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Broadband Technology Opportunities Program
Evaluation Study

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Case Study Report

South Dakota Network

Comprehensive Community Infrastructure

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ASR Analytics, LLC
1389 Canterbury Way
Potomac, MD 20854

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Submitted to:

Shelita Saint-Louis, Contracting Officer
Cassandra Sterba, Contract Specialist
Acquisition Services Directorate
National Business Center
Department of the Interior

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Executive Summary

About BTOP

The American Recovery and Reinvestment Act of 2009 (Recovery Act) appropriated \$4.4 billion in federal funding to the National Telecommunications and Information Administration (NTIA) to implement the Broadband Technology Opportunities Program (BTOP) in order to spur job creation, stimulate economic growth, and increase access to broadband services.¹ BTOP projects are intended to support increased broadband access and adoption, provide broadband training and support through community organizations, and stimulate the demand for broadband. NTIA distributed grant funding to 233 projects, benefiting all 50 states, 5 territories, and the District of Columbia. The types of projects BTOP funded include Public Computer Centers (PCC), Sustainable Broadband Adoption (SBA), and Comprehensive Community Infrastructure (CCI). CCI projects deploy new or improved broadband Internet facilities to connect households, businesses, and community anchor institutions (CAI) such as schools, libraries, hospitals, and public safety facilities.² CCI projects funded by BTOP are predominantly middle mile projects, although a small number of last mile projects were awarded.³

Comprehensive Community Infrastructure projects deploy new or improved broadband Internet facilities to connect households, businesses, and community anchor institutions such as schools, libraries, hospitals, and public safety facilities.

About the Evaluation Study

This case study report is one of twelve case studies performed by ASR Analytics, LLC (ASR) on CCI projects. It is part of a larger mixed-methods evaluation of the social and economic impacts of the BTOP program.

The purpose of this case study is to:⁴

- Identify how the grantee maximized the impact of the BTOP investment.
- Identify successful techniques, tools, materials, and strategies used to implement the project.
- Identify any best practices, and gather evidence from third parties, such as consumers and anchor institutions, as to the impact of the project in the community.

The information presented in this report intends to capture the social and economic impacts of the grant, and is not an evaluation of SDN, its partners, or its subgrantees.

This case study is primarily qualitative. Social and economic impacts are categorized by the five focus areas described in *Interim Report 1*, with the addition of the Government Services focus area.⁵ Section 2 includes the presentation of these impacts by focus area.

The evaluation study team collected information to evaluate the social and economic impact of the South Dakota Network, LLC (doing business as SDN Communications, "SDN") project during field visits. From July 29 to August 2, 2013, the evaluation study team met with representatives of SDN and CAIs connected by the project. In total, the evaluation study team performed ten case study site visit interviews. ASR transcribed these discussions and used this information, along with other information and reports provided by the grantee, to supplement Quarterly Performance Progress Reports (PPR), Annual Performance Progress Reports (APR), and other publicly available

information. The information presented here is intended to capture the social and economic impacts of the grant, and is not an evaluation of SDN, its partners, or its subgrantees.

About the Grantee



SDN is owned by seventeen independent telecommunications companies and cooperatives, known as “Members,” across South Dakota. Initially established in 1989 to provide centralized equal access and wholesale long distance services for its Members, SDN deployed a statewide broadband network in the mid-1990s and expanded its customer base to include state and local government entities, schools, financial institutions, and healthcare providers. SDN’s network of over 30,000 miles of fiber across 8 states connects to the area’s leading businesses and is the largest fiber-optic network in the region. SDN works with its Members to support their Internet connectivity to endpoint commercial and residential customers. The general managers of nine of the seventeen independent member companies serve on SDN’s Board of Managers.⁶

SDN completed Project Connect South Dakota at the end of 2012 at a cost of \$25,715,303.

On December 15, 2009, NTIA awarded SDN a BTOP CCI grant for \$20,572,242 to implement Project Connect South Dakota. SDN provided an additional \$5.1 million in matching funds, for a total project budget of approximately \$25.7 million. SDN completed the project at the end of 2012 at a cost of \$25,715,303.⁷

Project Proposal and Status

SDN planned to build on to its 1,850-mile fiber-optic network to serve CAI customers in rural and underserved areas of the state.⁸ SDN proposed the following, with results shown:⁹

- Add 140 miles of backbone network and 219 miles of middle mile spurs to SDN’s existing fiber-optic network. As of December 2012, SDN had exceeded this goal by completing 397 miles of new fiber.¹⁰
- Provide improved services to more than 300 existing CAIs and new fiber connections to more than 200 CAIs in underserved areas of the state. At the end of 2012, SDN had connected 638 CAIs to the network, including 334 that did not previously have fiber connections.¹¹
- Work with Avera Health Care Systems and Sanford Healthcare Systems to support telemedicine in rural areas. The grant planned to connect at least fifty-eight hospitals and clinics. SDN closed out the grant period having connected sixty-five medical and healthcare providers.¹²
- Provide state-of-the-art equipment and technology at Mitchell Technical Institute (MTI) telecommunications lab. This lab trains students for careers in broadband applications and deployment. SDN helped install a \$1 million telecommunications lab at MTI, replacing outdated equipment with the same technologies it used for the rest of the BTOP-funded network. Students have already seen a 20 percent increase in wages after graduating from the program.¹³

SDN accomplished the following from their proposed goals:

- Installed 397 miles of fiber
- Connected 334 CAIs that did not have fiber previously and improved fiber service to 304 CAIs
- The State of South Dakota raised the minimum subscription speed of K-12 schools from 1.5 Mbps to 10 Mbps at the end of the grant period, and further to 50 Mbps in July 2013

- Increase broadband access to improve participation in distance-learning programs by schoolchildren in sparsely populated areas. The State of South Dakota raised the minimum subscription speed of K-12 schools from 1.5 Mbps to 10 Mbps at the end of the grant period, and further to 50 Mbps in July 2013.¹⁴

As shown in Table 1, more than half of the CAIs connected by SDN are K-12 schools.¹⁵ The next most prominent group of connected CAIs is Other Community Support institutions, which includes state and local government agencies. Sixty-five hospitals and clinics were connected, the majority of which were in the Avera and Sanford systems. The BTOP-funded fiber also served public safety agencies including South Dakota National Guard facilities. Four public libraries and twenty-one postsecondary institutions were also connected.

Table 1. Community Anchor Institutions Located in the Service Area

Type	Connected by Grantee		Total in Service Area
	#	%	
School (K-12)	376	59%	756
Library	4	1%	109
Medical/Healthcare	65	10%	1,146
Public Safety	30	5%	444
University, College, or Other Postsecondary	21	3%	38
Other Community Support	142	22%	142
Total	638		2,635

Table 1 also shows other CAIs inside the service area counties, which highlights the potential to leverage the SDN infrastructure beyond the scope of the original CAIs proposed in the grant application. The fixed cost of extending SDN’s middle mile network to new areas of South Dakota has already been incurred. Without BTOP, the cost of connecting more CAIs would be higher.

Major Outcomes and Impacts

Through interviews and data collection from a number of sources, the evaluation study team observed qualitative and quantitative outcomes and impacts of the project. The list below highlights these outcomes and impacts, with additional detail provided in Section 2.

- SDN provided new or improved fiber connections to nearly half of the K-12 schools in the service area. Schools are using the improved connections to provide more distance learning opportunities for students through the state’s Digital Dakota Network (DDN). This network provides classes that would otherwise not be available to students, particularly those in rural schools. The faster speeds also enhance classroom instruction and facilitate more interactive learning.
- The same network that connects public K-12 schools also serves state government agencies, ninety-five of which have received new or improved service through the SDN grant.¹⁶ The increased speeds facilitate video conferencing between sites, which reduces travel time and cost.
- BTOP funds helped pay for a new telecommunications lab at MTI, which trains students for network technician and engineering technician jobs. Before BTOP, students trained on outdated equipment that SDN donated several years ago as it upgraded its network. Now, students use the same technologies that SDN and other telecommunications companies use. Students receive training on current technology, which can translate into greater job opportunities. MTI

reported that because of this upgrade, graduates have achieved an increase of 20 percent in wages from job offers.¹⁷

- The South Dakota National Guard plans to connect thirty-three of its facilities to the SDN network, replacing its T1 circuits. In most cases, the speed has increased thirtyfold, from 1.5 Mbps to 50 Mbps. The price paid for this faster service is 33 percent less than what it previously paid. The National Guard operates a secure network over SDN middle mile infrastructure and uses this connection for video conferencing, data exchange, and training. The increase in broadband speed provides the opportunity to virtualize servers, allowing the South Dakota National Guard to centralize storage at two data centers and use virtual desktop environments.
- The grant allowed SDN to connect rural medical facilities. Twenty percent of the healthcare providers that the grant connected are part of the Avera network. Avera's mission includes making eServices available to rural clinics and hospitals in order to provide its communities with service that would otherwise not be available. The grant-funded expansion of the SDN network allowed Avera to provide these services to more areas of South Dakota by increasing the broadband capacity available between these sites and centralized Avera facilities. Small rural clinics are taking advantage of the increased capacity to implement eServices that ensure patients have access to physicians, pharmacists, and specialists when needed. These services also provide support for rural physicians, who often are the only doctor in their area and are on call 24 hours a day. This enhances their quality of life and allows the clinics to hire from a wider applicant pool. Based on site visit interviews, cost savings are estimated at around 60 percent for small rural clinics.

Through BTOP, the project achieved the following community impacts:

- More distance learning opportunities for students
- MTI students train on the same equipment used by SDN
- The South Dakota National Guard can centralize storage at two data centers and use virtual desktop environments
- Small rural clinics are taking advantage of the increased capacity to implement eServices

Conclusions

SDN supported Recovery Act goals to improve access to broadband in unserved and underserved areas. With these connections, CAIs are beginning to transform their services for healthcare and education and provide digital literacy training in libraries and schools. The SDN network is enabling government agencies and National Guard facilities to make internal communications more efficient. It is improving economic outcomes for graduates, and helping to enhance job opportunities in rural communities.

Broadband cost savings of around 60 percent are likely for small rural clinics.

SDN implemented an open access network that made it possible for its Members to expand the availability of broadband service to businesses, households, and CAIs. Without the BTOP grant, it is unlikely that 638 CAIs would have connections to a fiber-optic network with the available speeds and prices. Most of the CAIs participating in the SDN grant already had broadband, but at much lower bandwidths or higher prices. The BTOP grant also provided equipment and support to CAIs as part of the upgrades to broadband access.

Section 1. Introduction

SDN's goal was to add 140 miles of backbone capacity and 219 miles of middle mile fiber to leverage its existing network to connect more than 300 CAIs that did not previously have fiber connections. The grantee intended to provide 10 Mbps service to each new CAI as well as to its existing network of 232 CAIs.¹⁸ The network also intended to facilitate broadband access by businesses and residents through the last mile providers that make up their membership. As of December 2012, SDN had completed 397 miles of new fiber and connected 334 new CAIs, in addition to improving service to 304 CAIs.¹⁹ Many CAIs, both those connected to the SDN network for the first time by the grant and those that were already on the SDN network, were in the process of upgrading from 10 Mbps service to 50 Mbps during the site visit.

As shown in Figure 1, SDN's application lists the following twenty-three counties as the service area of this grant: Beadle, Brookings, Brown, Butte, Clark, Codington, Deuel, Grant, Hamlin, Hand, Hughes, Hyde, Kingsbury, Lake, Lawrence, Lincoln, McCook, Marshall, Meade, Minnehaha, Pennington, Spink, and Walworth. The evaluation study team identified CAIs connected by the grant in thirty-seven additional counties: Aurora, Bennett, Bon Homme, Brule, Campbell, Charles Mix, Clay, Custer, Davison, Day, Dewey, Douglas, Edmunds, Fall River, Faulk, Gregory, Haakon, Harding, Hutchinson, Jackson, Jerauld, Jones, Lyman, McPherson, Mellette, Miner, Moody, Perkins, Potter, Roberts, Shannon, Stanley, Sully, Tripp, Turner, Union, and Yankton. Throughout the remainder of the report, references to the service area are based on the total sixty county area shaded in both red and black below.

Figure 1. Service Area Map

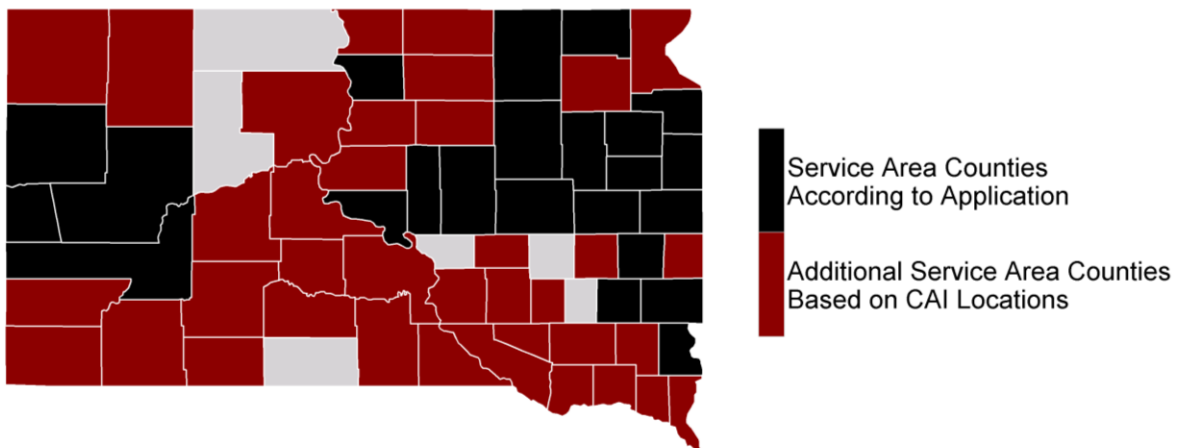
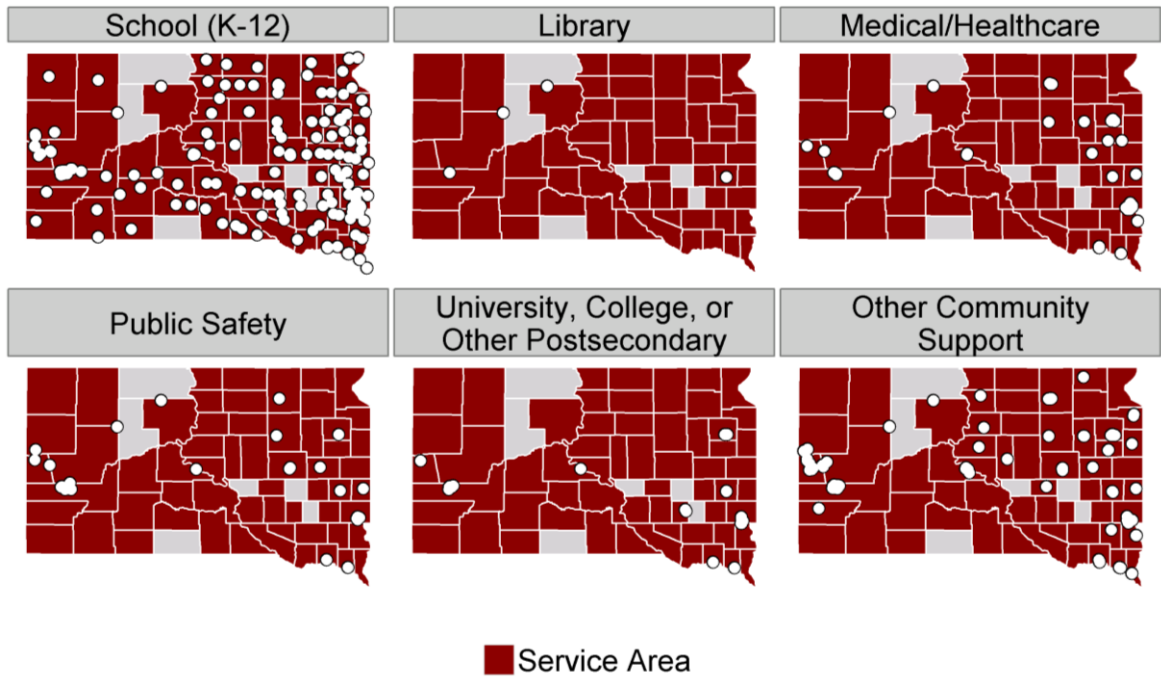


Figure 2 displays a map of the service area along with the locations of the CAIs connected.

Figure 2. Map of CAIs in the Service Area



The project targeted several underserved areas of South Dakota. The greatest obstacle to expanding broadband to consumers, businesses, and public institutions in these rural markets was the lack of affordable high-capacity backhaul. One such underserved area was near Highway 14 north of Sioux Falls and south of Watertown. Schools in this corridor include Arlington and Lake Preston, which were receiving T1 service through CenturyLink. Increased speeds were unavailable to these CAIs. In its application, the grantee reported that it did not make economic sense for SDN or other providers to build fiber to this underserved area. SDN conducted a feasibility study and reported that, in a five-year period, the extension would see a net loss without grant funding.²⁰ As a result, the middle mile infrastructure would not have been constructed without the BTOP grant.

The service area is predominantly rural, though the project does serve the state's three most populated towns: Sioux Falls, with a population of 153,888; Rapid City, with a population of 67,956; and Aberdeen, with a population of 26,091.²¹ The total population in the service area accounts for more than 83 percent of the population of South Dakota. The American Community Survey (ACS) Five Year Summary for 2007 to 2011 shows that approximately 88 percent of residents in these counties are White. Half of the population has a household income of less than \$50,000 per year, and 12.5 percent are in poverty.²² Using publicly available data, the evaluation study team identified 2,635 CAIs in the service area, including 109 libraries, 1,146 medical/healthcare facilities, 444 public safety institutions, 756 K-12 schools, and 38 universities, colleges, or other postsecondary institutions.

Table 2 shows the percentages of the populations in the service area and the rest of South Dakota by the number of broadband providers available according to data and speed thresholds defined by the National Broadband Map (NBM).²³ In June 2011, when the project was in its early stages, more than 20 percent of the service area population did not have access to a broadband provider, compared to nearly 51 percent of the rest of the state's population. Twenty-nine percent of service area residents had only one broadband provider available, compared to approximately 22 percent of the rest of South Dakota. According to the NBM, more than 43 percent of the service area population had access to broadband download speeds from 100 Mbps to 1 Gbps. These speeds were available to 30 percent of the population in the rest of the State of South Dakota.²⁴ All

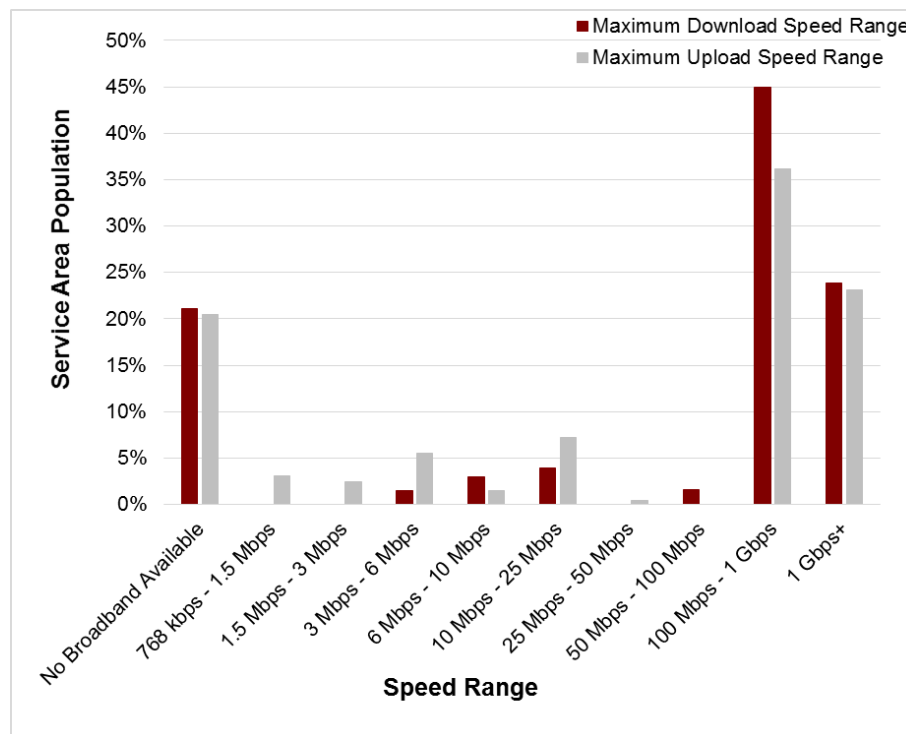
provider and speed statistics use the June 2011 release of the NBM and 2010 population data from GeoLytics.

Table 2. Number of Broadband Providers Available in South Dakota

Number of Providers	Service Area	Rest of South Dakota
0	20.47%	50.87%
1	29.09%	21.96%
2	30.10%	7.97%
3	18.07%	13.01%
4	2.26%	6.19%

Figure 3 lists the broadband providers available to at least one service area resident and the range of maximum download and upload speeds these providers offered in the service area.²⁵ According to the NBM, twenty broadband providers offered service somewhere in the service area. Maximum download speeds ranged from 3 Mbps to 1 Gbps, while maximum upload speeds ranged from 768 kbps to 1 Gbps.

Figure 3. Maximum Speed Ranges Available for the Service Area Population

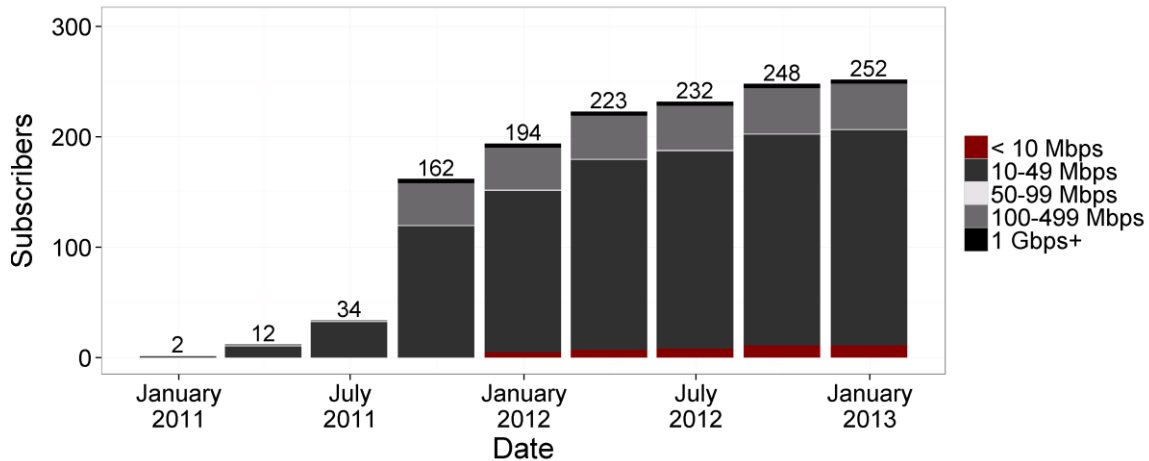


Broadband subscribership rates were higher in the service area than across the state. Federal Communications Commission (FCC) data from June 2012 show that more than 67 percent of the service area population subscribed to an Internet service that has at least 768 kbps download speeds and 200 kbps upload speeds.²⁶ Approximately 54 percent of the state's population subscribed to an Internet service with the same minimum thresholds.²⁷

Figure 4 presents counts of CAI subscriptions at different speed tiers since institutions began to subscribe to service in the first quarter of 2011.²⁸ The figure represents only the CAIs that have

subscribed to service through SDN. The largest speed tier by number of subscribers at the time of the site visit was the 10 to 49 Mbps range. However, the State of South Dakota, which aggregates demand for government agencies and public schools, has since increased the minimum speed offered to 50 Mbps. These institutions represent the majority of CAIs subscribing to service.

Figure 4. CAI Subscribers by Connection Speed



The evaluation study team met with SDN staff, CAIs, and private companies throughout eastern South Dakota. These interviews helped the team understand the grantee’s approach to project implementation and the strategies used to create demand for broadband service. The analysis in this report focuses on outcomes and impacts to organizations. Interviews conducted include the following:

- Schools
 - **Mitchell Technical Institute (MTI)** is a public, two-year technical college located in Mitchell, South Dakota. MTI is the only technical college in the state to offer telecommunications training and has done so since opening in 1968.²⁹ The college shares a 120 Gbps connection with the local school system. As part of the SDN BTOP grant, MTI received funding for a new telecommunications training lab. This lab ensures that students are trained on up-to-date equipment. MTI reported that program graduates’ average starting salary has increased by 20 percent because of the updated lab.³⁰
 - **Arlington School District**, one of 151 public school districts in South Dakota, is located in the Highway 14 corridor that was underserved before the BTOP project. All classrooms from kindergarten through the twelfth grade are located in a single building. Arlington School District staff members estimated that it serves between 250 and 300 students. Before BTOP, the school used two bonded T1 lines at a speed of 3 Mbps. At the time of the site visit, they had connected to the SDN fiber and increased their speed to 10 Mbps, and were preparing for an upgrade to 50 Mbps. Every high school student has a school-issued laptop, which they use at school and at home on a regular basis. Arlington School also connects to the state’s distance learning program in order to increase course offerings for its students, and the new speeds have allowed the school to install a second distance learning classroom.³¹
- Government Services
 - The **State of South Dakota Bureau of Information and Telecommunications (BIT)** manages the state’s wide area network (WAN) and Internet services for state government institutions, including free service to public K-12 schools. The State uses a network management service from SDN to monitor network usage and determine whether school needs are being met. The SDN network has allowed BIT to increase broadband speeds at

most state government offices and schools to 50 Mbps. Many of these sites were previously connected by bonded T1s.³²

- The **South Dakota National Guard** is a reserve military force that responds to state and national emergencies.³³ This National Guard unit was in the process of upgrading connections at thirty-three sites to its layer three network. The price it pays for the service after BTOP is 33 percent less than what it was paying previously, and in most cases the speed has increased thirtyfold, from a 1.5 Mbps T1 to 50 Mbps Ethernet. The National Guard reported that the upgraded speeds facilitated video conferencing between the sites, allowing for more efficient training and intra-agency communication.
- **Healthcare**
 - **Avera**, the health ministry of the Benedictine and Presentation Sisters, is a regional partnership of health professionals with more than 300 locations in eastern South Dakota and its surrounding states. Avera provides eICU, ePharmacy, and eEmergency services to subscribers using broadband Internet.³⁴ Avera serves as its own Internet Service Provider (ISP), using SDN's backhaul network to access the Internet. The expanded network reached rural clinics and hospitals, enhancing Avera's ability to provide eServices in the state. It also helped Avera implement electronic medical records (EMR). Although the evaluation study team does not have data for all 300 locations, cost savings are estimated around 60 percent for small rural clinics based on the site visit interviews.
- **Public Library**
 - **Madison Public Library (MPL)**, located in Madison, South Dakota, was founded with a grant from Andrew Carnegie in 1906. The library serves the City of Madison and Lake County. The mission of the library is to "provide access to dynamic collections, appropriate technology, and global information to support and enrich individual, family, and community life."³⁵ In addition to its physical collection, MPL also provides six desktop computers with Internet access and free wireless. After the BTOP-funded connection, it increased its broadband subscription from 1.5 to 5 Mbps, at a cost savings of approximately 13 percent. MPL staff members reported that online applications were running much faster, and down time has significantly decreased since the upgrade to fiber.
- **Business**
 - **Dakotaland Federal Credit Union** seeks to serve its members with economical, quality service in a friendly and convenient manner. The credit union has eight branches throughout South Dakota. Dakotaland has nearly 21,000 members and over \$180 million in assets.³⁶ Although Dakotaland was not a CAI, it used the middle mile infrastructure and paid for a fiber extension from the SDN network to seven branches. The credit union uses the increased speed and reliability to offer more broadband-enabled services to its members.
- **Last mile provider**
 - **Interstate Telecommunications Cooperative (ITC)** is an SDN Member company that provides service to nineteen school districts and ten counties. It serves most of the government institutions, libraries, and medical facilities in these counties, including between fifty and seventy-five CAIs. The BTOP grant installed just under eleven miles of fiber in partnership with ITC.

In addition, the evaluation study team met with a representative of Raven Industries. As a former Representative to the United States Congress from South Dakota, the interviewee provided information on the social and economic impacts of the grant for the state as a whole and for South Dakota farmers in particular, informed by both her former term in office and her current position with Raven Industries. Because it is a private business, Raven Industries did not obtain a new connection because of the BTOP grant. However, the Raven representative spoke to potential economic development impacts of the BTOP grant. As part of its Applied Technology division, Raven Industries manufactures and markets precision agriculture applications that rely on broadband technologies to increase efficiencies and decrease the environmental impact of

industrial agriculture. An estimated 10 percent of farmers in South Dakota use these technologies.³⁷

Section 2 provides a summary of the outcomes and impacts the evaluation study team observed.

Section 2. Impacts

This section describes the impacts of the SDN project in terms of the five focus areas described in *Interim Report 1*, with the addition of the Government Services focus area.³⁸ Digital Literacy is not a focus of CCI grants and the evaluation study team did not note significant Digital Literacy impacts outside of the outcomes and impacts related to the other focus areas.

The grantee provided qualitative support that nearly all CAIs participating in the grant were already broadband users, but at lower bandwidths. The majority of CAIs interviewed subscribed to a T1 connection previously. The SDN project provided additional supply of fiber infrastructure to meet the demand for bandwidth with these existing users, rather than increasing broadband adoption at CAIs that had no broadband connection.

2.1 Education and Training

Impacts within the Education and Training focus area are measured as changes to elements of educational content distribution and instruction. These impacts occur at K-12 institutions, community colleges, four-year institutions, universities, and other education providers. This focus area includes how the broadband Internet connections help the educational CAIs to perform activities that lead to helping students earn a certificate or diploma or receive training that is recognized as valuable for career advancement. Examples of certificates or diplomas include community college degrees, four-year college degrees, advanced degrees, general equivalency degrees, certifications in advanced software technologies such as network engineering, and other licenses or certifications that reflect knowledge of a particular subject at a level that would typically be taught at an educational institution.

Education and training was a primary focus area targeted by the grant. At the end of the grant period, 59 percent of the CAIs SDN connected were K-12 schools.³⁹ When assessing impacts it is important to understand the characteristics and composition of education providers within the service area. Table 3 identifies the school level of all public schools in the service area.⁴⁰ SDN served more primary schools than any other school level.

Table 3. South Dakota Public Schools (K-12) by School Level

School Level	Connected by Grantee	Others in Service Area
Primary	144	171
Middle	91	66
High	112	62
Other	2	20
Undefined	17	0
All	366	320

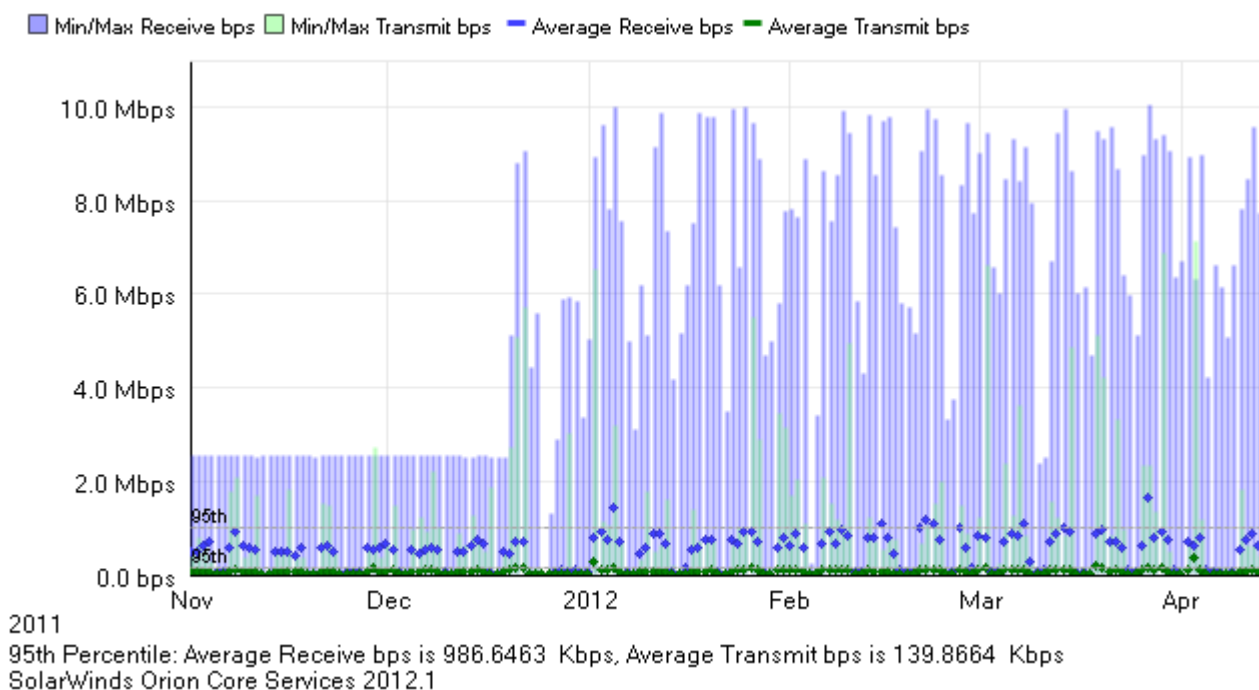
SDN also serves ten of the forty-six private K-12 institutions in the service area. In total, SDN connected schools serve more than 83,000 students out of approximately 133,000 in the service area (63 percent). More than 16,000 of these students are minorities and nearly 29,000 qualify for free or reduced lunch. This represents 64 percent and 67 percent of the respective populations at all public and private K-12 schools in the service area. Nearly 61 percent of the teachers in the

service area (5,997 teachers) work in SDN-connected schools.⁴¹ SDN also connects twenty-one of the thirty-eight postsecondary institutions in the service area.⁴²

This section summarizes the activities observed by the evaluation study team during site visits. The literature review presented in *Interim Report 1* provides evidence that these activities and situations lead to economic and social impacts. This report lists these impacts from the literature along with the evaluation study team's observational evidence supporting either the realization of impacts or their potential to occur.

- **Distance learning opportunities allow schools to broaden the variety of courses offered. They also represent an educational resource for nontraditional or disabled students, or those living in geographically remote or poor areas.**⁴³
 - The South Dakota Department of Education uses its broadband connections to offer the Digital Dakota Network (DDN), which delivers classes to public high schools and teleconferencing capabilities for state agencies and universities. The majority of South Dakota's 151 school districts have a small student population in grades 6 through 12, which limits the number of courses that can be offered without the distance learning program. During the 2012-2013 school year, K-12 institutions offered 43 classes using DDN, educating 776 students in 114 different locations.⁴⁴ In addition, Northern State University (NSU) offered 33 classes to 1,425 students.⁴⁵ The state has been offering a two-way voice and video network for this purpose since the early 1990s, but broadband makes the connections faster and more reliable. The state expects to be able to offer more classes with the faster speed.
 - Arlington High School does not employ a foreign language teacher. Students enroll in these courses and others through NSU via DDN. The school offers approximately six online courses per semester. Before connecting to fiber through the BTOP-funded project, Arlington subscribed to two T1 lines. Demand for broadband far exceeded this 3 Mbps speed, and students often had to watch DDN classes from home or stay after school to access the network when there was less demand. The school upgraded to 10 Mbps in January of 2012, and as Figure 5 shows, immediately made use of the increased speed.⁴⁶ In the summer of 2013, the school's speed increased further to 50 Mbps. At the same time, Arlington added an additional DDN classroom, which would not have been possible without the transition to 50 Mbps. Now, students can attend DDN classes during their scheduled class time.
 - The increased access to fiber infrastructure for schools in the service area allowed the South Dakota Bureau of Information and Telecommunications (BIT) to increase the bandwidth it provides to K-12 schools. BIT reported that broadband is becoming increasingly important in this environment. Higher broadband speeds facilitate the use of technology in the classroom, including individual laptops and notebooks. Many schools are also using the increased bandwidth to access licensed e-Textbooks and educational databases, which enable access to new versions faster than with traditional textbooks.

Figure 5. Arlington School Network Usage



- Ten percent of MTI students are participating in distance learning programs.⁴⁷ One course MTI offers via distance learning is a Speech Language Pathology Assistant program. This course requires high definition video so students can see practice subjects' faces and speech patterns clearly. MTI staff reported that they would not be able to offer high definition video reliably without the network upgrade they received through SDN.
- Students at Madison High School receive laptops and the Madison Public Library (MPL) Director reported a significant increase in students coming into the library to use the Wi-Fi connection since their BTOP-funded upgrade. This is particularly helpful for those students who do not have a broadband connection in their homes.
- **The use of digital tools enabled by broadband can save teachers time, allowing them to devote more effort to instruction.**⁴⁸
 - Before the BTOP grant, many schools in South Dakota had to work around their slow connectivity. For example, teachers had to schedule times to stream video in class because the bandwidth would not support more than one streaming video at a time. With the faster speeds schools have now, teachers do not have to limit bandwidth use.
 - One Arlington School teacher noted that before BTOP he would use a video camera to record educational videos at home and play them in class. Playing videos over the T1 connection was ineffective as it would slow the pace of instruction and make it more difficult for students to pay attention. Now, the increased speed allows teachers and students to stream many videos at the same time with greatly reduced interruptions.
 - An English teacher at Arlington School uses Wordle to let students create word clouds of difficult texts before reading them. This often gives students a visual clue about the main ideas of the book, which helps students who may otherwise find reading comprehension difficult. Before BTOP, this application would function slowly, taking time away from active instruction and often causing students to disengage. After BTOP, it functions quickly and efficiently. The students can use the application on multiple laptops at the same time, which would have been impossible before the network upgrade.

- **Broadband gives teachers a wide range of media through which to facilitate lessons. The integration of technology into classroom activities creates the opportunity for interactive and personalized educational experiences for students.**⁴⁹
 - Teachers at Arlington School noted that the level of service they had before the BTOP-funded network necessitated a teacher-centered educational experience when using technology for instruction. The teacher would project lessons on a screen, and students would follow along at the pace the teacher set. Teachers can now create a learning environment where students are more self-directed and engaged by using their own school-issued laptops.
 - One application of the increased service is using bandwidth-intensive websites in the classroom. For example, an English teacher at Arlington School uses National Geographic's Salem Witch Trials WebQuest in a unit about The Crucible.⁵⁰ Before the network upgrade, the teacher would project the web page and the class would follow along together. Now, students can engage with the material at their own pace.
 - Using the Internet also allows an English teacher at Arlington School to provide educational opportunities that would otherwise not be available. For example, students watch videos of opera and jazz, and relate the content to the unit they are studying. According to the teacher, Common Core standards emphasize the cognitive ability of students to relate two different concepts to a theme, and to be able to communicate those connections. Internet access makes this standard easier to teach by giving the responsibility to students to seek out those relationships. The teacher finds that more classroom activity is now student-directed and spontaneous, which engages the students more actively in their own learning. This level of engagement would not be possible without broadband speeds that allow multiple students to use the Internet at the same time.
- **Research has shown that computer use among students leads to improved academic performance, greater levels of educational attainment, improved school enrollment and graduation rates, and increased earning potential for students.**⁵¹
 - Before BTOP, Arlington School did not have enough broadband capacity to let students use their own laptops in class to access online content. Now, students can do this on a regular basis. The teachers at Arlington School find that the one-to-one use of laptops and broadband in the classroom prepares students for college, where homework and participation are increasingly online. For example, students learn how to use an online citation manager, which helps them with speed and precision in their writing for college courses.
 - An English teacher reported that more juniors passed the Dakota Step Test in 2013 than in previous years. Arlington School normally sees a decline in pass rates of about 20 percentage points between 8th and 11th graders because of disengagement in the older students. In the spring of 2013, the percent of juniors passing the test was 10 percentage points higher than eighth graders.⁵² The teacher attributes at least some of this improvement to increased student engagement resulting from more self-directed and spontaneous learning, although the sample size is too small to conclude statistical significance.
 - MPL has seen a large increase in the number of tests it proctors since it received an increase in broadband speed through SDN. These are mostly for online classes through community colleges and universities. The library proctors as many as twelve tests per month.
- **Innovative use of web resources, such as using social networking sites as learning management tools, leads to greater student-teacher engagement.**⁵³
 - The State of South Dakota provided a 21st Century Skills teacher training course that included how to use technology in the classroom to engage students. A major focus was allowing students to collaborate with teachers and other students both in and outside of school. Teachers reported that having the faster broadband service in place to support new applications that make this communication possible enhances educational outcomes for students.

- An English teacher at Arlington School uses Blackboard Learn, which the state provides, to post assignments, receive submissions, and engage students with a discussion board. She has found that many high school students are more willing to type than to speak in class or write on paper. With Blackboard Learn, students readily share their ideas online, and the teacher can better assess student learning and make appropriate modifications to the curriculum. Students can also access and turn in assignments if they miss school, which prevents homework from accumulating. The teacher stated that Blackboard Learn is the backbone of her instruction.
- **School administrations leverage broadband infrastructure to carry out internal operations. Broadband represents a rapid, reliable channel of communication to improve interactions among administrators, teachers, parents, and students.**⁵⁴
 - Deuel School received a fiber connection through SDN and has subscribed to faster speeds from ITC, an SDN Member serving areas in northeastern South Dakota. Faster broadband has allowed the school to virtualize servers and move to cloud-based applications on student laptops. Virtualizing servers benefits the school because it reduces network maintenance and hardware costs.

2.2 Government Services

One of the five core purposes established by the Recovery Act was to “improve access to, and use of, broadband service by public safety agencies.”⁵⁵ The Government Services focus area identifies how broadband improves services provided by government organizations to the public and includes both the provision and administration of public safety activities. Examples of public safety agencies include law enforcement agencies, fire departments, and emergency medical services (EMS). Some potential government service impacts include enhanced government efficiency, improved ability to save lives and reduce injuries, prevention of criminal activity, and improved information sharing between citizens and public safety entities.

Table 4 shows the number and type of government facilities that were connected to the SDN network with BTOP funds as of March 31, 2013.⁵⁶ These CAIs are as a mix of Public Safety and Other Support Organizations reported by SDN on PPRs and summarized in Table 1.

Table 4. South Dakota Government Facilities Served

Agency Type	Served by Grant
State Government	95
Local Government	33
National Guard Facility ⁵⁷	18
Sheriff's Office	3
Police Office	1
911 Center	1
All	151

This section summarizes the activities observed by the evaluation study team during site visits. The literature review presented in *Interim Report 1* provides evidence that these activities and situations lead to economic and social impacts. This report lists these impacts from the literature along with the evaluation study team's observational evidence supporting either the realization of impacts or their potential to occur.

- **By streamlining in-house operations with the use of broadband-supported tools, governments realize greater internal efficiency and productivity.⁵⁸**
 - The South Dakota National Guard reported that it was becoming very difficult to support missions, programs, and training requirements using the T1 connections they had at each site before BTOP. They now subscribe to 50 Mbps and use a layer three MPLS network over SDN middle mile infrastructure. One major use of their VPN network is to video conference for meetings and training. When a unit deploys, soldiers participate in several hours of training specific to their assignment. Individuals use the broadband connection to view the training through the Internet or the Non-classified IP Router Network (NIPernet). Often, up to fifty soldiers in one location need to access training at one time, and this is now possible because of the increased service on the fiber network. Previously, mobile training teams would travel between sites or the South Dakota National Guard would temporarily subscribe to commercial Internet services in order to accomplish a round of training. The increased bandwidth also enabled them to move to high-definition video, which enhances the quality of the training.
 - The increase in broadband speed to the South Dakota National Guard has opened up the possibility of virtualizing its servers so it can centralize storage at two data centers in Sioux Falls and Rapid City. The South Dakota National Guard is also researching virtual desktop environments, which would save hardware costs and allow the flexibility to access individual desktops anywhere on the National Guard network. This would also reduce administrative maintenance cost and facilitate data backups.
 - SDN is implementing an additional, separate network over the same fiber connections that it installed at the National Guard locations, specifically for distance learning. This will allow the sites to have direct access to business learning centers across the state, which are classrooms with video teleconferencing suites that seat twelve to twenty people. Trainers use these facilities to teach soldiers stationed remotely as well as those in the facility. Soldiers may also receive training from other National Guard units in other states using these learning centers.
- **Online tools allow government entities to offer better customer service and support.⁵⁹**
 - The increased network capacity and direct access at many government facilities has enabled more efficient government services, including Women, Infants, and Children (WIC), Supplemental Nutrition Assistance Program (SNAP), and Temporary Assistance for Needy Families (TANF) at the state level. It allows the government to offer services consistently across the state, whether residents live in urban, rural, or frontier areas.
- **Public safety entities, including police, fire, and emergency medical personnel, can reduce response times and improve the quality of services they provide with the use of broadband-supported applications and equipment.⁶⁰**
 - The Ethernet connections at the National Guard sites allow SDN to increase speeds from 50 Mbps up to 100 Mbps or 1 Gbps over the course of a few hours without the need for new equipment. For example, in 2011, the National Guard responded to a flood by setting up a mobile command center in a location with fiber-to-the-premise (FTTP). SDN increased the service provided from 6 Mbps to 100 Mbps within a few hours. At sites that had T1 connections, increasing capacity would take days or weeks because of the need to install new equipment.
 - The South Dakota Department of Social Services is preparing to increase broadband speeds to their sites in order to allow detained youth to video chat with their families.
 - SDN believes that some CAIs are now in a position to take advantage of the increased middle mile network. For example, the state maintains between fifty and sixty public safety radio towers, which are located on unpopulated high peaks or buttes in order to provide radio coverage. These systems provide mobile voice communications for first responders across the state. SDN was connecting these sites using T1 lines. Before BTOP, it would not

have been economically feasible for ISPs to install improved broadband connections to the towers because of their remote locations. However, predicted future needs will require fiber connections for applications such as radio over IP, video, and fingerprint and voice identification. These upgrades are less costly with the improved middle mile infrastructure.

2.3 Healthcare

This focus area includes activities intended to increase elements of the provision and administration of healthcare services, including health information technology, e-Care, electronic health records (EHR), telehealth, and mobile health. Impacts in the Healthcare focus area include broadband-enabled activities aimed at improving personal health or that of someone else. This definition includes not only sophisticated tasks, such as viewing medical records online, but also more common activities that might not involve a medical provider at all. Healthcare impacts might be observed at primary care physicians' offices, hospitals, or in areas served by nurse practitioners.

When assessing impacts it is important to understand the characteristics and composition of healthcare service providers within the service area. By March 31, 2013, SDN had connected sixty-five healthcare institutions.⁶¹ Table 5 identifies the taxonomy groups of these connected institutions and the taxonomy groups of all healthcare institutions in the service area according to the National Plan and Provider Enumeration System (NPPES).⁶² Fifty-eight of the healthcare institutions connected by the SDN project fall into the Hospital and Ambulatory Health Care Facility classifications, with an additional seven falling outside the NPPES taxonomy. Relative to the baseline provided by NPPES, SDN connected a similar percentage of Hospitals and Ambulatory Health Care Facilities in the service area.

Table 5. South Dakota Healthcare Institutions by Taxonomy Group

Taxonomy Group	Served by Grantee	All in Service Area
Agency	0	320
Ambulatory Health Care Facilities	41	331
Hospital Units	0	28
Hospitals	17	128
Managed Care Organizations	0	7
Nursing & Custodial Care Facilities	0	229
Residential Treatment Facilities	0	38
Other	7	0
All	65	1,081

SDN worked with two healthcare providers, Avera and Sanford, which have expertise in using telemedicine to serve rural areas. Their services reduce costs for both the health care providers and the patients. Avera or Sanford manage most of the sixty-five healthcare institutions connected through this project.

The site visit team met with Avera to determine the Healthcare impacts of the Connect South Dakota project. Avera's eCare services include five service lines to a centralized hub in Sioux Falls, which is the only healthcare facility in the country that is strictly dedicated to eServices. Through this center, Avera provides virtual Intensive Care Unit (eICU), ePharmacy, eEmergency, eConsult,

and long term care (eLTC) services. Avera estimates that since 2004, eCare services have touched 114,000 patients in 146 hospitals and clinics over a 352,000 square mile area, saving more than \$44 million in healthcare costs. In particular, Avera eICU services have saved 830 lives and \$30 million in medical costs, while serving 43,000 patients at 33 participating hospitals across 6 states. These outcomes are not a direct result of the BTOP project. However, they provide a useful quantitative benchmark of the kind of results achieved by telemedicine in areas served by the SDN project.⁶³

Before the BTOP grant, all of Avera's sites connected to their intranet through at least a T1 circuit. The sites used a clinic management system for booking appointments, though the sites with T1s were not able to take advantage of more advanced technologies. After the grant, Avera was able to increase speed at nine clinics and hospitals and provide new fiber service to four of its clinics and hospitals. Its new statewide minimum is 10 Mbps for clinics and 20 Mbps for hospitals. At each site connected by the new fiber, the cost per megabit decreased. Often, clinics were able to increase their connection speed from 1.5 Mbps to 10 Mbps while reducing total price. Although the evaluation study team does not have data for all 300 locations, cost savings are likely to be about 60 percent for small rural clinics, based on the site visit interviews. In addition to faster speeds, Avera staff members reported that the new technology also decreased latency from 15-30 milliseconds to below 5 milliseconds over Ethernet. With the T1 connection, sites were not able to meet the lowest requirement for some video software. Now, with the increased speed and lower latency, more sites are able to offer more telemedicine applications.

Avera received another federal grant from the FCC's Rural Health Care Pilot Program that allowed it to purchase the hardware necessary to upgrade its network to Ethernet in order to implement eServices over a virtual private network (VPN). This grant put Avera in a position to take full advantage of the improved SDN network to implement eServices to the extent they have.⁶⁴

This section summarizes the activities observed by the evaluation study team during site visits. The literature review presented in *Interim Report 1* provides evidence that these activities and situations lead to economic and social impacts. This report lists these impacts from the literature along with the evaluation study team's observational evidence supporting either the realization of impacts or their potential to occur.

- **Patients obtain improved ongoing care.**⁶⁵
 - Telemedicine is important in South Dakota because of the rural nature of the state, and the access provided to rural clinics through the BTOP grant helped to make eServices more widely available. Particularly for those with medical conditions that require a specialist, access to eConsults can increase positive health outcomes because patients will be more likely to attend follow-up visits when they can attend them from their own or a nearby town.⁶⁶
 - Avera's eICU CARE provides intensive oversight of patients in ICU beds. Many doctors and nurses in rural clinics have not undergone specialized intensive care training, so eICU allows remote specialists to monitor patients through video and vital signs. eICU is also used in larger city hospitals, as it has been found to be a successful way to monitor all ICU patients regardless of geography. Avera provides this service to approximately 130 beds throughout their service area.
 - eEmergency provides basic teleconferencing services in emergency rooms at small Avera hospitals that do not have full-time ER staff. This service provides emergency oversight by a trauma specialist as soon as a patient arrives, using equipment installed in rooms that connect immediately to the eCare Services Center in Sioux Falls.
- **Patients save time and money through reduced transportation, telephone calls, and face-to-face visit requirements.**⁶⁷ **Broadband-enabled applications lower patient costs by reducing the number of unnecessary in-home visits and hospital length of stay (LOS).**⁶⁸
 - Avera's eConsult services use video and audio to connect specialists with patients who would otherwise have to drive several hours for an appointment. This saves all patients time and money, but is particularly helpful for older patients who are able to stay in their homes

longer. It also saves their relatives time spent driving them to distant appointments or visiting them in hospitals or nursing homes that are far from their homes.

- Avera is beginning to implement long-term care as part of its eServices offering, which allows patients to stay in a familiar home environment and still receive needed health care services.
- **Patients are able to obtain more accurate prescriptions in a shorter amount of time.⁶⁹**
 - Avera's ePharmacy provides pharmacist oversight remotely, allowing hospitals and clinics that do not have a pharmacist on staff 24/7 to dispense prescription drugs when needed. Most states do not allow prescriptions to be dispensed without a pharmacist's oversight, so without these services, patients would have to wait until a pharmacist was on duty to obtain necessary medication.
- **Broadband connectivity enables providers to adopt new technologies and practices that enhance productivity, achieving outcomes such as improved appointment and treatment scheduling and more complete medical records at lower costs.⁷⁰**
 - Avera owns and operates a primary data center in Sioux Falls on property leased from SDN. Other regional hospitals are located in Aberdeen, Mitchell, Yankton, and Marshall, Minnesota, though the majority of data processing and storage is centralized in Sioux Falls. All hospitals and clinics are integrated into the centralized system that includes eServices, e-mail, Internet connectivity, security services, radiological imaging, and hundreds of other applications. Avera staff members estimate that they store 300-400 Terabytes of information in their data center, and that staff members access tens of thousands of records and images each day. Doctors use the system on laptops or computers in hospital rooms to access and update medical records, order prescriptions, and perform other functions.
 - All Avera hospitals and clinics meet stage one requirements for Meaningful Use, a set of standards defined by the Centers for Medicare and Medicaid Services Incentive Programs governing the use of electronic medical records (EMR). Stage one requirements include capturing patient records using EMRs and sharing them with patients or other health professionals.⁷¹ The BTOP grant allowed Avera to achieve this goal by implementing EMRs in an integrated and usable manner at all of its sites. Avera was also implementing a mobile version of the EMR that would allow doctors to view EMRs on their smart phones. Because of slow connection speeds at many of the clinics before the network expansion, Avera would not have been able to use its clinic management system at every location.
 - Avera reported that overall there have been staff productivity gains, although these have not been quantified. Avera has not changed its staffing model in response to the increased bandwidth, but it has centralized command-and-control somewhat.
 - The increased bandwidth and lower latency that resulted from the improved SDN network allowed Avera to consolidate services with SDN as a single provider and aggregator, with local member companies providing the last mile connections. This allows Avera to maintain and troubleshoot its network connectivity more easily.
- **Broadband enables providers to improve the range of health services offered.⁷²**
 - Avera reported that the bandwidth they receive influences the quality of service that healthcare providers are able to provide. For example, increased speeds have facilitated access to EMRs and radiological images, which reduces waiting times for patients. It also increases physician attraction and retention to rural areas by providing them with access to resources that are normally reserved for larger city hospitals, such as easy consultations with specialists and faster access to records and images. Many rural clinics are only able to hire one doctor, who is on call 24/7. Pressure on the local physician decreases with video access to remote physicians. In addition to improving the doctors' quality of life, this also increases the pool of physicians who are willing to live and work in a small, remote town.
- **The availability of online resources simplifies how patients obtain health information, improves the quality of information obtained, and provides the option to remain anonymous.⁷³ It also allows patients to access written product information related to their treatment more easily.⁷⁴**

- Though the site visit team did not speak with patients directly, Madison Public Library (MPL) provided evidence of individuals seeking health, treatment, and product information online. Librarians at MPL often answer reference questions related to healthcare using websites and databases. Generally, the patrons asking these questions either do not have a broadband connection in their homes, or need assistance in finding reliable information. The faster broadband speeds at the library can help librarians and patrons find the information more quickly.

2.4 Workforce and Economic Development

Impacts within the Workforce and Economic Development focus area can occur through activities intended to increase overall employment of the target population, or to assist employed members of that population in finding jobs that offer increased salaries, better benefits, or a more attractive career path, including self-employment. This focus area also includes activities to attract new businesses to locate along the fiber path or to expand the economic activity of existing businesses connected to the network. While this focus area primarily describes jobs, it also includes other economic impacts such as wages, property values, and the number of firms in a region.

This section summarizes the activities observed by the evaluation study team during site visits. The literature review presented in *Interim Report 1* provides evidence that these activities and situations lead to economic and social impacts. This report lists these impacts from the literature along with the evaluation study team's observational evidence supporting either the realization of impacts or their potential to occur.

- **Access to computers and broadband helps to reduce unemployment by enabling job seekers to engage in training programs, facilitating job seekers' ability to search and apply for open positions online, and reducing geographic limitations associated with the employment search.**⁷⁵
 - SDN and MTI have a unique business and educator partnership. The BTOP grant provided \$800,000 along with a \$200,000 match from MTI to update the equipment in MTI's telecommunications lab. This new equipment provides students with modern training for technical jobs. MTI also uses the equipment to provide continuing education and training for existing SDN staff members. The up-to-date training that the students at MTI are receiving because of the new equipment has resulted in a 20 percent wage increase for graduates.⁷⁶
- **Capabilities help to improve job matches by broadening the range of open positions obtainable by job seekers. Consequently, improved job matches increase employee productivity.**⁷⁷
 - SDN, its Member companies, and larger telecommunications companies recruit employees from the MTI graduate pool. SDN reported that MTI graduates make up 17 percent of the SDN workforce.⁷⁸ Part of the incentive for SDN to include funding for the telecommunications lab in its BTOP grant was to increase the knowledge and skills of the workforce that will be replacing retiring members of its staff. This not only improves the range of jobs MTI graduates can obtain, but also increases their productivity once they find employment.
- **New or enhanced connectivity benefits businesses by enabling the use of applications and processes that increase productivity and efficiency.**⁷⁹
 - Broadband provides benefits to the commodity farm economy, which makes up a large portion of commerce in South Dakota. It enables applications that improve the efficiency of farms and ranches, particularly for large operations. For example, cattle ranchers use video surveillance to observe when their cattle are calving. Farmers can watch the quantity of grain in storage using video cameras, and use their smart phone to control irrigation systems. They can implement precision agriculture applications such as autonomous equipment steering and the precise application of chemicals on fields. Most of these field applications function over cellular networks with a minimum of 2G or 3G. Because of the BTOP middle mile construction, wireless networks can support up to 4G in areas that did not have fiber

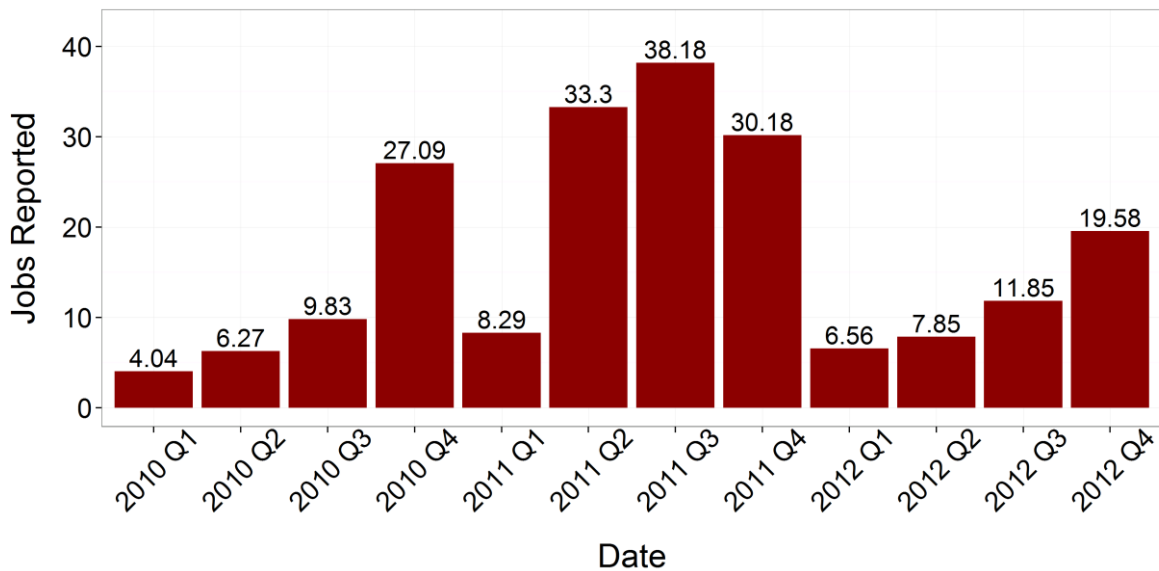
access previously. Farmers can also work with desktop computers in homes and farm offices, which are increasingly served by FTTP by SDN's Member companies across the state.⁸⁰ In a study conducted by the PrecisionAg Institute and the American Soybean Association (ASA), soybean growers who used precision technologies reported an average savings of about 15 percent on inputs such as seed, fertilizer, and chemicals.⁸¹ In a similar study, corn growers reported an average cost savings of 6.8 percent and an average yield increase of 7.6 percent. Growers farming more acres were more likely to report profit increases.⁸²

- The Dakotaland Federal Credit Union operates a network of eight facilities, and all but one of them received a broadband upgrade because of the new backbone fiber laid along the Highway 14 corridor. Before the BTOP grant, Dakotaland offices experienced significant downtime with the previous connections, making business applications that rely on broadband difficult to implement. For example, the office in Volga experienced an outage for three days, during which time members could not use the ATM. Since connecting to the SDN network, Dakotaland has not experienced an outage for more than fifteen minutes at a time, and outages happen far less frequently.
- Dakotaland benefits from improved network redundancy. Previously, when a failure occurred in its main facility, it took several days to restore the network. Now it can easily restore the network in a matter of minutes. Streamlining broadband access to all of its facilities also created more efficiency in maintaining their VPN, as they only work with SDN instead of a different provider at each of their eight locations.
- The Dakotaland director reported that staff productivity has increased, although there is no quantitative measure of the extent of the improvement. IT staff are spending less time diagnosing network issues, and other staff are able to perform tasks much faster with the increased speeds. Dakotaland is also able to use videoconferencing more effectively for employee training and staff meetings, which saves travel time and costs.
- Dakotaland Federal Credit Union has recently added a full suite of online account access and changed the phone systems in its locations to Voice over Internet Protocol (VoIP). They now have videoconferencing capabilities, and their ATMs are connected to the broadband network. Secondary locations send security videos over the network to their main office. Additionally, the credit union is imaging all of its paperwork, including loan files and membership cards. All of these services require reliable broadband.
- **Workforce and Economic Development activities supported by broadband infrastructure strengthen job and population growth.**⁸³
 - Because of the increased efficiencies it was able to achieve with faster broadband, Dakotaland added six positions, including four in a new facility.⁸⁴
 - Although SDN did not add any offices, it reported adding two engineers to work with new CAIs as part of the expansion of the network.⁸⁵
 - SDN's expansion of middle mile capacity through the BTOP grant benefited its Member companies by increasing network capacity. Ultimately, this affects the speeds it is able to offer to end users, which can bring in more customers.
- **Broadband access allows businesses to enhance marketing strategies by growing or establishing web presence, increasing the frequency of customer interaction, and thereby increasing customer bases.**⁸⁶
 - Dakotaland is looking ahead to its future needs when deciding to invest in fiber broadband connections. For example, they are evaluating videoconferencing equipment that would allow members to speak with a remote employee, both in buildings and at ATM terminals. The fiber connection through SDN can quickly accommodate the increase in demand for bandwidth that these new applications would create.
- **The availability of infrastructure in a community enables firms reliant on broadband services to relocate or open additional locations. Local businesses are able to obtain improved access to inputs and markets.**⁸⁷

- Dakotaland has recently opened three new branches that are connected to the BTOP middle mile infrastructure. The three new branches have brought an additional 800 to 1,000 new members and millions of dollars of assets to the credit union.⁸⁸
- SDN bought and installed two new interconnection points in industrial parks owned by economic development associations. These interconnection points can serve as an economic development tool by attracting businesses to an industrial park with reliable broadband.

As required by the Recovery Act, SDN reported the number of jobs created quarterly as a direct result of the project. As shown in Figure 6, SDN funded at least eleven full-time equivalent positions in half of the quarters beginning in the first quarter of 2010.⁸⁹ The majority of these jobs were for the construction of the network, and the variations reflect the phases of construction.⁹⁰ SDN also hired two engineers to work with new CAI subscribers. It is important to note that this only includes direct jobs created, and does not include indirect or induced job creation.

Figure 6. Direct Jobs Created by SDN



2.5 Quality of Life/Civic Engagement

The Quality of Life/Civic Engagement focus area includes activities that create stronger and more integrated communities through broadband. Impacts within this focus area are measures of broadband capacity for local institutions that provide public access and training in technology, such as libraries and other community centers.⁹¹ These institutions provide support for individuals to participate in activities that benefit their communities and society, access information about government, participate in communities and civic associations, engage in education and training, seek employment, and establish or support small businesses. For some residents, this public access provides their only means of Internet connectivity. For others, it provides a place to seek assistance, to learn, and to share ideas and information with others. Support of public broadband access is therefore a means of enhancing the civic commons and the quality of life in the community. There is growing evidence that while libraries are beginning to offer more services to support quality of life and civic engagement, over 75 percent of public libraries are falling behind in having adequate broadband speeds to meet the needs of the public.⁹²

When assessing impacts, it is important to understand the characteristics and composition of libraries or other institutions offering public access within the service area. Table 6 identifies the

locales of all libraries in the service area.⁹³ The Institute of Museum and Library Services (IMLS) determines locales based on the proximity of libraries to urban centers and their location in Census-designated rural territories.⁹⁴ Half of the connected libraries are located in rural areas. More than 80 percent of the remaining libraries in the service area are also located in rural areas.

Table 6. South Dakota Libraries by Locale

Locale	Served by Grantee	Others in Service Area
City	1	0
Suburb	0	1
Town	1	19
Rural	2	85
All	4	105

This section summarizes the activities observed by the evaluation study team during site visits. The literature review presented in *Interim Report 1* provides evidence that these activities and situations lead to economic and social impacts. This report lists these impacts from the literature along with the evaluation study team’s observational evidence supporting either the realization of impacts or their potential to occur.

- **Broadband lowers the effective cost of civic engagement by offering citizens flexibility in when, where, and how they can participate.**⁹⁵
 - MPL provides Internet connectivity to patrons through six public computers and free wireless throughout its building. The library serves the City of Madison and Lake County. It received a fiber connection through the BTOP grant and subscribes to a 5 Mbps service with SDN, which is an upgrade from its earlier T1 connection. It pays nearly 13 percent less for the faster fiber service than it did for the T1. MPL also reported that its network has become more stable after the SDN upgrade, so patrons experience less downtime.
 - The upgraded network made it possible for library staff to continue to view webinars from the South Dakota Library Network that are increasingly bandwidth-intensive. They have progressed from simple presentations to interactive sessions with chat boxes that sometimes include streaming video.
 - The library director reported that patrons sometimes use the library's public computers to look up volunteer activities on the city's website.
- **Online government services improve communication between citizens and government agencies.**⁹⁶ **Citizens save time and money by accessing content online rather than traveling to a government office or waiting to speak with a representative via telephone.**⁹⁷
 - MPL staff members are preparing to help patrons understand and sign up for healthcare under the Affordable Care Act (ACA). In addition to using the Internet to assist patrons with the website and online forms, they also used the connection to obtain training and access webinars on how the ACA will affect libraries and their patrons.
- **Using broadband for general social interaction improves social connections, especially in rural communities that tend to be sparsely populated or in other cases where parties must communicate over significant geographic distances.**⁹⁸
 - Patrons at MPL often use the public computers for social networking applications. They also participate in library programming that broadband connectivity enables. For example, MPL purchased a SMART Board with funds from a BIT grant. Library staff and volunteers use the SMART Board to present interactive books to children; give presentations on online genealogy tools such as Heritage.com and Ancestry Plus; and for webinars and video gaming.

- The MPL director reported that patrons often come in asking for help with their laptops and frequently use e-mail. Children from local communities use the public computers as well, and farmers often ask for help with selling farm equipment online. The library director reported that all of these services are smoother and more reliable with the upgrade to fiber.
- E-resources make up one-fourth of the circulation of MPL. The improved connectivity through SDN did not influence the choice to offer e-resources, but the improved download speed has increased patron use of these resources.

Section 3. Grant Implementation

This section presents SDN's strategy to maximize the social and economic impacts of the BTOP grant. The following subsections describe SDN's implementation strategies; SDN's approach to open access; major results of SDN's implementation strategy; an overview of sustainability efforts; and successful tools, techniques, and strategies identified during interviews with the grantee.

3.1 Implementation

SDN is owned by seventeen independent and cooperative telecommunications companies in South Dakota, called Members.⁹⁹ Initially established in 1989 to provide centralized equal access and wholesale long distance services for its Members, SDN deployed a statewide broadband network in the mid-1990s and expanded its customer base to include state and local government entities, schools, financial institutions, and healthcare providers.

SDN's network of over 30,000 miles of fiber across 8 states is the biggest fiber-optic network in the region. SDN is the prime contractor for the South Dakota Research Education Economic Development (REED) Network, which connects state government sites, state universities, and research sites. SDN's services include broadband Internet, MLPS and WAN connectivity, IP phone systems, network equipment, wholesale fiber, a data center, and managed services including a 24/7 Network Surveillance Center.¹⁰⁰

SDN works with its Members to support its Internet connectivity to endpoint commercial and residential customers. The general managers of nine of the seventeen independent Members serve on SDN's Board of Managers.¹⁰¹ The board tracked development of the BTOP application and approved the application and expenditures for the project. SDN also has a network management committee that is responsible for technology assessment, which promotes compatibility across the SDN network. Existing Member agreements fund network maintenance. SDN is responsible for operating and maintaining the backbone fiber and the electronics on the backbone.

SDN planned most of the network implementation with the help of the Members, though some Members could not participate in the BTOP project because they were implementing a Broadband Initiatives Program (BIP) grant through the Department of Agriculture. SDN hired MasTec North America as the contractor to work with Members to coordinate the build-out of the network. SDN also engaged the Martin Group, acquired by CHR Solutions during the grant period, to assist in permitting, documentation, and coordinating with communities to perform the environmental assessment (EA). The original environmental assessment required several months to complete, and took into account wetlands along the proposed route. SDN installed the network in the public right-of-way, which eliminated the need for easements or other special permitting. SDN built the network with buried fiber. While aerial fiber would have cost less to install, it would have taken more time and more expensive to maintain. Implementation of the project ran smoothly, with the exception of winter weather delays early in the project.

The grant provided SDN with an opportunity to increase the size of its business, but it represented an extension to its existing services rather than a new line of business. Before BTOP, SDN's existing in-state network consisted of 1,850 miles of fiber. The BTOP grant funded the installation of 397 additional miles of fiber, including backbone network middle mile spurs. The connections to the middle mile network are capable of up to 10 Gbps bandwidth, and the backbone network has 600 Gbps of bandwidth. The grant also provided funding for the following:¹⁰²

- Upgrades to the existing Dense Wavelength-Division Multiplexing (DWDM) network that is part of the core transport network used by SDN.
- The build of an MPLS network that will allow SDN's customers to have the dedicated circuits they require.
- The build of Ethernet aggregation points throughout the network.
- The installation of network endpoints within the system.

In addition to building from its existing backbone infrastructure, SDN leveraged an existing core router. The core router is located at the SDN headquarters in Sioux Falls.¹⁰³ SDN also added two buildings to house electronics used for regeneration along the long haul, middle mile portion of the fiber routes that were constructed.

SDN's rates for broadband services to business and residential customers declined due to the BTOP-funded infrastructure. SDN settled on a 10 Mbps standard based on conversations with the user community, though for CAIs connecting through the state contract, this standard has increased to 50 Mbps. In its application, SDN estimated that its fiber-based broadband offerings would cost approximately half of the cost of bonded T1 lines.¹⁰⁴ Based on pricing reported by CAIs during the site visit, the cost is significantly less than half for the SDN fiber.¹⁰⁵ In SDN's fourth quarter 2012 PPR, it reports that connected CAIs have seen an average of 44 Mbps increase over what they previously had. During the site visit, the grantee estimated that this number would rise significantly in the near future because of the increase from 10 Mbps to 50 Mbps for all of the schools and state government institutions. The effect of increased broadband availability because of the project depended in part on the service already in place with CAIs. Some CAIs had limited service through a single T1 line or a pair of T1 lines. These CAIs were able to obtain 10 Mbps at similar cost to their existing service. Other CAIs had sets of bonded T1s, which, when replaced with a 10 Mbps fiber connection resulted in lower cost for similar levels of service.

3.2 Open Access Policies

CCI projects funded by BTOP are predominantly middle mile projects, although a small number of last mile projects were awarded. These grants are intended to improve available broadband capabilities for CAIs, to facilitate the development of last mile services in unserved and underserved areas, and to promote economic growth. This investment through the BTOP grant is intended to "lay the foundation for the ultimate provision of reasonably priced end-user broadband services" through open and nondiscriminatory interconnection strategies to enable last mile providers to have open access to the network.¹⁰⁶

There is considerable debate on the impact of open access policies on the competitiveness of the broadband market.¹⁰⁷ Open access is implemented through a wide variety of strategies. "These can range from commercial or voluntary arrangements, between communication operators and third-parties, through to regulatory intervention aimed at promoting certain policy objectives, such as expanding broadband availability, increasing competition, or promoting investment that may otherwise not be economic, such as in the case of enabling the establishment and treatment of shared facilities."¹⁰⁸ The impact of open access will be dependent upon how well the practices and policies help to reduce the time, cost, and difficulty for last mile providers to interconnect to the network.¹⁰⁹ The impact also depends on how well the policy mechanisms ensure competitive pricing for wholesale services in the event of the presence of a middle mile provider that may also be a last mile provider.¹¹⁰

SDN has a policy of providing retail and wholesale broadband access to anyone for any lawful purpose. In its application, SDN stated its intention to connect any customer to the portion of the network funded by the BTOP grant where it is technically feasible to do so, where they do not reasonably expect to exceed network capacity, and where the customer is willing to pay reasonable and competitive prices for access.¹¹¹

SDN provides last mile services to CAIs through the BTOP grant and increased middle mile infrastructure to other ISPs. The grantee did not describe any agreements with non-Member last mile providers that they were contemplating or negotiating.

SDN provides circuits to some businesses, government, and wholesale customers, dividing revenues among the Member companies according to the share of services offered by each Member company. Member companies manage and bill for their own consumer and small business connections. The State of South Dakota serves as a demand aggregator for the public schools in the state. SDN does not have information on the agreements between the state and individual school districts. SDN acts as the ISP for the state government and large businesses. In addition to the CAIs, the middle mile infrastructure has made fiber services available for private sector customers, such as Dakotaland Federal Credit Union, although these customers must pay to connect to the fiber. It has also connected Verizon cell phone towers to the network.

SDN has some dark fiber on the backbone network, but has not sold Indefeasible Rights of Use (IRU). SDN would consider the sale of IRUs if requested. Members already negotiated agreements with third parties regarding the use of the middle mile infrastructure using an agreed-upon formula to distribute profits proportionally among Members based on the quantity of the network they own and maintain.

The expansion of the network along the Highway 14 corridor has increased the availability of broadband service in that area. The grantee anticipates that there will be increased investment in last mile infrastructure in that area. The availability of middle mile backhaul, both in the Highway 14 corridor and in other areas of the state, is expected to increase the availability of bandwidth to existing and new customers, and to result in overall reduced cost of access in unserved and underserved areas.

Other companies and institutions make connections to the middle mile infrastructure using both direct connections and connections through infrastructure owned by the Members. As an example, MTI is located on the route for the backbone network, and provides the facilities for a network node. In exchange, it receives a direct connection to the middle mile network. The SDN backbone also runs through the central offices of some of the Members. At those locations, a Network-to-network interface maps traffic from customers on the Member network through to the backbone network. Members connect other CAIs to the middle mile network through local fiber loops the Members own and manage.

3.3 Results

The evaluation study team observed three major results of the SDN project:

- The SDN project expanded the state's fiber infrastructure to provide increased broadband speeds to CAIs in South Dakota. Most of the CAIs the site visit team interviewed were previously subscribing to service over T1 lines, and speed increases were limited due to lack of adequate infrastructure and the prohibitively high cost of bonded T1 lines. The average subscription speed at CAIs increased 44 Mbps, and SDN expects this to increase further. Section 2 provides descriptions of early impacts observed by the evaluation study team because of these increases in speed.
- Project Connect South Dakota brought broadband infrastructure closer to residents and businesses in rural South Dakota, decreasing the cost to connect. After the BTOP build-out, SDN and its Members are building off the expanded middle mile network to provide services to customers in areas of the state that had limited access before the grant.
- The SDN fiber provides more reliable broadband service than what was previously available in the grant's service area. The network, in line with SDN's practices before the grant, is 100 percent redundant. Interviewees reported that they experienced much less downtime than

before the grant. This allows CAIs to deliver services to their clients more efficiently, and offers businesses the opportunity to use broadband technologies when reliability is critical.

The longer-term impact of the SDN network will depend on several factors related to the results listed above:

- The network must continue to meet the needs of CAIs by providing inexpensive and reliable broadband access. As of the site visit, SDN was offering pricing that was substantially better than CAIs had received from other sources. The BTOP investment allowed SDN to offer services to an expanded pool of CAIs, but its business model remains the same. It expects to be able to continue to offer the same services to CAIs. The new network also helped SDN work with the State of South Dakota to aggregate demand from more K-12 schools and state government entities throughout the state, which will likely continue to help keep costs down for these CAIs.
- The economic development impacts to the region as a whole will depend on SDN and its Members' ability to expand to meet the needs of homes and businesses, including farms. Agriculture makes up a large portion of the service area's economy, and technological applications such as precision agriculture can increase efficiencies and decrease environmental impact. Many of these technologies depend on robust broadband, and the middle mile network could expand these opportunities. One Member company reported that after the BTOP build-out, it is able to increase its base offering from 1.5 Mbps to 6 Mbps, at the same cost.
- SDN must maintain the reliability of the network over time. At present, SDN monitors the network and works with their Members to address any issues that require maintenance. SDN has been operating telecommunications networks for over 20 years, and its successful track record working together with its Members suggests that future network maintenance is well within its capabilities.

3.4 Sustainability

SDN anticipates that sustainability will not be an issue for the project, largely because SDN's business model has not changed from before the grant. BTOP facilitated a faster increase in the number of CAIs SDN was able to reach, and also enabled many of its Member companies to offer fiber services to residential and business customers much sooner than they would have without BTOP. SDN foresees that the increased backbone network may lower prices for their subscribers as they continue to add more customers to the network.

3.5 Successful Tools, Techniques, and Strategies

This subsection describes successful techniques, tools, and strategies identified by the grantee and interviewees. Successes and challenges described in earlier sections are not repeated here.

- SDN had successfully built and operated broadband networks before BTOP. Pre-existing relationships and infrastructure facilitated the rapid development of the BTOP grant application and the selection of the CAIs that were included in it, and allowed SDN to take advantage of the resources BTOP made available. The SDN project was complementary to the existing business of SDN. Existing assets, personnel, and processes were leveraged to complete the project. This reduces the amount of risk inherent in the project, reduces operations and maintenance costs, and leverages existing vendor and service arrangements.
- SDN had a pre-existing governance structure that included the local last mile providers that would benefit from the middle mile project. This increased cooperation and overall technical support, and provided a broad knowledgebase in how to install fiber networks in the local environment.

- The project size and scope were consistent with the size of SDN and the size of projects SDN believed it could accomplish. The project was also consistent with continued service to existing customers and growth in those relationships. SDN worked with the state to identify CAIs that would be appropriate for the project and to facilitate interactions with the CAIs.

Section 4. Conclusions

The American Recovery and Reinvestment Act of 2009 (Recovery Act) instructed NTIA to implement BTOP to promote five core purposes:¹¹²

1. Provide access to broadband service to consumers residing in unserved areas of the country.
2. Provide improved access to broadband service to consumers residing in underserved areas of the country.
3. Provide broadband education, awareness, training, access, equipment, and support to:
 - a. Schools, libraries, medical and healthcare providers, community colleges and other institutions of higher learning, and other community support organizations.
 - b. Organizations and agencies that provide outreach, access, equipment, and support services to facilitate greater use of broadband services by vulnerable populations (e.g., low-income, unemployed, seniors).
 - c. Job-creating strategic facilities located in state- or federally designated economic development zones.
4. Improve access to, and use of, broadband service by public safety agencies.
5. Stimulate the demand for broadband, economic growth, and job creation.

This section summarizes how SDN's implementation of BTOP has encouraged the fulfillment of the Recovery Act's goals. SDN supported Recovery Act goals to improve access in unserved and underserved areas. With these connections, CAIs are beginning to transform their services for healthcare and education, and provide digital literacy training in libraries and schools. The SDN network is enabling the South Dakota National Guard and the State of South Dakota to improve communication and training opportunities for its members and employees.

4.1 Improve Access to Unserved and Underserved Areas of the Country

The first two goals of the Recovery Act encourage improved access for unserved and underserved areas:

- Provide access to broadband service to consumers residing in unserved areas of the country.
- Provide improved access to broadband service to consumers residing in underserved areas of the country.

Project Connect South Dakota mostly targeted areas of the state that were underserved by broadband, though the service area also includes South Dakota's most populated cities and towns, which tend to have better broadband access. According to the June 2011 release of the NBM, approximately 20 percent of the population in the service area counties did not have access to a broadband provider, and 29 percent had only one provider available.¹¹³ The majority of providers in the service area are SDN's Member companies, most of which were formed to provide telephone service in areas where it was not economical for other companies to do so. They are now serving a similar function with broadband.

The greatest obstacle to expanding broadband to consumers, businesses, and public institutions in some rural areas was the lack of affordable high-capacity backhaul. One such underserved area was along Highway 14 north of Sioux Falls. Schools in this area were receiving T1 service but could not increase their speeds above 1.5 Mbps from their existing providers. The grantee reported

that it did not make economic sense for SDN or other providers to build fiber to this area. As a result, improved service would not have happened without the BTOP grant.

The SDN network also provides better access to backhaul for its Member companies. For example, ITC, which serves a substantial portion of northeastern South Dakota, owns and maintains the fiber installed by BTOP in its territory. It helped connect thirteen CAIs in its service area during the BTOP grant, and is also slowly expanding fiber infrastructure to homes and businesses. In July 2013, ITC completed a rate equalization project and increased its minimum speed offering from 1.5 Mbps to 6 Mbps.

4.2 Broadband Education, Awareness, Training, Access, Equipment, and Support

Most closely aligned with PCC and SBA grants, the next Recovery Act goal is for grantees to provide broadband education, awareness, training, access, equipment, and support to:

1. Schools, libraries, medical and healthcare providers, community colleges and other institutions of higher learning, and other community support organizations.
2. Organizations and agencies that provide outreach, access, equipment, and support services to facilitate greater use of broadband services by vulnerable populations (e.g., low-income, unemployed, seniors).
3. Job-creating strategic facilities located in state- or federally designated economic development zones.

Project Connect South Dakota focused on middle mile broadband infrastructure and last mile service to CAIs. In carrying out the grant, SDN provided outreach to both CAIs and the public through radio, print, and community events. This outreach focused on raising public awareness about the grant, including how it would benefit South Dakota. It also kept communities informed about construction progress.

The BTOP grant provided equipment for a new telecommunications lab at MTI, and the equipment needed to install the middle mile network, upgrade seven and install two new interconnection points, and connect CAIs that previously did not have access to fiber. SDN also provides support to CAIs for maintenance of the network, and seeks to provide increased bandwidth as needed. Because it uses Ethernet technologies, speeds to most CAIs can be increased in a matter of hours with no need to replace equipment.

Some CAIs connected to the SDN network are now able to provide access to the Internet to meet the growing information needs of the public. The public libraries are moving to faster broadband speeds, allowing them to offer better computer access. Schools are using the improved access to increase educational opportunities and improve instruction. Some also serve as a community access point, with parents and other community members using the school's wireless during evening programs. The healthcare organizations are reaching rural areas with more efficiency than before, increasing access to healthcare for rural populations and providing incentives to stay in or move to these small towns.

4.3 Public Safety Agencies

The fourth goal of the Recovery Act is to improve access to, and use of, broadband service by public safety agencies. As described in Section 2 of this report, the SDN project connected South Dakota National Guard locations throughout the state, allowing them to increase speeds both over their secure intranet and to the Internet. This has improved the way the South Dakota National Guard conducts training, allowing soldiers to stay at one facility and cut down on travel time and

expense. The technology used for the connection also allows for a nearly immediate speed increase in the event of an emergency.

The middle mile infrastructure has also enabled connections to public safety radio towers, which tend to be located in remote areas that are difficult to reach. Three Sheriff's offices, a police office, a dispatch center, and a 9-1-1 center were connected through the BTOP grant. The middle mile network also improves public safety by enabling better connections to cell phone towers, which improves 9-1-1 service. The state reported that the network lays the foundation for future adoption of bandwidth-heavy applications for public safety agencies, including video and high-resolution images. As the development and implementation of the network continues, public safety activities are expected to continue to improve in South Dakota.

4.4 Demand for Broadband, Economic Growth, and Job Creation

The final Recovery Act goal is to stimulate the demand for broadband, economic growth, and job creation. The majority of CAIs that received new fiber connections through Project Connect South Dakota had a T1 connection previously, including all K-12 schools and state government institutions. SDN's increased network capacity encouraged demand for broadband by allowing the grantee to offer services at a greatly reduced cost. For example, the state has been able to increase the minimum bandwidth it provides free of cost to K-12 schools and state government agencies from a T1 (1.5 Mbps) to 10 Mbps at the end of the grant period, and further to 50 Mbps in July 2013. While some CAIs had latent demand for broadband and used the faster bandwidth immediately, others may find the new speeds to be an incentive to explore more online applications.

Project Connect South Dakota laid the groundwork for economic growth and job creation by enhancing broadband availability in the service area. For example, the two interconnection points that SDN installed in industrial parks can serve as economic development tools by attracting businesses to the parks with reliable broadband. Other businesses in the service area have already taken advantage of the SDN network. For example, the Dakotaland Federal Credit Union is expanding quickly, partly because of efficiencies that have come from faster speeds and increased reliability.

Broadband also provides benefits to the agricultural economy, which makes up a large portion of commerce in South Dakota. Precision agriculture applications are beginning to increase productivity and may lessen the environmental impact of the use of farming chemicals. It also increases opportunities for the rural population to work remotely while remaining in their community.

Section 5. Next Steps for the Evaluation Study

In early 2014, ASR will deliver *Interim Report 2* to NTIA. This report will include a summary of the site visits to twelve CCI projects. It will also include a summary of the second round of site visits to the fifteen PCC and SBA grants.

For the CCI projects, *Interim Report 2* will summarize the activities underway by twelve CCI grantees and the social and economic impacts of these projects. For the PCC and SBA projects, *Interim Report 2* will provide an update to and refinement of the analysis presented in *Interim Report 1*.

In September 2014, ASR will deliver a *Final Report* that quantitatively and qualitatively assesses the economic and social impact of BTOP grants (including CCI, PCC, and SBA grants). The centerpiece of the *Final Report* will be an assessment of how and to what extent BTOP grant awards have achieved economic and social benefits in areas served by the grantees. To the extent that such information is available, ASR will use results from studies performed by the grantees to round out the conclusions presented.

Notes

¹ National Telecommunications and Information Administration, *Broadband Technology Opportunities Program (BTOP) 16th Quarterly Program Status Report*, 2013, http://www.ntia.doc.gov/files/ntia/publications/ntia_btop_16th_quarterly_report.pdf.

² National Telecommunications and Information Administration, “About,” *BroadbandUSA: Connecting America’s Communities* (Washington, DC, June 11, 2012), <http://www2.ntia.doc.gov/about>.

³ The Notice of Funds Availability (NOFA) includes the following definitions:

- Last mile project – any infrastructure project the predominant purpose of which is to provide broadband service to end users or enduser devices (including households, businesses, community anchor institutions, public safety entities, and critical community facilities).
- Middle mile project – a broadband infrastructure project that does not predominantly provide broadband service to end users or to end-user devices, and may include interoffice transport, backhaul, Internet connectivity, or special access.

National Telecommunications and Information Administration, “Broadband Initiatives Program; Broadband Technology Opportunities Program Notice” (Washington, D.C., 2009), http://www.ntia.doc.gov/files/ntia/publications/fr_bbnofa_090709.pdf.

⁴ National Telecommunications and Information Administration, “Statement of Work for Broadband Technology Opportunities Program (BTOP) Evaluation Study”, July 26, 2010, 6.

⁵ ASR Analytics, *Progress towards BTOP Goals: Interim Report on PCC and SBA Case Studies, Broadband Technology Opportunities Program Evaluation Study (Order Number D10PD18645)* (Potomac, MD, 2012), <http://www.ntia.doc.gov/report/2012/progress-towards-btop-goals-interim-report-pcc-and-sba-case-studies>.

⁶ South Dakota Network LLC, “About SDN,” *About Us*, June 8, 2012, <http://www.sdncommunications.com/about-us/about-sdn/>.

⁷ National Telecommunications and Information Administration, “Post-Award Monitoring (PAM) Database 2013-09-12” (Washington, DC: Distributed by National Telecommunications and Information Administration, 2013).

⁸ National Telecommunications and Information Administration, *South Dakota Network, LLC Project Connect South Dakota Fact Sheet, BroadbandUSA: Connecting America’s Communities*, December 2009, http://www2.ntia.doc.gov/files/grantees/BTOPAward_SDakotaNetwork_121709.pdf.

⁹ National Telecommunications and Information Administration, *South Dakota Network, LLC Project Connect South Dakota Fact Sheet*.

¹⁰ National Telecommunications and Information Administration, “Post-Award Monitoring (PAM) Database 2013-09-12.”

¹¹ The grantee reported serving 308 CAIs with new access and 204 with improved access. When matching the reported CAIs to public data sets, the evaluation study team identified instances where multiple schools received service but SDN reported them together as one CAI. The connected CAI numbers in this report reflect the larger number of individual institutions.

National Telecommunications and Information Administration, "Post-Award Monitoring (PAM) Database 2013-09-12."

¹² National Telecommunications and Information Administration, "Post-Award Monitoring (PAM) Database 2013-09-12."

¹³ Representatives of Mitchell Technical Institute, "Interview with author", July 31, 2013.

¹⁴ Representative of State of South Dakota Bureau of Information and Telecommunications, "Interview with author", July 31, 2013.

¹⁵ During its review of individual institutions, the evaluation study team identified several CAIs with incorrect anchor types: three were reclassified from University, College, or Other Postsecondary to Schools (K-12); one was reclassified from University, College, or Other Postsecondary to Public Safety; one was reclassified from Public Safety to University, College, or Other Postsecondary; and one was reclassified from Medical/Healthcare to Other Community Support.

Centers for Medicare & Medicaid Studies, "National Plan and Provider Enumeration System (NPPES)" (Washington, DC, July 2013), http://nppes.viva-it.com/NPI_Files.html; National Center for Education Statistics, "Elementary/Secondary Information System (ELSi)" (Washington, DC, August 15, 2013), <https://nces.ed.gov/ccd/elsi/>; National Center for Education Statistics, "Integrated Postsecondary Education Data System (IPEDS)" (Washington, DC, August 15, 2013), <https://nces.ed.gov/ipeds/>; National Telecommunications and Information Administration, "Post-Award Monitoring (PAM) Database 2013-09-12"; United States Department of Justice. Office of Justice Programs. Bureau of Justice Statistics, "Census of State and Local Law Enforcement Agencies (CSLLEA), 2008," *Directory of Law Enforcement Agencies Series* (Ann Arbor, MI: Inter-university Consortium for Political and Social Research, August 3, 2011); United States Fire Administration, "National Fire Department Census Database", August 8, 2013, <http://apps.usfa.fema.gov/census/>.

¹⁶ National Telecommunications and Information Administration, "Post-Award Monitoring (PAM) Database 2013-09-12."

¹⁷ Representatives of Mitchell Technical Institute, "Interview with author."

¹⁸ South Dakota Network LLC, *Project Connect South Dakota Application, BroadbandUSA: Connecting America's Communities*, August 19, 2009, http://www2.ntia.doc.gov/files/grantees/southdakotanetwork_application_part1.pdf.

¹⁹ National Telecommunications and Information Administration, "Post-Award Monitoring (PAM) Database 2013-09-12."

²⁰ South Dakota Network LLC, *Project Connect South Dakota Application*.

²¹ United States Census Bureau, "2006-2010 ACS 5-year Summary File," *American Community Survey* (Washington, DC, December 8, 2011), http://www.census.gov/acs/www/data_documentation/2010_release/.

²² United States Census Bureau, "2007-2011 ACS 5-year Summary File," *American Community Survey* (Washington, DC, December 6, 2012), http://www.census.gov/acs/www/data_documentation/2011_release/.

²³ National Telecommunications and Information Administration, "State Broadband Initiative June 30, 2011" (Washington, D.C.: United States Department of Commerce, 2011), <http://www2.ntia.doc.gov/Jun-2011-datasets>.

²⁴ National Telecommunications and Information Administration, "State Broadband Initiative June 30, 2011."

²⁵ National Telecommunications and Information Administration, "State Broadband Initiative June 30, 2011."

²⁶ FCC Form 477 data includes information at the census tract level on the population that subscribes to broadband using the following speed thresholds: at least 768 kbps download speed and at least 200 kbps upload speed. Because of this limitation, ASR is not able to filter for subscribers with download speeds of at least 3 Mbps and upload speeds of at least 768 kbps.

²⁷ Federal Communications Commission, "Local Telephone Competition and Broadband Deployment Form 477", June 2012, <http://transition.fcc.gov/wcb/iatd/comp.html>.

²⁸ National Telecommunications and Information Administration, "Post-Award Monitoring (PAM) Database 2013-09-12."

²⁹ Representatives of Mitchell Technical Institute, "Interview with author."

³⁰ Representatives of Mitchell Technical Institute, "Interview with author."

³¹ Representatives of Arlington Public School, "Interview with author", August 1, 2013.

³² Representative of State of South Dakota Bureau of Information and Telecommunications, "Interview with author."

³³ "South Dakota National Guard", October 4, 2013, sdguard.ngb.army.mil/.

³⁴ "Avera Health", October 4, 2013, <http://www.avera.org/experience/ah/>.

³⁵ "Madison Public Library: About the Library", October 4, 2013, <http://madisonpubliclibrary.blogspot.com/p/about-mpl.html>.

³⁶ "Dakotaland Federal Credit Union: About Us" (October 4, 2013), <https://www.dakotalandfcu.com/html/aboutus.html>.

³⁷ Representative of Raven Industries, "Interview with author", August 2, 2013.

³⁸ ASR Analytics, *Progress towards BTOP Goals: Interim Report on PCC and SBA Case Studies, Broadband Technology Opportunities Program Evaluation Study (Order Number D10PD18645)* (Potomac, MD, 2012).

³⁹ The grantee reported 247 connected Schools (K-12) in its 2012 APR. After reviewing individual institutions, the evaluation study team found many cases where the grantee listed a shared school building as a single educational institution rather than as multiple institutions. For example, the grantee listed Arlington Schools as a single institution, while National Center for Education Statistics (2013) lists Arlington Elementary, Arlington Junior High, and Arlington High School at the address. Where appropriate, the evaluation study team counts individual institutions as listed in National Center for Education Statistics (2013) as connected institutions, resulting in a larger count of connected Schools (K-12) than presented in the grantee's 2012 APR.

⁴⁰ National Center for Education Statistics, "Elementary/Secondary Information System (ELSi)."

NCES provides definitions for the following school levels:

- Primary: lowest grade offered is in pre-kindergarten through third grade and highest grade offered is in pre-kindergarten through eighth grade
- Middle: lowest grade offered is in fourth through seventh grades and highest grade offered is in fourth through ninth grades
- High: lowest grade offered is in seventh through twelfth grades and highest grade offered is twelfth grade
- Other: grades offered do not follow the primary, middle, or high school level configurations, or the school does not have a grade system
- Undefined: missing value

⁴¹ Teachers are reported as full-time equivalent (FTE) teachers. The number of individual teachers may be higher.

National Center for Education Statistics, "Elementary/Secondary Information System (ELSi)."

⁴² National Center for Education Statistics, “Integrated Postsecondary Education Data System (IPEDS).”

⁴³ Carly Shuler, *Pockets of Potential: Using Mobile Technologies to Promote Children’s Learning* (New York, NY: The Joan Gans Cooney Center, January 2009), <http://joanganzcooneycenter.org/Reports-23.html>.

Communications Workers of America, *Speed Matters: Benefits of Broadband* (Washington, DC, 2009), http://files.cwa-union.org/speedmatters/CWA_Benefits_of_Broadbandr_2010.pdf.

Scott M. Andes and Daniel D. Castro, *Opportunities and Innovations in the Mobile Broadband Economy*, *The Information Technology and Innovation Foundation*, 2010, <http://www.itif.org/files/2010-mobile-innovations.pdf>.

Linda Ann Hulbert and Regina C. McBride, “Utilizing Videoconferencing in Library Education: A Team Teaching Approach,” *Journal of Education for Library and Information Science* 45, no. 1 (2004): 25–35, <http://www.jstor.org/stable/40323919>.

⁴⁴ Vernon Brown, “E-mail Communication”, August 23, 2013.

⁴⁵ Brown, “E-mail Communication.”

⁴⁶ Brown, “E-mail Communication.”

⁴⁷ Representatives of Mitchell Technical Institute, “Interview with author.”

⁴⁸ Jessica Briskin et al., “26B-k: Smart apps: An analysis of educational applications available on smartphones and the implications for mobile learning (D&D),” in *Annual meeting of the AECT Convention* (Hyatt Regency Orange County, Anaheim, CA: Association for Educational Communications and Technology, 2010), http://convention2.allacademic.com/one/aect/aect10/index.php?click_key=1&cmd=Multi+Search+Search+Load+Publication&publication_id=430393&PHPSESSID=jgkifdqag6qgtckajo0k657jc7.

⁴⁹ Ruth H. Moody and Michael P. Bobic, “Teaching the Net Generation without Leaving the Rest of Us Behind: How Technology in the Classroom Influences Student Composition,” *Politics & Policy* 39, no. 2 (April 29, 2011): 169–194, <http://doi.wiley.com/10.1111/j.1747-1346.2011.00287.x>.

⁵⁰ For more information, visit <http://education.nationalgeographic.com/education/media/salem-witch-trials-interactive/>.

⁵¹ British Educational Communications and Technology Agency, *Extending Opportunity: Final Report of the Minister’s Taskforce on Home Access to Technology* (Coventry, UK, July 2008), <http://dera.ioe.ac.uk/8285/>.

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1. If a normal full-time schedule is 40 hours a week, multiply 40 hours x 52 weeks = 2,080 Total Hours per year.

2. Divide 2,080 Total Hours by 4 to equal 520 regular quarterly hours.
3. If two full-time employees each worked 520 hours (1,040 hours) for the quarter and another half-time employee worked 260 hours, the Total Hours for the three employees is 1300 (520 + 520 + 260 = 1300).
4. Divide 1300 by 520 to equal 2.5 Recovery funded jobs during that quarter.

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- City, Large: Territory inside an urbanized area and inside a principal city with population of 250,000 or more
- City, Midsize: Territory inside an urbanized area and inside a principal city with population less than 250,000 and greater than or equal to 100,000
- City, Small: Territory inside an urbanized area and inside a principal city with population less than 100,000
- Suburb, Large: Territory outside a principal city and inside an urbanized area with population of 250,000 or more
- Suburb, Midsize: Territory outside a principal city and inside an urbanized area with population less than 250,000 and greater than or equal to 100,000
- Suburb, Small: Territory outside a principal city and inside an urbanized area with population less than 100,000
- Town, Fringe: Territory inside an urban cluster that is less than or equal to 10 miles from an urbanized area
- Town, Distant: Territory inside an urban cluster that is more than 10 miles and less than or equal to 35 miles from an urbanized area
- Town, Remote: Territory inside an urban cluster that is more than 35 miles from an urbanized area
- Rural, Fringe: Census-defined rural territory that is less than or equal to 5 miles from an urbanized area, and rural territory that is less than or equal to 2.5 miles from an urban cluster
- Rural, Distant: Census-defined rural territory that is more than 5 miles but less than or equal to 25 miles from an urbanized area, and rural territory that is more than 2.5 miles but less than or equal to 10 miles from an urban cluster
- Rural, Remote: Census-defined rural territory that is more than 25 miles from an urbanized area and is also more than 10 miles from an urban cluster
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Glossary

Acronym	Definition
ACA	Affordable Care Act
APR	Annual Performance Progress Report
BIT	Bureau of Information and Telecommunications
BTOP	Broadband Technology Opportunities Program
CAI	Community Anchor Institution
CCI	Comprehensive Community Infrastructure
DDN	Digital Dakota Network
EHR	Electronic Health Records
EMR	Electronic Medical Records
EROS	Earth Resources Observation and Science
FCC	Federal Communications Commission
FTE	Full-time Equivalent
FTTP	Fiber to the Premises
ICU	Intensive Care Unit
IMLS	The Institute of Museum and Library Sciences
IRU	Indefeasible Right of Use
ISP	Internet Service Provider
ITC	Interstate Telecommunications Cooperative
LOS	Length of Stay
MPL	Madison Public Library
MPLS	Multiprotocol Label Switching
MTI	Mitchell Technical Institute
NBM	National Broadband Map
NPPES	National Plan and Provider Enumeration System
NSU	Northern State University
NTIA	National Telecommunications and Information Administration
PCC	Public Computer Centers
POP	Points of Presence
PPR	Quarterly Performance Progress Report
REED	Research Education Economic Development
SBA	Sustainable Broadband Adoption

Acronym	Definition
SDN	South Dakota Network
SNAP	Supplemental Nutrition Assistance Program
TANF	Temporary Assistance for Needy Families
VoIP	Voice of Internet Protocol
VPN	Virtual Private Network
WAN	Wide Area Network
WIC	Women, Infants, and Children

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