TLP:CLEAR

Kittitas County 911

Radio System Planning Review Final Report

W022-184 WA OP-ASMT / W022-185 WA ENG LMR LTE

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This document was prepared for Kittitas County 911 by the Department of Homeland Security (DHS) Cybersecurity and Infrastructure Security Agency (CISA) Interoperable Communications Technical Assistance Program (ICTAP) as part of Work Order # WO22-184 and WO22-185. Additional information about the program can be found at https://www.dhs.gov/safecom/ictapscip-resources.

Executive Summary

Kittitas County is in central Washington State and is approximately 2,333 square miles with a population of 44,337[1]. As of 2020, the County is home to 1,319 businesses, 18,772 households and has both light urban and rural mountainous regions. Kittitas County is bordered by Chelan County to the North, Grant County to the East, King County to the West, and Yakima County to the South.

Kittitas County 911 (KITTCOM) is a civilian staffed 911 center serving 17 public safety agencies within Kittitas County. KITTCOM owns and operates an aged radio system utilizing legacy equipment which is in need of replacement.

KITTCOM requested support from the Cybersecurity and Infrastructure Security Agency (CISA) in completing a system assessment, through a physical examination, signal mapping projections, and coverage drive testing. KITTCOM is the primary client for the assessment. The system assessment process involved an on-site visit to conduct a detailed assessment of the KITTCOM Radio System, a computerized radio frequency (RF) analysis based on identified system configurations and was then followed by an on-site drive test to provide real-world coverage assessment for a comparative analysis. An overarching factor in all discussions was KITTCOM's desire to develop reliability and resiliency in an LMR system while maintaining operability and interoperability.

KITTCOM provided valuable input in the overall assessment of the system and drive testing which led to this report. KITTCOMs part- time technicians should be commended for their due diligence, time, and effort put forth in keeping the system operational for public safety users.

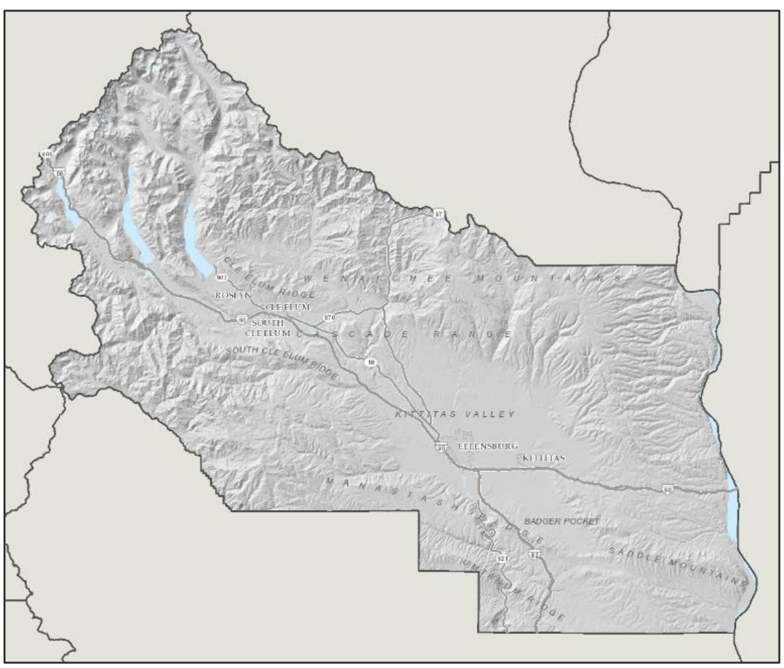

Figure 1: Map of Kittitas County, Washington

[1] According to the 2020 United States Census.

Objectives

The following objectives were identified and accomplished as part of this system review technical assistance (TA) to improve operability and interoperability while building reliability and resiliency with the implementation of a radio system.

Existing System Review and Analysis

- Review and assesment of system equipment and infrastructure.
- Develop understanding of overall process to date and decisions made regarding the current and proposed radio system concepts and sites.

Existing System Coverage Assesment

- Conduct geographical system radio frequency (RF) coverage analysis.

System Drive Testing

- Conduct on-site drive testing to validate and confirm areas with coverage issues or anomalies.

Recommendations for System Improvement

- Identify gaps and areas for improvement with system infrastructure and processes.
- Provide guidance and best practice concepts to Kittitas County related to radio system development.

Assessment Process

Data Collection

Upon initiation of the TA, the CISA subject matter expert (SME) team coordinated with the KITTCOM points of contact (POCs) who provided initial documentation of their system infrastructure including:

- General system infrastructure details;
- Map of radio system infrastructure locations, coverage areas and known coverage gaps; and,
- ICS-217A Communications Resource Availability Worksheet including channels utilized for both operations and interoperability by KITTCOM supported public service agencies.

The CISA SME team conducted a virtual kick-off meeting to revalidate TA objectives and discuss tentative timelines. The SME team reviewed the data and coordinated with the KITTCOM team to answer questions and provide clarification where needed on the provided system data.

The system data was used to develop a preliminary system RF coverage analysis. All data provided as well as derived data was then used to prepare for the initial on-site meeting.

On-Site System Review

An on-site visit was completed in December 2022. The CISA SME team met at the KITTCOM 911 Facility located at 700 Elmview in Ellensburg, WA. The visit was initiated with a discussion-based workshop including the KITTCOM team, the CISA SMEs and KITTCOM public safety stakeholders. During the workshop, the team reviewed and confirmed deliverables for the project and discussed details on operational needs, interoperability practices, system history and design. During the workshop KITTCOM also confirmed their request to complete system drive testing in its current state. The drive test was to be planned for a future on-site visit.

Following the on-site workshop meeting, the SMEs and the KITTCOM team successfully completed three site visits including the KITTCOM Communications Center, Beverly Tower Site, and Craigs Hill Tower Site. The site visits allowed for the SME team to visually confirm the system operating conditions, validate configuration, specifications, obtain operational power measurements, and scout the area for a future drive test operation. Additional sites visits were planned but were snowbound and were unable to be safely accessed during the visit.

RF Coverage Analysis

Based on the initial information provided by KITTCOM, the SME team completed a preliminary computerized analysis of the system for a single channel utilizing EDX SignalPro coverage mapping software. The preliminary information was presented at the on-site system review to the KITTCOM team to provide an example of the data that would be available shortly after the on-site visit was completed.

Upon completion of the on-site system review, the SME team was able to accurately adjust parameters for the analysis and complete a computer RF analysis of the system for all six simulcast tower sites as well as two additional standalone tower sites (shown in the table below). The analysis provided both “talk-in” and “talk-out” coverage plots of the tower sites for both a portable and mobile transceiver utilizing an audio quality standard of DAQ 3.4[2] as well as areas of time delay interference (TDI) between simulcast sites. The Hart Road standalone site was included per KITTCOM request as the site hosts the Kittitas County Roads primary repeater while the Manastash Ridge site hosts the KITTCOM Fire and Police backup repeaters.

Sites included in SignalPro RF Analysis	
KITTCOM Simulcast Tower Sites	**Standalone Tower Sites**
Baldy	Hart Road (County Roads)
Beverly	Manastash Ridge (Backup FD/PD)
Craig’s Hill	
Dodge	
Sky Meadows	
Stampede	

[2] Delivered Audio Quality (DAQ) 3.4 is defined as “speech understandable with repetition only rarely required, and with some noise and/or distortion.”

In addition to the RF coverage analysis for the existing Very High Frequency (VHF) system, an example analysis of the simulcast sites was computed simulating coverage for an 800-Megahertz (MHz) Project 25 (P25) system. The resulting analysis identified a decreased area of coverage if the region converted to 800 MHz P25 when compared to the coverage of the existing VHF system.

The data was provided in multiple formats to allow for easy visualization and efficient integration into geographic information systems (GIS) by the KITTCOM Team. Some examples are provided in the figures below.

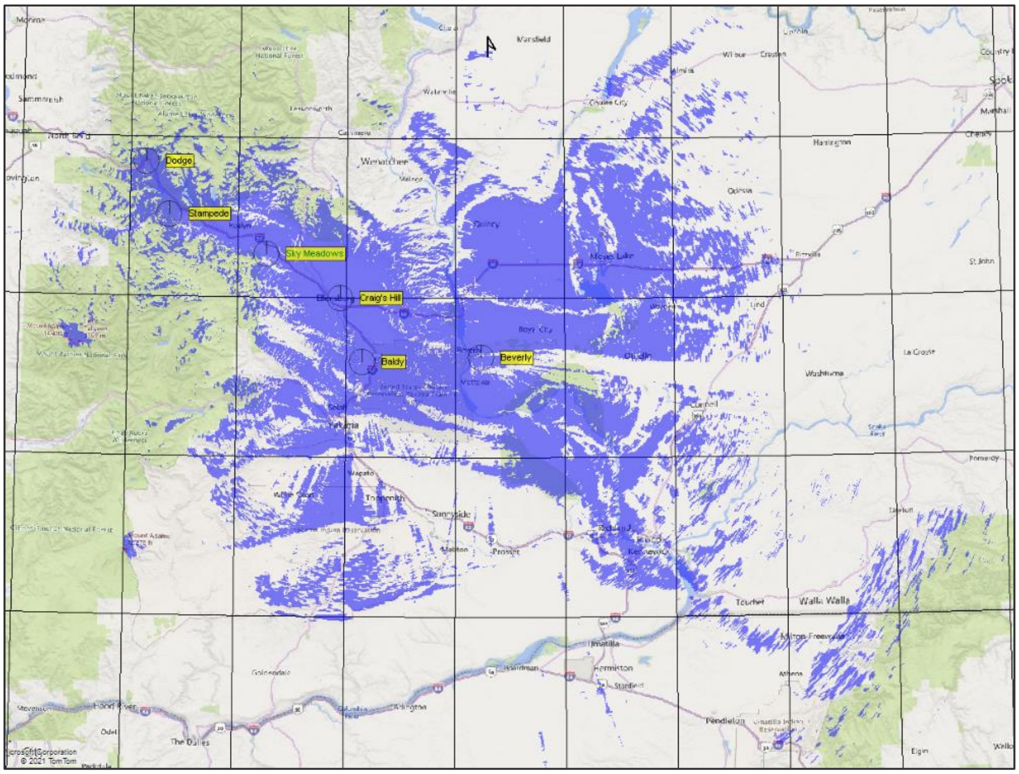

Figure 2: KITTCOM Full System Cumulative Coverage - Talk-In from Mobile Transceiver

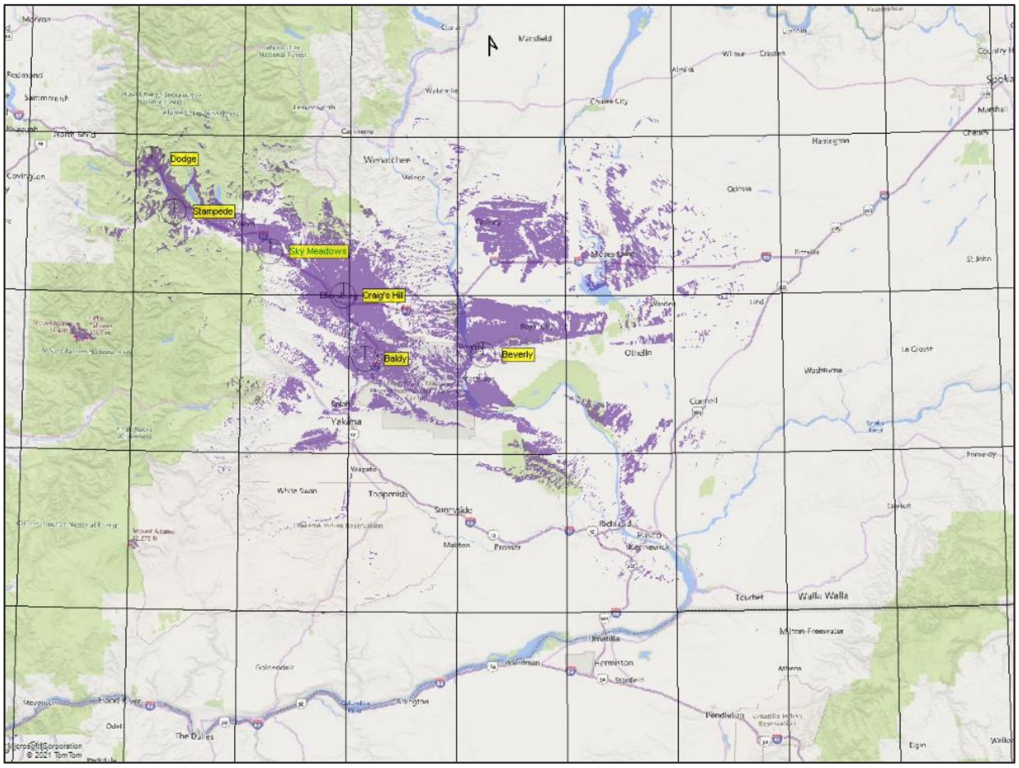

Figure 3: KITTCOM Full System Cumulative Coverage - Talk-In from Portable Transceiver

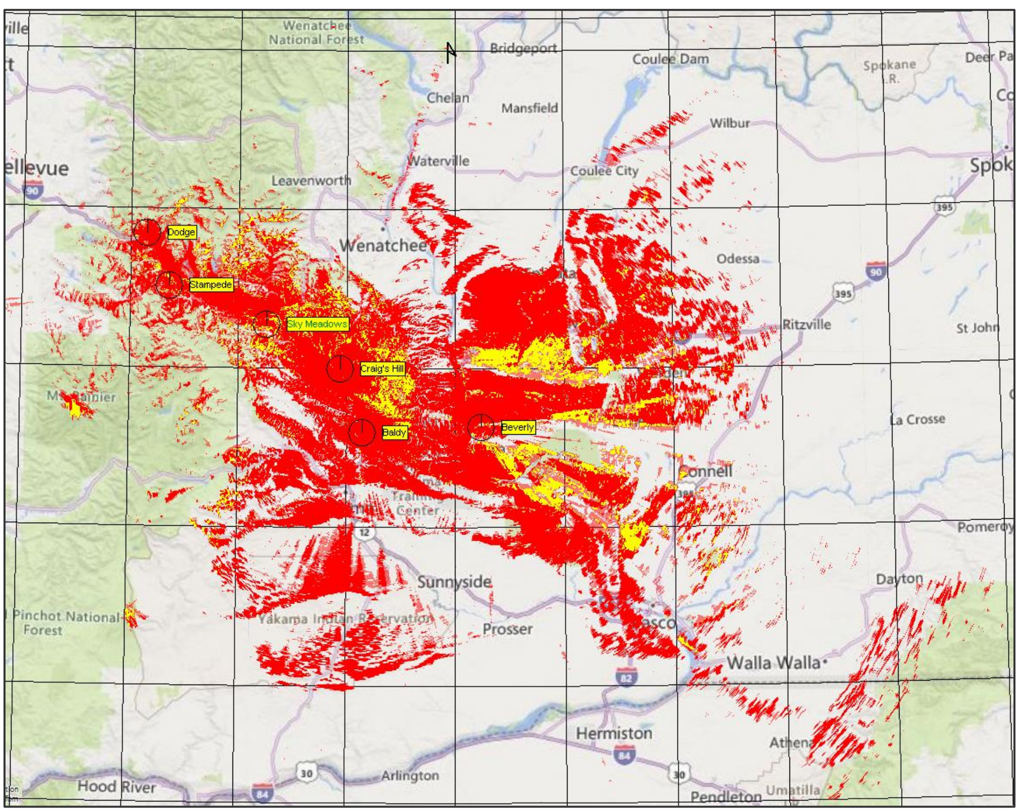

Figure 4: KITTCOM System Simulcast Time Delay Interference

Time Delay Interference and Simulcast Systems

Time delay interference, as shown in Figure 4 in yellow, are areas where signals from transmitters broadcasting at the same time overlap. This causes interference which leads to problems in the subscriber's radio audio understandability. In a simulcast system, signal overlap areas are one of several parameters that can affect system performance.

Simulcast radio systems are generally used when a limited number of frequencies are available and large areas needs to be covered. Simulcast occurs when two or more sites transmit at the same time on the same frequency; inevitably the coverage from multiple sites will overlap. TDI is present in almost any simulcast system, whether digital or analog. While the effects of TDI are more easily tolerated in an analog environment such as the KITTCOM system, they should be minimized as much as possible as TDI can cause subscriber radios to miss calls or cause the radio audio to become unreadable such as the sound of static and garble in the audio from the speaker. Additional details on alleviating TDI can be found in the Findings and Recommendations.

On-Site System Drive Testing

Leading up to the visit the SME Team coordinated with the KITTCOM team virtually, to schedule logistics for the drive test plan. Drive test equipment setup and route planning was conducted. Since a primary communications channel was required to be offline for testing, a backup communications plan was established to ensure dispatch to field communications could continue for daily operations. This plan also ensured channels used for testing could be quickly reactivated for responder use if a major incident were to occur.

The second on-site visit was completed in April 2023, focusing on system drive testing. Drive test configuration started the morning of the first day (April 3, 2023) once all configuration and checks were complete. Routes were reviewed and drive testing was initiated.

Survey Technologies "Field Test 7" software was utilized for testing in conjunction with Tait TM series mobile radios in the drive test vehicle. A second set of STI test equipment was linked to the voted receive audio in the KITTCOM facility. In order to test the analog simulcast signals, a signal generator was also tied in at KITTCOM so that the drive test equipment had a standard signal to receive.

The Audio Quality Test option was used which combines the ability to measure RSSI voltage, converted to signal strength through a calibration table, with the ability to digitize a sample of audio signal and compute Signal-to-Noise and Distortion Ratio (SINAD) or Delivered Audio Quality (DAQ) from the sample.

Drive testing was conducted for a total of three days covering 520 miles of Kittitas County over 5 different routes. A consolidated route map is shown in Figure 5, below.

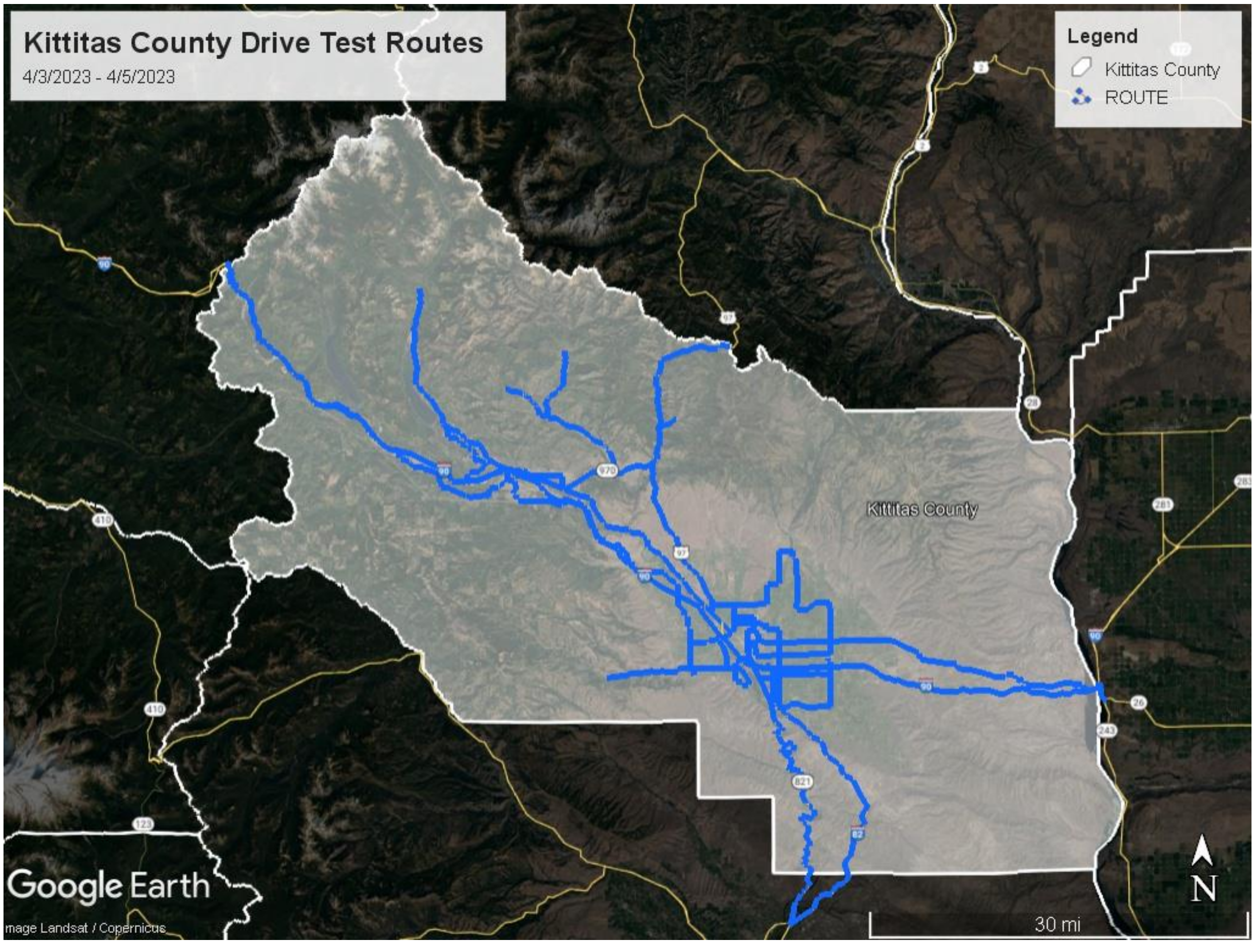

Figure 5: Kittitas County Drive Testing – Consolidated Route Map

Upon completion of drive testing, the SME team completed a preliminary analysis of the drive test data and provided the results to the KITTCOM team. Resulting data was provided in both Received Signal Strength Indicator (RSSI) and SINAD data. For high-level detail, the geospatial data files must be reviewed separately from this report due to the high number of data points.

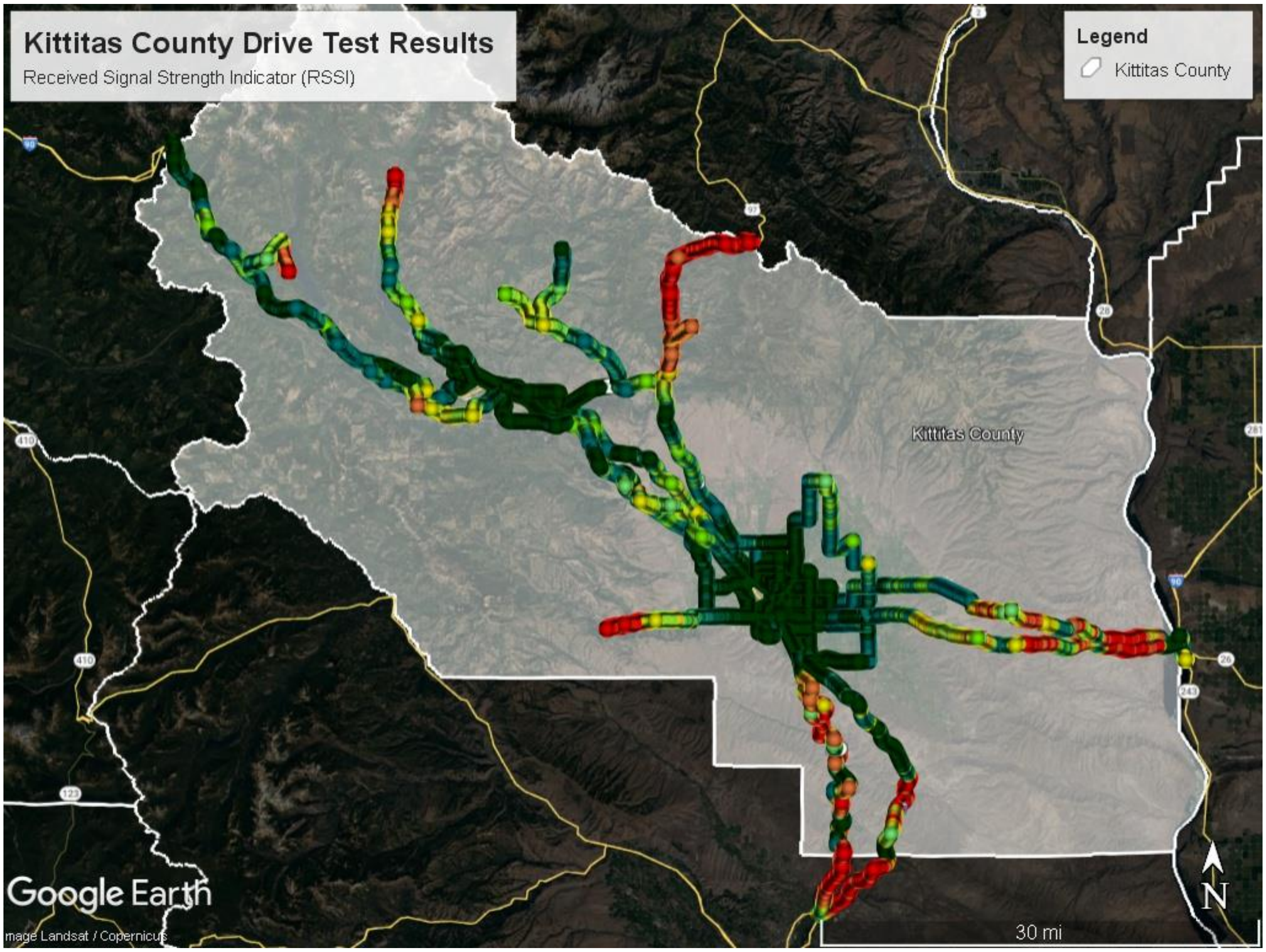

Figure 6: Kittitas County Drive Test Results – RSSI

The legend for the above RSSI map as well as the zoomed maps in Figure 8 and 9 highlighting the City of Cle Elum and Ellensburg is provided below in Figure 7. The desired minimum public safety standard is DAQ 3.4.

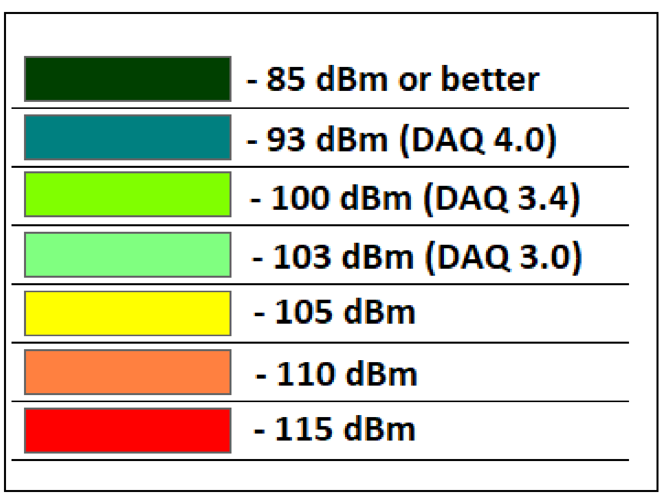

Figure 7: Map Legend - Receive Signal Strength Indicator (RSSI)

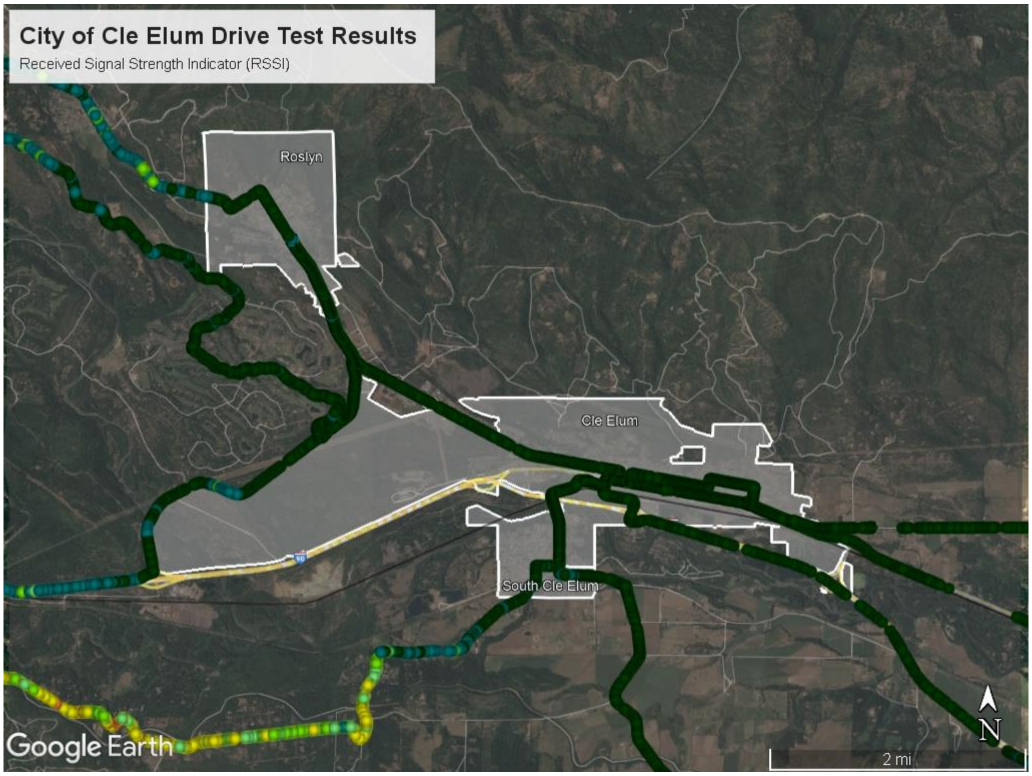

Figure 8: Highlighted Drive Test Results Map for City of Cle Elum – RSSI

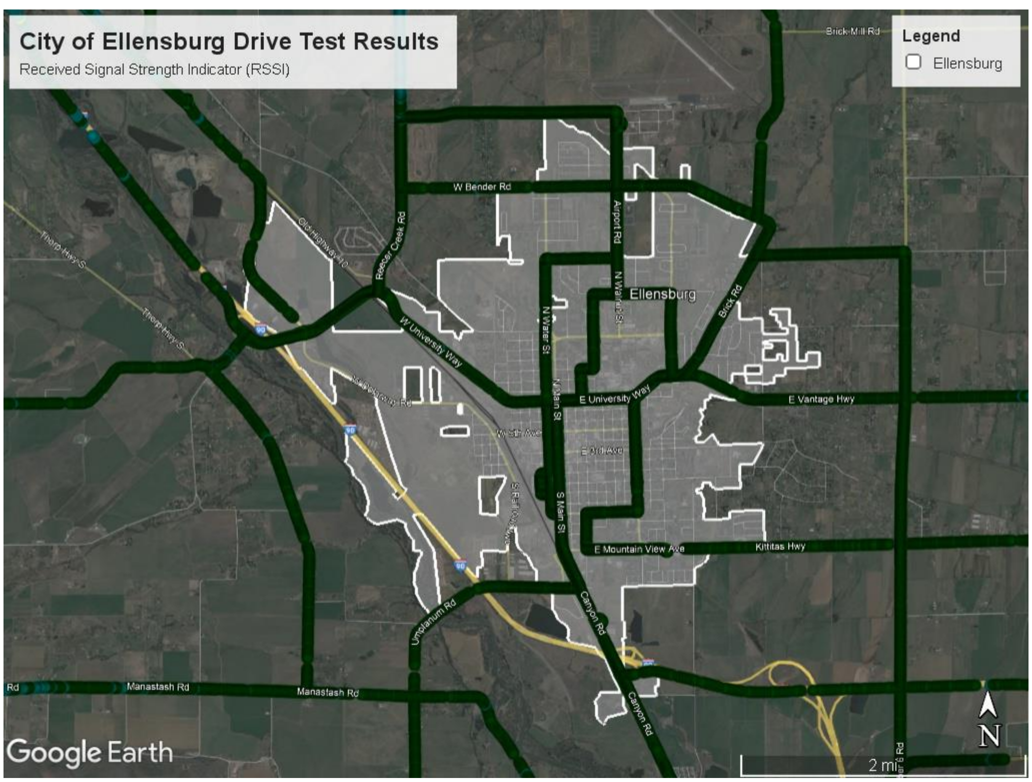

Figure 9: Highlighted Drive Test Results Map for City of Ellensburg – RSSI

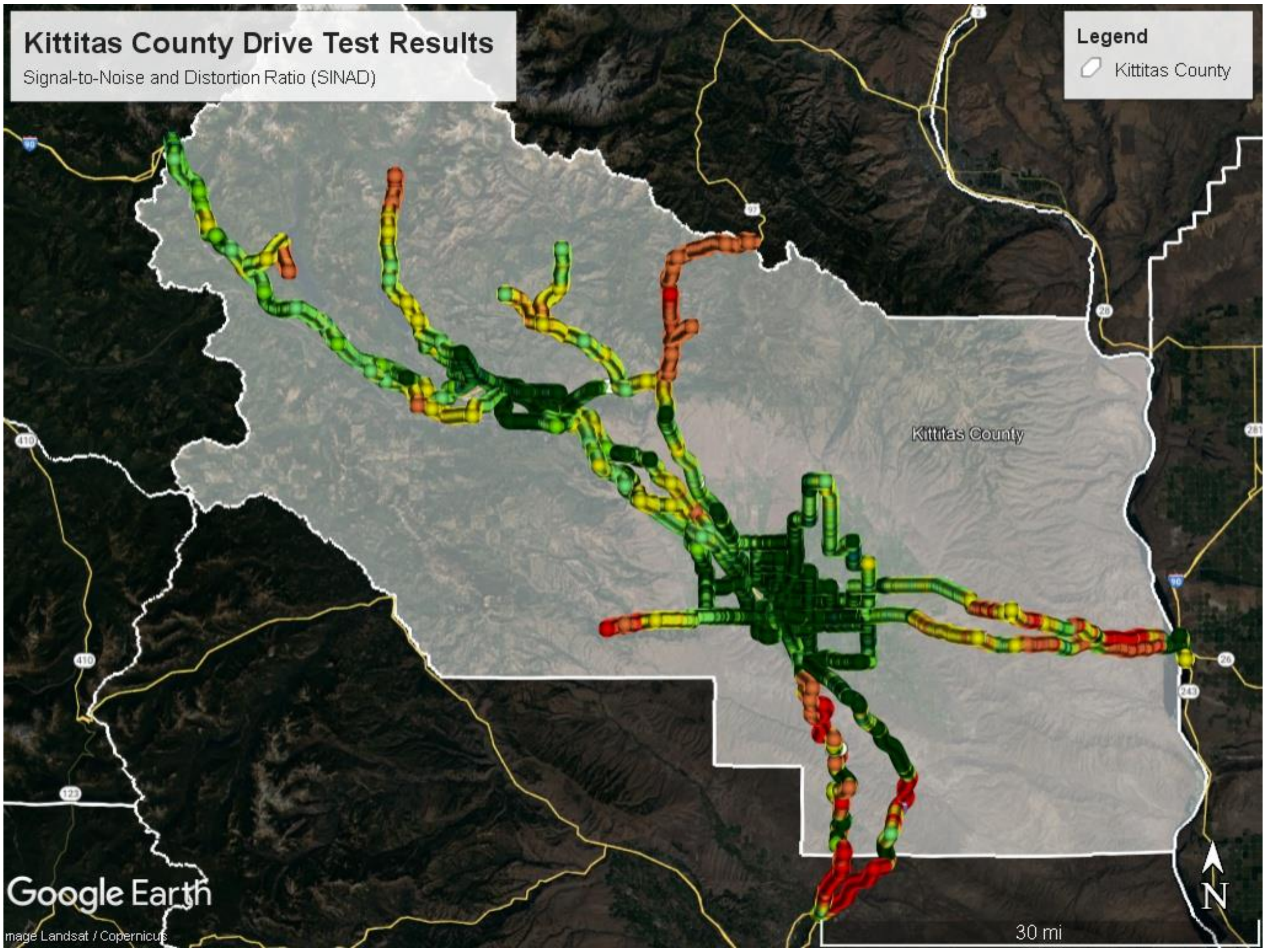

Figure 10: Kittitas County Drive Test Results - SINAD

The legend for the above SINAD map as well as the zoomed maps in Figure 12 and 13 highlighting the City of Cle Elum and Ellensburg is provided below in Figure 11. The desired minimum public safety standard is DAQ 3.4.

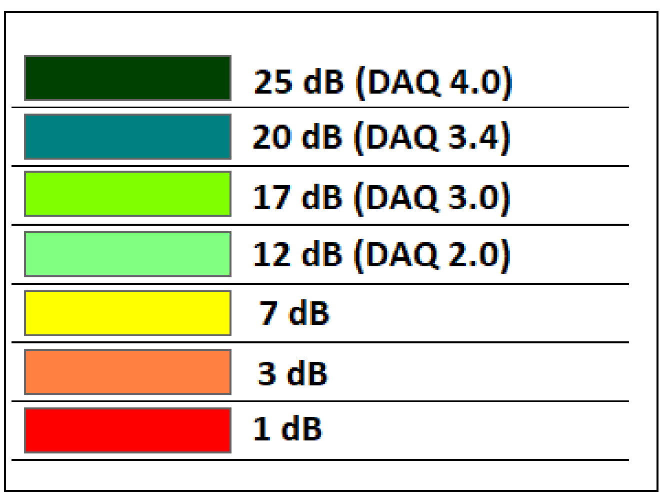

Figure 11: Map Legend - Signal-to-Noise and Distortion Ratio (SINAD)

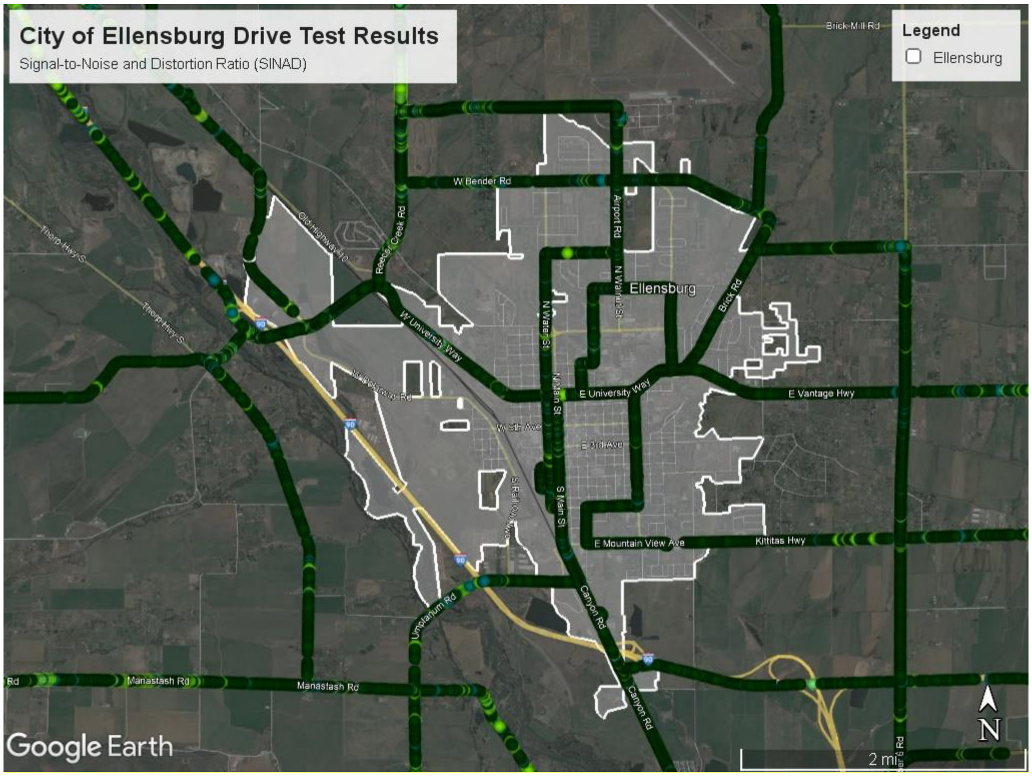

Figure 12: Highlighted Drive Test Results Map for City of Cle Elum – SINAD

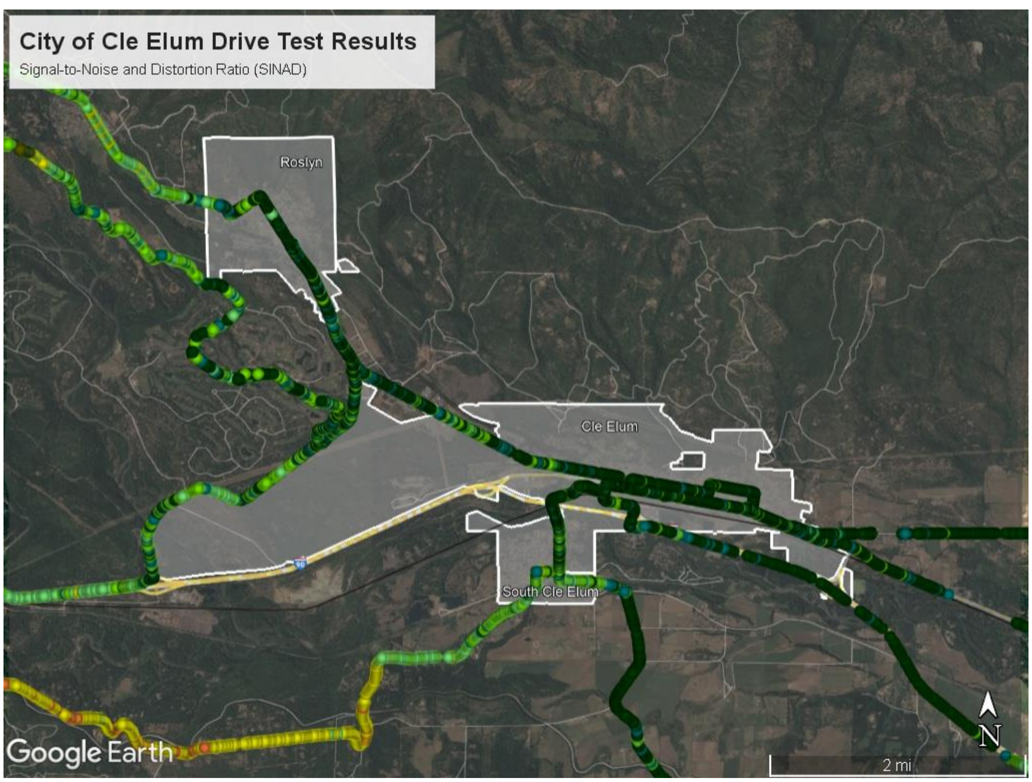

Figure 13: Highlighted Drive Test Results Map for City of Ellensburg – SINAD

In order to understand the test results, the reader needs to understand a few of the technical terms described below.

- **Signal -to Noise Ratio (SINAD)** is a measure of audio quality as found in communications systems. SINAD is the ratio of the total signal power level (Signal & Noise & Distortion) to unwanted signal power (Noise & Distortion). The higher the SINAD, the better the quality of the audio signal. SINAD is usually expressed as decibels (dB). Usually for radio systems SINAD values range between 12 dB and 20 dB (the threshold for reasonable intelligibility of voice). Under ideal reception conditions the SINAD could be greater than 40 dB.
- **Received Signal Strength Indication (RSSI)** is a measurement of the power presenting a received radio signal. RSSI is a method used to predict the coverage the radio system will provide. RSSI is usually expressed in dB.
- **Delivered Audio Quality (DAQ)** is a testing protocol that evaluates signal quality based on the ability to understand back and forth voice calls generally made from first responder radios to the dispatch center and vice-vera. The test process should involve stating specific spoken sentences using the first responder's handhelds. These sentences are known as Harvard sentences. Public safety DAQ standard is 3.4.
- **Decibel (dB)** is a relative unit of measurement used to express the ratio of one quantity to another on a logarithmic scale. A logarithmic scale is a method of displaying numerical data over a wide range of values in a compact way. Decibels tell us how much of a given quantity there is relative to another amount of the same quantity.

Delivered Audio Quality Metrics (DAQ): DAQ /SINAD (represented as dB) Equivalency		
DAQ	Subjective Performance Description	SINAD Equivalent Intelligibility
1	Unusable, Speech present but unreadable.	<8 dB
2	Understandable with considerable effort. Frequent repetition due to noise/distortion.	12+/-4dB
3	Speech understandable with slight effort. Occasional repetition required due to noise/distortion.	17+/-5dB
3.4	Speech understandable with repetition only rarely required. Some noise/distortion.	20 +/- 5 dB
4	Speech easily understood. Occasional noise/distortion.	25 +/- 5 dB
4.5	Speech easily understood. Infrequent noise/distortion.	30 +/- 5 dB
5	Speech easily understood.	>33 dB

Conversions in the following table shows the typical RSSI vs SINAD conversion measurements on Tait TB8100/TB9100 transceivers which are similar to those used in the drive testing.

SINAD to RSSI Conversions for Tait TB8100/TB9100 Transceivers	
SINAD	**RSSI**
20	-106.4
18	-110.2
16	-112.9
14	-115.6
12	-118.2
10	-120.4

Findings and Recommendations

Several findings were identified through the project both during meetings with the KITTOCM team as well as during on-site visits, site assessments, and during the drive testing. All findings and associated recommendations are identified within this section.

System Infrastructure

Finding: The KITTCOM Simulcast system is an ageing radio system. Some elements of the system are functioning with legacy equipment dating back to the 1980's that is past manufacturer end of life and is no longer being supported or repaired.

Recommendation: Aging equipment should be replaced on a phased replacement cycle (recommend 5-7 years) so adequate budgeting can occur and equipment replaced over time to avoid remaining in service after manufacturer end of life. This cycle should continue for future systems. End of life equipment can pose an increased risk of failure, extend system down time, and pose a cybersecurity threat when it is no longer supported for software and firmware upgrades.

Recommendation: Current VHF Simulcast infrastructure should be replaced with modernized equipment utilizing current industry standards and technologies. *See more detail on this in the Determining the Best Technology section.*

Finding: It was identified that in the past, some elements of the system were procured from secondhand marketplaces (e.g., online, etc.) and installed into system infrastructure without proper bench testing to confirm proper operation and calibration.

Recommendation: It is best practice to avoid using secondhand equipment on life safety communications systems whenever possible. All equipment should be bench tested for proper calibration and standards prior to installing to the system infrastructure.

Finding: Tower site facilities contained unused and out of service equipment in available rack space mixed with in-service equipment.

Recommendation: Remove out of service equipment when it is no longer in use. This allows for:

1. More timely troubleshooting of in-service equipment for outages and preventative maintenance.
2. Decrease risk of accidentally impacting in service equipment when working around out of service equipment (e.g., catching a cable, etc.).
3. Increase available rack space and floor space in tower buildings and infrastructure rooms for future technologies or system expansion.

Finding: SignalPro RF analysis and on-site drive testing confirmed some areas of simulcast interference and areas of limited or no outdoor coverage along major throughfares even with a mobile unit.

Recommendation: Improve simulcast site time delay interference areas (shown in Figure 4 above) to alleviate interference-caused audio degradation resulting in unintelligible transmissions or lower DAQ. Some potential options to control TDI are:

- Design to minimize overlap areas.
- Consider using lower sites and/or directional antennas.
- Precise failure repair and preventative maintenance is critical.
- Consider using lower power and directional antennas.

Recommendation: Explore options for additional sites to improve coverage. In the interim, work with stakeholders to standardize a PACE plan (Primary, Alternate, Contingency, Emergency) to ensure a unified approach to continue communications with dispatch and other field units.

Finding: Much of the current radio infrastructure service is handled by part-time in-house technicians. As a result, the available time technicians have is limited to do the necessary work. The current tech team has been “catching up” with “cleaning up” numerous outdated wiring and system features. At the same time, they have been dealing with issues that develop within the system. These activities are hard to keep up while using part-time technicians on the current radio system.

Recommendation: KITTCOM administration should identify and catalog the work the technicians currently do and the actual time involved in doing it. What is not being accomplished from a service standpoint also needs to be identified. Once the data is gathered the administration should determine expenses in the current environment, then project the costs of an ideal maintenance and repair environment utilizing the in-house technicians but allowing more time to be expended.

In addition to adding more work time to the existing maintenance environment, the administration should investigate outsourcing maintenance and service work. There are multiple models to consider such as complete maintenance contracts that cover preventative maintenance work and emergency repair response. The qualification and reputation of any contractor should be thoroughly investigated to include background checks of those technicians that are supplied to work in the facility. Parts, labor, and travel are all items that need to be considered. The administration needs to look at multiple items including but not limited to: quality control, response time, overall cost, security risks, inhouse knowledge and system familiarity vs. contractor knowledge, and problems with internal communication vs. external. The time needed to perform preventative maintenance is important.

Finding: KITTCOM technicians commonly use personally owned or agency borrowed test equipment to maintain the system. It is not always possible to determine the level of calibration of personal or borrowed test equipment. In the testing of a public safety LMR system it is important to utilize the most accurate testing possible to ensure proper function.

Recommendation: Procure and utilize agency owned test equipment for the preventative maintenance of system infrastructure. Calibrate test equipment on a regular cycle using third-party vendors who can certify accuracy and calibration. Agency rental or lease of equipment that is certified with proper calibration is another feasible option which may be more cost effective.

Recommendation: Establish and maintain a standard preventative maintenance cycle for system infrastructure to ensure all sites are tested to meet operational standard on a regular schedule. Repair/replace/recalibrate/realign equipment, as needed, when issues are identified and document accordingly to establish maintenance history log.

Finding: Until recently, KITTCOM system infrastructure has been fixed using “patch and fix” approach utilizing available components at the time of repair to keep the system online and there are limited standards for infrastructure equipment and hardware.

Recommendation: Develop a standardized list for infrastructure parts and keep spares on-hand to improve cost effectiveness and improve repair times.

Recommendation: Consider pre-staging of standardized spare equipment across multiple storage sites to decrease repair times and allow for a secondary location to obtain parts during a disaster in the event the primary site is unable to be accessed.

Fix It or Forklift

Finding: Key elements of the system are beyond end-of-life, yet certain elements of the system are still supported. System management is working on a comprehensive plan that fully evaluates the system. Based on evaluation, management will determine what funding is necessary and how to procure required funding.

Recommendation: Develop a project plan for a phased approach for replacement of the legacy system over a managed period that considers funding procurement and system aging. The phased forklift approach will allow for continued operation of the system as specific sites or elements of the system are replaced. A detailed transition plan will need to be established with both stakeholders and replacement vendors to ensure a complete understanding of the transition process.

Recommendation: Consider prioritizing existing system mitigation measures (e.g., power resilience, hardening, etc.) as initial steps to the phase forklift replacement. This will allow for improving system resiliency and known gaps while working through the procurement process for system replacement. Once the new system is in place, initiate and sustain a phased replacement cycle as mentioned previously under System Infrastructure.

Finding: Complete system documentation is not available. The technicians have an ongoing process to trace various elements of the system and document as their limited time allows.

Recommendation: Develop as-built documentation for existing system. Include line item in future system upgrades/replacements to include documentation as part of purchase contract requirements.

Determining the Best Technology

Finding: Based on Signal Pro RF Analysis of the KITTCOM Simulcast System in VHF (current frequency band in use) when compared to 800 MHz, the coverage would dramatically decrease if transitioned to 800 Mhz.

Recommendation: Focus on solutions that are simple and involve the "basics" of coverage and operability. Other than areas that are simply not covered by the current system, the combination of VHF frequencies with a simulcast system design function well in area of operation.

Recommendation: While some 700/800 MHz is identified in use in surrounding areas, we recommend continued use of VHF spectrum for the KITTCOM System. As coverage mapping indicated, the use of 800MHz would require the use of significantly more infrastructure.

Finding: KITTCOM stakeholders identified significant interest in advanced P25 features for Law Enforcement subscribers and the urbanized area (e.g., geo-location, radio identification (ID) management, emergency alerts, etc.); however, limited interest was identified for these features across fire, emergency medical services (EMS), and other public safety users in rural areas due to the increased costs of P25 subscriber equipment.

Recommendation: Consider a hybrid system allowing for P25 simulcast for law enforcement subscribers enabling access to P25 features while continuing use of VHF analog simulcast for fire, medical, and other rural public safety responders. With this hybrid approach, existing VHF analog simulcast infrastructure should be modernized to current industry standards and legacy equipment should be phased out.

Recommendation: Research the use and benefit of new smart connect style Internet Protocol (IP) technologies (integrated into P25 LMR), satellite via cellular, and cellular High Power User Equipment (HPUE) equipment to enhance system coverage in areas where there is no LMR coverage and adding additional tower infrastructure may not be feasible.

Coverage Improvement

Finding: As indicated in the coverage maps and the drive tests, coverage in areas of the jurisdiction was non-existent.

Recommendation: Additional satellite receivers and or transceivers will be needed to provide coverage. The use of microwave backhaul is still the preferential method for linking the infrastructure. All proposed sites should have a coverage study performed to show the projected impact of adding the site.

System Backhaul

Finding: Microwave has proven to be a good method of backhaul. Some sites are shared.

Recommendation: Continue to add microwave backhaul, where possible, as new sites are added. Evaluate the current microwave system for an upgraded modern solution utilizing current industry IP and topography standards.

Recommendation: Establish a KITTCOM owned and managed microwave backhaul solution for all sites. Continue to use existing backhaul partnerships with Washington Department of Transportation (DOT) and Washington State Patrol as secondary paths. Upgrade DOT backhaul connections to their current IP standard requirements to allow phase out of their old system.

Cybersecurity and Physical Access

Finding: Some current infrastructure buildings were shared access facilities.

Recommendation: Consideration should be given to hardening of infrastructure security. Secure KITTCOM rack space at shared access facilities to control access to KITTCOM equipment. Upgrade to key card access where possible to allow for better visibility and control of building access. Add access notification to any supervisory control and data acquisition (SCADA) data systems where the systems are available. Access control and monitoring should also be planned for new facilities.

Finding: Remote managing and monitoring of some LMR system elements is conducted due to the location and difficulty to access the sites. Additionally, remote management is crucial for the winter season when sites are snowbound and inclement weather may impede or significantly delay access.

Recommendation: Expand remote monitoring ability to allow visibility of additional LMR systems element status [e.g., commercial power, generator, Uninterruptable Power Supply (UPS), transmitters, voters, solar systems, Federal Aviation Administration (FAA) lights, etc.]

Recommendation: Conduct third party cybersecurity audit of radio system and infrastructure facilities to identify potential security gaps and mitigate as required.

Power Resiliency

Finding: Power resiliency varied from site to site. Some facilities had generators with UPS while others only had UPS. Some sites had no backup power solution in place.

Recommendation: Standardize power resiliency topology across all sites.

Recommendation: "Resilient Power Best Practices for Critical Facilities and Sites" from CISA should be consulted to provide guidelines for site power standards.

Subscriber Unit Standardization

Finding: A wide variety of subscriber devices are used on the KITTCOM LMR system. They range from lower power (e.g., 4 watt portables to 100 watt mobiles).

Recommendation: It is important when using a VHF LMR Simulcast radio system to use the minimum amount of transmit power necessary from subscriber devices to access the system. The use of high-power mobile transmitters can cause the system to operate ineffectively. KITTCOM and its users should standardize specifications and technical settings for subscriber devices.

Recommendation: Consider using available stakeholder and interoperability committees to help establish the subscriber standards for all subscriber devices used on the system including antennas. Less than "public safety grade" subscriber devices should be avoided.

Recommendation: Coordinate with vendors to establish radio packages that meet the established standard and negotiate discounted pricing which all stakeholders can utilize. This can allow an agency to purchase a radio directly from vendor(s) while still meeting the KITTCOM system standard.

Recommendation: All subscriber devices should receive preventative maintenance including testing and alignment on an annual basis.

Interoperability

Finding: Interoperability is possible among mutual aid response agencies; however, channel usage is not standardized, and coordination is limited. There is limited use of national interoperability channels among response agencies.

Recommendation: Consider inclusion of tactical repeaters at KITTCOM simulcast sites programmed with national interoperability channels which can be activated or patched as needed to support interagency communications.

Recommendation: Develop standardized interoperability zones for programming in any agency subscriber units based on radio band capability. Standardize channel labeling based on Association of Public-Safety Communications Officials (APCO) / National Public Safety Telecommunications Council (NPSTC) 1.104.2-2017, when applicable.

Recommendation: Develop a No-Notice ICS-205 Radio Communications Plan for daily operations and initial incident response. Collaborate with stakeholders to develop common understanding and usage guidelines. Integrate the communication standard into training and exercises in accordance with Federal Emergency Management Agency (FEMA) Homeland Security Exercise and Evaluation Program (HSEEP) training practices.

Recommendation: Build area Communication Unit Leader (COML) coordination working group to promote shared communication practices and channel deconfliction practices during incidents with partners. Consider ICTAP TA service offerings for Communications Unit (COMU) training if required.

Acronyms

Acronym	Definition
APCO	Association of Public-Safety Communications Officials
CISA	Cybersecurity and Infrastructure Security Agency
COML	Communications Unit Leader
COMU	Communications Unit
DAQ	Delivered Audio Quality
DOT	Department of Transportation
dB	Decibel
EMS	Emergency Medical Services
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
GIS	Geographic Information Systems
HPUE	High Power User Equipment
HSEEP	Homeland Security Exercise and Evaluation Program
ICTAP	Interoperable Communications Technical Assistance Program
ID	Identification
IP	Internet Protocol
LMR	Land Mobile Radio
P25	Project 25
MHz	Megahertz
NIWC	Naval Information Warfare Center
NPSTC	National Public Safety Telecommunications Council
POC	Point of Contact
PACE	Primary, Alternate, Contingency, Emergency
RSSI	Received Signal Strength Indicator. It is a more common name for the Signal value; meaning it is the strength that the device is hearing a specific device or signal.
SCADA	Supervisory Control and Data Acquisition
SINAD	Signal-to-Noise and Distortion Ratio. It is a measure of audio quality used in low signal-to-noise ratio situations such as radio communications systems.
TA	Technical Assistance
UPS	Uninterruptable Power Supply
VHF	Very High Frequency