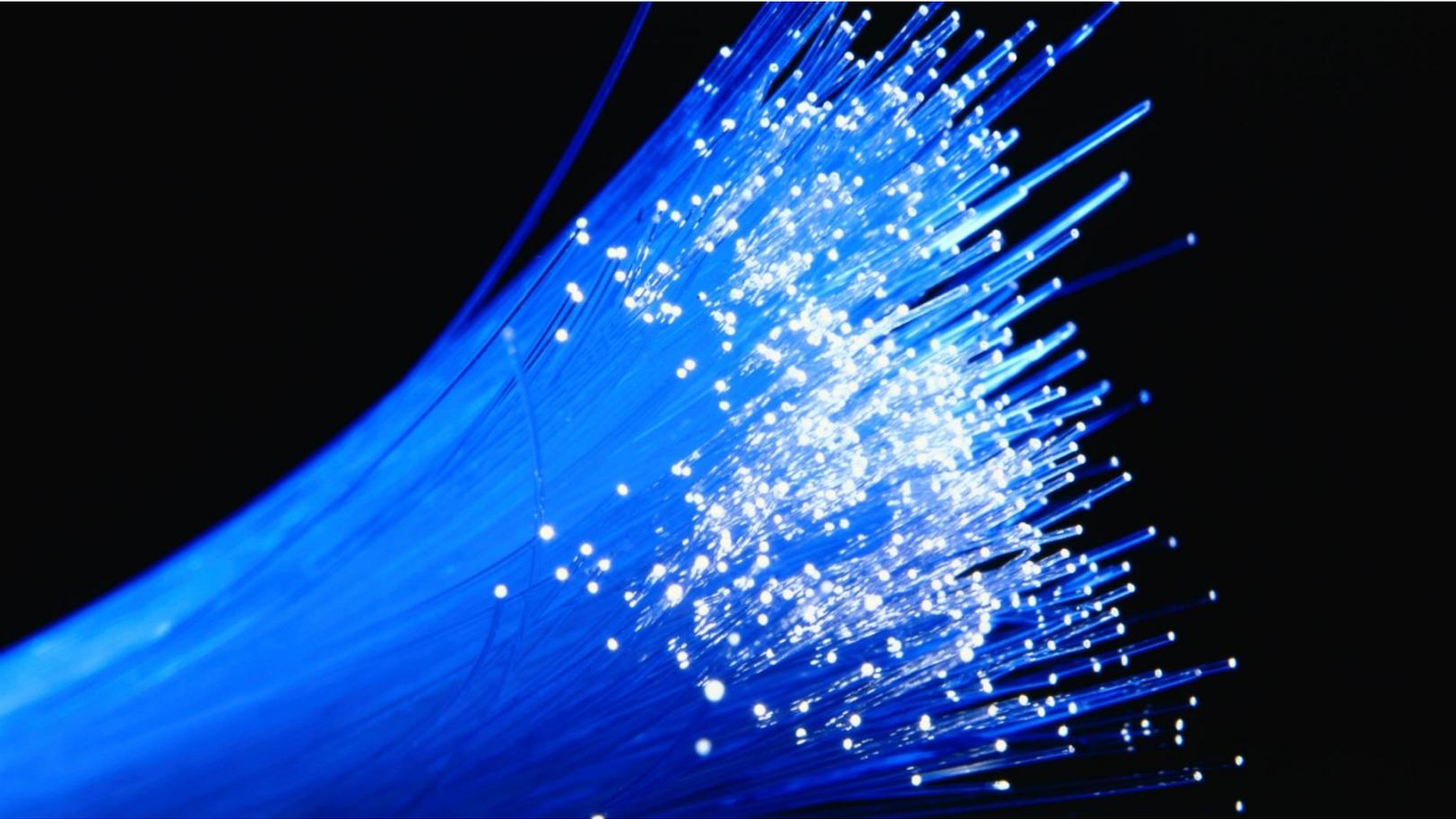




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## **Broadband in Summit County: Challenges and Opportunities**

**Prepared for Summit County, Colorado  
January 2017**

**Columbia Telecommunications Corporation**

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## 1 Executive Summary

### 1.1 Background and Objectives

Summit County, Colorado, has abundant natural resources and a tourism-based economy that capitalizes on its location along the I-70 corridor. However, despite its proximity to significant communications infrastructure, and the demand created by its residents and visitors, the County lacks sufficient access to reliable and robust broadband access, both wired and wireless—with particular weakness in mobile wireless services in three major areas.

The County has been striving to solve the issue of this insufficient mobile service for a number of years, with a particular focus on three areas: the Lower Blue River Valley north of Silverthorne, Montezuma, and the Summit Cove neighborhood.

These areas are frequented by not only residents, but motorists driving north of Silverthorne on CO-9, and visitors to the County who drive and ride their bikes along the Blue River; hike and mountain bike on the Montezuma/Keystone/A-Basin/Tenderfoot Mountain trails (including along a portion of the Colorado Trail and the Continental Divide); and who try their skills at the public shooting range next to the Landfill.

Ubiquitous cellular coverage, both for broadband and voice applications, is paramount to maintaining a safe environment for residents and visitors alike. Yet AT&T Wireless has twice withdrawn its plans to provide coverage in these areas, and the County has been unable—despite considerable ongoing efforts—to attract other service providers.

To identify strategies that will help the County reach its goals—including improved broadband connectivity for residents, businesses, and public safety users; greater digital inclusion; the delivery of municipal services; governmental cost savings; and more efficient “connected government”—the County hired CTC Technology & Energy to evaluate existing communications infrastructure, conduct outreach to the cellular carriers; evaluate potential solutions (including partnerships); and develop requests for information (RFI) to seek partners willing to engage on wireless or fiber-to-the-premises (FTTP) deployment in the County.

### 1.2 Methodology

To begin our project collaboration, CTC and the County conducted a kickoff meeting/needs assessment session to understand the County’s goals and objectives for the project. We gained an understanding from the following participants:

- Mr. Scott Vargo – Summit County Manager
- Mr. Byron Rice – Information Systems Director
- Bill Pessemier, Ph.D. – Director, Summit County 911 Center

- Mr. Jerry Del Valle – Network Administrator, Summit County
- Mr. Joey Moulis – Senior Systems Administrator

CTC staff then conducted the following tasks over the course of this engagement:

- Evaluated existing wired and wireless communications infrastructure and services in the County:
  - Conducted an inventory of physical assets and infrastructure
  - Developed a summary of communications services in use
  - Performed a desk survey of existing assets using County and other available documents
  - Performed site surveys of three target areas for potential construction of towers, poles, or manholes
  - Reviewed relevant assets in County buildings and other government facilities
  - Identified local service offerings
- Held numerous discussions with town managers and/or mayors, affected citizens, and other stakeholders to gather insight and information
- Facilitated discussions with cellular carriers and tower companies
- Developed a high-level design and cost estimate for a County-implemented wireless solution
- Developed two requests for information (RFI) to seek input on options for public–private partnerships, including:
  - Fiber-to-the-premises (FTTP)
  - Wireless broadband, primarily targeting the County’s unserved areas of the Lower Blue and Montezuma

Following the completion of the RFI process (after the date of this report), CTC will facilitate discussions with RFI respondents, prepare a summary and analysis of results, and present recommendations for the County’s consideration

## **1.3 Findings**

### **1.3.1 Cellular Coverage and Capacity**

Based on our experience and observations throughout the country, Summit County has undertaken every potential strategy and option it can to try to incent private sector services provision to fill the mobile broadband coverage gaps in the Lower Blue, Montezuma, and Summit Cove areas. In our view and, based on our experience, the County’s efforts to find a solution to the mobile broadband problem have been exemplary, particularly in light of the core economic challenge. Specifically, mobile service to remote locations in mountainous areas is very

challenging from an economic standpoint. For this reason, most of the counties of Colorado and the Mountain West (as well as the Mountain East, in states such as Maryland, Pennsylvania, Virginia, Maine, Massachusetts, and North Carolina) face significant gaps in mobile coverage in their more remote (and sometimes less remote) areas. Summit County is not alone in facing this challenge, though, in our experience, it has made singularly extensive efforts to address it.

The key challenge is the cost of deployment relative to the size of the market and likely return on investment. One issue is that the cost of building a mobile wireless site in the County (from \$300M to \$600M) climbs for more remote locations, because of the expense of providing a backhaul connection by either fiber or wireless means. Another issue is the cost of maintaining and operating a site, especially one that is remote from the rest of the network. As a result, the reality of the economics of rural broadband is that even if the County contributed substantially to the capital cost of infrastructure, the carriers and other potential private sector service providers have indicated that they are unlikely to deploy services in that area because, even with a substantial county investment, the return to the company would be insufficient to justify the expansion of service.

While AT&T's representatives stated unequivocally that AT&T Wireless would not install new infrastructure or otherwise expand its wireless service in the County, Verizon Wireless' representatives expressed a willingness to consider future expansion in the Lower Blue area and Montezuma—and the company has recently enhanced its coverage in the Summit Cove area. Verizon Wireless and the County have now established a relationship, and Verizon is evaluating the potential for filling these coverage gaps. These areas, however, are not in Verizon's current upgrade plan, and any expansion would require Verizon amending its plans or putting the expansion into a future plan.<sup>1</sup>

With regard to T-Mobile and Sprint, neither has extensive facilities in the County outside Breckenridge and Silverthorne. Both support customers primarily through roaming agreements on Verizon and AT&T Wireless infrastructure between their facilities. CTC is in contact with both companies to determine whether there exists even a long term plan to expand their infrastructure in Summit County, but based on our knowledge of this industry, we doubt that either company will be willing to offer a near term solution.

All four of the major carriers continue to enhance capacity in population centers of the County especially in Breckenridge and Silverthorne. This entails deployment of small cell infrastructure on buildings and other small structures.

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<sup>1</sup> Verizon recently received approval from the Town of Silverthorne for a new site in the Three Peaks neighborhood in the northern part of the Town; however, this site will not be high enough to provide coverage along CO-9 in the Lower Blue.

One public safety initiative on the horizon may help to alleviate the County's broadband issues. The First Responder Network Authority, or FirstNet, is responsible for overseeing the buildout of the nationwide public safety broadband network (NPSBN). This network will use LTE technology to improve and enhance data and voice connectivity among local, state, regional, tribal, and federal public safety users.<sup>2</sup> The network's excess spectrum capacity can be used for commercial services. As a result, the NPSBN, once deployed, may offer Summit County residents and visitors an alternative to the current commercial carriers' networks that provides better coverage throughout the County. It may also fund the construction of wireless sites and backhaul connections that can be used by commercial carriers in those areas, depending on the details of the eventual FirstNet design. The network, although slated to begin deployment in 2017, may not be available in Summit County for three to five years and if obstacles arise, may not be constructed at all.

Private landowners<sup>3</sup> in the Lower Blue have expressed willingness to build a site on their properties. This may help to accelerate any enhancements in the area, but the decision whether to invest is still in the hands of the mobile wireless companies.

### **1.3.2 Broadband in the County**

The population centers of Summit County, County government, and Town governments are served with wireless broadband, primarily by Comcast over cable modem networks and by CenturyLink over Digital Subscriber Line (DSL) networks – including the Summit Cove neighborhood. Town representatives surveyed agree that there is a desire for higher speeds. There was only evidence of such plans in an upgrade to the Hampton Inn in Silverthorne which is located very close to I-70 and therefore close to high-speed fiber infrastructure.

The unserved areas of Montezuma and the Lower Blue have only satellite communications and DSL available for a broadband link. There is CenturyLink fiber that runs along CO-9 in the Lower Blue, however, it does not extend into the ranches located there. Extending a fiber network over that "last mile" to the home or business is costly – averaging \$25,000 to \$250,000 per mile, depending on whether the construction is aerial or underground, and whether the provider already has infrastructure along the route – and is most likely the reason why fiber is not found in the Lower Blue, or, for that matter, to residents and businesses in other areas of Summit County.

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<sup>2</sup> More information about FirstNet and FirstNet Colorado can be found at [www.firstnet.org](http://www.firstnet.org) and <https://sites.google.com/a/state.co.us/firstnetcolorado/home>

<sup>3</sup> A landowner in the Lower Blue negotiated with AT&T Wireless to build a tower on his land but, due to AT&T's change in business model, AT&T did not build.

Regarding service to Montezuma, CenturyLink recently received federal funding to support rural broadband deployment; Montezuma is on its list of potential service areas.<sup>4</sup> The development of CenturyLink assets up to and into Montezuma may provide a terrestrial Internet option for residents there and provide a potential backhaul asset for wireless services as well.

Breckenridge today, and potentially Silverthorne in the near future as the downtown area is redeveloped, hope to be able to implement “SmartTown” initiatives. Enhanced and more available broadband services will be required to turn these initiatives into reality.

### 1.3.3 Requests for Information

Many municipalities are taking the lead to encourage the deployment of better broadband for community residents, visitors and businesses. To this end, the County has plans to release two Requests for Information (RFIs) to focus on the project objectives of providing wireless broadband services to unserved areas and to explore the potential for a County/private partnership for providing fiber-to-the-premises in the County.

To this end, CTC is developing two RFIs:

1. Fiber-to-the-Premises (FTTP) RFI – This RFI will solicit input from companies interested in providing fiber-to-the-premises in Summit County.
2. Wireless Internet Access RFI – This RFI will solicit input from companies interested in providing a wireless broadband solution that will target the unserved areas in the County, primarily those called out in the study – the Lower Blue, Montezuma, and Summit Cove.

The evaluation of these responses and the ensuing discussions with potential partners, will provide the County with a real understanding of the landscape for a public-private partnership solution.

For comparison sake, CTC developed a high-level conceptual design of a point-to-multipoint wireless broadband solution for both the Lower Blue area and Montezuma. This would entail using readily-available 5 GHz unlicensed and TV white space spectrum using existing or new poles for signal distribution to homes in the areas. The capital construction cost is approximately \$1,200,000 and \$60,000 for the Lower Blue and Montezuma, respectively.<sup>5</sup> Operating costs would be on the order of \$140,000 annually (for both locations).

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<sup>4</sup> [https://apps.fcc.gov/edocs\\_public/attachmatch/DOC-335269A2.pdf](https://apps.fcc.gov/edocs_public/attachmatch/DOC-335269A2.pdf)

<sup>5</sup> The cost is exclusive of the cost of backbone connectivity to the Internet. In the Lower Blue this would require connection of the wireless network to existing service providers in the CO-9 corridor. In Montezuma it would

This high level design and estimated cost would need to be verified by on-site evaluation of available sites and backhaul, however, this rough order of magnitude desk study illustrates the scale needed to build and operate such a system.

Results of the wireless RFI will also provide the County with potential solutions and costs for deployment of broadband networks in the Lower Blue and Montezuma.

## 1.4 Recommendations

Based on our findings, we make the following recommendations:

The County should continue to address its cellular coverage gaps in a variety of ways:

- Continue discussions with Verizon Wireless
- Maintain communications with other carriers to stay aware of new developments
- Monitor FirstNet developments as plans are made to build in Colorado and specifically in Summit County
- Maintain relationships with landowners willing to build a site on their property
- Discuss the costs of building and maintaining a tower (or towers) (with or without a partner) with the Board of County Commissioners; determine whether the County wishes to pursue building a tower and leasing space to carriers, while realizing that even this level of investment may not be sufficient to incent a mobile carrier to expand service
- Explore the purchase of the Blue Ridge tower site from the US Forest Service/Bureau of Land Management or co-location on another Blue Ridge facility for both public safety and site colocation opportunities for carriers

The County should also continue to seek enhanced broadband services through a range of means:

- Evaluate the FTTP RFI results to gauge interest and initiate discussions with responding firms to evaluate the potential for a public-private partnership as well as unique solutions for fiber to the premises
- Evaluate the wireless broadband RFI results to gauge interest and initiate discussions with responding firms to evaluate the potential for a public-private partnership, especially to enhance broadband in the unserved areas

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require connection through the CenturyLink telephone lines from Keystone, or potentially new fiber construction along that route, if the lines could not support adequate capacity.

- Work with the towns to develop solutions to their initiatives that require enhanced broadband services
- Coordinate efforts with the Northwest Colorado Council of Governments (NWCCOG)<sup>6</sup>

These recommendations are intended to enable the County to move closer to reaching its goals—including improved cellular coverage and broadband connectivity for residents, businesses, and public safety users; greater digital inclusion; the delivery of municipal services; governmental cost savings; and more efficient “connected government.”

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<sup>6</sup> The Northwest Colorado Council of Governments (NWCCOG) “is a voluntary association of county and municipal governments that believes in the benefits of working together on a regional basis. NWCCOG serves 27 member jurisdictions in a 5-county region” (<http://nwccog.org/>) including Eagle, Grand, Jackson, Pitkin, and Summit counties. NWCCOG developed a Regional Broadband Strategic Plan, in 2013, that outlines data collected about broadband offerings, or the lack thereof, as well as high-level strategies for policy, acquiring/disseminating knowledge, coordination and deployment. (See: <http://nwccog.org/wp-content/uploads/2015/04/FINAL-Regional-Broadband-Strategic-Plan-v2-1.pdf>) Summit County and NWCCOG member towns within the County should continue to coordinate efforts such as this one with the NWCCOG. CTC discussed the project with Nathan Walowitz, the NWCCOG Regional Broadband Coordinator.

## 2 Industry Background and Challenge

The wireless broadband ecosystem in the U.S. includes:

- Mobile network operators (MNO) such as AT&T Wireless, Sprint, T-Mobile, and Verizon Wireless;
- Tower companies such as Crown Castle and American Tower; and
- Independent neutral host operators, which are often fiber companies involved in cellular backhaul.

The MNOs have collectively invested an average of \$25 billion per year in infrastructure in each of the past four years—but most of that amount has been invested in urban and suburban markets, not less dense markets like Summit County. The MNOs have invested to expand infrastructure for LTE-4G; we are now seeing a further upgrade in denser markets to include the Cloud-Radio Access Network (C-RAN) architecture that will be needed to support future 5G deployment.

Importantly, industry trends indicate that the MNOs are investing in expanding their capacity in existing service areas—not in expanding those service areas or filling in coverage gaps.

Over the past several years the landscape has also changed as the MNOs have sold the majority of their towers to national tower companies and now are more likely to reside as tenants. If MNOs do construct new towers, it is typically to fill in coverage gaps with a single structure; they will generally turn to tower companies if they need to construct several towers in an area.

The tower operators sell space to multiple MNOs, and provide more coverage through new technologies and improved and larger antenna arrays. It also means that new monopoles (traditional larger cell towers) are being constructed less frequently, and with increased scrutiny on the return on investment.

Although on one level, this environment would seem to point Summit County toward approaching tower companies instead of MNOs, in fact the tower companies typically do not build unless they have one or more MNOs as an anchor tenant. This was confirmed by Roam Tower Development Group who has worked with the MNOs in the past.

### 2.1 Challenges of Rural Broadband

The challenges of rural broadband are the same whether the delivery technology is fiber or wireless:

- Large initial capital deployment

- Lack of existing usable infrastructure
- Extended payback with few potential customers (relative to more densely populated markets) for add-on revenue realization

Towers create more value for their owners when they attract a second or third carrier to locate antennas—especially given that, in today’s data-intensive world, almost all towers being constructed must have adequate (and expensive-to-construct) fiber backhaul. But even then, the cost of constructing a tower may outweigh its potential return on investment.

The cost to deploy a cell tower ranges from about \$150,000 to \$350,000, depending on numerous factors such as structure type, height, power and backup capabilities and environmental conditions. The cost to locate backhaul and power at a site can significantly increase the required deployment investment—even doubling the cost, depending on the site location and difficulty in reaching that site with either fiber or wireless infrastructure. For example, as a rough estimate, constructing a tower structure and connecting it to power and fiber backhaul might cost \$475,000 to \$575,000 in the Lower Blue area (up to \$275,000 for tower construction<sup>7</sup> and \$200,000 to \$300,000 for microwave or fiber backhaul and power<sup>8</sup>).

Due in part to these expenses—and the MNOs’ efforts to increase their profits—the MNOs are shifting their business models nationwide; rather than increasing their geographic coverage areas, they are seeking to improve capacity in the areas they already serve. The carriers’ coverage maps before and after recent deployments tell the story: The boundary edges do not change much, but the capacity and speeds in those areas improve sharply.

In Summit County (and other rural counties including Eagle County), the carriers are deploying numerous new “small cell” sites in the towns where additional capacity is needed, especially during the high winter and summer tourist seasons.

In Vail, for example, Crown Castle deployed 23 new cellular sites as part of a distributed antenna system (DAS) network enhancement; most of the sites are connected to fiber for backhaul. These sites are small, cost-effective to deploy, and well-suited to communicating around obstacles such as buildings by creating a mesh framework. In order to enable this deployment, the town changed ordinances to allow for taller poles, and to grant use of municipal buildings and conduit.

Improved capacity in well-served areas offers little to those in more rural areas that are desperate for some level of reliable coverage, and instead are witnessing a widening digital divide.

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<sup>7</sup> [http://www.americantower.com/Assets/uploads/files/PDFs/investor-relations/Americantower\\_investorrelations\\_towers-101\\_2Q14.pdf](http://www.americantower.com/Assets/uploads/files/PDFs/investor-relations/Americantower_investorrelations_towers-101_2Q14.pdf)

<sup>8</sup> This is a CTC estimate based on our experience designing fiber-to-the-premises projects.

## 2.2 Additional Challenges in Mountainous/Resort Regions

Many Colorado Front Range residents from Colorado Springs to Fort Collins have second homes in Summit County and other mountain communities. These homeowners are accustomed to somewhat ubiquitous cellular coverage and higher Internet speeds in their primary residences and localities. Lesser broadband availability and performance is thus all the more frustrating while in Summit County. The County (and towns within) bear the brunt of these frustrations and are compelled to seek solutions.

Cellular antennas mounted on towers require line-of-sight with one another to facilitate call handoffs as a phone travels from one tower's coverage area to the next. This becomes difficult in mountainous regions—which further complicates carriers' site selection; towers may also need to be higher, and the equipment may need to operate at a higher power.

In other parts of Colorado, as well as in other rural mountain counties in the U.S., municipalities are experiencing similar issues and are establishing initiatives and policies to address them:

- The City of Grand Junction is developing a master plan for the development of broadband.<sup>9</sup>
- Fraser and Winter Park have partnered on a broadband sub-plan for their towns, including a resident survey regarding Internet, telephone, and television services.<sup>10</sup>
- Ely, Nevada—a small town nestled in the mountains close to the Utah border—is attempting to resolve numerous issues with broadband, including satellite communications and customer service.<sup>11</sup>

## 2.3 The Nationwide Public Safety Broadband Network (NPSBN) in Colorado and Summit County

One public safety initiative on the horizon may help to alleviate the County's broadband issues. The First Responder Network Authority, or FirstNet, is responsible for carrying out a congressional act to develop “the first high-speed interoperable wireless, broadband data and cellular voice network dedicated to public safety, which will facilitate communication for first responders' daily and in the event of emergencies.”<sup>12</sup> The nationwide public safety broadband network (NPSBN) will use



<sup>9</sup> <http://www.gjcity.org/Administration-Dept.aspx?pageid=2147537939>

<sup>10</sup> <https://www.surveymonkey.com/r/JJ7R9ZD>

<sup>11</sup> <http://www.elynews.com/2016/03/11/att-holds-public-meeting-address-internet-issues/>

<sup>12</sup> <https://sites.google.com/a/state.co.us/firstnetcolorado/home/why-firstnet-for-colorado/executive-summary>

LTE technology to improve and enhance data and voice connectivity among local, state, regional, tribal, and federal public safety users.<sup>13</sup>

FirstNet prioritizes the need for communications in rural areas, such as Summit County, meaning that LTE infrastructure buildout for FirstNet in Colorado must consider the County's area. This is in contrast to commercial cellular networks, which prioritize the population centers and are currently enhancing capacity but not expanding coverage areas. FirstNet will also allow the entity managing a local network to utilize excess spectrum for commercial use. (If Colorado opts in to FirstNet, that would be the entity that wins the national contract; if Colorado opts out, it will be an entity that the state engages to manage the network.) In addition, to the extent that new towers and fiber need to be built to provide FirstNet coverage, those potentially become available to commercial cellular providers. Therefore, the NPSBN, once deployed, may offer Summit County residents and visitors better coverage and/or an alternative to the current commercial carriers' networks.

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<sup>13</sup> More information about FirstNet and FirstNet Colorado can be found at [www.firstnet.org](http://www.firstnet.org) and <https://sites.google.com/a/state.co.us/firstnetcolorado/home>

### **3 Cellular Carrier Outreach, Research, and Potential Solutions**

CTC conducted outreach and interviews with representatives of the major cellular carriers in Summit County—AT&T Wireless, Sprint, T-Mobile, and Verizon Wireless—on behalf of Summit County. Our mission was to engage the carriers to determine their current and future plans within Summit County, and whether they intend to expand coverage throughout the Lower Blue, Montezuma, and Summit Cove. Summit County wants to work with the commercial carriers to find a solution to fill coverage gaps in the three areas. One goal of our outreach was to determine what, if anything, the County can do to enable the carriers to support this objective.

#### **3.1 AT&T**

As noted previously in this report and in local news articles over the past few years, AT&T had been committed to building two towers on private land in the Lower Blue and on County land at the landfill across from Summit Cove. CTC was referred by Roberta Robinette, AT&T Colorado President—External Affairs, to the company’s local Principal-Technical Consulting Engineer, Ken Malm, to discuss the history and potential future of additional coverage in Summit County.

Per Mr. Malm, AT&T made a national decision to reduce new site plans across the country. Unfortunately, the two Summit County sites were abandoned due to this decision. AT&T’s focus shifted to adding 4G capacity to existing sites, thus providing better service in already served areas. He related that AT&T is currently enhancing capacity in Breckenridge (most likely Gold Creek) and Silverthorne (the La Quinta Inn).

Mr. Malm explained that it is a significant investment to locate cellular equipment on an existing structure (such as a tower) let alone build, own, and manage the structure. Building additional sites in Summit County is not part of their three-year plan. Only higher usage numbers would drive the sites up higher on AT&T’s list of potential future builds. When asked, he also noted that AT&T opted out of federal and other rural funding opportunities for the area.

#### **3.2 Verizon Wireless**

CTC spoke with Verizon Wireless’ (VZW) local sales representatives, Senior Manager of RF Design for the region, and an RF Engineer. We also spoke with a representative of Black & Veatch, the engineering company responsible for the build-out of some of the VZW sites in the County. According to the local sales representative, VZW has a deep history with the County, and, to alleviate coverage issues in Summit Cove, recently installed a structure for antennas at the Lake Dillon Fire Fire-Rescue Station 12. VZW is also enhancing capacity in the Frisco/I-70 and Silverthorne areas.

CTC and Scott Vargo, Summit County Manager, held meetings with VZW engineering representatives to discuss County issues and to understand VZW’s perspective and plans. The representatives confirmed the recent installation in Summit Cove and plans in the Three Peaks

area to enhance capacity and add coverage. As are the other carriers, VZW is continually assessing how to improve capacity within the population centers of the County and building out small cells to do so. In contrast to AT&T, VZW is not pulling out of the tower building/owning business altogether—they will potentially build a tower at a site after careful evaluation.

VZW's representatives were aware of AT&T's past plans (and withdrawals) and the company had itself looked at sites in the Lower Blue area a while ago. As with AT&T and tower companies, one of the major concerns was the cost of providing backhaul to a ridgetop site. Running fiber from CO-9 entails laying 10 to 15 miles of cable.

After discussions about the need for coverage in the Lower Blue as well as discussions about other potential mutual support between the County and VZW, the company representatives agreed to internally evaluate the potential for a site in the Lower Blue and continue conversations with the County over the next several weeks. In addition, the VZW representatives noted that the company has current plans that may provide some coverage around Montezuma.

Although the Verizon response appears more promising than AT&T's, it must be understood that all the wireless carriers, including Verizon, are primarily driven by usage and users. The County plans to remain available for future discussions with Verizon.

### **3.3 T-Mobile**

CTC spoke with a T-Mobile representative, Mr. John Wabiszczewicz, Manager, Engineering Development, regarding T-Mobile's plans within Summit County. Mr. Wabiszczewicz was familiar with the history in Summit County, however, they do not have any plans to build infrastructure within the County. They currently have some infrastructure within the County's Towns and roam onto AT&T between. As with the other carriers, their focus is primarily on alleviating capacity challenges, and more so in the Denver/Front Range area. He did note that having structures available for a site would make it easier for them to consider.

### **3.4 Sprint**

CTC has reached out to a Sprint representative who is in the process of connecting us with personnel who can answer our questions regarding Sprint's plans. Sprint typically roams onto Verizon's network where no Sprint infrastructure exists and, according to industry news, Sprint has greatly reduced future capital expenditures (which would include adding new sites).<sup>14</sup> Therefore, it is not likely that Sprint would consider adding infrastructure within the County.

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<sup>14</sup> <https://goo.gl/ctH0yL>

## 4 Needs Assessment

Last year, Summit County residents overwhelmingly voted to override Colorado Senate Bill 152 (SB 152) which “generally prohibits local governments from providing broadband without a local vote” according to the *Denver Post*.<sup>15</sup> Many other Colorado municipalities (including the cities of Boulder, Longmont, and Montrose) have done the same.

Having overridden the bill, Summit County can now pursue municipal solutions to its needs for cellular coverage and other broadband services. To establish a baseline understanding of those needs, CTC surveyed each of the towns in the County regarding broadband performance, including cellular coverage and other broadband services. The following sections outline the results of our outreach efforts.

### 4.1 Cellular Coverage

Three primary areas of poor to non-existent cellular coverage in the County are the Lower Blue, Montezuma, and Summit Cove. CTC gathered insight into the specific needs and issues surrounding the coverage gaps in these areas, as well as the coverage in other towns in the County.

#### 4.1.1 Lower Blue

The area along CO-9 known as the Lower Blue is a scenic area primarily populated with large ranch parcels. It has been noted by residents and County employees that cellular coverage is non-existent on any carrier (AT&T, Sprint, T-Mobile, or Verizon) from around the Everist Materials location at 28755 Hwy 9 in Silverthorne through Heeney and into Grand County.

CO-9 is a well-traveled thoroughfare between the Summit County population centers, Kremmling, and into Routt County and Steamboat Springs; an average of 10,000 to 14,000 cars per day in Silverthorne and 2,700 to 6,400 north of Silverthorne to the Grand County border. It is also the primary route from the Denver area to Steamboat Springs (a popular recreation destination for Denver residents, as well as for the many visitors who fly into Denver International Airport).

The lack of cellular coverage in the Lower Blue is not just an inconvenience but also potentially a public safety issue—when a public safety incident occurs in this area (e.g., accident, fire), those involved or who observe must go to a nearby residence to make a landline call or drive to a coverage area, potentially 10 to 15 miles away.

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<sup>15</sup> Timothy E. Wirth and Ken Fellman, “Should Colorado broadband law be revoked? Yes,” Opinion, *Denver Post*, Sept. 5, 2014 (updated April 26, 2016), <http://www.denverpost.com/2014/09/05/should-colorado-broadband-law-be-revoked-yes/> (accessed Oct. 11, 2016).

There are approximately 500 residences along this route. More development is planned in areas such as Maryland Creek, which is just on the fringe of the current coverage area. Residents are limited to landline or satellite communications access only.

AT&T and the County discussed the potential for a tower in the Lower Blue area for many years; however, in 2014, AT&T cancelled its plans. At the request of Summit County Commissioner Karn Stiegelmeier, AT&T re-engaged; the company conducted engineering studies, submitted an application to the County, and received approval for a tower on private land. However, in June 2015, AT&T again cancelled its plans. According to sources within AT&T and industry knowledge, the company's business model regarding building towers changed. AT&T is getting out of the business of building/owning/maintaining tower sites and is instead leasing space on other tower owners' structures.

Figure 1: AT&T Proposed Site in Lower Blue Area



Figure 2: AT&amp;T Proposed Site in Lower Blue Area from CO-9



Atlas Tower also looked at the potential for building a tower on the same landowner's property, but did not pursue the project. At the time, a fiber-to-the-tower solution by CenturyLink was considered for backhaul. This entailed running approximately 14 miles of fiber along the road from CO-9 to the site.

CTC spoke at length with the landowner, who is still interested in participating in a solution, with a carrier or tower builder, or as part of a public-private solution involving the County. CTC also spoke with other Lower Blue residents who expressed great interest in a solution. They spoke not only of the public safety aspects but also about logistical issues such as having contractors working at a residence and not being able to communicate while on site.

The Lower Blue, in light of AT&T's change of plans and the lack of other cellular carrier pursuits in the area, continues to have a great need for filling the gaps with some type of wireless voice and/or data solution.

#### **4.1.2 Montezuma**

This small town, located where the pavement becomes dirt road, is home to approximately 65 to 70 residents and hosts many visitors who come to recreate on the many trails and roads leading up to the Continental Divide. It boasts a State of Colorado Historical Site and many now-defunct mines.

The town of Montezuma has no cellular coverage “beyond the yellow sign with bullet holes” for Verizon (according to locals) and before reaching the Town for AT&T (based on CTC observations); communications are either via landline or satellite phones. Due to the popularity of backcountry skiing, biking, snowmobiling, snowshoeing, and hiking in Montezuma, and the inherent risks in these activities, there is a real need for residents and visitors to have some type of reliable communication. In addition, this area is heavily forested and has the potential for wildfires.

Figure 3: Montezuma



#### 4.1.3 Summit Cove

Summit Cove is a relatively dense community located between Dillon and Silverthorne, tucked in between Swan Mountain and West Ridge. This area also includes the Keystone Ranch Golf Course and residences.

To provide better quality cellular connections to its customers, Verizon Wireless built an antenna structure disguised as a “hose tower” at the Lake Dillon Fire Fire-Rescue Station 12, providing HD Voice (voice and data over LTE technology) service to Verizon customers in the area. However, the other carriers still do not provide adequate coverage in Summit Cove.

Along with the Lower Blue tower site, AT&T was slated to construct a site on the County landfill property (across US-6) to provide cellular service in the Summit Cove area; the company conducted engineering studies and submitted an application to build on this site as well. Based

on the AT&T coverage studies, the company anticipated that this site, later cancelled, would have provided excellent cellular coverage in Summit Cove as well as enhanced coverage along US-6 and into Keystone.

#### **4.1.4 Other Towns**

CTC contacted representatives of each of the towns in the County—Blue River, Breckenridge, Dillon, Frisco, Montezuma, and Silverthorne—to discuss cellular performance within the town. With the exception of the town of Blue River and, of course, Montezuma, each of the towns has some cellular capacity issues, especially in high tourist season.

There are minor coverage gaps within the towns, as well as between Dillon and Keystone on US-6 close to Summit Cove. Coverage is satisfactory, based on anecdotal evidence, at the Breckenridge ski area.

Most of the towns use Verizon Wireless as their cellular provider (i.e., for government staff) with the exception of Frisco. Frisco uses Sprint based on cost and equipment features that it believes are a better fit for its law enforcement and public works teams.<sup>16</sup>

As noted previously, the carriers are building new small cell sites to enhance capacity in Silverthorne:

- The Town Council recently approved a request from VZW to locate a tower at the Three Peaks location. If the coverage area is not satisfactory, the company may request to add height to the tower in the future.
- VZW is hoping to place a site at the Pavilion (400 Blue River Parkway).
- AT&T recently built a site at the LaQuinta Inn (560 Silverthorne Lane). The proximity of the hotel to I-70 makes it well-suited for enhancing services to its subscribers on the interstate.

## **4.2 Other Broadband Access**

CTC also assessed the needs for access to better broadband services in the under- and un-served areas of the Lower Blue and Montezuma, as well as in Summit Cove and the towns in the County. Although broadband/Internet connections are possible via wireless cellular infrastructure, these connections are usually slow (as compared to a wired connection) and costly.

### **4.2.1 Lower Blue**

There is a need for broadband access in the area. Many residents in the Lower Blue do not have access to any terrestrial broadband communications, although there may be some subscribers to

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<sup>16</sup> Sprint offers Direct Connect, which is a push-to-talk application/service.

HughesNet—a satellite Internet service provider (ISP). Satellite services are slower than wired and even cellular Internet access speeds—5 to 15 Mbps for satellite, compared to about 50 Mbps for 4G LTE. This hinders any home-based businesses, students, and others from access to information that has become the norm elsewhere (and right down the highway in Silverthorne). Satellite service is also highly asymmetrical, with minimal speed in the upstream (user to network) direction. Satellite service is also metered, making it costly for users to regularly stream video or use other high bandwidth applications.

#### **4.2.2 Montezuma**

As in the Lower Blue—and for the same reasons—there is a need for broadband access for Montezuma residents. Some residents use HughesNet in Montezuma as well.

#### **4.2.3 Summit Cove**

Summit Cove, most likely due to the number of residents and businesses in the area, is well-served by both Comcast and CenturyLink for broadband access.

#### **4.2.4 Blue River**

Based on information provided by the Town Administrator, residents of the town of Blue River are adequately served. The Town Hall uses Comcast for Internet access and is also adequately served.

#### **4.2.5 Breckenridge**

The town of Breckenridge has the following goals to enhance communications for its citizens, businesses, and visitors:

- Establish a reliable Town-wide Wi-Fi network (that may also alleviate congestion on the cellular networks)
- Attract better options for broadband to the home/business
- Explore several Smart City initiatives for parking, transportation, and other interests
- Increase cellular coverage/capacity

The town is not satisfied with the current speeds provided by the ISPs (especially during the busy seasons), primarily Comcast and CenturyLink, and would like to explore other options. To allow for the ability to pursue other options, the town has put the choice to override SB152 on its November ballot. If passed, the town will be free to explore other options. The County's FTTP RFI results may offer Breckenridge insights into options to develop infrastructure in the town to support its initiatives.

#### **4.2.6 Dillon**

The town of Dillon uses Comcast as its ISP (citing CenturyLink as being too slow), and is happy with Comcast's services. The town hosts a public Wi-Fi site at the Town Hall as well as several other sites used by public safety and other town services. There are no current initiatives within the town that would require enhanced broadband services.

#### **4.2.7 Frisco**

A Frisco representative noted that the town is well-served with Comcast services. There are public, municipal-run Wi-Fi hotspots throughout the town, using the Comcast network as the backhaul. There is no interest at this time in expanding these Town broadband services, according to the representative.

#### **4.2.8 Silverthorne**

Comcast is the primary ISP in Silverthorne. The town offers free Wi-Fi at both the Town Hall and the Rec Center. According to the town, CenturyLink does not offer the same level of service as Comcast; however, the Hampton Inn is in the process of finalizing an agreement with CenturyLink for a high-speed fiber (1 Gbps) connection to the hotel. Its close proximity to I-70 (where CenturyLink runs fiber) will reduce the cost for a drop.

The town is in the process of an urban renewal project with plans to redevelop the downtown area.<sup>17</sup> The town does not have any current Smart City initiatives, but will be considering them as part of the infrastructure improvements for redevelopment efforts in the future.

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<sup>17</sup> <http://www.silverthorne.org/index.aspx?page=582>

## 5 Overview of Existing Assets and Services

The following sections describe the ownership of land, the existing public safety sites, and the existing broadband and land mobile radio assets and services within Summit County. Land and other assets were considered in the potential solutions for broadband enhancements to the three underserved areas (see Section 6).

Only one site, the Blue Ridge public safety site, would be able to enhance the current cellular coverage (i.e., fill in gaps) in the northern part of the County on CO-9 close to the Grand County border. However, since that site is quite high and LTE technology has a relatively small coverage footprint (typically a radius of a few miles), the signal would not reach very far—so additional coverage along the highway would be minimal.

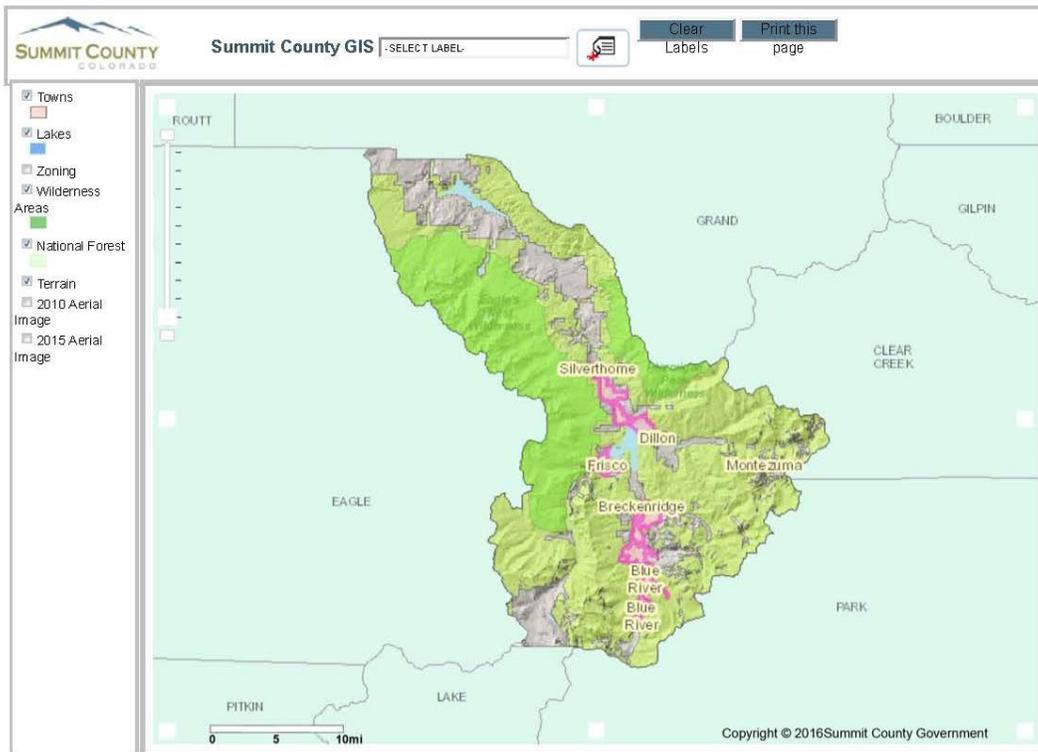
### 5.1 Land Ownership

As shown in Figure 4, most of the land in Summit County is owned by the U.S. government. Other land is private, owned by the County, or part of the County's seven towns. To construct broadband or land mobile radio communication sites within the County, the builder must comply with the restrictions in the relative area and submit applications to the appropriate entity.

The County's property, shown in the dark pink on Figure 4, is primarily around Heeney, the landfill, and at higher elevation around Montezuma.

Three landowners in the Lower Blue have offered to discuss—either with the County or directly with a carrier/tower company—the potential use of their property for a cellular carrier's site or other broadband infrastructure. Stephen Fausel and members of the Friends of the Lower Blue, John Hillman and Peggy Long, have expressed a willingness to provide land and/or contributions to establish a site in the area. AT&T was set to build a site on Mr. Fausel's property that would have provided coverage along a stretch of CO-9 in the Lower Blue and into the ranches. If and when a carrier chooses to build a suite in the Lower Blue, the landowners' willingness to collaborate on a site will facilitate the process. Figure 4 illustrates that the land along CO-9 north of Silverthorne in the Lower Blue area, colored grey, is primarily privately owned.

Figure 4: Private Land Ownership in Summit County



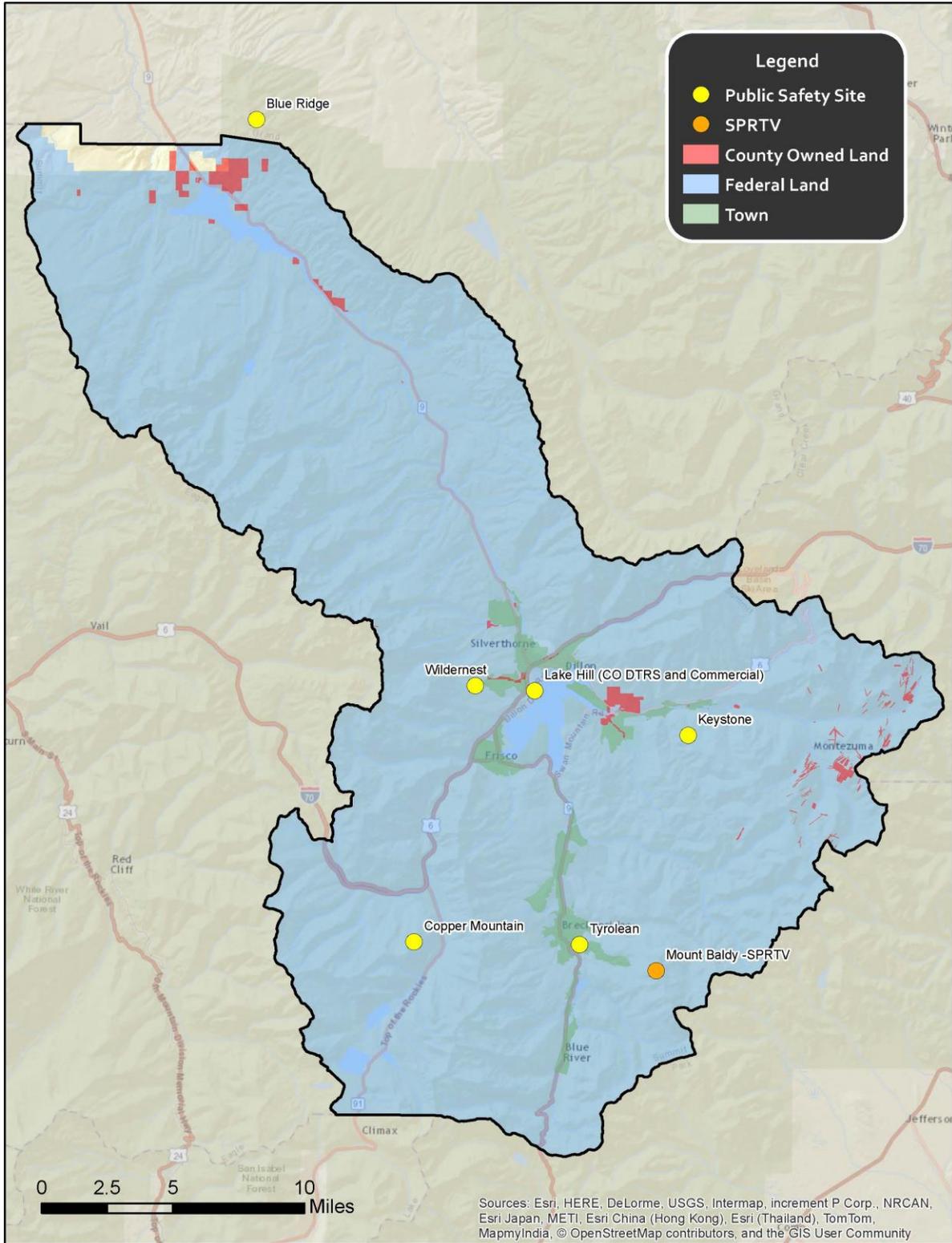
## 5.2 Summit County Public Safety and Public Radio Tower Sites

The Summit County 911 Center manages five tower sites throughout the County to provide public safety land mobile radio voice services to first responders. The sites are listed in Table 1 and illustrated in Figure 5. The public safety network is a very high frequency (VHF) system that adequately covers the County. In addition, the Summit Public Radio & TV (SPRTV) maintains a site on Bald Mountain (locally known as Mount Baldy) with several public and commercial radio and TV repeater antennas.

Table 1: Summit County Public Safety and Public Service Tower Sites and Elevations

| Site                    | Elevation (feet) |
|-------------------------|------------------|
| Wilderness              | 9,833            |
| Keystone                | 10,712           |
| Copper Mountain         | 11,671           |
| Tyrolean (Breckenridge) | 10,138           |
| Blue Ridge              | 10,857           |
| Mount Baldy             | 12,600           |

Figure 5: Public Safety and Public Service Radio Infrastructure in Summit County



CTC analyzed all five of the County’s public safety sites and visited the Wilderndest and Keystone sites to assess the potential for commercial carriers to use these sites to fill their coverage gaps. In addition, the County has run its own propagation studies to analyze the same. Per the County, each of the sites has space for additional equipment and the County is willing to allow other providers, such as cellular carriers, to co-locate.

The public safety structures are “hardened,” meaning they have been strengthened for improved resiliency during natural disasters or other threats. However, each time equipment is added, additional assessments must be made to ensure the integrity and maintain a hardened status.

### **5.2.1 Wilderndest**

The Wilderndest site is located above the Wilderndest residential areas. This site does not have direct line of sight to either the Lower Blue or Montezuma areas and is too far from either to provide cellular coverage. It does, however, provide LMR coverage to CO-9 in Silverthorne and north of Silverthorne.

Although there is theoretically space in the Wilderndest building for one or more cellular companies to place equipment, cellular companies typically place their own building and generator at a site and manage their infrastructure independently. The tower would also need structural analysis to determine its ability to support cellular antennas, and may require reinforcement or replacement. Cellular antennas are heavier and have greater wind loading than public safety antennas.

Figure 6: County Public Safety Tower Site – Wilderrest Tower and Equipment Room



### 5.2.2 Keystone

The new Keystone site is located on Dercum Mountain on U.S. Forest Service (USFS) land within the Keystone ski area; the County has a special land use agreement through Vail Properties to maintain the site. Although the site is nearer to Montezuma than the others, Independence Mountain, at an elevation of 12,614 feet, looms between the Keystone site and Montezuma, prohibiting an LTE signal from making it to the town. As with Wilderrest, another building would likely be required, and the tower may need to be reinforced or replaced. Placing another building would also require clearing trees on the ridgetop and permission from USFS and Vail Properties.

Figure 7: County Public Safety Tower Site – Keystone Tower



Figure 8: County Public Safety Tower Site – Keystone Shelter



### 5.2.3 Blue Ridge

The Blue Ridge site, on a high ridge east of Heeney located within neighboring Grand County, provides public safety LMR coverage from the northern end of Summit County and southward down CO-9. The site is on U.S.F.S land administered by the Sulphur Ranger District of the Arapaho and Roosevelt National Forest and Pawnee National Grassland (ARP). Use of this site must follow established USFS site management policies for site development and operations.<sup>18</sup>

There are several existing facilities comprising both a building and tower at this site<sup>19</sup>, some active and some decommissioned:

<sup>18</sup> [https://www.fs.fed.us/specialuses/special\\_comm.shtml](https://www.fs.fed.us/specialuses/special_comm.shtml)

<sup>19</sup> Blue Ridge Communications Site Management Plan, Arapaho and Roosevelt National Forests & Pawnee National Grassland, Sulphur Ranger District, 1/2010

Table 2: Blue Ridge Site Tenants

| Facility | Owner  | Use  | Active/<br>Decommissioned |
|----------|--|--|---------------------------|
| 1        | Western Area Power Administration                    | Microwave link   | Active                    |
| 2        | Bureau of Reclamation                                | Microwave link; private mobile radio service for Colorado Digital Trunked Radio System (statewide public safety network)                                     | Active                    |
| 3        | Green Mountain Networks (formerly Colorado CallComm) | Commercial mobile radio service; has a lease with the U.S.F.S. that allows them to have tenants/customers in their building in accordance with the site plan | Active                    |
| 4        | BLM/U.S.F.S.   | Private mobile radio service; tower tenants include Summit County public safety, ARP, White River and Routt National Forests                                 | Active                    |
| 5        | AT&T Wireless  | Commercial carrier   | Decommissioned            |

According to the Blue Ridge Communications Site Management Plan, tenants and customers “may co-locate in an existing facility when their communications use is an approved use in the site plan.” In fact, co-location, when practical, shall be required if feasible as opposed to building a new facility. Tenant rental fee policy, conditions for construction/modification/expansion of a facility and general operation and maintenance policies are outlined in the plan as well.

The Blue Ridge site may be helpful in filling in some coverage along CO-9 in the Heeney area and into Grand County. Although it is located approximately 3.6 miles from the highway, the site may be able to provide coverage along the highway in that area due to the elevation. However, access to the site is quite difficult, winding up Williams Peak Road (County Road 381/Forest Service Roads 200, 200.1) which may be impassable at times in winter. A four-wheel drive vehicle with high clearance is needed to get to the site. Cellular carriers tend to prefer sites that can be more easily accessed.

Figure 9: County Public Safety Site - Blue Ridge Location



Figure 10: BLM/USFS Tower at Blue Ridge Site/Summit County is Tenant



#### 5.2.4 Tyrolean and Copper Mountain

The Tyrolean and Copper Mountain sites are not in the vicinity of any of the areas of greatest need and therefore would not be considered.

Taken together, these sites provide excellent public safety coverage throughout the County. However, it must be noted that the public safety network is a land mobile radio system that uses different technology and a different spectrum for signal propagation than a carrier-grade solution for consumers, such as LTE. The characteristics of the frequency band used (very high frequency or VHF) is such that signal propagates a fairly long distance (10 to 15 miles as compared to one to two miles for LTE) and is known to work well in mountainous terrain (relative to other, higher-frequency bands used by cellular carriers). In addition, LMR technology is developed specifically for mission critical applications running on these networks, providing a much more robust communication exchange than a commercial network.

With the exception of Copper Mountain, the public safety system is backhauled on the State's wireless microwave network. That is, control data between the 911 center and the sites, as well as among the sites, is carried over another wireless system using microwave frequencies. This backhaul requires a direct line of sight between sites to operate properly.

Of note, there is a fiber connection to the Copper Mountain site. Therefore, if any other provider such as a commercial carrier were to request to co-locate, a high-speed backhaul connection is available.

### 5.2.5 Bald Mountain (Mount Baldy) SPRTV Site

Mount Baldy, located in the Arapahoe National Forest southeast of Breckenridge, is a beautiful and imposing feature in Summit County. At 13,684 and technically located in the Front



Range, it is the 12<sup>th</sup> highest peak in the County. Mount Baldy's "view" of surrounding areas and the relatively flat, long ridge across the top provides an ideal location for repeater sites.

Summit Public Radio and TV (SPRTV)<sup>20</sup> is a member-supported, non-profit organization fully funded by donations. SPRTV maintains repeater infrastructure on Mount Baldy that rebroadcasts public and commercial radio stations and digital television programming from the Denver area and Eagle and Summit Counties throughout Summit County.

As can be imagined (and duly noted on the SPRTV's website), "due to the high elevation and harsh weather, maintaining and improving our facility is costly." Although this is a high location, it is too far from the Lower Blue, Summit Cove and Montezuma areas to provide any commercial cellular coverage in those areas. Mount Baldy could, however, be considered for a link between sites or for coverage in its surrounding area.

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<sup>20</sup> <http://www.sprtv.org/summit/>

Figure 11: SPRTV Structures on Mount Baldy



### 5.3 State of Colorado DTRS Sites

The State of Colorado has sites that support the statewide 800 MHz Digital Trunked Radio System (DTRS) at the County's Blue Ridge, Tyrolean, Copper Mountain, and Lake Hill locations. Lake Hill, located between Dillon and Frisco and between Dillon Dam Road and I-70, is a good location for providing LMR coverage along I-70 and in Dillon, Silverthorne, and Frisco.

### 5.4 Hoosier Pass Communications Site

There is a U.S.F.S. site near Hoosier Pass where the County has access rights. Although this area is not a primary coverage area of concern for the County, there is the potential for carriers to locate there.

### 5.5 Existing Cellular Carrier and Other Infrastructure

As noted, the four major cellular carriers—AT&T, Sprint, T-Mobile, and Verizon Wireless—have infrastructure in the County. Discussions with residents, County personnel, and Town personnel indicate that AT&T and Verizon offer the most coverage. The carriers, based on site development applications to the towns and based on information received directly from representatives, are

also actively enhancing their networks to improve capacity in the more populated communities, including sites in Breckenridge, Silverthorne, and Frisco.

### **5.5.1 Lower Blue**

There is no cellular carrier infrastructure in the Lower Blue area.

### **5.5.2 Montezuma**

There is no cellular carrier infrastructure in Montezuma.

### **5.5.3 Landfill (to Serve Summit Cove) and the Northwest Beanpole Project**

The landfill on US-6 is located on County property and would potentially provide an ideal location for a carrier site. There currently are two unused “beanpole” tower structures on the property—one at the location that previously interested AT&T.

The Northwest Beanpole project has a long and varied history. Summit County received a \$472,688 grant (as did other counties), funded under HB 99-1102, a 1999 Colorado legislative act commonly referred to as the “Beanpole Bill.” “The Summit County Beanpole Project was ... a wireless implementation initially contracted to a company called NetBeam. When NetBeam and then its sister company Peak Speed filed for bankruptcy, the county appointed a trustee for the Community Wireless effort, but service problems in the fall of 2005 resulted in the county stepping in to retrieve the assets and seek a new operator.”<sup>21</sup> This operator, WisperTel/Skybeam, provided service to the County for a period of time.

WisperTel/Skybeam is now Rise Broadband, headquartered in Englewood, Colorado. A Rise representative provided additional information about their services: They are a fixed wireless Internet provider which requires customers to mount an antenna to a roof and have line of sight to their tower. Their website claims Internet speeds between 3 Mbps and 1 Gbps.

Rise no longer serves Summit County based on a chat with a representative checking on service to Keystone Resort and the address of the Old County Courthouse in Breckenridge. The sites at the landfill (as well as other “Beanpole” sites in the County) can be considered in a solution for wireless broadband in a partnership with the County.

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<sup>21</sup> [http://wikis.ala.org/connectivitystudy/index.php/Northwest\\_Beanpole\\_Project\\_I#Summit](http://wikis.ala.org/connectivitystudy/index.php/Northwest_Beanpole_Project_I#Summit)

Figure 12: Landfill Site – Existing “Beanpole” Structure



CenturyLink provides fiber along US-6 and has extended its lines up Landfill Road; it has plans to provide fiber to the landfill building(s). This fiber was also intended to provide backhaul to the abandoned AT&T site.

Figure 13: Landfill Site – Fiber Optic Cable



Verizon Wireless, understanding that plans to construct a tower at the landfill fell through, has recently enhanced its network in Summit Cove with a 4G LTE site at Lake Dillon Fire District Station 12 in Summit Cove.

#### 5.5.4 Other Carrier Sites in the County

There are numerous other cellular carrier sites throughout the County. One of the main sites is the Lake Hill site located on towers on a hill between the Dillon Reservoir and I-70.

According to representatives of the towns and the carriers, there are many additional sites throughout the towns, primarily to enhance capacity.

#### 5.6 Fiber Assets

The map in Figure 14 illustrates the fiber in the County; we describe the various fiber owners and operators in the sections below.

##### 5.6.1 Summit County and CDOT

Summit County does not own any fiber assets but it has access to Colorado Department of Transportation (CDOT) fiber. CDOT is currently in the process of putting fiber along I-70 from Denver to Vail.<sup>22</sup> Work is scheduled to be completed in October 2016.

CDOT also owns fiber assets from I-70 in Frisco through Breckenridge along CO-9. The County and CDOT have an established agreement for the County to use strands for County government operations. This agreement provides the County with very high speed Internet and data communications among government locations in Frisco and Breckenridge (primarily the County Commons and the Justice Center) as well as fiber repair services. The County provides maintenance and locate services as part of the agreement.

The County's access to CDOT fiber could be important for enabling a public-private partnership for fiber construction; absent the backbone connection, it would be difficult for a private fiber company building fiber in the County to obtain a return on its investment.

##### 5.6.2 Comcast

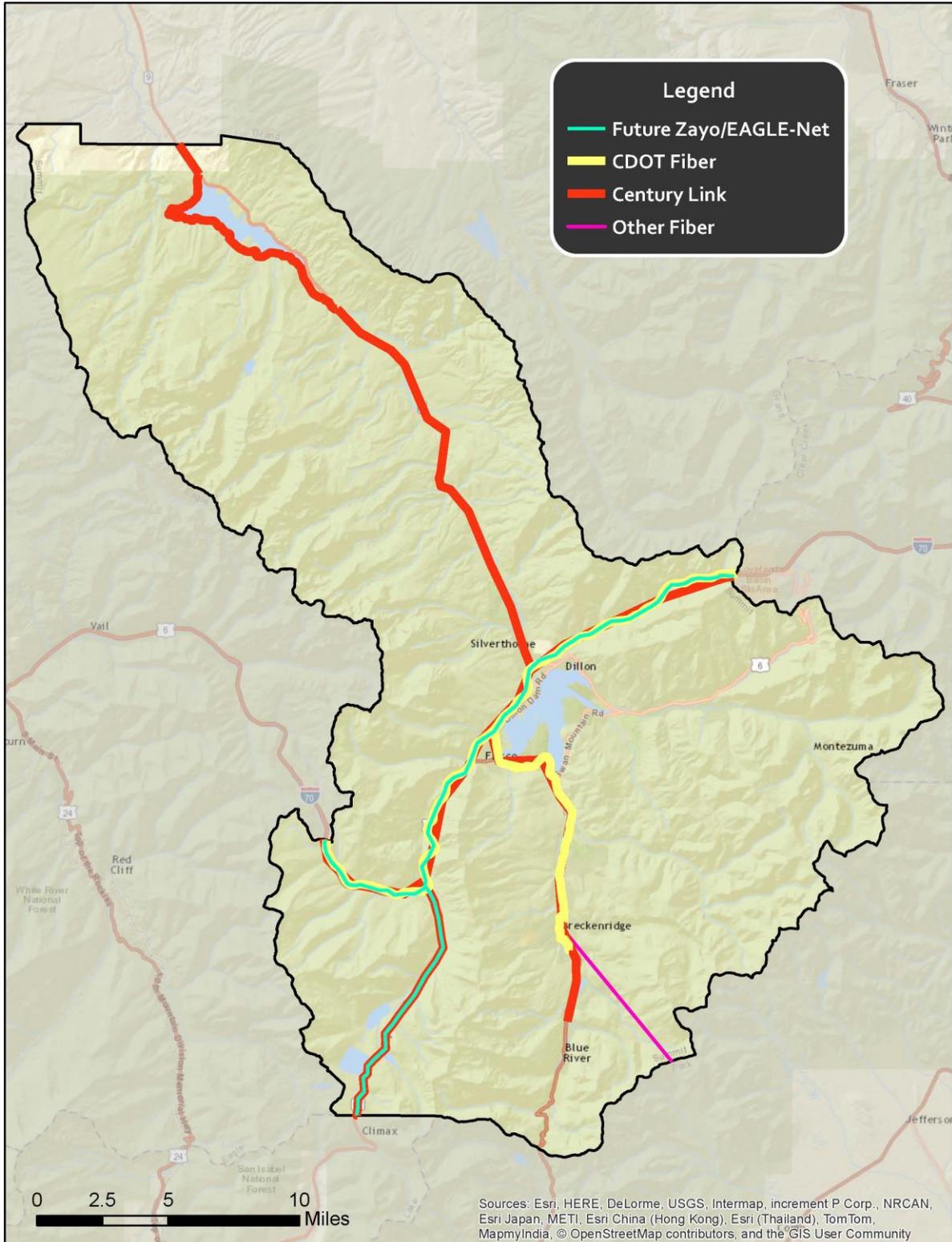
Comcast uses a limited number of CDOT fiber strands along I-70 to bring cable and broadband consumer, business and MetroE services to the County (and through to Grand Junction). Comcast operates fiber within the County, typically to within a half-mile to a mile of each premises. However, most of the company's services are delivered to the end-user via coaxial cable.<sup>23</sup>

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<sup>22</sup> "Projects: I-70 from Denver to Vail: Intelligent Transportation System installation," Colorado Department of Transportation, <https://www.codot.gov/projects/i-70-from-denver-to-vail-intelligent-transportation-system> (accessed October 13, 2016).

<sup>23</sup> <http://broadbandnow.com/Colorado/Dillon?zip=80435#show=all>

Figure 14: Existing Fiber Assets in Summit County



### 5.6.3 Century Link

There is some CenturyLink fiber within the County, however, most of the company's services are delivered to the end-user via copper DSL lines.<sup>24</sup> The County reports that the DSL service is offered up to 7 Mbps, substantially lower than what is available in metro areas. CenturyLink recently received federal funding to support rural broadband deployment; Montezuma is on its list of potential service areas.<sup>25</sup> The development of CenturyLink assets up to and into Montezuma will provide the much-needed terrestrial Internet option for residents there and provide a potential backhaul asset for wireless services.

### 5.6.4 EAGLE-Net/Zayo

"EAGLE- Net Alliance (EAGLE- Net) is a Colorado intergovernmental entity which operates a cost-sharing cooperative that delivers a carrier quality broadband network to more than 170 communities across the state."<sup>26</sup> The network was designed to connect schools, libraries, governmental buildings, and health care facilities. EAGLE-Net also provides commodity Internet services and access to advanced research and education networks.

In July, 2015, Zayo Group Holdings assumed network oversight and support responsibility for EAGLE-Net.<sup>27</sup> Zayo is a Boulder, Colorado-based bandwidth infrastructure services company owns and operates thousands of miles of high-capacity fiber throughout the U.S. and Europe. Zayo also provides metro connectivity to buildings and data centers in some areas.

Prior to the Zayo partnership, EAGLE-Net was working with CDOT to provide connectivity along I-70 through Summit County and along CO-91 from Copper Mountain to the County border. This would be middle-mile fiber that could potentially be tapped to connect facilities along I-70. The locations would require last-mile connectivity. The current status of this endeavor is under investigation with Zayo.

### 5.6.5 Long-Haul Fiber

Long-haul networks connect metropolitan areas to each other or interconnect with other long-haul networks, enabling seamless and efficient intercity and international connectivity. These networks usually connect to local networks that then distribute data within a metro area. Long-haul networks carry a lot more data than any other type of network, and over much greater distances (i.e., hundreds or thousands of miles). However, they frequently do not connect to local networks outside of metro areas and may not be accessible except at major network and telecommunications cross-connect points and exchanges.

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<sup>24</sup> <http://broadbandnow.com/Colorado/Dillon?zip=80435#show=all>

<sup>25</sup> [https://apps.fcc.gov/edocs\\_public/attachmatch/DOC-335269A2.pdf](https://apps.fcc.gov/edocs_public/attachmatch/DOC-335269A2.pdf)

<sup>26</sup> "EAGLE-Net," <https://www.co-eaglenet.net/>

<sup>27</sup> <http://www.zayo.com/news/zayo-to-oversee-and-support-network-for-colorados-eagle-net-alliance-2/>

CenturyLink has some long-haul fiber that runs along I-70. Many carriers have long-haul fiber that runs along the Union Pacific's Central Corridor rail line from Denver, through the Moffat Tunnel and to Grand Junction from the north.

## 5.7 Internet Services

Internet access throughout the County is provided primarily by CenturyLink, via DSL and Comcast, via cable modem. There are providers in the area with a limited footprint within a resort or town including ResortInternet, Sundial Communications and Mammoth Networks. HughesNet, and Dish/DirecTV provide satellite service to any location in the County with a view of their satellite.

Table 3: Internet Providers and Types of Service

| Internet Provider  | Type of Service   |
|--|---|
| Century Link   | DSL   |
| Comcast  | Cable   |
| Mammoth Networks (Visionary Communications) (formerly VailNet) | Metro Ethernet (may use CenturyLink fiber), <sup>28</sup> DSL |
| Sundial Communications   | Hospitality/In-building solutions                             |
| ResortInternet   | In-building solutions   |
| HughesNet  | Satellite   |
| Dish/DirecTV   | Satellite   |

<sup>28</sup> If fiber, would require last-mile construction.

## 6 Potential Broadband Services Solutions

We considered a range of technologies to determine the most suitable and cost-effective approach to meeting Summit County's needs for improved service to residents in the Lower Blue and Montezuma (see Section 4 for more details). These solutions are in lieu of an LTE, commercial carrier-based solution.

### 6.1 Technology Options

The best-case scenario would be for a commercial cellular carrier to fill in the coverage gaps in the County with additional infrastructure to provide voice and data services in the underserved areas. The County will continue to seek cooperation from the carriers. In the absence of a carrier deployment, the County's other technology options include the following:

**Unlicensed spectrum (5 GHz) (point-to-multipoint or point-to-point):** Unlicensed spectrum in the 5 GHz band has been made available for Wi-Fi and other high-speed applications. Although using unlicensed spectrum has disadvantages due to the potential for interference from competing users, this primarily occurs in more urban areas and is unlikely to happen in Summit County. 5 GHz can be deployed in a point-to-point or point-to-multipoint configuration. 5 GHz is a near-line-of-sight technology that is blocked by terrain or buildings. The bandwidth is sufficient to support an aggregate capacity of hundreds of Mbps.

**TV white spaces:** Another available technology, "TV white spaces" (TVWS), uses spectrum that does not require line-of-sight, and can cover relatively long distances. It can also deliver connectivity at a level higher than available services; users would get typical download speeds of 3 Mbps and typical upload speeds of 1 Mbps (potential for up to 15 Mbps down and 3 Mbps up). Finally, TVWS base station equipment is inexpensive relative to 3G, WiMAX, and LTE technologies typically used in licensed spectrum.

TV white spaces are the unused buffer zone separating stations on the broadcast spectrum; the FCC has made that portion of the spectrum available for unlicensed use because, with improvements and efficiencies in broadcast technology, the white space is no longer needed by the broadcasters to fully broadcast their signals. Even in urban areas where the broadcast spectrum is congested, there are white spaces available for other uses.

White space spectrum has excellent propagation characteristics—including indoors. It is able to penetrate physical obstructions that cannot be penetrated by the spectrum used for traditional Wi-Fi—from exterior building walls to broad-leaf trees and, in a limited way, larger physical obstructions such as hills.

That said, TVWS deployments are in their infancy. The FCC only recently approved the strategy and formalized the rules that will make it possible. So although there has been significant

research and development, the earliest deployments have been by pioneers. In addition to the potential technical disadvantages of being an early adopter, launching a TVWS network has some financial disadvantages, as well: There has not yet been widespread adoption, so manufacturers have not yet realized economies of scale. There are few sources of equipment, and prices are not as low as they will be when scale has been achieved (as in the Wi-Fi market).

**Wi-Fi:** Traditional Wi-Fi hotspots would not be an effective way to provide the needed services because they do not have the range to effectively fill the gaps without deployment of dozens of hotspots and many miles of fiber optic cable.

**Licensed spectrum (point-to-point):** Licensed spectrum approaches would not be optimal because, if spectrum is available at all,<sup>29</sup> the technology to operate it is typically very costly. A point-to-point network would also entail high costs, because it would require separate line-of-sight connections to each user, which would be costly and often impossible over the terrain to be covered. It would be best suited for backhaul for other wireless technologies.

## 6.2 Conceptual Design and Rough Order-of-Magnitude Costs for a Point-to-Multi-Point Wireless Broadband Solution

CTC developed a high-level/conceptual design of a potential broadband network using a point-to-multipoint strategy, similar to cellular, where a base station antenna transmits and receives from the surrounding area, and can communicate with a large number of devices.

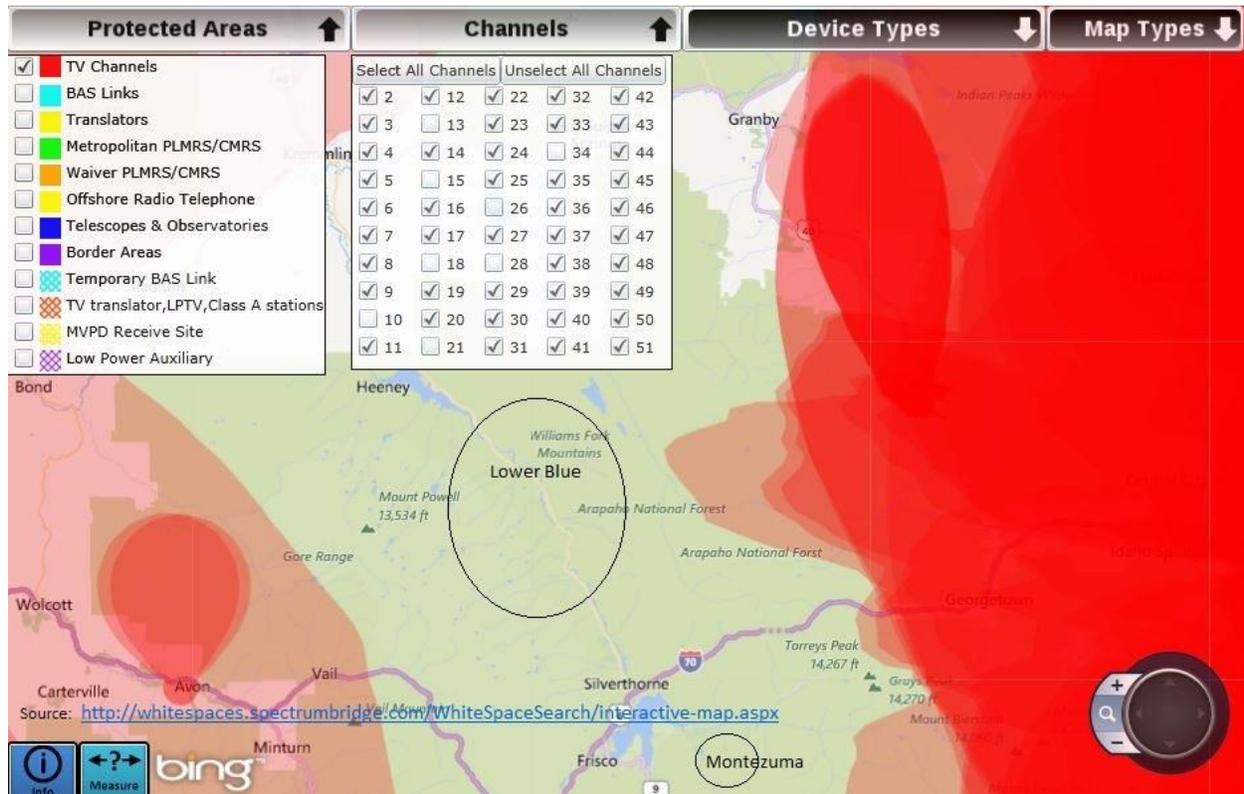
The Summit County network could be set up using a hybrid frequency strategy deploying an 5 GHz sector in each coverage area augmented with a TVWS point-to-multipoint network. In this way, some of the harder-to-reach homes could still get coverage via the TVWS network, while many or most homes would have access to the higher speeds available on a 5 GHz system. A quick check using Spectrum Bridge's TV White Spaces US interactive map<sup>30</sup> shows that there are several unused TVWS channels in the area. Channels 10, 13, 15, 18, 21, 26, 28, and 34 are in use, leaving several unused channels that could be used for the TVWS portion of the network. These channels can be used in the green areas in Figure 15, which include the Lower Blue and Montezuma.

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<sup>29</sup> Most of the licensed bands suitable for cellular phone and data communications are licensed by the commercial cellular providers.

<sup>30</sup> <http://whitespaces.spectrumbridge.com/WhiteSpaceSearch/interactive-map.aspx>

Figure 15: Area of TV White Space Channel Availability



The areas served by the 5.8 GHz networks would receive speeds up to 25 Mbps on the downlink and 3 Mbps upstream. Areas only served by TVWS would receive up to 10 Mbps down and 5 Mbps up. Although the TVWS is significantly slower than the 5.8 GHz, it is better than the current situation.

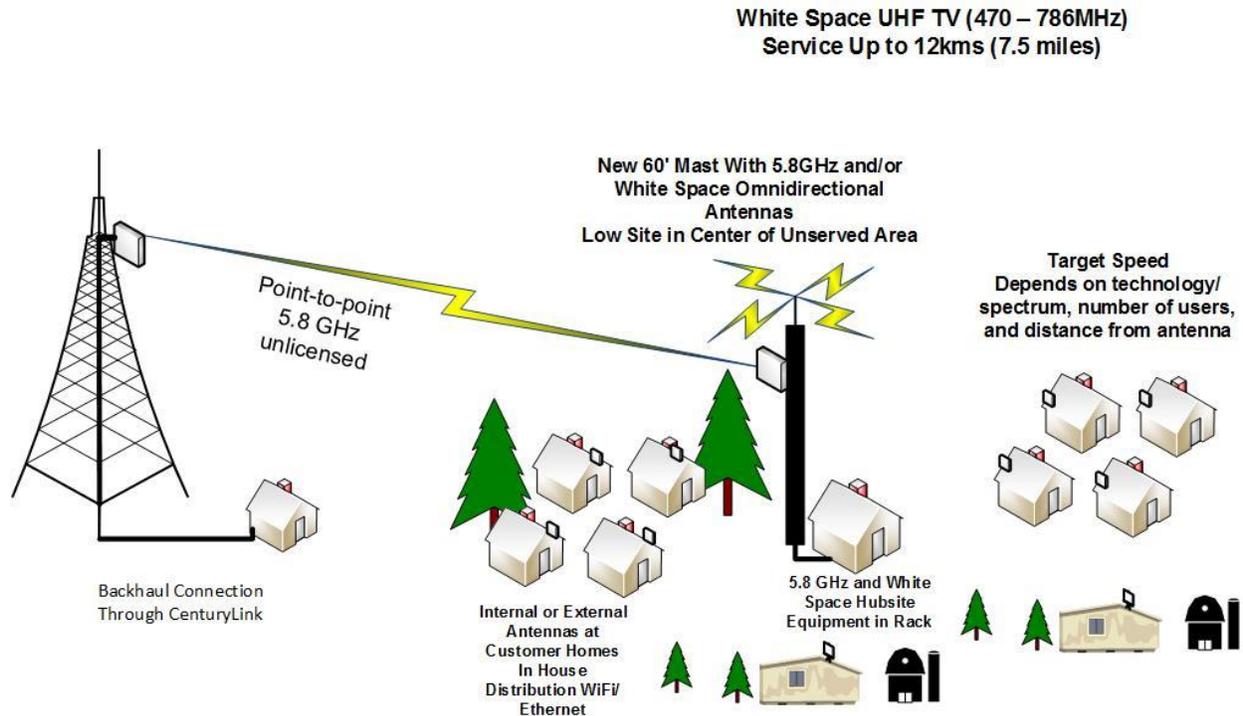
### 6.2.1 Lower Blue

Based on information from Summit County, there are 529 buildings in the Lower Blue north of the Everist location; 73 of these buildings are classified as farm/ranch improvement, leaving approximately 450 that are likely residential or commercial buildings.

Within six service areas in the Lower Blue, a 5 GHz or TVWS base station would be installed on an existing structure or new tower. Each station would connect to the Internet backbone, most likely through CenturyLink fiber located on CO-9, using a direct fiber connection or a point-to-point wireless connection.

Each subscriber would need customer premises equipment (CPE)<sup>31</sup> and potentially an external antenna to receive service. Within each home, connectivity to individual devices would be enabled by a wireless router, similar to the equipment commonly used with DSL or cable modem service. The network design is illustrated in Figure 16.

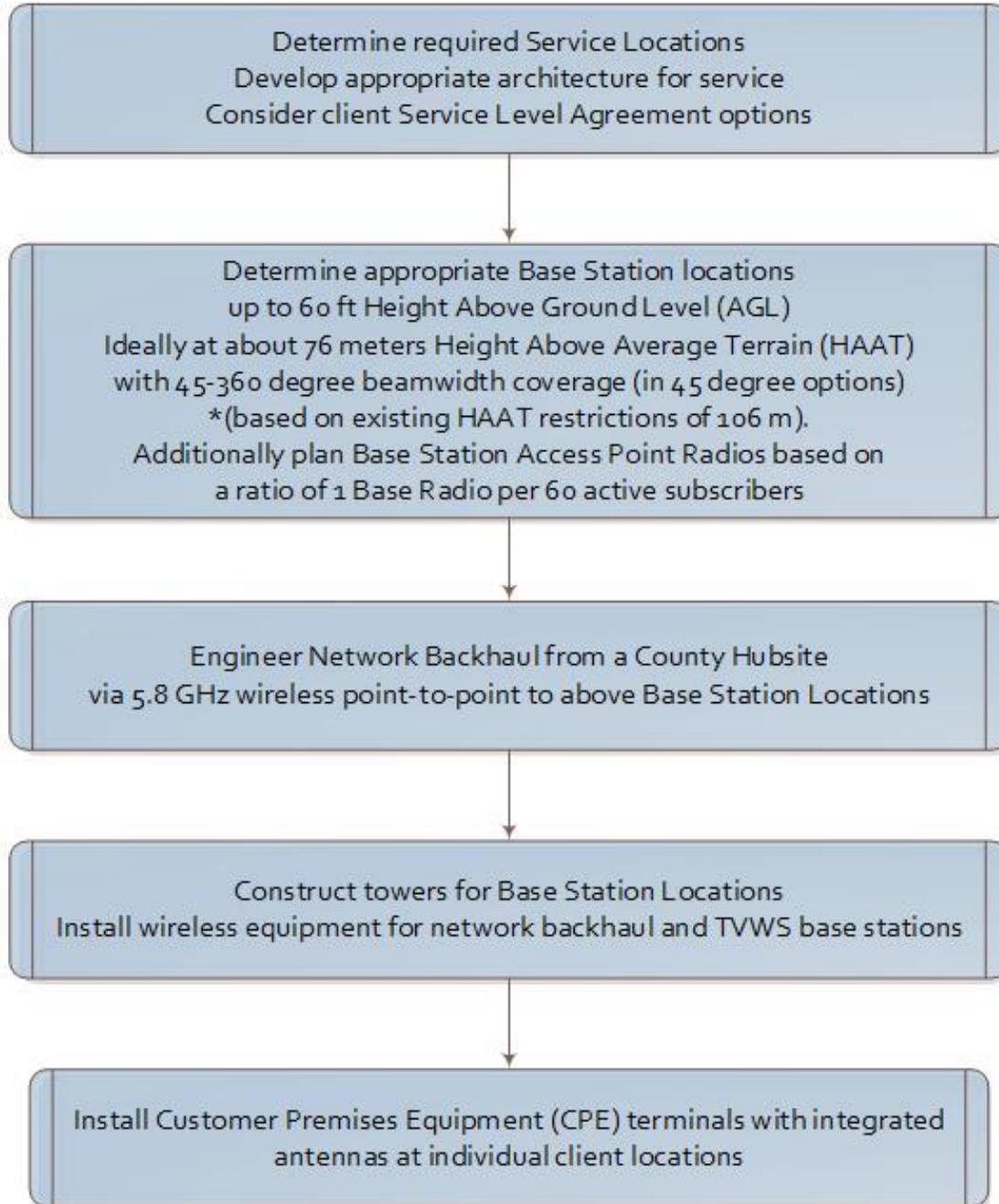
Figure 16: Point-to-Multipoint Solution Diagram



The network design process is illustrated in Figure 17.

<sup>31</sup> The user would need a user device and potentially a small antenna, provided by the network service provider. This device would mount in a window or other part of the customer premises and would need to be pointed at the network antenna. It would communicate with the devices within the home or business via Wi-Fi or Ethernet.

Figure 17: Network Design Process



\* If FCC final rules for the TVWS are amended to include a change in the HAAT restriction (as proposed to 250 m HAAT), existing taller towers (and water towers, mountain ridges, etc.) may be utilized. This may reduce the number of necessary Base Station Locations since each station can cover a larger service area.

We estimate for budgetary purposes a take rate—that is, the percentage of residents that would purchase the service—of 40 percent based on typical levels in similar environments, or 180 total homes on the network. Our concept assumes that adequate locations can be found to distribute the wireless signal; the network will need approximately 15 distribution sites using roughly 60-foot poles (based on our experience designing networks; we did not conduct onsite engineering to verify this high-level design).

Using these estimates, the costs for building the network would be approximately \$1,200,000, with the following breakdown:

**Table 4: Estimated Cost of Network in Lower Blue**

| <b>Network Element</b>                                   | <b>Estimated Cost</b> |
|--|-----------------------|
| CPE Units (purchased by homeowners; could be subsidized) | \$230,000             |
| Distribution sites                                       | \$610,000             |
| Engineering and project management support               | \$400,000             |

Annual operating costs, based on a percentage of the equipment costs (5 percent) plus half time (salary and benefits) of a Network Engineer II<sup>32</sup> and one-quarter of the time of an administrator<sup>33</sup> is approximately \$114,000.

### 6.2.2 Montezuma

The same type of solution could be deployed in Montezuma.

The expected take rate—that is, the percentage of residents that would purchase the service—also estimated at 40 percent based on our experience, or 27 total homes on the network. Our concept assumes that adequate locations can be found to distribute the wireless signal; the network will need just one distribution site using a 60-foot pole (based on our experience designing networks; we did not conduct onsite engineering to verify this high-level design).

Using these estimates, the costs for building the network would be approximately \$60,000 assuming construction at the same time as the Lower Blue, with the following breakdown:

<sup>32</sup> <http://swz.salary.com/salarywizard/Network-Engineer-II-Salary-Details-Littleton-CO.aspx?hdcbxbonuse=off&isshowpiechart=true&isshowjobchart=false&isshowsalarydetailcharts=false&isshownextsteps=false&isshowcompanyfct=false&isshowaboutyou=false>

<sup>33</sup> <http://swz.salary.com/salarywizard/Office-Services-Assistant-Salary-Details-Littleton-CO.aspx?hdcbxbonuse=off&isshowpiechart=true&isshowjobchart=false&isshowsalarydetailcharts=false&isshownextsteps=false&isshowcompanyfct=false&isshowaboutyou=false>

**Table 5: Estimated Cost of Network in Montezuma**

| <b>Network Element</b>                                   | <b>Estimated Cost</b>           |
|--|---------------------------------|
| CPE Units (purchased by homeowners; could be subsidized) | \$34,000                        |
| Distribution sites                                       | \$26,500                        |
| Engineering and project management support               | Included in Lower Blue estimate |

Annual operating costs, based on 5 percent of the equipment costs and an additional 25 percent of a full-time-equivalent Network Engineer are approximately \$31,500. These costs assume that the Montezuma network is connected to the Lower Blue hub.