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## *Pacific Consulting Services*

# **LARIMER COUNTY RADIO SYSTEM STRATEGIC PLAN**



*Larimer County, Colorado*

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## Executive Summary

### Purpose

Larimer County officials are in the process of evaluating future paths for their VHF radio communication system. The current system has served them well for many years and continued to improve until approximately twelve years ago when at its peak in performance, it began a slow but steady decline.

There are primarily two reasons for these system performance limitations. Where communications had been acceptable, they are now marginal. An ever-increasing noise level and a greater number of neighboring systems (paging, commercial, and FM broadcasters) have continued to interfere with system performance. This coupled with increasing population and greater interest in outdoor activities in the County, has created a need to communicate in areas that the radio system was not originally designed to cover.

Over the years, tower sites, voting receiving systems, transmitter steering controls have been integrated into the system in order to improve performance. As with all technology to date, these improvements allowed Larimer County to maintain an acceptable level of performance. These changes have also created a more complex system overall. The decision now, is whether to continue down this path in the VHF spectrum or to work towards different design alternatives.

Over the past decade, public safety users throughout Colorado have been planning and discussing options available to them for upgrade or replacement of their two-way radio systems. As neighboring agencies made decisions to change their particular radio systems, it was never clear as to the best direction to satisfy the future needs of Larimer County. With the recent construction and implementation of two new 800 MHz systems, one by the Northern Colorado Regional Communications Network (NCRCN) and the other by the Cooperative Communications Network of Colorado (CCNC), the problem of interoperability and the question of future system direction have come to the forefront.

Changes in FCC regulations and technology have spurred planning toward a statewide 800 MHz trunking system (CCNC). Many agencies have chosen to participate in this statewide system, while others have taken a more “wait and see” approach while continuing to upgrade their VHF and UHF systems. With this, Pacific Consulting Services was contracted to evaluate the current County system, to review the two 800 MHz systems and conduct a study that would weigh the advantages and disadvantages of the County’s participation in either of the systems or to improve their current VHF system with a method of maintaining interoperability with the 800 MHz systems.

Not all agencies have chosen to move to the 800 MHz systems. USFS, RMNP and Boulder County, for example are planning to remain in the VHF spectrum. In time, these agencies may choose to move to the CCNC system or at least carry a trunking capable radio, however a definitive timeframe has not been established nor has any commitment been made to this effect. With this split in direction, Larimer County remains in a quandary as to the best direction to take.

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## **Findings & Short Term Recommendations**

During personal interviews, radio system users throughout the County clearly stated that their major concerns were:

- Poor or non-existent coverage in certain response areas (Poudre Canyon and Laramie River Valley, in particular)
- Lack of interoperability with surrounding agencies
- Desire for additional channels for multiple, simultaneous incidents

### ***Coverage***

The prescription for radio coverage problems in Larimer County involves the relocation of a site to a more effective location and the construction of additional sites to provide for stronger transmit and receive signals in and out of areas that now need better communications.

The short-term goals are primarily directed at the relocation of the Deadman Mountain site to South Bald Mountain and development of additional tower sites at North Middle and Green (or Red) Mountain areas. Site development will need to include site acquisition or partnership agreements, access, installation of a suitable building, commercial power, and all site equipment (transmitters, tower, antennas, cabling, etc.). Costs for each of these VHF sites, depending on location, are estimated at \$250,000 per site. This estimate may be offset if partnering is explored and costs are negotiated with interested agencies particularly at South Bald Mountain.

By developing these sites, they provide an improvement to the existing VHF system and are then available to a trunking system should Larimer County decide to move to that platform. It is conceivable that as a site is developed, perhaps in partnership, trunking equipment may be installed by the CCNC system to be co-located with the County's VHF equipment.

There has been an expressed concern by some Larimer County users that moving to an 800 MHz system will not necessarily provide additional coverage and features and will, most certainly, require large amounts of unavailable capital. These same users believe that VHF is the appropriate spectrum for their operations. Once the trunked system is live and established in co-located County sites, actual field testing can be done to validate the suitability for Larimer County's needs and the additions required to it to meet those needs.

### ***Interoperability***

Interoperability, by definition, is the ability for different agencies and departments to communicate internally and externally. This holds true within Larimer County, as evidenced by the Road & Bridge and Natural Resources Departments not having the ability to communicate directly with the Parks, Sheriff's and other departments within the County. Interoperability has always been a problem between Larimer County on VHF and Weld County and the City of Fort Collins operating on UHF.

Full interoperability is accomplished by having all agencies sharing the same radio system. Barring that, at least having all users in the same spectrum would provide some

ability to talk among users on different systems. The existing mixture of systems in use today makes full interoperability difficult without requiring users to carry multiple radios for use on each system.

Agencies across the country have attempted to provide interfaces and console patching to link VHF and 800 MHz systems together. Although this can work in the short term for specific incidents, it is considered a “band-aid” approach and should not be employed as a permanent solution to interoperability.

### ***Additional Channels***

Some users of the Larimer County system desire additional channels. This is particularly true when multiple incidents occur simultaneously. The availability of additional VHF channels has been and still remains very limited along the Front Range and is not likely to change appreciably unless agencies moving out of the spectrum release their licenses. As other agencies move away from the VHF to the 800 MHz spectrum, more frequencies may become available, but this remains a slow and time consuming process

### **Long Term Recommendations**

Pacific Consulting Services sees great value in the long-term goal of participation in a multi-agency 800 MHz trunking system. The immediate capital investment required for such participation is extensive however. Immediate needs of improving coverage, establishment of non-existent coverage, and the enhancing of system performance are better addressed through short-term means. These short-term goals must be met regardless of whether Larimer County remains in VHF or moves to a trunking system.

Advantages are numerous to participating in a trunked system in the future. In addition to improving interoperability, coverage and additional channel capability, other features include a more simplified, automated system that is less prone to operator error. The same style and age of radio would be available for all users for the first time. Enhanced features would include data transfer, unit to unit communications, encryption, unit identification and emergency alert to name a few. All these features are readily available in a trunked system.

At the time that Larimer County considers moving to the trunking system as their primary radio system, all portable and mobile radios will need replacement. An estimated cost of \$1,000,000 for existing Larimer County mobile and portable units will be needed as well as, an additional \$400,000 for mobile and portable units for the rural fire district users.

Trunking site equipment at Larimer County sites that have not already been incorporated into the CCNC system will need purchase and installation. Estimated cost for this equipment is \$500,000 per site. Again, partnering with other interested agencies at these sites may allow for cost sharing. For example, both Horsetooth and Buckhorn Mountains are of interest to the CCNC system and can offer some relief in terms of capital cost. South Bald is and Middle Mountain may be of interest also, providing additional opportunity for assistance in cost sharing. The existing site on Cactus Hill may of interest to the City of Fort Collins.

Estimated costs for establishing Horsetooth Mountain, Buckhorn Mountain, Middle Mountain, Green (or Red) Mountain, Cactus Hill and South Bald Mountain, the purchase of mobile and portable radios for all users is estimated at \$4,000,000. Other agencies have committed similar funding to construct an existing network that appears along the Front Range and is planned to cover the entire State of Colorado. Their investment provided for a system controller and the existing sites that offer coverage throughout the system and within Larimer County.

In addition, the trunked systems in question require a subscriber fee of \$420,000 per year based on the number of units added to the system. These fees may also be negotiable based on the contributions to the infrastructure.

By approaching the long-term goal of participating in a trunking system in this manner, Larimer County is better able to budget in more manageable amounts for system upgrade while maintaining a usable radio system. In the meantime, the trunking systems in question (NCRCN & CCNC) will have merged and matured in terms of established infrastructure, organizational structure, by-laws and governance methods. System performance will be documented and necessary sites will have been established that directly affect the users of Larimer County.

It must be stressed that the radio system, whether it be VHF or 800 MHz trunking must be viewed as a functional, useful tool for all users. The system must provide the necessary features as seen by various users from its inception or it will be considered faulty. System coverage must remain the highest concern, for without it, any other feature of the system is meaningless.

## 1.0 Introduction

### *County Information*

Larimer County, Colorado is the seventh largest county based on population and is located in the north central portion of the state. The county extends to the Continental Divide on the west and includes several mountain communities as well as, the Rocky Mountain National Park. Larimer County encompasses 2,640 square mile including irrigated farmland, vast stretches of scenic ranch land, forests, and high mountain peaks. Over 50% is publicly owned, primarily in the Roosevelt National Forest and the Rocky Mountain National Park. In addition to these federal lands, Colorado State Parks and Recreation Area, Larimer County parks and local parks within urban areas combine to provide a wide spectrum of recreational opportunities enjoyed by residents and visitor alike. The County has many large employers including Hewlett-Packard, Anheuser Busch, Teledyne WaterPik and Colorado State University. Although Larimer County has retained an agricultural atmosphere, the labor force is not quite diverse working in both the tourist industry and high tech fields.

Larimer County includes numerous cities and towns such as:

<u>City/Town</u>	<u>Population (1999)</u>
Berthoud	4,407
Estes Park	4,821
Fort Collins	115,630
Loveland	49,331
Timnath	231
Wellington	2,151
Windsor	10,000
Unincorporated	66,029

### *Current Radio System Descriptions*

The Larimer County radio system is comprised of five (5) tower sites located on Buckhorn Mountain, Cactus Hill, Deadman Mountain, Horsetooth Mountain and the communication center in Fort Collins. Each site is equipped with commercial power with the exception of Deadman Mountain, which is solar powered only.

The system is composed of several different conventionally designed VHF simplex and repeated channels with differing capabilities and configurations. Voting receivers are used in conjunction with a repeated system in order that all receivers on a particular channel may contribute their signal reception to the system and the best quality reception is “voted” and supplied to the dispatcher to hear at the same time it is provided to the repeater transmitter for retransmission.

Repeated and voted radio system configurations are designed to allow a portable radio to communicate over large countywide areas. Public Safety service providers are relying more and more on portable radios for their communications requirements.

The Parks Department radio system consists of one simplex VHF frequency and one VHF repeater located on Horsetooth Mountain. Together, these offer adequate coverage in the Horsetooth and Carter Lake parks areas. The Parks Department operates on a repeater at the Horsetooth site and on a simplex frequency of 154.115 MHz.

The Public Works radio system is comprised of two Lowband repeater channels with talkaround capability. One repeater is located on Buckhorn Mountain and provides coverage along the Front Range and middle mountain areas. The other repeater is located on Deadman Mountain and covers the northwest Larimer county area.

The Sheriff's department's main dispatch channel 2 is repeated and has the most extensive system of voted receivers and multiple automatically selected transmitters located at most of the County's available sites. Channel 3 is used, as a voice channel for passing voice data and is a simplex channel with voting receivers and transmitter selection. Channel 4 is the FireNet channel used for dispatching fire agencies throughout the county and has voting receivers and transmitter selection. As the fire agencies are dispatched on Channel 4, they then move to other tactical channels for interdepartmental or tactical communications. Channel 4 is similar to Channel 2 in the extensiveness of the equipment throughout the available sites in order to provide both mobile and portable operation throughout the county.

Channel 1 is configured as a standalone base station at the Horsetooth site and is primarily used for foothill and east county radio coverage.

The County Corrections facility uses a VHF repeater frequency and radiax cable for radio coverage within the jail with little radio coverage outside the facility.

The EMS channel (155.340 MHz) has equipment on three sites and is voted and transmitter steered based upon voting selections.

The Road and Bridge Department operates on a low band VHF frequency of 45.02 MHz. The availability of equipment decreases each year as many manufacturers have dropped production of radios in this spectrum. Over the years agencies have moved from this spectrum because of its susceptibility to interference, propagation fluctuations, physically large awkward antenna requirements and interest in migration to advanced systems developed in the higher frequency spectrums. The Road and Bridge system consists of a control station on Cactus Hill that can transmit direct or through repeaters established in the Deadman and Buckhorn sites. Offices are wired with remote controls that are connected to the control station on Cactus Hill. The channel is shared with the operations of the Larimer County Natural Resources Department.

## 2.0 Agency Interview Data Collection

The following is a collection of information gathered during interviews with primary agency and department representatives. The agencies identified are those with critical roles within and surrounding the Larimer County radio system. The information was current at the time of the interviews and may have changed as a result of developing systems and conversations to date. Needs and basic requirements remain the same however the final recommendations reflect the updated information.

To begin, each participant interviewed appeared willing to candidly discuss their experiences and desires with regard to the public safety radio systems in use in Larimer County. Each had a personal and specific view of the system as it pertained to them and was able to offer perspective that will ultimately be combined to form the overall recommendations. Participants included representatives from the Sheriff's Office, Information Management Services, Department of Natural Resources, and the communication center, Engineering, Road & Bridge Department, Emergency Management and the Parks Department. Agencies within and surrounding Larimer County were also contacted including Loveland Police Department, Weld County Sheriff's Office, Boulder County Sheriff's Office, US Forest Service, Rocky Mountain National Park, State of Colorado Telecommunications Services and Motorola Communications and Electronics Inc.

### 2.1 Larimer County Information Management Services Department

Date: 8/7/00

Interviewed: Andy Paratore, Gary Janezich and predominantly, Mike Slavick

#### **Project Purpose**

Discussions centered on the history behind the decision to conduct this study. The Information Management Services Department has been monitoring and to some extent participating with the planning and design of the various communications systems of the neighboring agencies throughout the last several years. As neighboring agencies made decisions to change their particular radio systems, it has never been clear as to the best direction to satisfy the future needs of Larimer County. With the recent construction and implementation of two new 800 MHz systems, one by the Northern Colorado Regional Communications Network (NCRCN) and the other by the Cooperative Communications Network of Colorado (CCNC), the problem of interoperability and the question of future system direction came to the forefront. With this impetus, Pacific Consulting Services was contracted to evaluate the current County system, look into the two 800 MHz systems and conduct a study that would weigh the advantages and disadvantages of the County's participation in either of the systems or to improve their current system with a method of maintaining interoperability with the 800 MHz systems.

## **System Description**

The current Larimer County system is composed of several different conventionally designed VHF simplex and repeated channels with differing capabilities and configurations.

The later discussions with Mr. Mike Slavick involved more of an overview of the various systems in use by the departments and some description of the timeline and intention of the development of the various County radio sites.

Mr. Slavick explained that the Sheriff's department's main dispatch channel 2 is repeated and has the most extensive system of voted receivers and multiple automatically selected transmitters located at most of the County's available sites. Channel 3 is used, as a voice channel for passing voice data and is a simplex channel with voting receivers and transmitter selection. Channel 4 is the FireNet channel used for dispatching fire agencies throughout the county and has voting receivers and transmitter selection. As the fire agencies are dispatched on Channel 4, they then move to other tactical channels for interdepartmental or tactical communications. Channel 4 is similar to Channel 2 in the extensiveness of the equipment throughout the available sites in order to provide both mobile and portable operation throughout the county.

## **System Coverage**

The current Larimer County radio systems achieve approximately 90% mobile radio coverage throughout the county. This has been accomplished over the years with the addition of radio sites and equipment. Portable radio coverage is not equal to the mobile coverage due to the limitations of antenna and transmitter power available with portable radios. When compared to a mobile radio with an efficient gain antenna mounted on a metal vehicle with a 100 watt transmitter, a portable with a 6 inch antenna on a plastic case with a 5 watt transmitter, it is very clear why achieving the same radio coverage with a portable radio requires an extensive system beyond that for a mobile radio.

## **System Challenges**

When asked what the primary challenges with the current County radio systems were, the responses revolved around the size and topography of the County, site and frequency availability and the ever-increasing interference on the VHF spectrum. Each of these influences created difficulties for the field units.

An example of the challenges involved in establishing radio communications in Larimer County is the Sheriff's Department Channel 2. The channel is designed in such a way that the default transmitter site is Cactus Hill, which doesn't always provide a good signal for reception throughout the entire county. When transmitting from the Cactus Hill site, monitoring the channel in some parts of the county reception is difficult but when the appropriate transmitter is selected for the area the unit is in, communications are good. Replacement transmitter steering equipment is being installed that has the ability to better control the selection of transmitters based upon voting receivers, but the situation of the default transmitter will still persist. Consideration is being given to changing the default

transmitter to one that provides for better reception throughout areas that a majority of the field units are located in, but doesn't provide the signal throughout the entire county as well as the Cactus Hill site. A negative impact of this is that the channel will require the dispatchers to manually select the Cactus Hill transmitter to contact units in the areas not covered by another transmitter. With the use of the Cactus Hill transmitter at least everyone receives some level of signal, even though it may not be as clear as desired.

Seventeen (17) digital radios have been purchased and introduced into the system without activating the digital features. A problem with the scan function of the radios is causing the loss in reception of the first few words of transmissions and is making the scan features of the radios almost unusable. The manufacturer and the County IMS technical personnel are pursuing a solution to the problem.

### **Future Planning**

Mr. Slavick has been involved with the various agencies developing the NCRCN and CCNC systems since their inception. His overall concern for all County radio systems is that any changes should not just equal the capabilities of the current systems but also improve upon them. With the investment required to make major changes in the radio systems an improvement in coverage, interoperability and features is a necessity. For Larimer County to participate in any other radio system they would look for 95% portable coverage within the area of responsibility including the mountain agencies. Motorola has indicated that this could be achieved with the implementation of some 12 sites. This cursory determination was made with the unconfirmed availability of a list of potential sites supplied by Larimer County.

A new site on South Bald Mountain is being discussed between the State of Colorado, City of Fort Collins and Larimer County. So far, thoughts run to the State providing the tower, the City and County providing the road and building for the site. The most expensive item is obtaining power to the site estimated to be approximately \$50,000. The availability of the site comes up on next year's US Forest Service agenda.

The Larimer County dispatch center was relocated in January 2000. The move provides the addition of several pieces of new equipment and capabilities. Significant to this is the upgrading of the console software to the Motorola Centracom Gold Elite™ and the installation of dual central electronics banks in the equipment room. This dual CEB arrangement will allow the consoles the capability to operate on the Northern Colorado Regional Communications Network (NCRCN) trunked 800 MHz system via a T-1 connection into the Platte River Power Authority. This will allow monitoring as well as full operation from the communications center to those agencies participating on this system. It also provides for an extremely limited form of interoperability by manual temporary console patching with those agencies on Larimer County's system.

By establishing this connection into the NCRCN system, it allows the Larimer County Communications Center to provide backup facilities to the Loveland and Poudre Emergency Communication Emergency Communications Centers. To facilitate this capability and to further interoperability among the agencies, the Larimer Emergency Telephone Authority (LETA) provided \$100,000 toward funding the connection to the NCRCN system. Should the communications center drop this capability, the funds

provided for this purpose would need to be repaid to LETA. Rich Riley and Ron Lutz, both engineers with Motorola, were instrumental in the equipment design that provides this interconnection.

## **2.2 Larimer County Sheriff's Department**

Date: 8/8/00

Interviewed: Sheriff James Alderden, Steven Bebell and Bill Nelson

### **System Concerns**

#### **Interoperability**

When asked what the number one concern about the department's existing communications system is, the answer was a lack of interoperability with surrounding agencies. With the changes being made by neighboring agencies, it is feared that interoperability will be affected. With the exception of the City of Fort Collins, direct communications was possible with most every agency operating in the County because they all operated on conventional VHF systems. As these agencies change their radio systems, this direct communication is lost. The Sheriff's department is concerned as to the direction their communications system should take to maintain and reestablish this interoperability. They are aware of the plans of the Colorado State Patrol and other state agencies such as Department of Wildlife moving to a statewide 800 MHz trunking system. Even though these agencies will most likely maintain a second radio in their vehicles to continue their interoperability with VHF agencies, there will be a loss in the ability of the Larimer County agencies to monitor CSP normal communications and to stay informed of situations developing around them. This has been a concern all along with Fort Collins Police Department and was pointed out that many a time, a County Deputy has assisted a Loveland PD officer as a result of being able to monitor a dispatched call and respond. Now this monitoring is lost with their move to the NCRCN system. The same is true with County and CSP officers providing backup for each other on traffic stops within the County.

#### **System Performance**

The second concern is the diminishing capabilities of their current system. Since the first radio was installed in Larimer County the communications system has been in a steady state of advancement until approximately twelve years ago, when at its peak in performance, it started a very slow but steady decline. Where communications before were acceptable, they are now marginal. This decline in system performance is acknowledged by the technical department and is attributed to changes of the noise environment in the VHF spectrum and has become their greatest challenge in maintaining the performance of the system.

Observations indicate that it is more commonplace to be able to only hear one side of a conversation, usually only the dispatch side. This is not uncommon on simplex channels but is also being experienced on the repeated channels. The reason being that the field radios are not receiving as well as they once did. This may be due to environmental interference and the increased popularity of the use of remote speaker / microphones on the portable radios fastened to the belt. The human body shields the radio antenna

requiring higher signal levels to properly receive. These performance observations have the effect of highlighting the limitations of the radio system.

### **Coverage**

One area identified needing improved system coverage is the Laramie River Canyon and this was emphasized by a recent search and rescue operation. As the population in Colorado grows so do the incidents in areas that were seldom visited. There are now areas that the communications system wasn't expanded to cover or used to cover and no longer does.

The solar powered Deadman site was identified as a system restriction because of its power limitations but also as an asset because it provides radio coverage into areas that are unavailable from any other County site.

### **Cost**

When the discussions turned to the other systems being developed in the area, the subject of cost arises. Cost of moving to a new system for the Sheriff's Department becomes a serious consideration due to the number of radios when compared to those of other departments throughout the County. There are more mobiles and portables in the Sheriff's department inventory and any other County department. The Sheriff's Department and the fire districts are the largest users of the County radio systems.

### **Future Planning**

What the Sheriff's Department would like to see in their future communications system is reliable, consistent communications throughout most areas of the county and the ability to communicate and monitor those agencies with which they interface. To do this requires consideration of the developments in the NCRCN and CCNC systems.

Mobile data communications is seen as method of operating more efficiently and to reduce the workload of the communications center that continues to steadily increase year by year.

## **2.3 Larimer County Communications Center**

Date: 8/7/00  
Interviewed: Ms. Diane Jaso

The Larimer County communications center is currently set up with 4 positions of Watson furniture and Moducom console electronics. The layout is efficient and provides adequate workspace with a center rotating resource center in the middle of the consoles accessible to all. A small supervisors office is provided near the center itself.

The communications center operates with 14 full time employees and normally has two on duty.

The radio dispatcher is responsible for LCSO 2, Firenet, NLEC and CLEER channels.

LCSO 2 will typically have four deputies, two sergeants, one traffic officer, one fugitive officer, a mountain deputy and after 5:00 pm, Berthoud Police officers. The Berthoud Police Department does it's own dispatching during normal business hours. After 5:00 pm the County provides the service.

The call taker / dispatcher will do the NCIC / CCIC inquiries and take over the FireNet channel during a fire incident.

The data voice channel (LCSO 3) is used by several agencies to do queries from NCIC and CCIC. Among these agencies are of course the Sheriff's Department, the County Parks Department, Berthoud Police Department (after hours) and the State Parks rangers as well as some instances where the State Patrol troopers are in locations where they are unable to access their own system.

The Sheriff's deputy assigned the Estes Park area is dispatched via the Estes Park Police department communications center.

The communications center is relocating in January 2000. The new center will have six (6) radio console positions and two (2) call taker positions. It will also use Watson furniture, but the console electronics will be Motorola Centracom Elite™. The selection of Motorola radio console electronics makes the interfacing with the CCNC system easier and is the same electronics used by the Poudre Emergency and Loveland Communications Centers, thereby complimenting the plan to provide the ability to act as backup for the other centers.

The channels available on the consoles currently are Larimer County Sheriff's Department channels 1,2 & 3, FireNet, Larimer County Tactical, CLEER, NLEC, EMS, USFS and the Road and Bridge channel.

The consoles have the ability to control all the voting receivers on each channel and to manually control the transmitter selection for each channel. Due to the number of receivers and transmitters this control system has a level of complexity that requires training and regular use to stay proficient. The technical department provides four hours of system training to dispatchers in order to explain the various and numerous system capabilities such as the voting and transmitter control system.

As part of the new communications center equipment and as improvements to the current radio systems, new transmitter steering controls are being purchased that allows for a better control of the automatic transmitter selection for each channel.

The Forest Service radio system control station is tied into the communications center via a phone line from their communications center across town.

The Colorado State Patrol several years ago discontinued using their Channel 3 as a mutual aid channel and at that time the communications center lost radio capability with the field units and now communications is conducted with their communications centers via phone and radio channels such as NLEC and the Colorado Law Enforcement Emergency Radio (CLEER) channel.

The National Law Enforcement Channel (NLEC) used for mutual aid communications between agencies has two transmitter locations to select from.

The EMS channel north is used for medical calls

### **System Needs**

When asked what comes to mind when considering improvements to the existing systems, suggestions included:

- Having more channels available. This is based upon situations where several incidents are occurring simultaneously, large incidents with several departments involved or special operations that need to be conducted off the primary channels. The channels get extremely busy and the ability to separate the various communications would be helpful.
- Improvement to the system design that would prevent the unexpected automatic transmitter selection that causes reception problems for field units. This problem is being addressed by the installation of new more intelligent steering equipment and with reconsideration of designated default transmitters.
- A communications center concern is the limited radio interoperability with Ft Collins PD. The communications center has to monitor and relay information to County officers. With Loveland and other agencies moving to the NCRCN and CCNC systems this monitoring and relaying will increase.
- Improved mountain radio coverage with the Fire agencies especially with portables in locations such as Poudre Canyon, which continues to experience growth in travelers especially on weekends.

## **2.4 Larimer County Emergency Management**

Date: 8/7/00  
Interviewed: Don Griffith

### **System Use**

Emergency Management personnel work and communicate with many different agencies throughout Larimer County. With the Dive and Search and Rescue teams, wild land fire suppression responsibilities the department requires the use of most every channel available in Larimer County to include, all LCSO channels, Firenet, FERN 1&3, EMS, Poudre Fire Authority (PFA), Mountain Rescue Association (MRA), USFS, Rocky Mountain National Park (RMNP), Loveland Rural Fire's VHF channel and a couple probably forgotten.

### **System Needs**

#### **Channel Availability**

Even with all these channels it was expressed that there are not enough channels to operate from a tactical perspective. More available channels and improve system coverage would top the list of requests.

### **Coverage**

System radio coverage is estimated at approximately 70% of what would be desired and there are instances where a person has to be stationed at a favorable position in order to relay radio communications.

Paging system coverage in the canyons is spotty. Two satellite telephones are being used within the department with some success. A disadvantage to using satellite phones is the cost and the one on one conversation that doesn't include the other responders in the communications. On the other hand the one on one conversation does allow the transfer of sensitive information.

### **Cost**

When considering moving to a different radio system, the costs to all agencies for radios and service charges for use of the system is the major concern. Some agencies will still need to retain their VHF radios in order to maintain interoperability with agencies that stay with VHF such as the National Forest and Parks Service. This would mean dual radios installations in vehicles. The cost of trunking radios will have a serious impact on agencies such as Poudre Canyon, Livermore and Risk Canyon districts with minimal funding sources.

### **Interoperability**

Fort Collins units have had dual band radios to deal with the UHF / VHF interoperability needs of the different departments. In addition to this they will now have an 800 MHz trunked radio.

Should a trunked radio system be considered for the County, the ability to scan or monitor the activities of other departments would be seen as a requirement and is understood to have an impact on the system design.

### **Other Issues**

Mobile data is not seen as a strong need for the rural fire districts in the immediate future however emergency management could use some of it's capabilities in their support roles.

The Loveland rural fire department has VHF packsets and some VHF mobiles after their transition to the CCNC system. It has been suggested that Loveland rural is having difficulties with there new system in terms of canyon coverage and interoperability. Motorola and the CCNC have installed a temporary repeater and are developing additional sites to address this problem.

## **2.5 Larimer County Volunteer Fire Districts**

Following interviews with representatives from local districts, results were consistent among users. Their primary concerns are radio coverage. Most agencies believe the current VHF radio system comes very close to satisfying their needs. When questioned

further, every agency had a particular area that could use improved coverage. Every agency believed that VHF was the preferred spectrum for their radio system. The availability of multiple vendors and lower cost radios were a benefit to the departments restricted by donated funds.

The agencies appreciate and understand the value in interoperability particularly with the Sheriff's Office and USFS and are concerned about the loss of this interoperability should agencies change to a different system. The technical improvements that have been made over the years are recognized and appreciated and the dispatching services are quite satisfactory as well. When Poudre Fire Authority moves to an 800 MHz system, agencies that perform mutual aid are concerned about how they will communicate.

The initial problems that Loveland Rural Fire District experienced have tainted the perception of 800 MHz and trunking systems in general. Until these problems have been alleviated and the Loveland department can speak favorably of the new system, this perception will be a reality for other Larimer County users.

## **2.6 Larimer County Parks Department**

Date: 8/4/00

Interviewed: Jack Naus, Park Ranger

### **System Design**

The Parks Department has available one repeated and one simplex channel for their daily communications needs. They also have the ability to interface with the Sheriff's Department on Sheriff's Department channels and do so on a regular basis. The rangers issue citations and utilize the communications center to advise of their activities and to run NCIC /CCIC queries. The ability to perform these queries from the field via mobile data and relieve this task from the communications center would be an asset for the future.

The park rangers also have the capability to communicate with the State Division of Wildlife officers and do so frequently. The Parks Department personnel also have the capability and do communicate with the various fire districts on the Firenet channel and several tactical channels used by the fire districts. The department has the Marine channel 16 programmed into their portables and radios in three of their boats for communications between themselves and recreational boaters on the waters of Larimer County. Most every vehicle has a mobile radio installed in it, a base station at the office and many portables are used throughout the department.

### **System Needs**

#### **Interoperability**

It is apparent by the number of channels used by the Parks Rangers that they have a strong need for and an interest in maintaining their current interoperability with all surrounding agencies. They are reasonably satisfied with their radio system and those other systems on which they operate. Should the agencies they communicate change

their systems it would require that the rangers have additional radios to continue this interoperability

### **Coverage**

As would be expected, the department would like to have improved coverage especially with portable radios.

## **2.7 Larimer County Road and Bridge Department**

Date: 8/7/00

Interviewed: Dale Miller and Drew Davis

### **System Design**

The road and bridge department utilizes a fairly simple conventionally designed low band 45.02 MHz radio system. It consists of a control station located at the Cactus Hill site and a repeater at Buckhorn and another at Deadman radio sites. The control station has the capability of transmission direct as well as through the repeaters.

Most vehicles in the department have radios installed and the inventory consists of approximately 150 radios with approximately 25 portables. The radios are equipped with three channels, setup as channel 1 for repeater at Buckhorn, channel 2 for simplex or repeater bypass, and channel 3 for the repeater at Deadman. Remote control units are located in department offices and wired into the communications center consoles and control base station at the Cactus Hill radio site

### **System Concerns**

County coverage is reported as “not too bad” with some problems of noise and interference. The department’s communications requirements are predominately with mobile radios, which is easier to satisfy, unlike the public safety responders increasing dependence on portable radios. The department’s portable radios in use now experience Citizens Band (CB) like performance.

Acquiring additional equipment is starting to become a problem especially with accessories such as antennas. Purchasing equipment through used equipment sources has been fairly successful. Even though the communications center has their channel capability, the volume is usually turned down because of normal non-emergency radio traffic and therefore it is not usually possible to contact communications via radio. The communications center more often contacts Road & Bridge units rather than the other way around.

The channel is shared with the County Natural Resources department, which has a fair amount of communications traffic especially within the landfill operations.

### **Future Planning**

The department foresees an expanded use of mobile data in their operations with mapping, AVL, resource coordination, planning, remote reporting, inventory control and

analysis for costing of services. Some use of CDPD wireless data is being used for administration purposes now.

Consolidating pager, radio and phones into a single device was expressed as a desire.

Having the ability to interoperate with the various city street departments, fire districts and others at various times would be desirable.

The ability to monitor the radio system away from the hardwired remote control units is desired such as having portables that are capable of receiving and transmitting throughout the county.

## **2.8 *Larimer County Department of Natural Resources***

Date: 8/7/00

Interviewed: Steve Harem and Steven Gillette

### **System Design**

The Department of Natural Resources uses their radios primarily to coordinate operations at the landfill and also in their weed control efforts. They share the same system as the Road and Bridge department however operate more on the simplex (direct) mode rather than on the repeated countywide mode.

### **System Concerns**

The department has approximately 25 radios and should moving to a new system become a reality, the ruggedness of the radios would be of special concern. Very similar to the Road and Bridge Department, their radios are mounted in heavy machinery with dirt and vibration considerations. The department is conscious of the sharing of the channel with Road and Bridge and see value in each department having a separate channel.

## **2.9 *Larimer County Engineering Department***

Date: 9/1/00

Interviewed: Mark Peterson

The Engineering Department has approximately twelve radios mounted in vehicles; a few portables used by the survey crews and a remote base is located in the office. They share the same frequencies and repeaters as the Road & Bridge and Natural Resources departments.

The department's communications has evolved into the use of cellular phones almost exclusively. They find them convenient for departmental use and for interfacing with their customers and suppliers. The cellular coverage is good for the most part except in the mountains.

The department hasn't explored the use of wireless data but could see possibilities for the future.

## **2.10 Poudre Emergency Communications Center**

Date: 1/19/01

Interviewed: Mary Moore, Communications Manager

While working with the City of Loveland in the early planning of the NCRCN system, Ms. Moore's understanding was that the system was to be constructed during the period that the CCNC system was still searching for funding. At the point that the CCNC system was operational in the northern Colorado area, the two systems would merge. This is much like has been done with Arapahoe, Douglas and Jefferson County's systems. Ms. Moore has expressed concern to the CCNC users about the lack of structure, by-laws and regional representation noted in the system. She explained that in the November 2000 meeting of CCNC, the first draft of by-laws was presented. In the upcoming January 2001 meeting, these by-laws are slated to be the primary topic of discussion.

The City of Fort Collins is intending to participate in an 800 MHz trunking system with approximately 500 units. The original intention was to join with the NCRCN system but consideration is being given to the CCNC system now because of its technology. Final decisions have not been made as of this writing. Discussions are continuing in the upcoming NCRCN and CCNC meetings.

Discussions with Motorola concerning plans to upgrade the Poudre Valley School District radios to digital standards so that a clear path is available to migrate the NCRCN system to that of the CCNC system. This is one of the obstacles that must be overcome in order to merge the two 800 MHz systems. Federal fire grants are being pursued for the Town of Wellington in order that they may join with the trunking system along with Poudre Fire to facilitate interoperability and coordinated communication center efficiency.

Currently, the NCRCN system has expressed the possibility of joining with the CCNC system in the year 2008. CCNC system users are concerned about this delay, noting that much of the engineering is in progress and will be completed long before the merger of the two systems.

## **2.11 United States Forest Service (USFS)**

Date: 8/9/00

Interviewed: Mark Nelson

The Forest Service communicates regularly with the various Larimer County fire districts and the Sheriff's department, especially during fire incidents. Communications also occur with the Sheriff's department involving search and rescue and law enforcement incidents such as illegal cutting and trespassing.

### **System Design**

The USFS radio system for Larimer County coverage consists of a base/control station on Buckhorn Mountain with repeaters on Deadman and Twin Sisters mountains. Their current system is analog VHF and therefore allows them to communicate with other VHF agencies such as the State and County Parks departments and the Colorado State Patrol.

### **Future Planning**

The USFS is under direction from the NTIA to replace their system to 12.5 KHz narrow band technology and is planning to do so by the year 2002. Their plans are to move to a VHF digital system and will most likely operate with a dual mode backbone system until such time as all radios are replaced with digital over a ten-year period.

The USFS understands that when the Colorado State Patrol changes to their new system the patrol will most likely maintain two radios in vehicles to continue the ability to interoperate with those agencies on VHF such as the USFS using channels such as NLEC.

#### **2.12 Rocky Mountain National Park**

Date: 8/23/00  
Interviewed: Chris Holien

### **System Design**

The RMNP rangers and dispatch center primarily conduct their communications needs on their own conventional VHF system. The RMNP communications centers as well as, the ranger's vehicles have multichannel radios with the ability to monitor the various VHF agencies operating in Larimer County. The Estes Park Police Department channel is monitored frequently especially in the communications center to stay aware of events involving Estes Park and the Larimer County Sheriff's Deputy dispatched thru the Estes Park communications center.

### **Future Planning**

The National Park Service is following the guidelines set forth by the NTIA to migrate their system to 12.5 KHz narrowband technology by the year 2005. The NTIA is applying the same guidelines to all federal agencies such as the USFS, FBI, INS and Federal Marshall's Office. The RMNP foresees their system evolving in the same direction as the USFS with digital VHF radios and the system operating in the dual mode of analog and digital until such time as all radios are digital capable.

#### **2.13 Boulder County Sheriff's Department**

Date: 8/30/00  
Interviewed: Capt. Charles Pringle

### **System Design**

The Boulder County Sheriff's Department is similar to all agencies along the Front Range. They have been watching the development of radio systems around them while continuing to make improvements to their own system over the years. Boulder County and the City of Boulder have systems based within the VHF spectrum and therefore provide a high degree of interoperability.

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## **Future Planning**

Capt. Pringle continues to participate in APCO and the CCNC meetings in order to stay current with developments. At this point and after several meetings on the subject, the Sheriff's department is inclined to remain with their current VHF systems and continue to enhance them for the next ten years. In time, technology and circumstances will change and at some point the decision and direction to change the radio system will perhaps be clearer.

In the meantime, they are implementing changes to their system to improve it's operation such as adding channels obtained from those agencies moving to 800 MHz systems (Arapahoe and Jefferson Counties). These additional channels are being used to relieve loading on channels, separate operationally different agencies and to multicast the Sheriff's primary dispatch channel for better countywide coverage.

Boulder County feels that the timing is not right to invest in a major change to their communications system at this time. Their current system provides for a strong interoperability with those agencies within the county especially their fire districts and the USFS. These are the agencies that they need to communicate with on a daily basis. The understood plan is that State Patrol vehicles will have VHF radios as well as their 800 MHz radios for the next several years so that limited interoperability will continue there.

Those neighboring agencies such as Jefferson County that are migrating to 800 MHz will be missed in terms of interoperability but not so much so to offset the huge expense of a move to an 800 MHz system. Interoperability hasn't been available with Weld County's UHF system and therefore doesn't change much with their move to the CCNC system. The other side to that is that it isn't improved by Boulder County not participating in the CCNC system either.

Boulder County would like to see an interface from the CCNC system to VHF in the future and would be interested in helping to establish it. When Boulder County contemplates participation in the CCNC system, the number of available 800 MHz channels to build a wide area system, loose administrative structure and uncertain financial support for maintenance, causes them hesitation.

### **2.14 Weld County**

Date: 8/23/00  
Interviewed: Sheriff Ed Jordan

#### **Migration Plan**

Weld County is one of several counties that have joined in the partnership of the CCNC system. The City of Greeley Police and Fire Departments as well as the City of Evans, will be first on the system with the Sheriff's Department and Fire districts to follow later. Plans are for the City of Greeley to join the system in February 2001.

Weld County will be phasing in their participation over the next 3-5 years. Their procedure for acquiring the necessary mobile and portables is to not replace any equipment for the next couple of years and allow their replacement fund to build.

There are twenty three fire districts that will need to deal with radio replacement or additions and in some cases Weld County may make arrangements to lease back radios to departments.

### **System Needs**

#### **Interoperability**

According to Sheriff Ed Jorden, the number one reason he is looking forward to entering into the CCNC system is to facilitate interoperability. Over the last 14 ½ years the Sheriff's Department has participated in probably twenty emergency management exercises involving several different agencies and every time the number one problem identified is the inability to communicate between the various radio systems.

Capt. Mike Savage with the Greeley Police Department is the Director of Weld County Communications. Weld County contracts with Greeley for communications dispatching and system maintenance.

### **2.15 Northern Colorado Regional Communications Network (NCRCN)**

Dates: 8/9/00 & 8/23/00

Interviewed: Capt. John Walker, Loveland Police Department  
Motorola employees Rich Riley, Don Maser and Jim Cleveland

#### **Background**

Three years ago, Motorola and agencies in Larimer County formed a consortium (NCRCN) in which they participate in an 800 MHz, APCO 16, Motorola SmartZone™ trunked radio system. At this time, the City of Loveland Police and Fire Departments, Loveland City Public Works, Poudre School District, Loveland Rural Fire Protection District and the Northern Colorado Water Conservancy District. Soon to join will be Fort Collins PD and the Bureau of Reclamation. Discussions are also going on with Public Service of Colorado.

Each participating agency is looking at the opportunity to combine resources and take advantage of a system that provides for better coverage, additional channels, interoperability and other features available with trunking systems. Establishing countywide interoperability is a goal of the system and towards that end the 911-authority board has provided funding to link the Larimer County communications center into the system.

Motorola assigned Jim Cleveland as the dedicated manager of the system and is responsible for the operation of the system which includes such items as establishing talk groups, monitoring system performance and directing it's evolution. While the manager establishes the talk groups via a management terminal linked to the system, a Board from the consortium actually approves and assigns talk groups for each agency. The Board is also responsible for directing the expansion of the system. The Board is created and

staffed under the rules set forth in the Bylaws of the NCRCN. It is reported that management of the system is conducted smoothly and efficiently. The NCRCN has a contract with Motorola until December 31, 2008. After that date the system will belong to the NCRCN.

The participating agencies agree to a ten-year contract that stipulates that hardware and general maintenance of the system will be the responsibility of Motorola and any functional improvements or upgrades will be the responsibility of the consortium. Service charges are collected from the agencies at approximately \$50.00 per month per radio. It is anticipated that the service charges will be reduced with the addition of system participants. With the high capital costs of establishing the infrastructure of such a system, Motorola is not looking at subscriber fees to quickly recoup costs for the system but rather they see value in providing the service and selling infrastructure equipment, mobiles and portables. Motorola has made it possible for participating agencies to lease to own, over a ten year period, or to rent radios for the system. This addresses the difficult upfront capital costs usually involved in establishing and participating in such a system for smaller sized agencies. Approximately four million dollars has been invested into the system and participating agencies radios at this point. The intent is to continue to expand the system by providing radio equipment to develop additional sites made available by the NCRCN participants. The Board is the decision making group that guides the addition of sites and the evolution of the system.

### **System Design**

As stated, this radio system was established using APCO Project 16 standards that were established in 1979 and served as the basis for analog trunking systems. The main benefits of these systems were interoperability and fault tolerance. Following that, APCO Project 25 was established to improve upon several aspects of analog trunking and to provide enhanced capabilities available to digital trunking systems. It improves upon spectrum efficiency by moving to 12.5 KHz bandwidth, provides for a faster control channel, improves data transfer capabilities, talkgroup construction and encryption options, thus improving efficiency to the users. The Project provides for manufacturers to offer common goals of equipment specification, common air interface standards, and digital standards for operation.

The NCRCN system consists at this time of four sites, Horsetooth, Buckhorn, Bald and a two-channel site in Granby set up specifically for the use of the Water Conservancy District. A site on Prospect Mountain, at the moment, has only a conventional repeater but is under development as a trunked site and will be on line soon. Sites are being established to provide for the coverage required by agencies participating in the system. As the system has developed so far there is coverage for those agencies operating primarily within and east of the foothills. As you proceed westward from the foothills, the coverage decreases and the site in Granby covers that area of interest for the Northern Colorado Water Conservancy. Further expansion of the system within the mountains is expected with the participation of the Bureau of Reclamation. From those sites already on line coverage has been achieved from the tunnel down through Poudre Canyon, 50 to 60 % mobile coverage around the Red Feather Lakes area and throughout the Front Range from the southern to the northern County lines.

1,800 public safety radios were planned to be on the system and included all the Larimer County public safety agencies. Based upon this anticipated number of radios, 30 channels in the 800 MHz spectrum were licensed for the NCRCN system thereby limiting the number of channels available for other systems construction in the area. Only 7 channels are set aside from the NPSPAC frequencies for Larimer County. It is anticipated that other system developers will request some of the 30 channels because it is unlikely that the NCRCN system will be able to put this number of channels into use in the near future.

As the system is configured now, there are four channels established in Loveland, four at Bald Mountain, three at Buckhorn and three at Horsetooth. More channels will be added at Buckhorn and Horsetooth when Ft. Collins joins into the system. A two-channel low-density site is established in Granby for the Northern Colorado Water Conservancy communications needs in that area and reportedly covers some portions of Trail Ridge Road. In the Motorola SmartZone™ system design one channel at each site is normally reserved as the control channel and the rest are available for voice or data.

At this time digital trunking capable radios both portable and mobile from Motorola are priced in the neighborhood of \$3,500.00 and soon there will be a second tier of radios available in the neighborhood of \$2,000.00. Analog portables are available now in the \$1100.00 range. Just recently E.F. Johnson is offering radios capable of operating in the Motorola SmartZone™ system ranging from \$1000 to \$2000. The current system is dual mode for analog and digital capabilities and conforms to the common air interface established by the developing APCO P25 standards, and used to be a proprietary system utilizing Motorola radios. Loveland PD and FD are operating with digital radios while the other agencies are using analog. Digital radios are able to be flashport programmed to the APCO P25 trunking standards when available.

It is possible that the NCRCN system could be incorporated into the statewide Cooperative Communications Network of Colorado (CCNC) system in the future should this be seen as an advantage to the NCRCN agencies. Regular contact is maintained with the CCNC and as they develop their protocols and procedures and at the point that the NCRCN is comfortable with the structure they could merge systems.

### **System Participation**

Issues to resolve are local control, system maintenance, coverage beyond 95% mobile especially for in building coverage, migration beyond P25, access fees and especially limitations to membership. The NCRCN contains agencies such as Bureau of Reclamation, Northern Colorado Water Conservancy and the Poudre Valley School District that are currently not considered eligible for participation in the CCNC. Eligibility in the CCNC is one of the undefined structures of the CCNC that creates the understandable hesitation of the NCRCN to pursue further ventures with the CCNC.

When interoperability issues are considered, School districts are prime methods of evacuation, public works and road & bridge departments play important roles in major incidents along with the public safety entities. The NCRCN looks forward to increased coverage and further interoperability with partnering with the CCNC as long as impacts to channel loading of the NCRCN system has a clear method of resolution. They would anticipate the CCNC having more of an impact on the NCRCN system rather than the reverse.

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## 2.16 Cooperative Communications Network of Colorado (CCNC)

Date: 8/9/00  
Interviewed: Paul Nelson, Larry Brooks - Colorado Telecommunication Services  
Rich Riley, Don Maser - Motorola

### Background

The Cooperative Communications Network of Colorado is a project in which the State of Colorado is partnering with local governments to construct a statewide digital trunked radio system.

The idea behind the project is to replace existing conventional radio systems with a system that offers agencies improved interoperability, wide area coverage, improved spectrum efficiency while adding additional agency channel capabilities and to share costs and resources while providing added value for all users.

This project has developed over several years of the State Telecommunication Services efforts in pursuing funding and soliciting support to construct a statewide system. Original plans were to construct the system, estimated at \$50 million, and to invite state and local government agencies to participate. Funding at this level was not available after several attempts. Funding has been obtained to construct the radio system in a phased approach and the amount of funding restricts the development of the system to meeting the State agencies system design requirements. Phase 1 of the project encompassed the Denver Metro area with Arapahoe, Denver, Douglas and Jefferson Counties. Phase 2 brought in Adams, Boulder, Clear Creek and Gilpin Counties. So far 10 sites have been installed. Phase 3 is now underway in which Larimer, Weld, Elbert, Phillips, Sedgwick, Yuma, Washington, Kit Carson, Cheyenne, Lincoln, Morgan and Logan Counties are to be brought in. Later in this section is a list of agencies within these counties that are participating in the system.

### System Design

The State's requirement for their agencies system coverage is specified as 95% mobile coverage on roads and highways. Naturally while providing this level of coverage, a large portion of off road coverage is also provided. In order to provide for the additional coverage for portables and in building required by other participating agencies it necessitates the addition of County and City level sites. This is where the partnering with multiple agencies comes into play.

Cities and counties, for the most part, already have existing sites that provide for their current communications systems. As these sites and equipment from the partnering agencies join together with the infrastructure already established, the CCNC system grows to better meet the needs of all. Should an agency have sufficient coverage obtained from sites established by the State for their coverage needs then the agency would only need to provide their own mobiles, portables, and console equipment. Should it be determined that the number of channels need to be increased at a site to satisfy the requirements of the joining agency then the agency would be responsible for those additional channels. The current plan is that all sites will be equipped at minimum with four channels and are all licensed for five.

The philosophy in the construction of the system is that there is no clear separation of each participating agency's equipment but rather an integrating of equipment into a single system each piece relying on other pieces of the system to function. This helps to solidify the participating agencies together and discourages agencies from pulling their system equipment prematurely out of the network rather than resolving issues.

The system is designed around the APCO 25 standards for digital radio communications. In so doing, it will allow multiple manufacturers the opportunity to construct radios that will function in the system. Having multiple vendors to select from permits the participating agencies a choice of radios and allows for fair competitive bidding procedures. This allows local government agencies and others to comply with their purchasing policies and take advantage of price competition.

The use of low speed, low-density data is being considered for use on the CCNC system. In areas where radio traffic is low, the advantages of digital data technology can be put into use now where normally the cost would be prohibitive due to the low number of users. Agencies with high throughput data needs would be best served by dedicated data systems at this point. This could change in the future depending on the needs of the partners of the CCNC.

The list of partnering agencies grows constantly. At this time, agencies participating in the infrastructure are:

- Douglas County Sheriff
- Jefferson County Sheriff
- Arapahoe County Sheriff
- State of Colorado
- El Paso County & Colorado Springs
- Weld County & City of Greeley
- City of Aurora

Those agencies that are participating as users of the network are:

Colorado State Patrol	Jefferson County Sheriff
Colorado Department of Corrections	Jefferson County Road and Bridge
Colorado Parks and Recreation	Pleasant View Fire
Colorado Division of Wildlife	Larkspur Fire
Colorado Department of Transportation	Town of Morrison Police
Colorado Division of Telecommunications	Golden Police
Douglas County Sheriff	Golden Fire
Douglas County Public Works	City of Edgewater Police
Town of Mountain View Police	Franktown Fire
Town of Lakeside Police	Skyline Fire
Arapahoe Community College	Cunningham Fire
Colorado School of Mines	Jackson 105 Fire
Parker Police	Castle Rock Police
Parker Fire Protection	Castle Rock Fire Rescue
Parker Public Works	Littleton Fire Department
South Metro Fire Department	

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## **Agency Contribution**

The partnering agencies so far in the CCNC system have joined and contributed in a variety of ways. Some agencies have contributed their existing systems where others have constructed systems with the assistance of the CCNC providing key components to the overall network. Other agencies have submitted Letters of Intent and are working towards purchasing equipment.

## **System Components**

The CCNC has decided to outsource the system management and monitoring of the system. At this time, Motorola is performing this function much like AT&T, who has a central monitoring and management control in Redmond, WA for their wireless network across the country.

Talk groups and priorities are established within the CCNC system and are the same regardless of the size of the agency. So far, the partnership approach has been working well and meetings of the CCNC have been productive and well attended.

The CCNC is reviewing a fee structure as a method of offsetting operational costs for maintenance and management.

System maintenance is an issue that is developing as the system expands. The CCNC foresees maintenance being performed in a variety of ways that best suits the area of the system. The State Telecommunications Service has 14 service facilities throughout the state. Some participating agencies have their own service facilities as well as, commercial service facilities such as the Motorola authorized Legacy Communications in Denver. The CCNC foresees the use of a combination of all of these to provide service to the system with the system management coordinating.

The State Telecommunications Service is providing engineering and some equipment to those agencies that submit a Letter of Intent and a document outlining their system requirements.

As Phase 3 of the CCNC system develops, the State is providing the network switch for the northern Colorado area. The State site at Mead is now part of the CCNC and the system uses a microwave path from Mead to Horsetooth and then will have a path from Horsetooth to Greeley where the system controller will be located.

Larimer County is assisting the CCNC system construction by providing the State space on the County's Horsetooth to Buckhorn microwave link for the equipment on the CCNC system at Buckhorn.

### *Agency Interview Summary*

Larimer County, Colorado has identified the fact that communications technologies have become an integral part of daily operations throughout the county. Throughout interviews and discussions with the users of the Larimer County radio system and surrounding agencies, several common concerns and desires were apparent. These included:

- Maintaining and creating interoperability with all surrounding agencies;
- Coverage throughout the entire county including the mountainous regions;
- Reasonable cost to all users, particularly volunteer agencies;
- Planning for the future in terms of FCC regulations and global spectrum issues.

### **3.0 Alternatives**

#### **Needs**

The radio system has evolved over many years. Problems have been addressed to solve individual areas of concern but, the system as a whole has not changed appreciably. As population has grown and the amount of tourism has increased particularly in the mountain regions of the county, the need for greater coverage, interoperability and channel availability has been identified.

#### **System Coverage**

In 2000, the Larimer County radio systems achieve approximately 90% mobile radio coverage throughout the county. This has been accomplished over the years with the addition of radio sites and equipment. Portable radio coverage throughout the county is estimated at 70%. Responders are expected to communicate more and more via portable radio, making the need to improve system coverage particularly in those areas being frequented by visitors. Areas including the Poudre Canyon (Hwy 14) and the Laramie River Valley are of great importance due to the increase in outdoor activities.

Primary challenges for establishing adequate coverage in the county are the size and topography of the County and the ever-increasing interference on the VHF spectrum. An example of coverage difficulty is with the Sheriff's Department Channel 2. The channel is designed in such a way that the default transmitter site is Cactus Hill, which doesn't always provide a good signal for reception throughout the entire county. When transmitting from the Cactus Hill site, monitoring the channel in some parts of the county, reception is difficult but when the appropriate transmitter is selected for the area that the unit is in, communications are good.

Replacement transmitter steering equipment is being installed with the ability to better control the selection of transmitters based upon voting receivers, but the situation of the default transmitter will still persist. Consideration is being given to changing the default transmitter to one that provides better reception throughout areas where a majority of field units are located, but doesn't provide the signal throughout the entire county as well as the Cactus Hill site. A negative impact of this is that the channel will require the dispatchers to manually select the Cactus Hill transmitter to contact units in the areas not covered by another transmitter. With the use of the Cactus Hill transmitter, everyone receives some level of signal, even though it may not be as clear as desired.

Any system changes from this point forward will be directed at achieving 95% portable coverage in prime areas of responsibility, particularly in the mountain areas discussed earlier.

#### **Interoperability**

Interoperability is the ability for units in one agency to easily communicate and monitor units of another agency. Examples in the Larimer County area would include the Larimer County Sheriff's Office, Weld County Sheriff's Office, City of Fort Collins, City

of Loveland, all area fire departments and EMS units, Larimer County agencies, the Colorado State Patrol, and the Division of Wildlife.

For many years, the City of Fort Collins and Weld County agencies have not been able to easily communicate with Larimer County due to spectrum differences between the UHF and VHF bands. The Larimer County Road & Bridge Department (Lowband) is not able to communicate with other agencies in either UHF or VHF.

Now that agencies such as Loveland, Colorado State Patrol and the Division of Wildlife are moving to 800 MHz systems, the interoperability situation is changing even more with the addition of another spectrum.

Although there are methods to alleviate some of these interoperability issues, the solutions are not without fault or awkwardness at best. One method is for field units to carry one radio in each spectrum. This would provide the most reliable form of communicating but obviously is the most expensive and the least space efficient, not to mention complicated for the user. Other band-aid approaches include links in the trunked radio systems, but this requires dedicated channels and additional equipment at each site.

It is easily seen that the best solution for all agencies is to migrate toward one common system. The question remains, however, what that system design should be in order to provide the greatest flexibility to the largest number of users at an affordable price.

### **Interference & Additional Channel Availability**

From our interviews, it has been determined that overall interference has affected the performance of the Sheriff Department's radio channels. The radio frequency noise floor has risen throughout the Front Range due to paging systems, a greater number of radio systems in use and aging equipment for all agencies. This interference is not easily corrected due to the complexity of locating the source of interference and the inability to change it.

Every department would like to have additional coverage throughout the County, especially for portable radios. Improved radio coverage for the Poudre Canyon and Laramie River Valley was an expressed desire by each department. Additional channels in the VHF spectrum are not easily found unless agencies moving toward the trunked 800 MHz systems relinquish them.

### **Purpose**

The purpose of this document is to determine the best direction for the Larimer County radio system in the future. At this time, Larimer County has three (3) available options. These include:

- Remaining with the current VHF system while making necessary improvements to it,
- Participating with the Northern Colorado Radio Communications Network (NCRCN), or
- Participating with the statewide Colorado Communications Network. (CCNC)

The first option allows county users to remain in the VHF spectrum while the remaining options require participation in the 800 MHz spectrum. The final decision is not a simple one. There are advantages and disadvantages of each option, which will be explored in the following pages.

### ***Option A. Remain with Current VHF System***

It has been estimated that three-quarters of public safety communications systems nationwide will remain in the VHF high band spectrum. Most of these agencies have conventional analog systems. Perhaps half of them will replace and upgrade their equipment but the majority will stay in VHF.

Approximately 30% of all agencies making changes will be in the trunking environment by the year 2010. Others will operate in conventional 800 MHz systems. Changes from VHF to 800 MHz (trunking and conventional) will most likely occur in larger agencies and in metropolitan areas.

The cost of moving to a different system in a different spectrum is considerable and requires the replacement of every radio in the system. Additionally, all equipment at each tower site requires replacement and the system design as a whole, must be reviewed.

Propagation characteristics of VHF frequencies are suitable for affordable wide-area coverage systems with limited construction of multiple sites. Foliage path loss is low and urban building penetration are low, but interference is moderate making VHF a desirable spectrum in which to operate. It is reasonable for Larimer County to consider remaining in the VHF spectrum at this time.

### **Coverage & System Improvements**

Remaining with the current VHF system is one option open to Larimer County users. In order to make the most of this option, it will be necessary to continue to improve the system both from the addition of radio tower sites and with upgraded field equipment.

A frequently heard concern from VHF users located close to metropolitan areas is that of radio frequency noise interference. The more heavily developed the site, the greater the problem. Larimer County is no different in this respect. As the radio frequency noise environment uncontrollably increases, it becomes necessary to construct additional sites to make up for lost performance.

The addition of sites will expand the coverage of the radio system into areas where inadequate coverage has existed in the past. The overall degradation noted in the current system will be improved with the addition of sites as well.

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## Coverage Map Analysis

### Overview

Computer generated radio coverage prediction maps have been included in this study to provide information about potential coverage from various tower sites. Planners and vendors use these coverage maps as another tool in the design of radio systems. There are various propagation predictions programs available and each have their strengths and weaknesses. These programs use prediction models such as Okimura, Longley-Rice, and Bullington. As with any computer prediction programs, results are dependent on the parameters and methods of analysis. These programs are constantly evolving in order to more accurately predict the actual field performance of radio systems. Software emphasis is placed on the topography. Distances and reflections that add and cancel radio signals are difficult parameters for the various programs to accurately calculate. For example, a mountain in the radio path is viewed as blocking signal and is clearly pictured in that way, but the reflection of signals down a canyon is a difficult phenomenon for the program to analyze. The result is that the maps must be viewed as a tool, not as a definitive prediction of coverage.

Coverage maps are concentrated across the county with selected locations identified within county boundaries. Radio sites are illustrated with light blue wheels with the site name alongside. Major roadways are shown in red. Secondary roads are not shown to avoid unnecessary clutter and confusion. Green areas are forests and gray areas are plains with lakes and streams in light blue.

Maps are generated using existing towers, antennas, transmitters, and cabling for those established sites. For proposed sites, standard configurations of these key elements were used including 100-watt base station transmitters, 6 dB omni-directional antennas, 5-watt portables and 100-foot towers. All VHF coverage maps were generated for portable radios, outdoor use, no speaker mic antenna, and portable talking back into the system (talkback).

Inadequate (less than  $-104.0$  dBm) portable radio coverage is illustrated with dark blue shading. Those areas not shaded are areas indicating adequate portable radio coverage.

### VHF System Coverage Map Analysis

Appendix A, the composite map of the current VHF system, shows the areas of the Poudre Canyon and Laramie River Valley as having extremely poor portable radio coverage, which agrees with interview information. The map is composed from individual site coverage maps included in Appendices B (Cactus Hill), C (Horsetooth Mountain), D (Buckhorn Mountain), and E (Deadman Mountain). Each site provides their contribution to the overall system performance.

Appendix F was generated for the South Bald Mountain site illustrating the difference and improvement in the Poudre Canyon coverage over that obtained from the current Deadman Mountain site. The South Bald site was substituted for the Deadman Mountain site in the VHF composite map (Appendix G) in order to compare the coverage differences shown in Appendix A.

Appendix H is a map generated for a proposed Red Mountain site in order to evaluate its potential for portable coverage in the mid and lower Poudre Valley. It illustrates favorable possibilities in this area. Appendix I (Green Mountain) illustrates similar coverage possibilities. Either site offers good potential and selection would be based on availability.

Appendix J (Middle Mountain) is proposed based upon previous research and maps generated for sites in the area. This location provided the most beneficial improvement while looking like it had the most chance for development.

Previously, a site at Panorama Mountain was considered for addition into the Larimer County radio system design. A coverage map was generated (Appendix K) using this site to evaluate its coverage into the Estes Park area which is currently not well covered by the system as indicated in Appendix A, but is offered by the Estes Park Police Department radio system.

Finally, Appendix L adds the Green, Middle and Panorama Mountain sites to the composite of the current system. This map illustrates the overall radio coverage addition when compared to Appendix A.

When comparing Appendix L to that of the current system illustrated in Appendix A, it appears that by adding the additional sites that the radio system can be expanded to cover the areas of concern within Larimer County. These sites will be required whether the system remains in the VHF spectrum or moves to 800 MHz. Incorporating these new sites into the radio system can be accomplished as has been done in the past by adding receivers to the voting system and making transmitters available by manual selection or by taking a more overall system operational approach using such methods as multicasting or establishing multiple channels.

### **System Design Improvements**

Multicasting is the ability to transmit the same audio on two different frequencies at the same time. By establishing different channels, one appropriate site could be utilized to cover that area rather than trying to cover the entire county from a single default transmitter site. The same audio could be provided on each channel (multicasting) so there is no impact to the operation of the dispatcher. This method would require field units to select the appropriate channel for the area of their operation. This is usually not difficult for the field units as they operate in a designated area, while the dispatcher is required to communicate with all units in every area.

If a multicasting system is desired, an additional channel is required to form the pair of frequencies needed. Available channels for use in a multicasting scenario in the VHF spectrum have been scarce in the Front Range for many years. As agencies move to different radio systems however, the opportunity to procure additional VHF channels may be available to Larimer County. The City of Loveland, for example, may be a source for an additional VHF channel. This could only occur when they relinquish the channel after completely moving to the 800 MHz NCRCN system.

Boulder County has recently implemented multicasting technology by utilizing frequencies obtained from Arapahoe County. Frequencies were made available after Arapahoe County units moved to the 800 MHz CCNC system.

Larimer County could establish a similar scenario with the addition of a frequency that appears as a separate channel on field radios. This could be established to dispatch Sheriff's or fire district units in one section of the county. This channel would improve the receive signal in a particular section of the county.

Additional channels would also offer Larimer County the opportunity of separating communications of different departments, such as Natural Resources and Road & Bridge, and allow those agencies the opportunity of moving into the high band region of the VHF spectrum. Once located in the high band region, interoperability would be improved between county fire districts, the Sheriff's Department, Parks Department and the Road & Bridge Department.

### **Interoperability**

Interoperability considerations are two-fold. The first being the ability to communicate on mutually available channels and the second being the ability to monitor each other's dispatch channels. Interoperability, by definition, includes the ability to effectively communicate within and around Larimer County as well as with agencies outside county borders. First priority for any system is that of interoperability with its own user departments.

Currently, local interoperability planning usually revolves around VHF for law enforcement agencies. The fire protection, EMS and forestry services have relied on VHF for many years. These radio users remain in VHF because the frequencies function as needed.

It is clear that the USFS and RMNP will remain on VHF while migrating to digital narrowband technology. The radios being manufactured today have the ability to operate in both modes invisibly to the user thus allowing for easy migration and maintaining interoperability with those agencies that have not yet migrated.

Boulder County has determined that they plan to remain with VHF for the immediate future until circumstances change that would make a change provide a clear benefit to their current system. To that end, they have acquired additional channels and invested in the equipment that utilizes the additional channels.

Laramie County, Wyoming is operating in the VHF spectrum along with its neighboring counties. Until such time as the State of Wyoming implements a statewide trunking system, there would be no reason for them to change. The State of Wyoming has been exploring a statewide trunking system for several years and the last word was that it still remains a desire for the future.

In Colorado, the state agencies that Larimer County often interoperates with such as the Colorado State Patrol (CSP) and the Division of Wildlife come to mind immediately. It is clear that the CSP will move to the CCNC system. It has been confirmed that the CSP

units will continue to maintain their VHF radios in vehicles and be used to communicate with those agencies on VHF. There are many instances where CSP units use local law enforcement channels because their system coverage is inadequate. Unless the CCNC (800 MHz) system is constructed in such a way that would also satisfy Larimer County's radio coverage needs, CSP units will continue to utilize the County's radio channels as before. The Division of Wildlife will operate in much the same manner. As they frequently interface with the Sheriff's and Parks Departments, they will require two radios or everyone being on the same system. Since they interface with Boulder County as well as Larimer County, they will need to maintain a VHF radio.

The Larimer fire districts operate daily with mutual aid agreements with other fire districts across county lines and with the USFS and will therefore, need to maintain a VHF radio in their units also.

The number of units required to provide this type of interoperability must be weighed for each agency. Equipping a small number of Wildlife units with VHF radios is relatively inexpensive compared to equipping the large number of units in the Larimer County Sheriff's Office with 800 MHz-capable radios.

To clarify, the following agencies are planning to remain in the VHF spectrum and will maintain VHF radios for communications and interoperability:

- USFS
- RMNP
- BLM
- Boulder County
- Laramie County, WY

Those agencies moving to the 800 MHz spectrum include:

- CSP
- Bureau of Reclamation
- City of Fort Collins
- City of Loveland law enforcement and fire
- Weld County
- Poudre Valley School District
- Poudre Fire District

As the list indicates, there are interoperability issues that are equally weighted between the various radio systems and within the two 800 MHz systems. Larimer County agencies often work together with those agencies in the VHF spectrum as well as those in the 800 MHz systems.

The question remains, which agencies do Larimer County users find it most important with which to communicate and monitor activity? The answer depends on the situation at hand and no one agency is more obvious than another.

If there were one particular agency, communicating one to one could be accommodated by simply providing the technical solution of channel cross patching. This however is not the case. Providing channel cross patching for each agency on the list is impractical and an inefficient solution to the problem.

## Cost

By remaining in the VHF spectrum, there would be no additional cost for mobile and portable radio equipment. There would only be minimal costs in the communication center itself for programming and equipment to control the additional tower sites.

Ideally, additional tower sites would include South Bald Mountain, Middle Mountain and either Red or Green Mountains. Consideration of developing either Prospect or Panorama Mountain should also be considered. The cost of developing these sites is determined primarily by estimating the cost of equipment including microwave, building, tower, and providing utilities. If private lands are considered, lease or land acquisition costs must be added to the equation.

The South Bald Mountain site is of interest to several different agencies and the cost for development can be shared among them. There have been discussions with the USFS about relocating the radio site on Deadman to South Bald because the lookout at Deadman is a popular hiking location and may become a historic site. The USFS has suggested South Bald as the alternate location and conversations have been conducted over the last five years with the State of Colorado, Fort Collins and Larimer County as to funding for site utilities and facility. The USFS is also interested in locating a repeater at this site.

This move would have a positive effect in providing better radio and paging coverage along the Poudre Canyon from Poudre Park westward and especially from Kinikini west. The lower part of the Laramie River Valley is also improved over the coverage from Deadman. Solar power currently limits capability at the Deadman site. Providing commercial power to the South Bald site would be a system improvement.

Utility provision is one of the largest costs and is estimated at \$50,000. A road needs to be provided to the site and may be offered by the Larimer County Road and Bridge Department. The County microwave link that currently supports the Deadman Mountain site could be used at the South Bald site. The tower and building may be provided by contributions from other interested agencies (USFS, City of Fort Collins and the State of Colorado). The radio equipment for Larimer County can be moved over from the Deadman Mountain site, thus limiting equipment cost to the County. Any additional channels desired such as the paging channel, would require additional site equipment.

The improved coverage is only achieved if the antenna tower is permitted to extend over the crest of the mountain. There have been discussions of limiting the tower height to below the peak for aesthetic reasons. Limiting height would have the adverse effect of reducing the 360-degree coverage of the site. This could be addressed by constructing an antenna system that would be on both sides of the peak, but would require additional expense and engineering and should only be considered if absolutely necessary.

Some coverage provided by Deadman is lost northwest of Kinikini, where Deadman actually blocks the area from South Bald. The improved coverage created by South Bald however, offsets lost coverage by a large degree. This lost coverage can be partially restored by an additional site (Middle Mountain) and would provide better coverage in the Laramie River Valley.

Middle Mountain is undeveloped at this time. It will require utilities, a maintained access road to the site, building, tower, microwave and radio equipment. As the actual location has yet to be determined, only rough budgetary estimates can be offered. An estimated cost for this site is \$ 250,000.

The development of either Red or Green Mountain would be approximately equal to that of Middle Mountain. To include utilities, building, tower, microwave link and all radio equipment is estimated to cost \$250,000. Again, if the site is located on private land or a lease fee exists, that must be included in the total cost of the site.

Cooperative ventures among all interested agencies, both public and private should be explored on a continuing basis. The possibility exists that the State of Colorado may be interested in improving mobile radio coverage from the Middle Mountain site and may be willing to assist in providing funding contribution to this end.

### **VHF Summary**

Remaining in the VHF spectrum with the necessary addition of tower sites is a reasonable solution to one set of concerns. The concern of coverage can be managed with additional sites and improvements.

Interoperability is only partially solved by remaining with the VHF system. It is maintained with the USFS and Rocky Mountain National Park, Estes Park, Boulder County, and Laramie County, Wyoming, while they don't establish interoperability with Fort Collins or Weld County. Existing interoperability is lost with the City of Loveland and the Loveland Rural Fire District.

Cost is limited to the development of additional sites. Existing mobile and portable radio units and all site equipment and microwave are maintained.

## Trunking System Overview

Trunking, by definition, is a group of radio channels that may be accessed by any user when required and then, returned to available status when not in use. The term is derived from the telephone industry where a “trunk” line is the primary communications tool. A radio system using this technology is similar to that of the telephone system. The system controller determines availability within the system and assigns the user appropriately without the user being aware of the assignment.

The primary reason for most agencies entering into a trunking system is to obtain additional operational channels. No longer is the “channel” considered a pair of frequencies, but instead a talkgroup of radios programmed with a common goal in mind. All “channels” in the system area available to all users with the net result being more available channels to all users. Some worldwide satellite communications systems are an example of trunking

Spectrum efficiency and technical capabilities are major advantages for trunking systems. Technical system advantages include unit identification, emergency alert, lost/stolen radio deactivation, selective calling, encryption, data transfer capability, a level of privacy, unit tracking and transmitter selection.

Interoperability is enhanced allowing for agencies to communicate and monitor each other’s dispatched operations. Since talkgroups can be dynamically managed, resources can be interconnected for specific instances with relative ease.

Trunking systems automate the use of transmitters and the control of voting receivers by keeping track of radio units on the system. This would no longer be a task of the dispatcher. As a result, the coverage offered by the trunking system would be viewed as optimal and would be provided without human intervention, thus reducing errors.

Because of the crucial situations in which trunking systems are used, they are designed with many redundant features to avoid outages to the point of resorting to a basic operation when a major failure occurs. These built-in redundancies provide the users with greater reliability and system satisfaction.

Most trunking systems in use in the public safety environment are in the 800 MHz spectrum. Although trunking in the VHF & UHF spectrum is possible, frequency restrictions and interference between agencies in the already crowded spectrum make it a difficult option in metro areas.

Interfaces between a VHF/UHF and a trunking system are technically possible and have been used successfully for specific circumstances. These interfaces, however, are not recommended for use on a daily basis largely because VHF users will not have access to available features inherent in the trunking environment. For example, the Larimer County Sheriff’s Office VHF channel could appear as an individual talkgroup on the trunking system. This does not allow the Sheriff’s Office to have other channel capabilities such as car-to-car operations unless an additional talkgroup is established for that purpose. Spectrum efficiency is diminished each time an interface is established.

The same situation would be true for the fire channels. Units would not have selective calling capability and talkaround channels with full trunked system users. Other features such as unit identification, emergency alert, and lost/stolen radio deactivation would not be made available to the users of the interfaces. Adding interfaces for all existing channels on the VHF system would serve to congest a system that should be designed to streamline operations and would therefore, defeat the purpose of the trunking system.

Larimer County is in a unique position in terms of trunking radio systems. Two such systems exist in the area and are being refined at this time. The merits of joining with these systems deserve consideration. The two systems are known as the Northern Colorado Regional Communications Network (NCRCN) and the Cooperative Communications Network of Colorado (CCNC).

The intended users of the NCRCN system at this point include:

- City of Loveland
- Poudre Valley School District
- Poudre Fire Districts
- Loveland Rural Fire Districts
- Northern Colorado Water Conservancy
- City of Fort Collins
- Bureau of Reclamation

Contributors to the CCNC infrastructure include:

- Douglas County Sheriff
- Jefferson County Sheriff
- Arapahoe County Sheriff
- State of Colorado
- El Paso County & Colorado Springs
- Weld County & City of Greeley
- City of Aurora

#### **Technical Differences - NCRCN and the CCNC systems.**

Fundamentally the CCNC system is being constructed around the ASTRO 25 Motorola system that is intended to be fully compliant with the APCO Project 25 digital standards. This means that it is a totally digital system, whereas the NCRCN system is constructed around the ASTRO Motorola (APCO 16) system that is a combination of digital and analog.

The control channels of the two systems operate at different baud rates, 3600 and 9600 and are on different frequencies. Because of this, it is impossible for radios in each system to be able to operate or monitor each other's system. It is, therefore, difficult to merge the two systems seamlessly.

Because of the significant differences in the equipment of the two systems, there is little common equipment that can be shared between the systems. Other than antennas, the two systems would sit side by side at a shared site.

To convert the NCRCN system to the CCNC system, there would have to be complete equipment replacement not only at the sites but also with those field radios that are purchased as analog radios. At this time, only the Poudre School District radios are analog due to the lower cost of the radios. Other users of the system have elected to go with the digital radios that can be reprogrammed.

The NCRCN system has elements of the APCO 25 standards in terms of the CAI (common air interface), which means that in the digital mode the radios of the two systems can talk together as long as they are off of the trunking systems, on a common conventional mutual aid channel. Because the radios will only be able to communicate together off of their respective trunking systems, the goals for interoperability aren't completely realized.

The reason that the CCNC system is being constructed around the ASTRO P25 system is due to technical advantages of faster speeds offering greater capacity, voice over data, packet based IP addressing and the ability to integrate the developing APCO 25 trunking standards.

Digital communications, like the very computers that are the heart and brain of, is in constant evolution. When implementing a new system, technology influences one to go with the latest innovations available to postpone the inevitable obsolescence of the system as long as possible. This momentum is difficult for commercial, income generating agencies to stay on top of and is almost impossible for public safety agencies. Because of this, public safety agencies are usually slow to leap into volatile cutting edge systems. When a move is made, it requires remaining with it for a period of time before being able to consider the next move.

Staying at the cutting edge of technology has a price to pay for the advanced features that have initiated its development. Equipment usually costs more to start as sales are few at first and engineering and development costs are recouped. Beta products and system bugs are encountered in the beginning and oftentimes patience is required while these are solved. This additional cost and system unreliability are difficult for public safety communicators to accept. Tried and true methods are favored by public safety, even at the loss of features.

The NCRCN system was built around the ASTRO 3.0 trunking platform with accepted APCO 16 standards and trunking technology used in previous systems with the introduction of digital capabilities while also maintaining the analog. This allows for the use of previously developed analog trunking radios and even, for the first time, some manufactured by other than Motorola.

### **Coverage Map Analysis - NCRCN**

At this point, the NCRCN system is primarily focused on foothills and eastern county coverage due to the participating agencies. The CCNC proposed system is intending to provide 95% on-road (primarily highway) mobile radio coverage of Larimer County.

Appendix M is a map that illustrates the anticipated coverage from Horsetooth, Buckhorn and South Bald Mountains planned in the CCNC system. Mobile coverage is reasonable

in the eastern portion of the county. Those areas around Thompson Canyon and Estes Park are not adequate for Larimer County use, but a site on Prospect Mountain or Panorama may address these areas. Mobile coverage is spotty along the Poudre Canyon and Laramie River Valley.

Appendix N illustrates these same sites for portable coverage. Keep in mind, Larimer County is primarily interested in portable coverage for the public safety providers. Where portable coverage is provided, mobile is easily accomplished. In terms of portable coverage, the Thompson Canyon is difficult to accomplish, as is the Laramie River Valley. The Poudre Canyon is extremely spotty in coverage. Portable coverage is improved by the addition of those same sites as mentioned earlier in the VHF system (Middle, Red or Green Mountains).

Appendix O is designed to illustrate coverage from Horsetooth Mountain, which is the primary site for Larimer County in the CCNC system. It primarily covers the foothills and the eastern portion of the county.

Appendix P (Buckhorn Mountain) provides some coverage to the northwest over Horsetooth's coverage and provides some spotty coverage in the Red Feather Lakes area. Improvement is minimal from this location.

Appendix Q is the South Bald site, which better covers the Red Feather Lakes area and provides some coverage along the Poudre Canyon. Included, as Appendix R is the Deadman site although as discussed earlier, is not recommended as a trunking site location and is provided only as a comparison to the South Bald site to further emphasize the value in relocating to the South Bald site.

As with the VHF system, the Red and Green Mountain sites are valuable in providing portable coverage in the Poudre Canyon. In terms of 800 MHz coverage, Appendix S (Green Mountain) has a slight advantage over the coverage obtained from the Red Mountain site (Appendix T). Middle Mountain (Appendix U) provides the Laramie River Valley coverage as with the VHF system.

Maps are provided for Prospect Mountain (Appendix V) to illustrate coverage in the Estes Park area and some coverage in the Big Thompson Canyon. A map is also included for the county Cactus Hill site (Appendix W), which could be included in the system in order to provide saturation in-building signals for Fort Collins, Loveland and some foothill canyons fill.

Composite maps were created with all the suggested sites including a site in Drake to illustrate the total county coverage potential for portable use (Appendix X). Appendix Y illustrates the mobile coverage potential using the same sites.

## **Option B. Northern Colorado Regional Communications Network (NCRCN)**

### **Planned System Coverage & Improvements**

The NCRCN 800 MHz coverage is designed around those agencies participating in the system. The sites in use provide adequate radio coverage for those users primarily in the eastern portions of Larimer County. Additional sites are required if all Larimer County units are to be willing to participate in the system.

The NCRCN is currently using tower sites that include Horsetooth Mountain, Buckhorn Mountain, Bald Mountain (not to be confused with South Bald), Granby, and some equipment on Prospect Mountain above Estes Park. A possible site near Drake is planned for the near future.

In this design, the foothills and eastern county radio coverage is obtained as well as limited coverage up the Thompson Canyon to Estes Park. For cities like Loveland and Fort Collins, good coverage is provided throughout.

For the county fire districts, the Sheriff's Department and other county departments, additional coverage must be provided in the western part of the county. The existing site at Cactus Hill may be included to provide solid in-building penetration in the cities and canyon fill along the foothills.

The site planned for South Bald Mountain should be developed to improve coverage in the Poudre Canyon and to replace the Deadman Mountain site. Again, the Deadman Mountain site is a poor choice for a trunking system due to limited capabilities resulting from the use of solar power.

As with the VHF system design, the Poudre Canyon and Laramie River Valley are in need of improved coverage beyond what is currently offered. It is recommended that the same sites of Middle and Green or Red Mountains be established for these areas in the 800 MHz system.

With the system designed in this manner, mobile coverage is fairly consistent throughout the county. Portable coverage is also obtained, but contains some spotty areas along the Poudre, Laramie and Thompson rivers.

### **Interoperability**

As stated, agencies participating in the northern Colorado system at this point include:

- City of Loveland
- Poudre Valley School District
- Poudre Fire Districts
- Loveland Rural Fire Districts
- Northern Colorado Water Conservancy
- City of Fort Collins
- Bureau of Reclamation

Those users on the 800 MHz NCRCN have full interoperability features available to all participants on that same trunking system. Users also have the ability to communicate

with participants on the CCNC system using conventional mutual aid channels only. They do not have the ability to operate or monitor the CCNC user activities however.

Because the NCRCN system is in the 800 MHz spectrum, VHF interoperability is lost with those agencies remaining on VHF. A solution many agencies use is having field units carry a separate VHF radio. Many agencies have elected to keep and maintain their VHF radios for just this purpose.

Full interoperability is lost unless VHF system users install trunking radios as separate units on the 800 MHz system. The system itself must be built to accommodate users from both systems. It doesn't behoove a county officer to have a trunking radio in his vehicle when it only works in a portion of the county. Additionally, a subscriber fee would be required in order to participate in the trunking system.

### **Cost**

Much of the cost of joining the NCRCN 800 MHz system for Larimer County lies in having to replace all mobile and portable radios. The average cost range of a mobile radio is \$2,000 to \$3,500. A portable radio is estimated at approximately the same cost per unit. At the low end of \$2,000 per radio, Larimer County can estimate a cost of \$1,000,000 and \$ 400,000 to outfit the rural fire districts. Lease or lease purchase arrangements are available with major manufacturers for approximately \$20 per month per radio.

In addition, there are subscriber fees of \$50 per month per unit. With an approximate total of 700 radios in Larimer County, the subscriber fees alone are estimated at \$35,000 per month or \$420,000 annually.

Funds for providing the NCRCN components, system engineering and the interfaces at the console level were provided by the Larimer Emergency Telephone Authority (LETA) at an amount of \$100,000. Due to this, minimal additional costs may be involved in converting the entire county to its use. Some limited programming changes may be required at the console level. Dispatcher training on the use of newly configured consoles will be required but need not be extensive at less than 8 hours per employee.

As with the VHF system, partnerships must be established to ensure tower site development and construction costs are shared equitably. Ongoing discussions must be conducted with the System Administrator of the NCRCN system to determine what costs may be involved with the development of this system. Sites that are of primary interest to Larimer County may possibly be the responsibility of the County to construct and maintain. Negotiations must be conducted in the event Larimer County decides to participate in the system.

Individual tower sites will require the establishment of trunking capable equipment. Although the locations of the sites may be the same as the VHF system, each site will need to be configured for the 800 MHz system. Configuration includes newly purchased trunking specific site equipment and will utilize existing microwave links. Estimated cost per site is \$500,000. Each site cost will vary based on land availability, the existence of a suitable building, adequate access, and the number of channels required for the equipment.

### **Option C. Cooperative Communications Network of Colorado (CCNC)**

#### **System Coverage & Improvements**

When considering the 800 MHz CCNC system, it must be assumed that the primary sites are developed based on the needs of the current participants. At this time, the State of Colorado is interested in establishing coverage on 95% of the major highways within the county. With this criterion, the State Division of Telecommunications is planning on using the Horsetooth and Buckhorn sites. As discussed previously the State has expressed interest in the South Bald site, which would provide additional coverage. Based upon the maps created for those sites, there are large areas that would need additional coverage for Larimer County use.

The process up to this point is that the CCNC or State of Colorado would assist in the development of these primary three sites with the remaining sites being the responsibility of Larimer County. As identified, the remaining sites would include Middle Mountain, Green (or Red) Mountain and Cactus Hill.

At first glance, the Cactus Hill site looks as though it provides redundant coverage obtained by other sites such as Horsetooth. In reality, it actually provides for solid in-building penetration in the cities and canyon fill in along the foothills.

The Middle and Green (or Red) Mountain sites would provide for improved portable coverage for Larimer County. Since the State's requirement is for mobile coverage, they would most likely not be interested in assisting with the development of these sites leaving them the responsibility of Larimer County

The CCNC system is interested in a site that addresses the Thompson Canyon, which would be either from Prospect or Panorama. Development of these sites will be a matter of negotiation. Site development for Prospect Mountain is underway at this time.

#### **Interoperability**

Agencies currently contributing to the CCNC infrastructure are:

- Douglas County Sheriff
- Jefferson County Sheriff
- Arapahoe County Sheriff
- State of Colorado
- El Paso County & Colorado Springs
- Weld County & City of Greeley
- City of Aurora

Users of the system include:

Colorado State Patrol  
Colorado Department of Corrections  
Colorado Parks and Recreation  
Colorado Division of Wildlife

Jefferson County Sheriff  
Jefferson County Road and Bridge  
Pleasant View Fire  
Larkspur Fire

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Colorado Department of Transportation	Town of Morrison Police
Colorado Division of Telecommunications	Golden Police
Douglas County Sheriff	Golden Fire
Douglas County Public Works	City of Edgewater Police
Town of Mountain View Police	Franktown Fire
Town of Lakeside Police	Skyline Fire
Arapahoe Community College	Cunningham Fire
Colorado School of Mines	Jackson 105 Fire
Parker Police	Castle Rock Police
Parker Fire Protection	Castle Rock Fire Rescue

The interoperability that a system of this magnitude can provide is substantial. In particular, CSP and Weld County are two participants of the CCNC system that are of interest to Larimer County units. Advantages of a wide area system are readily seen in instances with corrections transports, for example, from Larimer County to Buena Vista and Canon City. Detectives conducting investigations outside county borders can remain in communication with their local communication center without having to resort to other agency's systems in a radio system of this sort. Interoperability among all the above agencies is easily accomplished by being on the same system. All features of the trunking environment are available to all users.

Users also have the ability to communicate with participants on the NCRCN using conventional mutual aid channels only. They do not have the ability to operate or monitor the NCRCN user activities however. This is due to each system using a separate control channel, thus preventing one system user from monitoring another system user. Should the systems merge, then a common control channel would exist. As of November 2000, intense discussions concerning the merging of the two systems are occurring.

As in the NCRCN scenario, because the CCNC system is in the 800 MHz spectrum, VHF interoperability is lost with those agencies remaining on VHF. Carrying a separate VHF radio is one solution used by agencies nationwide. Again, full interoperability is lost unless VHF system users also install trunking radios as separate units on the 800 MHz system. It doesn't behoove a county officer to have a trunking radio in his vehicle when it only works in a portion of the county. Trunking radios in selected vehicles, however, may provide for limited interoperability and the capability to monitor the evolution of the trunking system.

### **Cost**

The largest capital cost to participation on the CCNC system is the purchase or lease/purchase of 800 MHz trunking capable mobile and portable radios. The average cost range of a mobile radio is between \$2,000 and \$3,500 depending on manufacturer and included features. A portable radio is approximately the same cost. Larimer County can anticipate a minimal investment of \$1,000,000 for county units and \$400,000 for rural fire districts. Lease purchase arrangements are available for approximately \$20 a month per radio. In addition, a subscriber fee of \$30 per radio is required for those agencies not directly contributing to the infrastructure.

Programming changes at the console level will be needed in the communications center. Additional equipment similar to that added for the NCRCN system will also be required

at the communication center. Since the Larimer Emergency Telephone Authority furnished funds for the NCRCN equipment at the center, Larimer County would be required to pay them back the \$100,000 and to purchase and install new 800 MHz trunking equipment compatible with the CCNC system.

The costs of developing necessary tower sites for participation in the CCNC system are similar to that of the NCRCN. Since there is a stated partnership with several other agencies, these costs may be shared. The State Division of Telecommunications plan is to establish five (5) channels at each of their desired sites. Any channels beyond this will be the responsibility of the agency or agencies requiring the additional channel capability. Some sites, as mentioned, will be the responsibility of Larimer County to develop.

Assuming that the CCNC system is interested in establishing four or five channels at each site, estimated costs for sites such as Horsetooth, Buckhorn, or South Bald Mountains may be shared among the users. The impact to Larimer County is therefore reduced and remains negotiable.

Maintenance on site equipment is a negotiable item with the State of Colorado Division of Telecommunications. Maintenance is offered in those areas lacking in commercial or county maintenance capabilities. At this time, Motorola acts as the System Administrator in order to control system growth and coordinated maintenance efforts.

## 4.0 Recommendations

Larimer County is in the position of deciding on future directions for their countywide radio communication systems. Larimer County is not alone in this position as many agencies look to their radio systems in terms of relief from interference, expanding coverage requirements and the need to implement technological advancements required by their users. The unique aspect of Larimer County's determination is that in 2001, multiple radio systems are in operation in and around the county and efforts are underway to establish trunking systems that have the potential to replace and consolidate these various systems into one.

The County's radio system is divided into the lowband VHF operations of the Road & Bridge Department, Engineering and Department of Natural Resources, and the use of highband VHF for other county departments such as the Sheriff's Department, county fire agencies, the Parks Department and Emergency Management. These lowband and highband VHF systems have served Larimer County for the past several decades. As time has passed, population has increased, and the need for greater interoperability and expanded system coverage has become apparent. In order to provide better interoperability, additional channels are required to establish all Larimer County departments onto the same spectrum and to relieve channel congestion.

Obtaining additional VHF frequencies in the Front Range area is not an easy task. As other agencies move away from the VHF to the 800 MHz spectrum, more frequencies may become available, but this remains a slow and time consuming process. Once the frequencies are obtained, they may be employed throughout the system. In order for these frequencies to be of particular use, however, additional tower sites must be constructed to optimize portable and mobile coverage and provide clear communications in those geographic areas that do not currently have adequate coverage.

### *Short Term Recommendations*

#### **System Expansion - VHF**

Two areas identified as requiring additional radio coverage continue to be the Poudre Canyon and Laramie River Valley. These areas were identified during personal interviews and later, confirmed and illustrated by composite coverage maps. (See Appendix A).

Public safety users are becoming increasingly more dependent on their portable radios. Expectations of the users are that all emergency situations can be handled via portable radio. Therefore, it behooves Larimer County to build a system that will support portable radio use in most every location throughout the county.

Expanding the system for portable radio use will require additional tower sites. Sites to be considered are located on South Bald Mountain, North Middle Mountain, and either Green or Red Mountain. Funds for the construction of these sites will be well spent for operations regardless of whether Larimer County remains in the VHF spectrum or they choose to move to an 800 MHz trunked radio platform.

An expressed priority concern for most users in the County is enhanced radio coverage in the Poudre Canyon. To best address this geographic area is to replace the existing site on Deadman Mountain with a newly developed site on South Bald Mountain. Discussions between Larimer County and the US Forest Service began years ago and are continuing to date. The US Forest Service is also interested in users vacating the Deadman site. As recent as February 2001, the State of Colorado CCNC system has expressed interest in the use of a South Bald site as well.

As time and funds permit, the remaining sites should be developed for improved coverage in the Laramie River Valley and Poudre Canyon. The priority for determining the next site to be constructed should be based on results of actual field use of portable radios in both areas with the addition of the South Bald site.

Once additional sites are developed, the opportunity is present to not only provide better reception for the system but, to provide better reception for field units with the increased capability for transmitter steering and/or multicasting from these sites. These technical capabilities would allow users to realize overall improvement and satisfaction in their current system.

### ***Long Term Recommendations***

The next question to be answered is whether or not the current VHF system can carry the communications needs of the Larimer County agencies for the next 5 to 10 years without jeopardizing the safety of the users and citizens. The answer to this question is “yes”, as long as Larimer County is committed to the construction of additional sites using VHF equipment and providing the necessary portable and mobile radio coverage in those areas that currently lack sufficient coverage.

If, in the future, Larimer County chooses to participate in a trunking system, these sites will be available for use as mentioned. The VHF equipment would need to be replaced with 800 MHz trunking capable equipment both at the sites and with every field unit (mobile and portable).

As an alternative to remaining in the VHF spectrum, Larimer County should consider moving to a trunked radio system such as the NCRCN or CCNC systems. These two systems have operated independently to date but are making strong efforts toward their merger. As of February 2001, no written agreement has been signed between the two systems, however discussions continue on how to best combine both systems. The similarities and differences in the two systems are explained in detail on pages 21-26 and 38-45. With the merger of the two systems, the differences disappear and the advantages proliferate. The merger of the two systems is consistent with their interests in promoting interoperability and cost sharing.

Participation in these systems has several advantages for Larimer County including:

1. Greater spectrum efficiency and additional operational channels - A trunked radio system provides greater spectrum efficiency by “pooling” channels for use by all system users when available rather than one unit being assigned to communication on only one channel. This provides the user with the appearance and functionality of additional operational channels. The ability to split

departments onto separate channels is desirable while maintaining the ability to monitor and communicate with all departments.

2. Interoperability - Full interoperability is the ability to routinely communicate and monitor units both within and surrounding county borders and being able to efficiently establish group mutual aid configurations in the event of large and small-scale emergencies. This enhanced interoperability is one of the driving forces behind the development of the CCNC and NCRCN systems. Interoperability is afforded to those agencies sharing the same trunked radio system and is tremendous compared to the existing mixture of systems in use today. Simply by having all users in the same spectrum provides the ability to talk among users that didn't exist before.
3. Expanded technical capabilities - Operational complexities would be automated by the electronics found in a trunking system. Multiple transmitters controlled by the system, which automatically tracks the location of units, would address the radio coverage problems throughout the County.

Data transfer capabilities are present with a trunked radio system and is especially useful in the proposed digital design of the CCNC system. It is increasingly important for public safety users to have access to various databases to include CCIC/NCIC, CHEMTREC, and selected Internet data. Other internal capabilities may also be readily available such as report writing, accessing work orders, job tasking, and dispatch capabilities. These options are a function of added agency software components to the system. Commercial and private data systems are available in eastern Larimer County today. These systems were designed to provide data capabilities in the City of Fort Collins, the Poudre Fire District and some of the more populated areas along the Front Range. Expanding these systems to cover the western portion of the county is not cost effective to these commercial enterprises due to the low customer base. Combining data with an existing trunking system is a more cost effective solution, especially for all agencies including Larimer County.

Unit to unit personal communications would be possible for which cellular phones are currently used. The trunking system could also provide these personal communications in areas that are not commercially feasible for the construction of the cellular system today.

Additionally, unit identification, emergency alert, automatic vehicle location, lost or stolen radio deactivation, and dynamic talk group construction are all features available in a trunked system. These features are provided for enhanced efficiency and system security that are required particularly by public safety users.

### **Performance Expectations**

In order for Larimer County to participate in a trunking system, the system must provide portable radio coverage throughout the County. This is only accomplished by the construction of the necessary sites outlined earlier. Again, these sites can be developed

for immediate use with the current VHF system and can also be available for use in the trunking system now or in the future.

At this time, agencies participating in the existing 800 MHz systems have their primary response areas surrounding the metropolitan areas of Loveland and Fort Collins as well as, paved highways in the County. The metropolitan agencies do require portable coverage within their jurisdictions. Agencies such as the State of Colorado are interested in developing a system that provides for only mobile coverage outside of the metro areas and into western Larimer County. With this in mind, the existing trunking systems would not adequately cover the western portion of the county for portable radio use. Agencies other than Larimer County would see little value in developing additional sites that do not directly effect their personal operations and would, therefore, not be as receptive to offering financial assistance to site development. Agencies such as the State of Colorado would, however, see value in developing these sites that provided for mobile radio use.

Larimer County cannot enter into a trunking system that doesn't immediately supply the necessary coverage to all agencies. This necessary coverage includes areas that are not adequately covered today. It should be realized that it will be cost prohibitive to achieve system coverage perfection, but efforts must be made to achieve as much as possible from the beginning. There is skepticism among some County radio users that the 800 MHz spectrum and trunking system complexities are not the right choice for the rural portion of the County. To enter into a new system that doesn't offer the best possible system design and coverage is to begin its use with distrust and confrontation from the users.

### **Financial Considerations**

While there are several excellent reasons for Larimer County to participate in the trunking environment, the question is whether the advances in communication justify the cost of construction, equipment and user fees at this time. Making a substantial investment now, in the hopes that the future will be protected, is particularly difficult with local governmental agencies.

The cost of equipment revolves around infrastructure, and mobile/ portable radios. Additionally, user fees are present for agencies to participate in the system and are intended to support maintenance of the system. The amount of the fees are determined based on when the agency entered into agreement with current trunked system and the level of participation of the agency in terms of site contribution. Once the infrastructure is established, it is likely that fewer financial incentives will be available as compared to today, before the system is fully operational. If Larimer County chooses to wait for the system to be built, they may be in a position of funding additional site development completely on their own. The other side of this is that the County can wait until a significant portion of the system is constructed and testing can be done to validate the suitability of the system for Larimer County's needs and the additions required to it to meet those needs.

The cost of mobile and portable radio equipment is decreasing as major manufacturers recover research/development costs, and markets expand with increased competition, much the same as is found in the computer industry. By delaying the purchase of mobile and portable radio equipment, financial impact will be lessened due to this decrease in

component cost. Infrastructure equipment cost, on the other hand, will most likely remain steady. Manufacturers prefer to offer more features rather than to lessen the cost to the consumer.

### **System Governance**

As the trunking systems mature and develop into one cohesive system, protocols for system governance will become clearer. A clearly defined organizational structure will be available as well as, outlined expectations of users and the remedies available for system non-compliance. The need for written responsibilities and system policies and procedures is apparent to all users and is developing at this time. By-laws have existed for the NCRCN system and are being developed for CCNC as of January 2001.

### **Partnering**

It is in the best interest of all agencies to participate in the development and use of the 800 MHz trunking system. Partnering with the system as it develops is critical to its meeting the needs of Larimer County agencies. Maximum benefits are seen by immediate participation in terms of interoperability, coverage and cost effectiveness however, participation in the future will be available to varying degrees.

One such example of partnering is found with the State of Colorado. Their users will need to construct sites in Larimer County to provide for 95% mobile radio coverage along the highways. Larimer County has a similar requirement and has valuable contributions to offer the trunked system in terms of established microwave and tower sites.

A partnership currently exists between Weld County and the CCNC system users. In this instance, CCNC is establishing four (4) sites and Weld County is adding an additional five (5) to provide for countywide coverage necessary for their units. A similar agreement could be established between the 800 MHz system users and Larimer County. This agreement could stipulate that the 800 MHz systems would establish the first four (or possible five) channels at agreed upon sites and additional channels would be the responsibility of Larimer County. Additional channel capability may be a shared responsibility among existing users in Larimer County including the City of Fort Collins and the Poudre Fire District to name two.

### ***Recommendations Summary***

In the short term, improvements to the current VHF system and the construction of additional sites and equipment will provide the required radio coverage, as well as site availability for potential transfer to a trunking system. Partnering with interested agencies on each of these sites will help to reduce cost, develop cooperative relationships, possibly expand the trunking system into the County, and make it that much easier to participate in the trunking system in the future.

It behooves Larimer County to equip selected county vehicles with trunking capable, 800 MHz mobiles and portables to provide a limited amount of interoperability and the ability to monitor the growth and capabilities of the trunked system. This is not the recommended method for achieving long term interoperability.

In the long term, participation in the trunking system is recommended. As the system develops, it will undergo upgrades that will allow advanced features to be available to all users of Larimer County. Throughout the process, it is recommended that Larimer County participate in the planning and development of the trunking system so that its design keeps Larimer County users in mind.

**5.0 Appendices**

*Appendix A – L VHF Coverage Maps*

*Appendix M – Y 800 MHz Coverage Maps*

*Appendix Z NCRCN By-Laws and Intergovernmental Agreements*