fire Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	17	\$5,700	\$96,900
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	33	\$5,800	\$191,400
New Vehicular Repeater	3	\$15,000	\$45,000
Control Station Antenna System	3	\$3,000	\$9,000
<b>Equipment Subtotal (rounded)</b>			<b>\$343,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	53	\$100	\$5,300
Mobile Radio Installation	17	\$400	\$6,800
Control Station Installation	3	\$2,000	\$6,000
Sales Tax	0%		\$0
Spares	5%		\$18,000
<b>Services Subtotal (rounded)</b>			<b>\$37,000</b>
<b>Total Equipment and Services</b>			<b>\$380,000</b>





Rainier Police Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	6	\$5,700	\$34,200
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	10	\$5,800	\$58,000
New Base/Control Stations	0	\$11,000	\$0
Control Station Antenna System	0	\$3,000	\$0
<b>Equipment Subtotal (rounded)</b>			<b>\$93,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	16	\$100	\$1,600
Mobile Radio Installation	6	\$400	\$2,400
Control Station Installation	0	\$2,000	\$0
Sales Tax	0%		\$0
Spares	5%		\$5,000
<b>Services Subtotal (rounded)</b>			<b>\$9,000</b>
<b>Total Equipment and Services</b>			<b>\$102,000</b>

Mist-Birkenfeld Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	27	\$5,700	\$153,900
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	39	\$5,800	\$226,200
New Vehicular Repeater	1	\$15,000	\$15,000
Control Station Antenna System	0	\$3,000	\$0
<b>Equipment Subtotal (rounded)</b>			<b>\$396,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	67	\$100	\$6,700
Mobile Radio Installation	27	\$400	\$10,800
Control Station Installation	0	\$2,000	\$0
Sales Tax	0%		\$0
Spares	5%		\$20,000
<b>Services Subtotal (rounded)</b>			<b>\$38,000</b>
<b>Total Equipment and Services</b>			<b>\$434,000</b>







West Port Fire Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	7	\$5,700	\$39,900
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	16	\$5,800	\$92,800
New Base/Control Stations	0	\$11,000	\$0
Control Station Antenna System	0	\$3,000	\$0
<b>Equipment Subtotal (rounded)</b>			<b>\$133,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	23	\$100	\$2,300
Mobile Radio Installation	7	\$400	\$2,800
Control Station Installation	0	\$2,000	\$0
Sales Tax	0%		\$0
Spares	5%		\$7,000
<b>Services Subtotal (rounded)</b>			<b>\$13,000</b>
<b>Total Equipment and Services</b>			<b>\$146,000</b>

Columbia City PD Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	3	\$5,700	\$17,100
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	6	\$5,800	\$34,800
New Base/Control Stations	0	\$11,000	\$0
Control Station Antenna System	0	\$3,000	\$0
<b>Equipment Subtotal (rounded)</b>			<b>\$52,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	9	\$100	\$900
Mobile Radio Installation	3	\$400	\$1,200
Control Station Installation	0	\$2,000	\$0
Sales Tax	0%		\$0
Spares	5%		\$3,000
<b>Services Subtotal (rounded)</b>			<b>\$6,000</b>
<b>Total Equipment and Services</b>			<b>\$58,000</b>





**Table C.3 – Alternative 4 Subscriber Unit Cost Estimates**

<b>CRFPD Subscriber Equipment Cost Estimate</b>			
<i><b>Subscriber Equipment</b></i>	<i><b>Quantity</b></i>	<i><b>Unit Cost</b></i>	<i><b>Extended Cost</b></i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	18	\$6,500	\$117,000
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	39	\$6,500	\$253,500
New Base/Control Stations	1	\$11,000	\$11,000
Control Station Antenna System	1	\$3,000	\$3,000
<b>Equipment Subtotal (rounded)</b>			<b>\$385,000</b>
<i><b>Implementation Services</b></i>	<i><b>Quantity</b></i>	<i><b>Unit Cost</b></i>	<i><b>Extended Cost</b></i>
Radio Programming	58	\$100	\$5,800
Mobile Radio Installation	18	\$400	\$7,200
Control Station Installation	1	\$2,000	\$2,000
Sales Tax	0%		\$0
Spares	5%		\$20,000
<b>Services Subtotal (rounded)</b>			<b>\$35,000</b>
<b>Total Equipment and Services</b>			<b>\$420,000</b>

<b>CCRD Subscriber Equipment Cost Estimate</b>			
<i><b>Subscriber Equipment</b></i>	<i><b>Quantity</b></i>	<i><b>Unit Cost</b></i>	<i><b>Extended Cost</b></i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	78	\$6,500	\$507,000
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	30	\$6,500	\$195,000
New Base/Control Stations	0	\$11,000	\$0
Control Station Antenna System	0	\$3,000	\$0
<b>Equipment Subtotal (rounded)</b>			<b>\$702,000</b>
<i><b>Implementation Services</b></i>	<i><b>Quantity</b></i>	<i><b>Unit Cost</b></i>	<i><b>Extended Cost</b></i>
Radio Programming	108	\$100	\$10,800
Mobile Radio Installation	78	\$400	\$31,200
Control Station Installation	0	\$2,000	\$0
Sales Tax	0%		\$0
Spares	5%		\$36,000
<b>Services Subtotal (rounded)</b>			<b>\$78,000</b>
<b>Total Equipment and Services</b>			<b>\$780,000</b>







CRF&R Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	30	\$6,500	\$195,000
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	50	\$6,500	\$325,000
New Base/Control Stations	5	\$11,000	\$55,000
Control Station Antenna System	5	\$3,000	\$15,000
<b>Equipment Subtotal (rounded)</b>			<b>\$590,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	85	\$100	\$8,500
Mobile Radio Installation	30	\$400	\$12,000
Control Station Installation	5	\$2,000	\$10,000
Sales Tax	0%		\$0
Spares	5%		\$30,000
<b>Services Subtotal (rounded)</b>			<b>\$61,000</b>
<b>Total Equipment and Services</b>			<b>\$651,000</b>

SRFD Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	30	\$6,500	\$195,000
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	79	\$6,500	\$513,500
New Base/Control Stations	5	\$11,000	\$55,000
Control Station Antenna System	5	\$3,000	\$15,000
<b>Equipment Subtotal (rounded)</b>			<b>\$779,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	114	\$100	\$11,400
Mobile Radio Installation	30	\$400	\$12,000
Control Station Installation	5	\$2,000	\$10,000
Sales Tax	0%		\$0
Spares	5%		\$39,000
<b>Services Subtotal (rounded)</b>			<b>\$73,000</b>
<b>Total Equipment and Services</b>			<b>\$852,000</b>





St Helens Police Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	23	\$6,500	\$149,500
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	31	\$6,500	\$201,500
New Base/Control Stations	0	\$11,000	\$0
Control Station Antenna System	0	\$3,000	\$0
<b>Equipment Subtotal (rounded)</b>			<b>\$351,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	54	\$100	\$5,400
Mobile Radio Installation	23	\$400	\$9,200
Control Station Installation	0	\$2,000	\$0
Sales Tax	0%		\$0
Spares	5%		\$18,000
<b>Services Subtotal (rounded)</b>			<b>\$33,000</b>
<b>Total Equipment and Services</b>			<b>\$384,000</b>

Metro West Ambulance Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	2	\$6,500	\$13,000
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	14	\$6,500	\$91,000
New Base/Control Stations	0	\$11,000	\$0
Control Station Antenna System	0	\$3,000	\$0
<b>Equipment Subtotal (rounded)</b>			<b>\$104,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	16	\$100	\$1,600
Mobile Radio Installation	2	\$400	\$800
Control Station Installation	0	\$2,000	\$0
Sales Tax	0%		\$0
Spares	5%		\$6,000
<b>Services Subtotal (rounded)</b>			<b>\$9,000</b>
<b>Total Equipment and Services</b>			<b>\$113,000</b>







CCSO Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	15	\$0	\$0
New Mobile Radios	25	\$6,500	\$162,500
Re-use Portable Radios	13	\$0	\$0
New Portable Radios	94	\$6,500	\$611,000
New Base/Control Stations	0	\$11,000	\$0
Control Station Antenna System	0	\$3,000	\$0
<b>Equipment Subtotal (rounded)</b>			<b>\$774,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	147	\$100	\$14,700
Mobile Radio Installation	25	\$400	\$10,000
Control Station Installation	0	\$2,000	\$0
Sales Tax	0%		\$0
Spares	5%		\$39,000
<b>Services Subtotal (rounded)</b>			<b>\$64,000</b>
<b>Total Equipment and Services</b>			<b>\$838,000</b>

Vernonia Fire Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	17	\$6,500	\$110,500
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	33	\$6,500	\$214,500
New Vehicular Repeater	3	\$15,000	\$45,000
Control Station Antenna System	3	\$3,000	\$9,000
<b>Equipment Subtotal (rounded)</b>			<b>\$379,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	53	\$100	\$5,300
Mobile Radio Installation	17	\$400	\$6,800
Control Station Installation	3	\$2,000	\$6,000
Sales Tax	0%		\$0
Spares	5%		\$19,000
<b>Services Subtotal (rounded)</b>			<b>\$38,000</b>
<b>Total Equipment and Services</b>			<b>\$417,000</b>





Rainier Police Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	6	\$6,500	\$39,000
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	10	\$6,500	\$65,000
New Base/Control Stations	0	\$11,000	\$0
Control Station Antenna System	0	\$3,000	\$0
<b>Equipment Subtotal (rounded)</b>			<b>\$104,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	16	\$100	\$1,600
Mobile Radio Installation	6	\$400	\$2,400
Control Station Installation	0	\$2,000	\$0
Sales Tax	0%		\$0
Spares	5%		\$6,000
<b>Services Subtotal (rounded)</b>			<b>\$10,000</b>
<b>Total Equipment and Services</b>			<b>\$114,000</b>

Mist-Birkenfeld Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	27	\$6,500	\$175,500
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	39	\$6,500	\$253,500
New Vehicular Repeater	1	\$15,000	\$15,000
Control Station Antenna System	0	\$3,000	\$0
<b>Equipment Subtotal (rounded)</b>			<b>\$444,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	67	\$100	\$6,700
Mobile Radio Installation	27	\$400	\$10,800
Control Station Installation	0	\$2,000	\$0
Sales Tax	0%		\$0
Spares	5%		\$23,000
<b>Services Subtotal (rounded)</b>			<b>\$41,000</b>
<b>Total Equipment and Services</b>			<b>\$485,000</b>







West Port Fire Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	7	\$6,500	\$45,500
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	16	\$6,500	\$104,000
New Base/Control Stations	0	\$11,000	\$0
Control Station Antenna System	0	\$3,000	\$0
<b>Equipment Subtotal (rounded)</b>			<b>\$150,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	23	\$100	\$2,300
Mobile Radio Installation	7	\$400	\$2,800
Control Station Installation	0	\$2,000	\$0
Sales Tax	0%		\$0
Spares	5%		\$8,000
<b>Services Subtotal (rounded)</b>			<b>\$14,000</b>
<b>Total Equipment and Services</b>			<b>\$164,000</b>

Columbia City PD Subscriber Equipment Cost Estimate			
<i>Subscriber Equipment</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Re-use Mobile Radios	0	\$0	\$0
New Mobile Radios	3	\$6,500	\$19,500
Re-use Portable Radios	0	\$0	\$0
New Portable Radios	6	\$6,500	\$39,000
New Base/Control Stations	0	\$11,000	\$0
Control Station Antenna System	0	\$3,000	\$0
<b>Equipment Subtotal (rounded)</b>			<b>\$59,000</b>
<i>Implementation Services</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Extended Cost</i>
Radio Programming	9	\$100	\$900
Mobile Radio Installation	3	\$400	\$1,200
Control Station Installation	0	\$2,000	\$0
Sales Tax	0%		\$0
Spares	5%		\$3,000
<b>Services Subtotal (rounded)</b>			<b>\$6,000</b>
<b>Total Equipment and Services</b>			<b>\$65,000</b>





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## **Appendix D - Sample CRESA and WCCCA Agreements**





## Appendix D

### Sample CRESA & WCCCA Radio Agreements

## Appendix D

### Sample CRESA Radio Agreement



## CONTRACT FOR 800 MHz TRUNKING RADIO SERVICES

This is a Contract for radio service entered into between Clark Regional Emergency Services Agency (CRESA) and the **AGENCY** (User).

### RECITALS

**WHEREAS**, CRESA has implemented a regional P25 digital public safety radio system, herein after System; and,

**WHEREAS**, CRESA is willing to provide User access and use of CRESA's radio system on the conditions set forth herein; and,

**WHEREAS**, purchase and maintenance of the portable and mobile radio units and control stations (desk top radios) to be used on the System, herein after Subscriber Units, are the sole responsibility of User;

**NOW, THEREFORE**, in consideration of the mutual promises and covenants contained herein it is agreed as follows:

#### 1. ORGANIZATION

The administrator for the System shall be the Clark Regional Emergency Services Agency Director or appointed designee.

#### 2. SCOPE OF SERVICES

- A. Access. CRESA shall provide User such access to the System as is necessary for the use of said System. User shall operate only CRESA approved and programmed Subscriber Units on the System.
- B. Purchase, Installation & Maintenance. User shall purchase its required Subscriber Units and related installation of same independently of this Contract as well as maintenance of the Subscriber Units. All Subscriber Units shall meet CRESA's requirements.
- C. Programming. To enable any Subscriber Unit to operate on the System it must be programmed by CRESA. CRESA requires one radio template for each model of approved radio to be programmed. Upon initial and future radio template programming and reprogramming of radios, User must provide the necessary hardware, control heads and/or cables to program and test the template.

Talkgroup usage and aliases: Talkgroup name/alias changes must be reviewed and approved by CRESA's Technical and Support Division Manager as uncoordinated talkgroup changes can affect other users of the system.

CRESA is not responsible for limitations of radio features, i.e., scan, due to non-standard template design. User will use the "SCAN" feature at their own risk.

CRESA's Technical and Support Division Manager reserves the right to disable a User radio from one or more radio sites should User's radios cause site busies.

Should User request a cancellation in service, all radios with CRESA template programming must be reprogrammed and erased of all talkgroups and System parameters at User's expense.

- D. Security. User may not loan, issue or assign any Subscriber Units on a permanent or temporary basis to any other organizations or individuals without the prior written authorization of CRESA. Prior to loaning or issuing any radios to anyone other than User, User must first obtain written authorization from the organization for which the talkgroup is assigned and from CRESA's Technical and Support Division Manager.

Radio programming security requires that no codeplug modifications can be made to the Subscriber Units without the written approval of CRESA's Technical and Support Division Manager. These modifications include the system ID number, radio ID number, control channels, connect tones, call alert parameters, secure parameters, emergency options, radio wide options, trunking wide options, preferred site tables, conventional channels or any present or future options in future Customer Programming Software (CPS) releases. User will be responsible and will assume the cost of the corrective measures needed to eliminate system problems due to any unauthorized codeplug modifications. User shall not disclose any codeplug information to anyone without CRESA's written permission. Talkgroup ID's and template information provided to User for the template design process is considered confidential information. If User makes an unauthorized disclosure of confidential information, CRESA may terminate this Contract on giving ten days written notice upon its intent to terminate.

### 3. COMPENSATION

User shall pay CRESA for services provided as follows:

- A. For access to CRESA's radio system, the sum of \$40.00 per month or \$480.00 per year for each Subscriber Unit for which CRESA provides access. **The above access fee does not cover repair, maintenance, or replacement of AGENCY's damaged radio equipment.**
- B. The cost of the initial template design and programming of each such unit shall be included in the access fee for the unit. Subsequent template redesign or reprogramming required to maintain equipment identification number/unit affiliation or by way of a customer requested template change, that charge will be \$55.00 per hour including tax.
- C. The foregoing charges will remain in effect through December 31, 2019. CRESA reserves the right to increase or decrease the charges set forth above at the end of this period, based



upon documented operating costs. CRESA shall notify User by December 15<sup>th</sup> of the upcoming year's fees.

- D. Initial access charges shall be prorated and paid upon Subscriber Unit activation in the Provisioning Manager (PM) of the System. After the initial billing, access charges will be paid annually.

#### **4. BILLING AND PAYMENT PROCEDURE**

CRESA shall bill User for access under this Contract. Initial billing will be billed upon activation of Subscriber Units. Annual billing will be billed on the 10<sup>th</sup> day of January. User will pay on or before 30 days.

Charges for additional services such as template redesign or reprogramming will be billed on the 10<sup>th</sup> day of the month following the services. User will pay on or before 30 days.

#### **5. TERM OF CONTRACT/TERMINATION**

- A. This Contract shall become effective upon the date of the last authorized signature of the parties and shall have an initial term to **December 31, 2019**. The Contract shall continue from year to year thereafter unless any party provides the other party with not less than three hundred sixty five (365) calendar days written notice that they intend not to renew the Contract.
- B. CRESA may terminate this Contract without the aforementioned notice; instead upon thirty (30) days written notice for non-payment of required fees and charges due CRESA from User. CRESA will advise User in writing of any improper User use of the radio system. Upon such notification, User shall have fifteen (15) days to cure such issues; if not corrected within five (5) additional days following written notice from CRESA, CRESA may cease providing such service as outlined herein. User may petition the CRESA Administrative Board for reinstatement, which will be at the Board's sole discretion.
- C. This Contract is subject to all applicable public contracting laws, subject to the constitutional debt limitations of counties, charter debt limitations of cities, and is subject to the funds being appropriated therefore.

#### **6. SOFTWARE**

- A. CRESA has adopted policies and entered into licensing Contracts relating to the ownership, use and maintenance of related software; Users use of software shall be in accordance with those policies and licensing Contracts.
- B. In the event that this Contract is terminated, any and all software provided to User pursuant to this Contract shall be returned to CRESA.

#### **7. ACQUISITION AND DISPOSITION OF PROPERTY**

Any property acquired as a part of the System shall be deemed property of CRESA and shall remain CRESA's property upon the termination of this Contract. Any property acquired as part of User's radio system shall be deemed the property of User and shall remain the property of User upon the termination of this Contract.

**8. WHOLE AGREEMENT**

This Contract is the complete and exclusive statement of the Contract between the parties relevant to the purpose described above and supersedes all prior Contracts or proposals, oral or written, and all other communication between the parties relating to the subject matter of this Contract. This Contract or any modification of this Contract will not be binding on either party except as signed by authorized agents of both parties.

**9. GOVERNING LAW/VENUE**

This Contract shall be governed by the laws of the State of Washington. Any action or suit commenced in connection with this Contract shall be in the Superior Court of Clark County. The prevailing party shall be entitled to reasonable attorney fees and costs as awarded by the court including any action at the appellate level.

**10. INDEMNIFICATION**

Subject to constitutional limitations and the provisions of RCW 35.21.730, each party to the Contract will defend, hold harmless and indemnify the other from any liability to any third party arising solely out of the negligent acts of its officers, employees or agents in the performance of this Contract.

**11. NO WARRANTY OR GUARANTY**

It is expressly agreed and understood between User and CRESA that the provision of any equipment, materials or services by CRESA to User pursuant to the Contract shall not be construed by User as CRESA guaranteeing or warranting radio equipment, materials or services as free from defects and/or flaws or that they are fit for any particular purpose or use.

**12. JUDICIAL RULING**

If any provision of this Contract as applied to either party or to any circumstance shall be adjudged by a court to be void or unenforceable, the same shall in no way affect any other provision of this Contract or the validity or enforceability of the Contract.

**13. INTERPRETATION**

The terms and conditions of this Contract shall be liberally construed in accordance with the general purposes of this Contract.

**14. ASSIGNING AND SUCCESSORS**



If CRESA and/or User assign their duties as communication provider to another entity, such entity shall be responsible for performance of this contract as written.

DATED this \_\_\_\_\_ day of \_\_\_\_\_, \_\_\_\_\_.

**AGENCY**

**CLARK REGIONAL EMERGENCY SERVICES  
AGENCY**

\_\_\_\_\_  
*Signature*

\_\_\_\_\_  
*Signature*

\_\_\_\_\_  
*Name and Title (Typed or Printed)*

**Dave Fuller, Director**

\_\_\_\_\_  
*Name and Title (Typed or Printed)*

**Approved as to Form:**

**Approved as to Form:**

\_\_\_\_\_  
*Signature*

\_\_\_\_\_  
*Signature*

\_\_\_\_\_  
*Name and Title (Typed or Printed)*

\_\_\_\_\_  
*Name and Title (Typed or Printed)*

## Appendix D

### Sample WCCCA Radio Agreement



# RADIO AGREEMENT

This Agreement is entered into this fifteenth day of March, 2002 by and between Washington County Consolidated Communications Agency (hereinafter "WCCCA"), an ORS 190 organization 17911 NW Evergreen Parkway, Beaverton, Oregon 97006 and **Clackamas 800 Radio Group** (hereinafter "C800"), an ORS 190 organization 2200 Kaen Road, Clackamas, Oregon

## RECITALS

WHEREAS, WCCCA has implemented a Motorola 800 MHz Public Safety Voice and Data Communications System (the "WCCCA System"); and

WHEREAS, C800 has implemented a Motorola 800 MHz Public Safety Voice and Data Communications System (the "C800 System"); and

WHEREAS, WCCCA and C800 desire to inter-connect their respective Radio Systems to effect economies in development and operating cost; and

WHEREAS, WCCCA and C800 are willing to allow access to their respective Radio Systems to the other party and it is in the interest of the parties to enable access to the respective Radio Systems for Data and Voice radio use;

NOW, THEREFORE, pursuant to the authority provided in ORS 190.010 and in consideration of the mutual promises contained herein, the parties agree as follows:

## 1. DEFINITIONS

The terms used in this Agreement have the following definitions:

- a. "C800" means **Clackamas 800 Radio Group** an ORS 190 organization and its participating entities collectively and separately as outlined herein.
  - i. CCOM means the Clackamas County dispatch center.
  - ii. LOCOM means the City of Lake Oswego dispatch center.
- b. "CADI Interface Software" means computer software provided by Motorola to allow a data communications link between the Radio System and Computer Aided Dispatch (CAD) systems.
- c. "Install" and "installation" means the process of mounting mobile Subscriber Radio Units in automobiles, etc.
- d. "IntelliRepeater (IR) System" Means a single radio site with multiple radios, each on a different frequency, with full Radio System features. Each IR site is independent with separate frequencies from any other IR site or Simulcast System.
- e. "Maintenance" or "Radio System Maintenance" means the maintenance of the system backbone or infrastructure as defined herein.
- f. "Prime Site" means the physical location of the primary radio system controller which is located at CCOM, 2200 Kaen Road Oregon City, Oregon, for the C800 System

and at WCCCA, 17911NW Evergreen Parkway Beaverton, Oregon, for the WCCCA System.

- g. "Program," "programmed" and "programming" means the process of coding particular Subscriber Radio Units to transmit and receive specified radio communications.
- h. "Radio Network Controller" means the computer device located at WCCCA which allows access between Computer Aided Dispatch (CAD) systems and the mobile data portion of the Radio System.
- i. "Radio Sites" means the physical remote radio site where the Radio System is housed and includes such items as the building, grounds, antenna tower, electrical systems (including battery, generator, UPS, or utility), environmental control systems, and the like.
- j. "Radio System" means the combined WCCCA System and C800 System backbone radio network including but not limited to: the Prime Sites, and remote radio sites housing radio transmitters, receivers, antennas, combiners, microwave systems, and associated radio equipment as well as the subsystems of the WCCCA and C800 System's comprised of Simulcast Systems and IntelliRepeater Systems.
- k. "Simulcast System" means multiple radio sites with multiple radios at each site, each radio on a different frequency at an individual site but then duplicated at all the other sites, with full Radio System features, transmitting on a single frequency at the same time. Providing optimum coverage for primary coverage area with minimum frequency use.
- l. "SmartZone Controller" means the Motorola device located at WCCCA that is the call data processing hub for the Radio System and its associated "Audio Switch" or audio processing hub which allows multiple radio subsystems to interoperate.
- m. "Subscriber Radio Unit" means a radio that is capable of transmitting receiving radio communications over the System. This includes either voice or data radios.
- n. "Talk group" means a group of Subscriber Radio Units programmed to hear all communications directed to units in that group.
- o. "Subscriber Radio Unit Maintenance" means repair of Subscriber Radio Units or replacement of such Subscriber Radio Units with spares purchased by the C800 pursuant to this Agreement.
- p. "WCCCA" means the Washington County Consolidated Communications Agency an ORS 190 organization and its participating entities, including the Washington County dispatch center PO Box 6375 Beaverton, Oregon 97007.

## **2 FUNCTIONALITY**

WCCCA shall provide C800 joint use of the "SmartZone Controller" This device allows the subsystems of the C800 and WCCCA System to communicate. It facilitates communication between the C800 system and the WCCCA System, and it allows Subscriber Radio Units to roam between the coverage provided by all the sub-systems.

C800 will have access and use of the C800's Radio System as well as the WCCCA Radio System per the programming of the C800 Subscriber Radio Units. WCCCA will



strive to provide the maximum availability of the Radio System for the C800 use. It is anticipated that Radio System up time will exceed 98%.

3. **ACCESS**

The parties will afford each other access to their respective 800 MHz Radio System. Such access shall be by means of a Subscriber Radio Unit purchased and installed at the using agency's expense, so long as the placement and operation of such equipment does not materially interfere with either of the respective 800 MHz Radio System's operation or maintenance..

WCCCA shall afford C800 access to the Zone Controller for the purpose of connection of the CCOM and/or LOCOM's CAD system(s). This connection will allow access to Subscriber Radio Unit data per Motorola's CADI Interface Software utility. C800 will be responsible for the communications connection and related equipment from the CAD system to the Zone Controller including any and all cost related thereto. CCOM and/or LOCOM shall be responsible for the interface, licensing, and related programming of their respective CAD systems to facilitate this feature including all costs related thereto. This connection does not allow or permit C800 use of the WCCCA dispatch computer or WCCCA use of the CCOM and/or LOCOM dispatch computer.

WCCCA shall afford C800 access to the Radio Network Controller for the purpose of connection of the CCOM and/or LOCOM CAD system to the mobile data portion of the Radio System for the purpose of allowing the CCOM and/or LOCOM CAD system to integrate the mobile data radio system into their dispatch operation. C800 will be responsible for the communications connection and related equipment from the CAD system to the Zone Controller including all costs related thereto. CCOM and/or LOCOM shall be responsible for the interface, licensing and related programming to their respective CAD systems to facilitate this feature including all costs related thereto. This connection does not allow C800 use of the WCCCA dispatch computer or WCCCA use of the CCOM and/or LOCOM dispatch computer.

4. **EQUIPMENT PURCHASE**

Backbone / Infrastructure: WCCCA and C800 have each developed and constructed their own radio system backbone or infrastructure at their respective costs. This agreement does not transfer ownership of those assets. WCCCA and C800 are individually responsible for the cost of any and all expansion, upgrade, addition, or replacement of equipment within their respective system.

Subscriber Radios: C800 shall be allowed to purchase any model of Subscriber Radio Units, compatible to the Radio System, directly from any manufacturer of such units, including the manufacturer or manufactures that supply Subscriber Radio Units to WCCCA. (C800 understands that due to Radio System architecture, Subscriber Radio Units utilize proprietary software to enable them to be utilized on the Radio System.) WCCCA shall approve any Subscriber Radio Unit to be utilized on the Radio System. WCCCA's approval of Subscriber Radio Units shall not be unreasonably withheld.

C800 may make arrangements with the manufacturer(s) to deliver new Subscriber Radio Units to WCCCA for initial programming or C800 will deliver Subscriber Radio Units to WCCCA for programming.

C800 may purchase extra Subscriber Radio Units to be left with WCCCA for quick replacement of Subscriber Radio Units brought in for repair.

**5. PROGRAMMING**

All programming of Subscriber Radio Units acquired by C800 pursuant to Section 4 above shall be performed solely by WCCCA at a location or locations to be specified by WCCCA. C800 shall pay all costs, as provided herein, incurred by WCCCA for programming the Subscriber Radio Units. WCCCA shall program and return any Subscriber Radio Unit as soon as reasonably possible and except for circumstances beyond WCCCA's control, in no event more than 5 days. All programming of Subscriber Radio Units to be installed in C800 vehicles shall be performed prior to such installation.

Programming of the C800 mobile data devices to the Radio Network Controller connection including related modems and routers shall be completed by C800 or its assigned vendor at C800's sole cost and expense. C800 shall pay all costs, as provided herein, incurred by WCCCA for programming between C800's communications equipment / CAD system and the Radio Network Controller.

WCCCA shall maintain lists of the individual address codes of each C800 Subscriber Radio Unit programmed.

WCCCA shall charge C800 for programming services at its regular technical service hourly fee and any actual cost incurred from vendors if applicable.

**6. INSTALLATION**

Installation of mobile Subscriber Radio Units and/or associated computer units in C800 vehicles may be done either by C800 or by WCCCA at C800's option. If C800 requests WCCCA to install such mobile units, WCCCA shall do so as soon as reasonably possible and charge for such service at its technical service hourly fee.

Installation of C800 related data lines, modem connections, and router connections to the WCCCA radio network controller shall be the sole responsibility of C800 but under the supervision and authorization of WCCCA. C800 shall install or have installed such equipment at C800's sole cost and expense.

**7. SUBSCRIBER RADIO UNIT MAINTENANCE**

If C800 wishes WCCCA to coordinate maintenance of a Subscriber Radio Unit, C800 shall notify WCCCA Technical Support staff before bringing the Subscriber Radio Unit to WCCCA. WCCCA's Technical Support regular hours of operation are Mondays through Fridays from 8:00 a.m. through 4:00 p.m., and at other times as may be mutually agreeable.



WCCCA shall submit the Subscriber Radio Unit for repair as quickly as reasonably possible and shall notify C800 when the repaired and reprogrammed Subscriber Radio Unit is ready to be picked up. C800 may pick up the repaired Subscriber Radio Unit, Monday through Friday from 8:00 a.m. through 4:00 p.m., or at such other times as may be mutually agreeable.

C800 shall maintain equipment associated with the CAD system and its communications link up to the Radio Network Controller and/or Zone Controller including all related data lines, modems, connections, routers, and communications service being responsible for all costs related thereto. WCCCA will assist C800 with the communications link, as it is capable, at its technical service hourly fee.

C800 shall be solely responsible for the maintenance and programming of the vehicle data devices. WCCCA will provide installation and removal of these units, if requested by C800. Such service will be provided by WCCCA at its regular technical service hourly fee.

**8. RADIO SYSTEM MAINTENANCE**

WCCCA shall provide maintenance of the C800 Radio System components such as radios, microwave, and associated accessories and appurtenances as outlined on Exhibit "A" attached hereto; provided however, WCCCA will not provide maintenance of the physical C800 Radio Sites including such items as generators, buildings, and towers.

**9. RADIO LOSS**

If C800 loses a Subscriber Radio Unit, or believes that a Subscriber Radio Unit has been stolen, C800 shall immediately inform the WCCCA Director or Technical Support staff.

**10 FCC LICENSING**

WCCCA and C800 shall be solely responsible for obtaining and maintaining any and all required FCC licenses for their respective system.

FCC radio licenses issued to WCCCA and or its participating jurisdictions either currently or in the future are exclusively for their use.

FCC radio licenses issued to C800 and its partners including but not limited to Clackamas County either currently or in the future are exclusively for their use.

**11. FEES**

Radio System Access and Maintenance Fee: Radio system access and maintenance fees for use of the WCCCA System and maintenance of the C800 System shall be pursuant to the fiscal year (July 1 to June 30) fee schedule, as approved by the WCCCA Board of Commissioners. The fee will be charged on a per Subscriber Radio Unit basis for the number of Subscriber Radio Units programmed for a participating entity. This fee will be adjusted annually on or before March 1st of each year for the following fiscal year, and initially is as shown in Exhibit "B" fees for fiscal year 2002 - 2003. The fee will

be imposed for an added Subscriber Radio Unit at the beginning of the next quarterly billing cycle following the programming of the added Subscriber Radio Unit.

Technical Services Fee: Programming, installation, repair, maintenance fees for Subscriber Radio Unit repair and any work requested beyond the scope of work as outlined in Exhibit A shall be pursuant to the current fiscal year fee schedule as approved by the WCCCA Board of Commissioners plus any actual out of pocket costs incurred.

**12. PAYMENT**

Each participating entity of C800 agrees to pay their respective Radio System Access and Maintenance Fee and any other fees and charges incurred for services provided them during the term of this Agreement. Payments for Radio System Access and Maintenance Fee's shall be made in advance on a quarterly basis. The first payment shall be due at the C800 Radio System available for service date. WCCCA shall submit an invoice to each participating entity of C800 not less than thirty (30) days prior to the due date for Radio System Access and Maintenance Fee's. Other fees and charges shall be paid within 30 days of invoice for such fees and charges. C800 shall be liable for any and all fees incurred by participating entities if not paid directly to WCCCA as invoiced.

**13. EFFECTIVE DATE AND RIGHT TO TERMINATE**

This Agreement shall become effective on the last date signed by one of the parties and shall continue thereafter on an annual July 1 to June 30 term, until terminated consistent with the provisions below.

Either party may terminate this Agreement on July 1st of any year, providing written notice of intent to terminate the Agreement is received on or before April 1<sup>st</sup> of the previous year in which the party wants to terminate.

**14. INDEMNIFICATION:**

WCCCA and C800 shall hold harmless and indemnify the other for the negligent acts, actions or omissions to act of their respective participating jurisdictions, participating entities, officials, employees, agents and contractors in the performance of their respective responsibilities and duties under this Agreement, subject to limits of the Oregon Tort Claims Act and the Oregon Constitution.

**15. REMEDIES**

WCCCA shall notify C800 in writing of any violation of term or provisions of this agreement. C800 shall have 10 calendar days from the date of its receipt of notification to cure the violation of terms or provisions. If C800 does not cure such violations WCCCA may disable the C800's non-complying Subscriber Radio Units.

Further WCCCA shall notify C800 verbally and subsequently in writing of system users who access restricted talk groups or of actions that affect normal operations, or normal resources of the Radio System. C800 shall cause such activity to cease as soon as

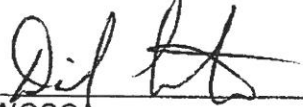


they are notified, whether verbally or in writing. If any C800 system user continues with such activity or repeats such activity WCCCA may, upon verbal and subsequent written notice, immediately disable the specific Subscriber Radio Unit or units associated with such activity

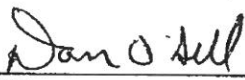
A decision to disable a C800 Subscriber Radio Unit shall be made by the Director of WCCCA and subject only to review by the WCCCA Board of Commissioners.

IN WITNESS THEREOF, the parties have executed this Agreement this 15th day of March, 2002.

BY: Dave Austin,  
Interim Communications Director

  
WCCCA

BY: Chief Dan O'Dell, Chair

  
C800

## **EXHIBIT "A"**

### **SCOPE OF MAINTENANCE SERVICES**

Dated: June 8, 2001

The following is EXHIBIT A to the Agreement between Clackamas 800 Radio Group and WCCCA.

#### **1. SCOPE OF SERVICES:**

- a. WCCCA agrees to provide the operational management, maintenance, repair and related services described herein. Maintenance, repair and services for infrastructure shall be provided at the location or locations specified in the as built documentation, on a 24-hour a day, seven day a week basis.
- b. C800 agrees to maintain a suitable environment for the equipment, and to provide WCCCA full, free and safe access to the equipment to provide maintenance services.
- c. Services shall include:
  - i. Provide scheduled Preventive Maintenance (PM) during normal business hours based on the specific needs of the Communications System on a semi-annual basis. Preventive maintenance shall include adjustments to maintain Radio System specifications, lubrication, cleaning, replacement of defective parts, correction, retrofitting for engineering changes. The PM will include, but not limited to:
    - Physically inspect cabinet, general circuitry and connections.
    - Measure transmitter power output and adjusts to rated output.
    - Check and adjust all combiners.
    - Measure reflected power of the transmitter antenna system and transmitters.
    - Measure and adjust frequency and modulation, as required by the Federal Communications Commission's (FCC) Rules and Regulations.
    - Measure and adjust receiver sensitivity.
    - Check Radio System levels.
    - Remove any oil, dust, and/or foreign substances from equipment.
    - Record and report, no more than two weeks from when work is completed, the following critical parameters related to trunked radio equipment:
      - transmit frequency;
      - maximum deviation;
      - transmitter power;
      - combiner loss;
      - reflected power in antenna line;
      - receive frequency;
      - receive sensitivity;
      - audio output levels;
      - deviation of critical parameters;
      - model and serial number;
      - description of problem and corrective action taken



- WCCCA shall take any corrective actions necessary to maintain equipment in full compliance with the Federal Communications Commission's (FCC) Rules and Regulations, and within Radio System's specific tolerances.
  - BERT Test (Bit error test).
  - Verify standards
  - WCCCA will provide documentation as to the results of the annual PM. This information will contain a minimum of the following data: Model and serial number; power output and VSWR of station and combiner; frequency check; Modulation levels; receiver sensitivity; line levels; location of equipment; and site information.
- ii. Provide unscheduled, on call maintenance as required for inoperative equipment. Maintenance includes determining the cause of failure and/or intermittent service, removing, repairing or replacing parts or elements as necessary in order to conform with the manufacturer's factory specifications along with Radio System specific specifications, delivering and reinstalling the parts, and placing the equipment or software back into service. Procedure is as follows:
    - Contact C800 to define complaint.
    - Use Remote Diagnostic tools including Radio, Computer Terminal.
    - Determine course of action and respond accordingly per agreement with C800.
  - iii. Provide maintenance materials, tools, site logs, database at prime site containing all actions regarding Radio System, diagnostic and test equipment necessary for the maintenance services described herein.
  - iv. Routine Maintenance Schedule shall include quarterly visits to the remote sites and the prime site to be visited one time per month. Prime site visit will include checks of all status alarms and contact of the Radio System manager along with floor supervisor for any Radio System input.

## **2. STAFF PERSONNEL, QUALIFICATIONS AND TRAINING:**

- a. WCCCA shall perform the services in a timely and workmanlike manner, using only qualified staff that is familiar with the equipment they are servicing.
- b. WCCCA's service delivery staff shall be properly factory trained by the primary manufacturers of the equipment (Motorola and Tadiran) to deliver the services requested and will continue to be kept properly trained as technology evolves.

## **3. SERVICE STANDARDS:**

- a. Telephone Trouble Line: WCCCA shall furnish the C800 with a central telephone number where notice shall be given of the need for equipment maintenance. This telephone service shall be available 24 hours a day, seven days a week.
- b. Response Time: WCCCA shall provide service delivery including periodic monitoring and maintenance by remote access diagnostic equipment as available on the

Communications Radio System and, where trouble is reported through such equipment or by an individual, fully qualified service delivery staff shall respond by telephone to the trouble call within 30 minutes of being notified of the problem. Response for this purpose shall mean to identify and log an automatically identified fault or problem, and calling to confirm that a trouble report has been made to the person reporting the fault or designee. Should the problem not be identified as one that can be corrected remotely or, if it is identified as one which is of a Radio System critical nature, then fully qualified service delivery staff shall be on the site where the fault occurred within two hours of the determination it requires on site response if it is the Prime Site and four hours if it is a remote site. This on site response is subject to site access conditions, weather. Any cost associated with unusual access to the site is the responsibility of C800 i.e., snow cats, helicopters, etc.

- c. **Down Time:** Because of the critical public safety nature of the Radio System, WCCCA shall ensure that major down time, i.e., down time of any complete site, will be kept to the minimum time necessary to maintain the site equipment to manufacturers' specifications and peak operational performance. WCCCA shall not intentionally: disable any site; put any site into site trunking or "fail soft"; or interrupt any microwave path to or from a site without first notifying the C800 and obtaining approval.
  - d. **Maintenance to Radio System's Specifications:** All equipment maintained under this agreement shall be maintained to the manufacturer's factory specifications and Radio System specific specifications; provided however, service standard exceptions may be allowed by the C800 when special circumstances can be demonstrated.
  - e. **Spare Parts:** C800 shall obtain adequate spare parts as recommended by the manufacture and the WCCCA Technical Systems Manager. All spare parts must meet or exceed the specifications of the manufacturer of the unit in which the part is installed and shall be free of defects in title, material, and workmanship.
4. **COORDINATION AND SITE ACCESS:** Because the Radio System is primarily intended for public safety, uses multi-vendor equipment, and there are shared uses and diverse ownership of communications sites, WCCCA's delivery of services will require coordination and cooperation with a variety of vendors, governmental agencies and site owners.
- a. **WCCCA coordination with C800:** WCCCA shall keep C800 informed of all actions and developments affecting Radio System performance, to every extent possible, in a proactive way. All coordination undertaken below will, to the extent feasible, be carried out with the full knowledge of C800; and WCCCA shall make every effort to inform C800 of developments and coordination efforts in a proactive way.
  - b. **WCCCA Coordination with Site Owners:** WCCCA shall coordinate its staff access to work sites with site owners as per the site access guidelines developed with each site owner by C800.
  - c. **WCCCA Coordination with Vendors:** Maintenance of the equipment will involve relationships with vendors, most notably Motorola, Inc., and Tadiran, possibly under a number of relationships. Such relationships may include warranty maintenance relationships, contracts for telephone support in troubleshooting, on-site technical support in crises, parts replacement contracts, or other relationships, formal or informal. WCCCA shall maintain and coordinate these relationships as specified by C800.



## **5. ASSET TRACKING:**

- a. Asset Tracking: The maintenance services to be provided by WCCCA under this Agreement shall include asset tracking of each piece of equipment in the 800 MHz Radio System. Such tracking shall include, at a minimum: the manufacturers or other unique identification of each piece of equipment; its acquisition and installation dates, dates of repair, dates of operating problems or suspected operating problems, maintenance records; costs and other historical data related to the repair of the equipment; operating features; and other reasonable information as the C800 may request be tracked. Asset tracking shall be by manufacturer's serial number as well as C800's asset number.
- b. Site Log: WCCCA shall maintain a site log at each site in the 800 MHz and 150 MHz Radio System.
- c. WCCCA's staff shall record in this log, every visit to the site, its date, purpose, and resolution by themselves or other participants in the Radio System. They will also update each log with respect to any events that might significantly affect the site even if those events do not take place at the site, for example, if communications to the site is discontinued because of failure at another site.
- d. For each incident of equipment or software defect or malfunction, WCCCA shall record in the site log at least the date and time notified, the date and time of arrival, the date, time, and duration of all maintenance work performed, a description of the cause for the work, diagnostic reports of correction, adjustments, or updates, and a description of the work performed.
- e. A master log of all sites will also be maintained by WCCCA. Master log is a composite of all the site logs and will be updated quarterly at record computer at prime site. Log will contain a minimum: date, time, action taken and by whom.
- f. C800 shall have unlimited access to all site logs and to the master log.
- g. Availability and Accessibility of Records: All records required, as listed above, to be maintained under this subsection must be kept up to date by WCCCA shall be available to C800 with two working days' notice.
- h. Reporting: A summary report of actions taken, expenses incurred, charges being invoiced, and other relevant information relating to maintenance of C800's Communications Radio System shall be delivered by WCCCA to C800 promptly at the end of each month.

## **6. SUBCONTRACTING MAINTENANCE SERVICES:**

- a. Neither WCCCA nor any approved subcontractor may enter into any subcontract with any third party for the performance of any part of the WCCCA's duties or obligations without first obtaining prior written permission from C800. In no event shall the existence of a subcontract operate to release or reduce the liability of the WCCCA to C800 for any breach in the performance of the WCCCA's duties.

## **7. ADDITIONAL MAINTENANCE SERVICES:** WCCCA shall provide the following additional Maintenance Services:

- a. Check and record battery condition including voltage and charging status.

- b. Conduct and record visual building and tower inspection.
  - c. Inspect and record generator run hours to verify test cycle and check for fluid leaks.
  - d. Provide all labor related to the repair of the microwave system.
  - e. Provide local monitoring of the Communications Radio System with direct dial in capabilities.
  - f. Log and report to C800 all Radio System anomalies and actions.
8. **EXCLUDED MAINTENANCE SERVICES:** WCCCA specifically excludes the following services:
- a. Maintenance or repair of Subscriber Radio Units.
  - b. Maintenance or repair of dispatch center equipment such as consoles, central electronic banks, or dispatch terminals or equipment.
  - c. Maintenance of the physical radio sites including such items as generators, buildings, towers.
  - d. Maintenance, repair, or replacement related to antennas, antenna accessories, tower top preamps and feed lines.
9. **COMMUNICATION RADIO SYSTEM DESCRIPTION:** Per the "As Built Radio System Documentation" provided by vendors.



## **EXHIBIT "B"**

Dated: March 15, 2002

**The following is EXHIBIT B to the Agreement between C800 and WCCCA and is made a part thereof.**

1. **Agreement Start Date:** Upon availability of the Radio System for use or as agreed to by WCCCA and C800.
2. **Radio System Access and Maintenance Fee Contract Pricing:**
  - a. Radio System Access and Maintenance Fee per Subscriber Radio Unit per year. \$175.93(for FY02/03)
3. **Technical Service Fee for Additional Work performed by WCCCA:**
  - a. Shop work \$ 50 per hour (for FY02/03)
  - b. Field work \$ 50 per hour (for FY02/03)
  - c. Materials 5% mark up over cost