# ASR ANALYTICS

# National Telecommunications and Information Administration

Broadband Technology Opportunities Program
Evaluation Study
Order Number D10PD18645

# Case Study Report

# Massachusetts Technology Park

## Comprehensive Community Infrastructure

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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 MassTech, 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 impacts of the Massachusetts Broadband Institute: MassBroadband 123 (MB123) project during site visits. The Massachusetts Technology Park Corporation (doing business as Massachusetts Technology Collaborative, MassTech) is the grantee and carries out all fiduciary responsibilities of the grant, while the Massachusetts Broadband Institute (MBI) works with the staff at MassTech to execute the project. From October 28 to October 31, 2013, the evaluation study team met with representatives of the MBI and CAIs connected by the project. In total, the evaluation study team performed twenty case study site visit interviews and focus groups. ASR transcribed these discussions and used this

information, and 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 MassTech, its partners, or its subgrantees.

## About the Grantee

The MBI is one of three divisions of MassTech, a public economic development agency that supports the Massachusetts innovation economy. Created by Governor Deval Patrick and the state legislature, the MBI works with municipalities, broadband service providers, and other stakeholders to create new economic opportunities and bridge the digital divide in Massachusetts.[6] The MBI's mission is to expand affordable high-speed Internet access to strengthen the state's economy, improve educational opportunities, and enhance the delivery of healthcare, public safety, and government services.[7]

On July 1, 2010, NTIA awarded MassTech a BTOP CCI grant for $45,445,444 to implement the Massachusetts Broadband Institute: MassBroadband 123 (MB123) project. Matching funds totaled $26,200,000. Altogether, the project planned to invest at least $71,645,444 in western Massachusetts. The Commonwealth of Massachusetts, through the Executive Office of Public Safety and Security (EOPSS), supported the project by contributing $3.1 million in matching funds. In addition, the Massachusetts Information Technology Division (ITD) invested $3.1 million in capital towards the MB123 fiber network build. As of September 30, 2013, the MBI projected total expenditures to be $88,490,695, including funds contributed by the Commonwealth of Massachusetts.

> The Massachusetts Broadband Institute: MassBroadband 123 project initially planned to invest at least $71,645,444 in western Massachusetts.

## Project Proposal and Status

The MBI planned to construct and deploy a high-speed, fiber-based network in western Massachusetts to provide the region with the same broadband backbone available in the eastern part of the state. The project proposed to link 1,237 CAIs through a new middle mile fiber network. The MBI intends to provide access to speeds between 5 Mbps and 10 Gbps to public safety institutions, K-12 schools, community colleges, local and state government facilities, and healthcare providers in western Massachusetts.[8] At the time of the site visit, the project had connected a majority of CAIs, but the MBI was still completing construction and testing the network. Many CAIs were in discussion with service providers, but most were not yet subscribing to broadband on the MB123 network. The project successfully connected more than 400 additional CAIs in the fourth quarter of 2013, after the site visit. The MBI proposed the following, with results shown:

> As of October 2013, MBI accomplished the following from their proposed goals:
>
> - Installed 1,179 miles of new and leased fiber
> - Provide service to 1,187 CAIs
> - Establish agreements with Internet service providers to increase Internet availability to CAIs, residents, and businesses.

- Deploy over 1,300 miles of fiber, including constructing 958 new miles, in areas such as the Pioneer Valley and mountainous Appalachian regions.[9] The MBI had deployed 950 new network miles and 229 new, leased miles as of December 31, 2013. A majority of the new construction was aerial.[10]

- Provide high-speed Internet access for all 10 community colleges and over 360 other educational institutions, including K-12 schools and public libraries.[11] As of December 31, 2013, the MBI had connected 12 colleges and universities, 214 K-12 schools, 136 public libraries, 370 public safety institutions, 56 medical facilities, and 399 other community support institutions to the MB123 network.[12]

- Partner with the Massachusetts eHealth Institute (MeHI) at MassTech to help connect every critical care hospital in the region and over forty healthcare providers, improving information exchange and connectivity to teaching hospitals.[13] At the time of the site visit, the grantee estimated the project would connect between 65 and 70 healthcare organizations. In addition, approximately 200 hospitals and clinics are within two miles of the network, reducing the cost to connect to fiber infrastructure in the future.[14]

- Help to catalyze high-speed Internet availability for as many as 388,000 households, 44,000 businesses, and 700 additional CAIs by enabling local Internet service providers to utilize the project's open network.[15] Axia, the MB123 network operator, offers only wholesale services and has signed agreements with eighteen providers.[16] The MBI solicited over thirty letters of intent from potential providers in the service area. In addition, at the time of the site visit, Axia was in communication with at least four towns that were planning to build fiber-to-the-home networks.

As shown in Table 1, nearly 65 percent of the 1,187 CAIs connected by the end of the fourth quarter of 2013 are public safety or other community support institutions, largely state government offices.[17]

### Table 1. Community Anchor Institutions Located in Massachusetts

| Type | Served by Grantee | | Total in Service Area |
|------|------------------:|---|----------------------:|
| School (K-12) | 214 | 18% | 1,287 |
| Library | 136 | 11% | 245 |
| Medical/Healthcare | 56 | 5% | 2,469 |
| Public Safety | 370 | 31% | 610 |
| University, College, or Other Postsecondary | 12 | 1% | 99 |
| Other Community Support | 399 | 34% | 399 |
| **All** | **1,187** | | **5,109** |

## 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 grantee reported that only CAIs in a small portion of western Massachusetts were receiving service due to the incomplete status of the project. The MBI estimated that about 14 percent of network segments were lit at the time of the site visit.[18] All of the CAIs the evaluation study team interviewed were waiting for the remainder of the network to receive service. As a result, many of the impacts CAIs discussed are expected to occur after subscribing to broadband service on the MB123 network. The list below highlights observed and anticipated outcomes and impacts, with additional detail provided in Section 2.

- The EOPSS reported that before BTOP, agencies in western Massachusetts connected to the state's criminal justice information system (CJIS) via a 56 kbps frame relay network operating over T1 lines. Agencies are expected to connect with a minimum symmetrical bandwidth of 50 Mbps on the MB123 network, and EOPSS expects to save $15 to $20 per agency, per month. Agencies have access to criminal history, registration information from the Department of Motor Vehicles, and access to interstate and national systems, among other applications. EOPSS reported that it would not be able to increase bandwidth or connections to the CJIS without the BTOP grant.

- EOPSS expects to provide telemedicine services to inmates of correctional facilities in western Massachusetts. This saves transportation costs and time, improves inmate healthcare, and mitigates the danger of inmates escaping when being transported to and from healthcare facilities.[19]

- Other state agencies in western Massachusetts expect to have a direct fiber link to the state's data center in Springfield. This will provide them with more secure storage capacity, easier backups, and improved disaster recovery.

> Through BTOP, the project expects to achieve the following community impacts:
>
> - Increased technological capabilities for public safety agencies
> - Expanded educational opportunities for K-12 institutions
> - Improved services for public libraries
> - Increased capabilities for state government agencies

- Eighty-nine member libraries of the Central/Western Massachusetts Automated Resource Sharing (C/W MARS) library system expect to receive a more reliable connection and faster upload speeds through the MB123 fiber network. C/W MARS is using the network to aggregate bandwidth through one provider, Crocker Communications. While only about one third of the libraries expect to increase download speeds, nearly all of the eighty-nine libraries expect faster upload speeds because providers offer symmetrical bandwidth to CAIs. C/W MARS reported that the new network would benefit libraries because they were limited primarily by upload speeds prior to the grant. In addition, the eighty-nine libraries are saving a total of nearly $800 per month.[20] C/W MARS also reported that libraries will be able to download and share greater amounts of bibliographic data and participate in remote video conferencing, including webinars for staff and telemedicine opportunities for patrons.[21]

- The Southwick-Tolland-Granville Regional School District connected to the MB123 network, which provides a more stable and reliable connection enabling the district to pilot test a Microsoft remote desktop application that students and teachers can access from computers at school and at home. The district plans to use the increase in broadband speed to offer high-quality instruction using digital tools. For example, the speed and reliability is expected to help online applications such as Lexia, Accelerated Reader, and Study Island run more smoothly. It is also expected to facilitate access to educational material from websites such as Khan Academy. Staff members expect that the high-speed connection will enable the district to implement online standardized testing more reliably with fewer interruptions, upload exams faster because of the symmetrical connection, and receive results more quickly.

- The MeHI expects that approximately sixty-five healthcare facilities will use the MB123 network, enabling greater participation in the statewide health information exchange (HIE) and electronic health records. Increased speeds and symmetrical connections are expected to allow healthcare agencies to operate more efficiently and transfer radiological imaging, video, and other types of data. MeHI expects that the broadband infrastructure will enable communications with the HIE to be synchronous and more efficient, enabling information transfer instantaneously.

## Conclusions

Without the BTOP grant, it is unlikely that 1,187 CAIs would have connections to a fiber-optic network with the available speeds and low prices. The MBI expects that over 50 additional CAIs will be connected to the network when the remaining fiber is lit by February 2014. Out of the 122 communities being served by the grant, a little over one third (45) had no access to cable or fiber infrastructure.[22] The grantee reported that existing copper telephone lines, through which CAIs, businesses, and residents may subscribe to T1 and DSL service, were aging and overloaded. Most of the CAIs connected by the MB123 project had much lower bandwidth or paid higher prices for service before BTOP. With the new fiber network, CAIs have the opportunity to transform their service provision to citizens in western Massachusetts. The MBI is collaborating with nonprofits and state agencies to increase economic development opportunities and decrease the digital divide in the region.

> Community anchor institutions interviewed reported that the average price of broadband per megabit per month decreased and capacity increased with the connection to the MB123 network.

The BTOP grant connects institutions of higher education, K-12 schools, libraries, hospitals, government agencies, and public safety institutions to the MB123 network. The MBI reported that it could not have expanded fiber infrastructure into western Massachusetts as quickly and expansively as it did without the BTOP grant because of construction costs. The MBI implemented twenty-seven interconnection points to give last mile providers the opportunity to expand broadband service in Massachusetts. At the time of the site visit, Axia, the MB123 network operator, had secured letters of intent from thirty-three third party providers. Approximately seventeen signed interconnection agreements and six were interconnected and providing services over the network. Although none of the CAIs interviewed by the evaluation study team were subscribing to service over the network at the time of the site visit, the majority expected to subscribe to faster speeds at lower costs. For example, Berkshire Health Systems expected to increase bandwidth to one of its hospital from 50 Mbps to 100 Mbps. The healthcare provider expected to save about $37,000 per month after transitioning several of its hospitals and clinics to service over the MB123 network.[23]

# Section 1. Introduction

The goal of the Massachusetts Broadband Institute: MassBroadband 123 project was to connect nearly 1,400 CAIs and to provide middle mile broadband connectivity in 122 western and central Massachusetts towns.[24] As shown in Figure 1, the grant serves six counties in Massachusetts: Berkshire, Franklin, Hampden, Hampshire, Middlesex, and Worcester. All references made to the service area throughout this report refer to these six counties, except when noted otherwise. The project's fiber route, shown in black below, reflects fiber deployed by the MBI using BTOP funds. There are more than twenty points-of-presence (POP) located along the MBI fiber that are expected to facilitate an open network by enabling future interconnection by service providers. The fiber route shown in grey is a previous fiber build completed by the MBI before BTOP.[25]

## Figure 1. Service Area Map
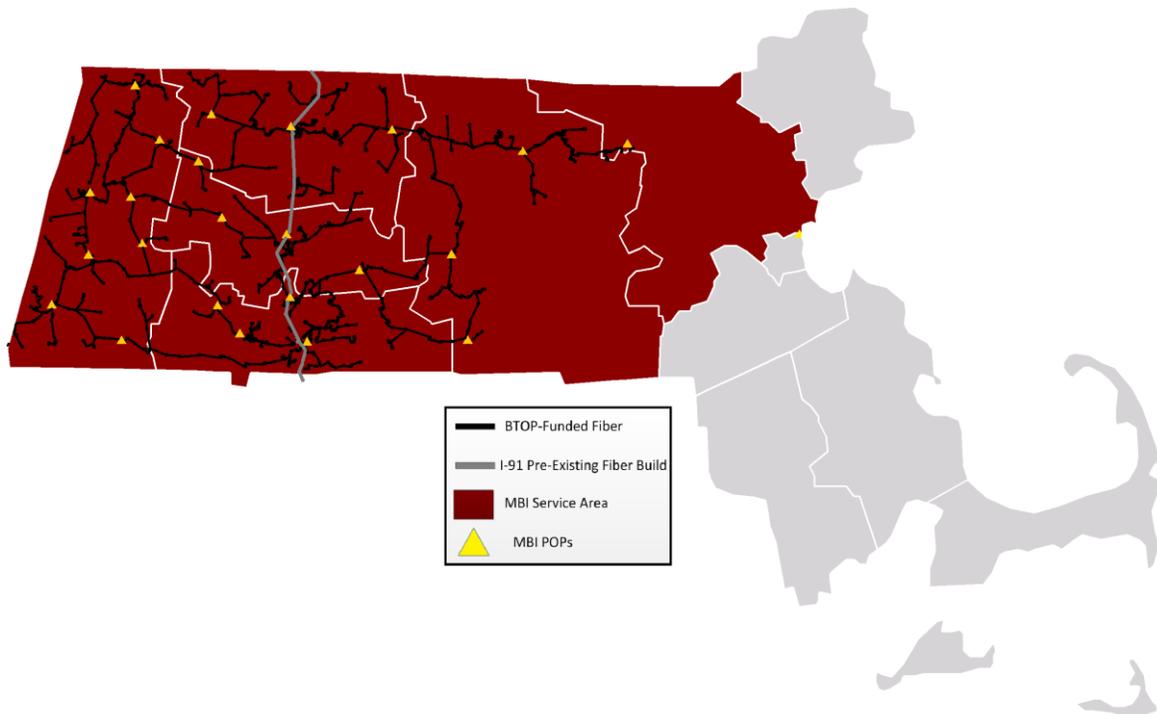


The project targets the western portion of Massachusetts. The service area includes areas such as the Pioneer Valley and mountainous Appalachian regions where Internet subscription costs are often two or three times as high as the same services in the eastern portion of Massachusetts.[26]

As seen in Figure 1 above, the BTOP fiber route is most extensively located in the four westernmost counties in Massachusetts (Berkshire, Franklin, Hampden, and Hampshire). While a portion of the BTOP fiber route is located in Worcester and Middlesex Counties, the counties located just west of Boston, its presence is limited. For consistency in defining grantee service areas at the county level, Middlesex County and Worcester County are included in service area metrics calculated throughout this report, unless otherwise noted. Because of these counties' proximity to Boston, their demographic composition and broadband availability levels differ from the rest of the service area. In order to highlight the intended service area population, those located in the four western-most Massachusetts counties where the network is most prominent (Berkshire,

Franklin, Hampden, and Hampshire), metrics are presented across this more focused portion of the service area, unless described otherwise.

The American Community Survey (ACS) Five Year Summary for 2007 to 2011 shows that the service area population represents almost 48 percent of the state population. Without Middlesex and Worcester County, the service area represents just 13 percent of the state population.[27] This is largely due to the difference in population density, which is far higher in the eastern portion of Massachusetts. The portion of the service area excluding Middlesex and Worcester Counties is also less affluent. Thirty-eight percent of the full service area population has a household income of less than $50,000 but forty-nine percent of the service area population excluding those in Middlesex and Worcester County fall under the same threshold.[28]

Using publicly available data, the evaluation study team identified 5,109 CAIs in the service area, including 245 libraries, 2,469 medical/healthcare facilities, 610 public safety institutions, 1,287 K-12 schools, 99 universities, colleges, or other postsecondary institutions, and 399 other community support agencies.

Table 2 shows the percentages of the populations in the service area and the rest of Massachusetts by the number of broadband providers available according to data and speed thresholds defined by the National Broadband Map (NBM).[29] The table also includes the metrics for the adjusted service area, only the four westernmost counties in Massachusetts (Berkshire, Franklin, Hampden, and Hampshire). A slightly larger portion of the service area population does not have access to any broadband providers (1.8 percent) compared to the rest of Massachusetts (1.2 percent). The same is true of the relative populations of the service area and the rest of Massachusetts with one broadband provider available: 7.3 percent of service area residents have access to one provider, compared to 5.6 percent of residents in the rest of Massachusetts. Excluding Middlesex and Worcester County, nearly 4.8 percent of the service area population has no broadband providers available. All provider statistics use the June 2011 release of the NBM and 2010 population data from GeoLytics.

### Table 2. Number of Broadband Providers Available in Massachusetts

| Number of Providers | Service Area | Rest of Massachusetts | Adjusted Service Area |
|---|---|---|---|
| 0 | 1.82% | 1.20% | 4.76% |
| 1 | 7.34% | 5.63% | 16.75% |
| 2 | 43.79% | 33.18% | 75.34% |
| 3 | 30.40% | 47.95% | 3.08% |
| 4 | 16.28% | 11.56% | 0.06% |
| 5 | 0.32% | 0.46% | 0% |
| 6 | 0.05% | 0.02% | 0% |

The grantee reported that 45 out of the 122 towns in which CAIs were connected did not have cable infrastructure. Institutions, businesses, and residents in these areas relied on T1, DSL, or satellite service for broadband. Some areas also have wireless LTE coverage, but it is limited.[30]

Figure 2 shows the percentages of the service area population, and adjusted service area population, with respect to the fastest download and upload speed range available to them.[31] According to the NBM, there are fifteen service providers operating in the service area. Twelve service providers operate in the four westernmost counties of the service area. Their maximum advertised download speeds range from 3 Mbps to 1 Gbps and the maximum advertised upload speeds range from 768 kbps to 1 Gbps. For the full service area, 69 percent of the population has access to download speeds of 100 Mbps to 1 Gbps. Excluding Middlesex and Worcester Counties,

58 percent of the population has access to these speeds. The figure below shows maximum available upload and download speeds for the full six-county service area and for the adjusted four county service area.

**Figure 2. Maximum Speed Ranges Available for the Service Area Population**
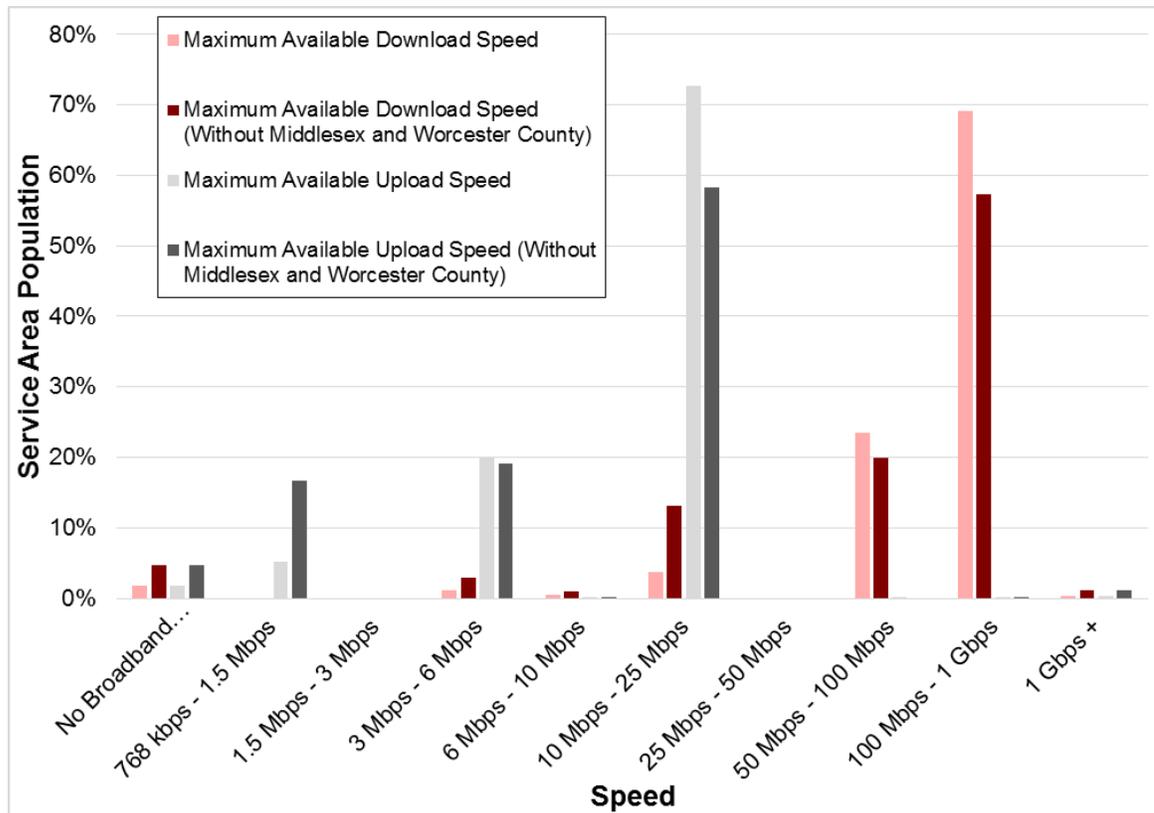


Broadband subscribership rates are slightly lower in the service area than across the state. Federal Communications Commission (FCC) data from 2012 show that 78 percent of households in the service area subscribe to an Internet service that has at least 768 kbps download speeds and 200 kbps upload speeds.[32] In the service area without Middlesex and Worcester Counties, the subscribership rate is 68 percent. Seventy-nine percent of the state's population subscribe to an Internet service with the same minimum thresholds.[33]

The first CAI connected by the grant received service in the third quarter of 2013, when thirty-one CAIs and service providers subscribed to service. By December 31, 2013, twenty-one CAIs subscribed to speeds between 5 Mbps and 10 Mbps. Seven subscribed to speeds between 20 Mbps and 100 Mbps, and three subscribed to service at or above 1 Gbps. The MBI expects more subscriptions in subsequent quarters.

Figure 3 presents the grant's service area and the locations of connected CAIs as of December 31, 2013.[34] The grantee based the design of the network around connecting public safety facilities, schools, community colleges, and 123 municipalities. After this initial design, it connected public housing buildings, healthcare facilities, and other CAIs. The grantee reported that after the initial design, one liaison from each community modified the list of CAIs according to input from the towns.[35]

**Figure 3. Locations of Connected Community Anchor Institutions**
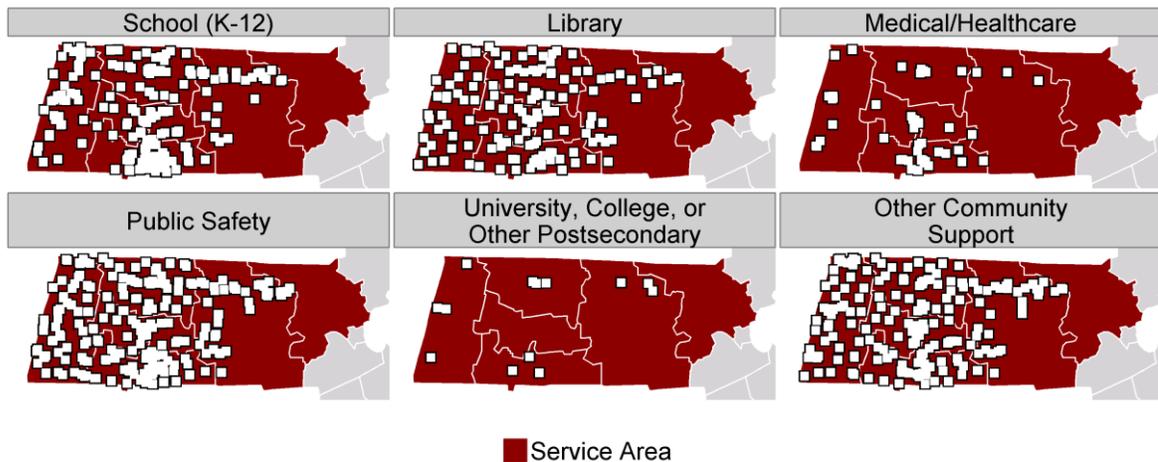


The evaluation study team met with MBI staff, project partners, economic development specialists, and government agencies. These interviews helped the team understand the grantee's approach to project implementation and the strategies used to create demand for the broadband service. Additional interviews with key CAIs and partners throughout Massachusetts focused on describing the impact on CAIs in relation to several factors, including the quality of service of the upgraded network, especially speed, reliability, flexibility, and cost. The analysis in this report focuses on outcomes and impacts to CAIs. Interviews conducted include the following:

- Education
  - **Southwick-Tolland-Granville Regional School District** has between 500 and 600 students in each of 4 buildings, including the Granville Village School, Woodland Elementary School, Powder Mill Middle School, and the Southwick-Tolland Regional High School.[36] All buildings connect to the high school via one strand of district-owned fiber. Before BTOP, the district subscribed to a commercial cable connection, in addition to two residential accounts in individual buildings. The IT director reported that this service ranged from 3 to 20 Mbps for downloads and 3.5 to 4 Mbps for uploads. The district paid a total of $104 per month for these connections. The district connected to the MB123 network on November 13, 2013 and subscribes to 50 Mbps symmetrical service at $650 per month. The district plans to retain the previous connection as a backup.[37] The district plans to use the increase in service to offer high-quality instruction using digital tools. The district also expects an increase in administrative efficiency.[38]
  - **Greenfield Community College (GCC)** is the only institution of higher learning in Franklin County, and has an annual enrollment of over 2,500 credit students.[39] The college has three sites, all of which are expected to connect to the MBI fiber. At the time of the site visit, GCC had a 45 Mbps DS3 connection costing $2,200 per month, and several cable connections for backup. The majority of the traffic used the DS3 connection and the grantee reported that use often reached capacity during business hours. In no case was bandwidth use below 20 Mbps. After it transitions to MBI-built fiber, the college plans to subscribe to 100 Mbps at the main site, and between 5 and 20 Mbps at the two remote sites. Based on estimates received from four providers, GCC estimates that it will be paying approximately the same cost for the improved service. IT staff reported that without the MBI fiber, the college would not be able to afford the bandwidth that students and faculty demand. IT staff also reported that they expect the college to use increased bandwidth to offer more online courses, to use more technology in the classroom, and to share resources with other institutions of higher learning.[40]
- Healthcare

- o **Berkshire Health Systems (BHS)** is a private, nonprofit organization that serves the region through a network of affiliates, including Berkshire Medical Center (BMC), the BMC Hillcrest Campus, Fairview Hospital, Berkshire Visiting Nurse Association, thirty-five physician practices, and a long-term care facility.[41] BHS reported that the larger hospitals had adequate bandwidth at the time of the site visit. For example, BMC subscribed to a 50 Mbps Internet connection. However, MB123 is expected to provide the redundancy that is becoming increasingly important as healthcare becomes reliant on electronic data such as electronic medical records (EMR).[42] In addition, BHS expects the network to connect its smaller facilities on a centralized and reliable network. Many of the smaller clinics subscribe to Internet service via T1s, which are costly and do not allow the clinics to transfer radiological images or conduct video conferences. MB123 is expected to connect many of BHS's facilities with the exception of some remote medical practices and nursing facilities. Axia, described at the end of this section, is seeking grant funds to connect thirteen additional nursing facilities that are less than two miles away from the fiber backbone. BHS estimates it will save about $37,000 per month for all sites connected to the MB123 fiber.[43]

- Government

  - o **Executive Office of Public Safety and Security (EOPSS)** provides oversight of law enforcement and public safety entities throughout Massachusetts. EOPSS contributed $3.1 million in matching funds to the BTOP grant, and will purchase wholesale fiber from Axia to connect local and state law enforcement agencies and E911 call centers in western Massachusetts.[44] At the time of the site visit, the fiber had been installed, but service was not activated. Staff anticipated activating service in January 2014, after running a pilot with a small number of offices. EOPSS reported that before BTOP, agencies in western Massachusetts connected to the state's CJIS via a 56 kbps frame relay network operating over T1 lines. Some agencies did not have direct access to the system, but did connect with limited capabilities via the Internet. Agencies will now connect with a minimum symmetrical bandwidth of 50 Mbps, and EOPSS will be saving $15 to $20 per agency per month.[45] EOPSS reported that it would not have been able to increase bandwidth or connections to CJIS without the BTOP grant.

  - o **The Massachusetts Information Technology Division (ITD)** provides IT services to state agencies. It invested $3.1 million in capital to ensure the MB123 network was constructed and available for most state agencies in western Massachusetts.[46] ITD will purchase wholesale fiber from Axia to serve about 450 CAIs. ITD reported that many of these state agencies were connecting to the state's system through a T1 circuit, and, after BTOP, will move to subscription speeds between 5 and 100 Mbps.[47]

  - o **Pioneer Valley Planning Commission (PVPC)** is a regional planning body of forty-three communities in Hampden and Hampshire Counties. PVPC collaborated with the MBI to conduct community outreach, facilitate project planning and permitting, and to identify CAIs within its service area with the help of local governments. The PVPC office is also receiving a fiber connection through MB123, and is planning to increase its bandwidth from a 4 Mbps DSL service to at least 20 Mbps. PVPC also plans to switch telephone service to voice over Internet protocol (VoIP), and estimates that this packaging will save between $300 and $500 per month. It plans to use the increased service to offer more online classes and workshops for residents.[48]

- Libraries

  - o **Central/Western Massachusetts Automated Resource Sharing (C/W MARS)** is a nonprofit organization that was formed in 1982 to enhance resource sharing among participating libraries.[49] As of summer 2013, it had 145 member libraries.[50] C/W MARS offers a shared online computer system and combined collections of more than nine million items.[51] The shared systems require a broadband connection to function properly, as large amounts of data are transferred between member libraries and the centralized system in Worcester. Eighty-nine of the member libraries received a fiber connection through the MB123 project, and C/W MARS is using the network to aggregate bandwidth through one provider. The average proposed speed to member libraries that received a MB123

connection is a symmetrical 8.3 Mbps, which is about 3 Mbps lower than the average download speed prior to MB123 and about 6 Mbps faster than the average upload speed. While only about one third of the libraries expect to increase download speeds, nearly all of the libraries expect faster upload speeds because providers offer symmetrical bandwidth to CAIs. Libraries will be saving an average of about $8 per month.[52] C/W MARS expects to improve administrative efficiencies by interfacing with a single broadband provider for the eighty-nine locations. Member libraries will receive a more reliable connection to the shared resources. Symmetrical services are increasingly important for libraries as they transition to services that require fast upload speeds. For example, the Massachusetts Library System (MLS) is promoting remote telemedicine centers in libraries, which would require sufficient bandwidth to video conference.[53]

The evaluation study team met with the following businesses that supported the network's construction and operation.

- **Axia NetMedia Corporation (Axia)** is an international broadband Next Generation Network (NGN) company that won the competitive bid process to function as the network operator for the MB123 network. Axia leverages the open access MB123 network to provide wholesale services to last mile providers and state agencies, which provide services to CAIs, businesses, and residential customers.[54]

- **Phoenix Communications** specializes in construction, engineering, and support for fiber-optic cable in Massachusetts and New York.[55] The company was a subcontractor under G4S for the MB123 project, constructing 289 laterals to CAIs and performing splicing and testing of the network.[56]

- **The Center for Educational Leadership and Technology (CELT)** is a nonprofit organization that provides research, planning, and implementation services for educational institutions. It serves as an Internet Service Provider (ISP) for 100 educational organizations in Massachusetts including public, private, and charter schools. CELT works collaboratively with educational organizations to support and advocate for the needs of schools and students. As an ISP, the organization also helps schools with E-Rate funding. It also manages security for some of the organizations that it connects, and brokers among software vendors to obtain reduced pricing for the educational institutions on information technology (IT) services.[57] CELT has signed contracts to provide service to nine CAIs connected by MB123, including one town and eight schools. Many of these include multiple sites; for example, the town is connecting six sites, four of which were connected through MB123. CELT expects that fifteen to twenty more CAIs will subscribe to its service after the fiber is lit.

- **Cornerstone Telephone Company** was founded in 2001 in Troy, New York. Its service area now includes businesses in western Massachusetts. Cornerstone reported that the MB123 network allows it to compete with larger carriers, and it expects to expand its business and hire new employees in the service area.[58]

- **Westfield Gas and Electric** provides telecommunications services in Westfield for municipal and commercial buildings. The company constructed the backbone through the city and laterals to all twenty-eight CAIs in the area. As a municipal gas and electric company, it had existing infrastructure that made the build less expensive. After the construction phase, it is responsible for maintenance of the network in Westfield. It also plans to build from the backbone to serve other customers, both on its portion of the build and outside of the city.[59]

- **South Hadley Electric Light Department (SHELD)** serves the electric needs of the town of South Hadley, with approximately 8,000 electric customers. SHELD built the section of the MB123 project that runs through South Hadley, as it had existing conduit and infrastructure. SHELD also helped the MBI determine which CAIs to connect in South Hadley, in an effort not to duplicate the existing fiber in the town. It operates the Stonybrook Interconnection Facility, which serves as a data center and interconnection point for the MB123 fiber.[60] SHELD has also discussed building a fiber to the home network with Axia. If that occurs, SHELD will hire three new employees to expand and maintain the fiber network.[61]

The evaluation study team also met with the following groups that provided information on the social and economic impacts of the grant, although they did not directly receive broadband service because of it.

- **The Massachusetts eHealth Institute (MeHI**), like the MBI, is a division of MassTech. MeHI is responsible for advancing the dissemination of health information technology throughout Massachusetts, including the deployment of electronic health records systems in all healthcare provider settings networked through the statewide health information exchange (HIE). MeHI provided outreach to healthcare organizations as part of the MB123 project.[62]

- **Executive Office of Housing and Economic Development (EOHED)** oversees state agencies that focus on economic growth, supports dynamic communities, and encourages competition for consumers and businesses. The primary goals of the EOHED are to increase job creation, stabilize housing, enhance consumer awareness, and improve regulatory solutions in order to sustain economic and community growth.[63] EOHED served as a partner on the MB123 project. Its responsibilities included legislative and interagency outreach and research.[64]

- **Franklin Regional Council of Governments (FRCOG)** is a regional organization offering a variety of programming, products, and services to twenty-six towns in Franklin County. FRCOG has been working since 1997 to promote broadband development in Franklin County through demand aggregation. Its study examining the level of public funding necessary to incentivize the private sector to invest in western Massachusetts helped to inspire the formation of the MBI at the state level in 2008.[65] The council collaborated with the MBI on the MB123 project to conduct community outreach, facilitate project planning and permitting, and work with local governments to identify CAIs within its service area with the help of local government. FRCOG sees the middle mile infrastructure as a necessary tool for the economic development of the region. It assists towns in Franklin County in developing IT plans to benefit from broadband use. The council also plans to build a data center and interconnection facility to attract businesses and to promote local entrepreneurship.

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

# Section 2. Impacts

This section describes the outcomes and impacts of the MB123 project in relation to the five focus areas described in *Interim Report 1*, with the addition of the Government Services focus area.[66] These outcomes and impacts focus on understanding the effect on CAIs. 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.

Because the site visit occurred before the majority of CAIs had received service, most of the impacts discussed below are potential future impacts from activities that CAIs are planning to implement using the new infrastructure.

## 2.1 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." [67] 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.

The MBI connected 370 public safety institutions by the end of the fourth quarter of 2013.[68] Almost 74 percent of the public safety institutions connected by the grant by this time were fire or police departments.

### Figure 4. Public Safety Institutions Connected by MassBroadband 123
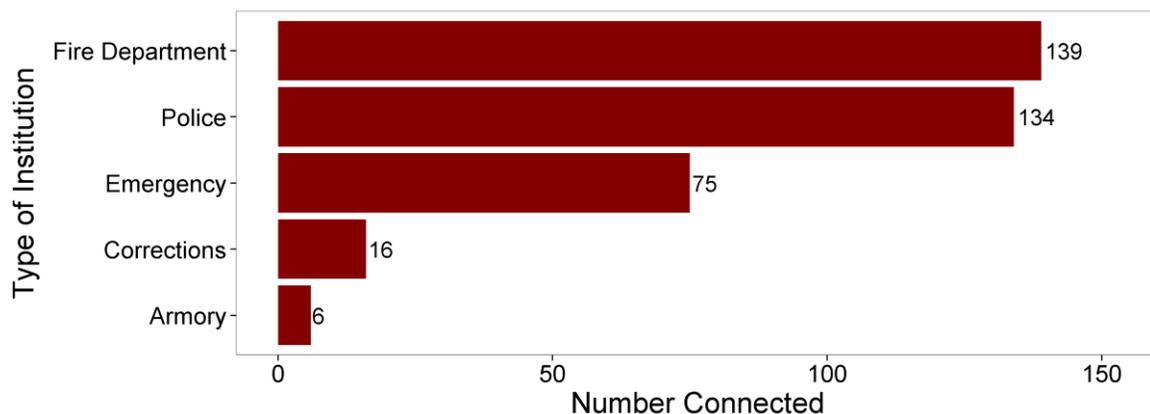


This section summarizes the activities observed by the evaluation study team during site visits. This report lists impacts from the literature along with the evaluation study team's observational evidence supporting either the realization of impacts or their potential to occur.

- **The use of broadband at all levels of government allows government entities to deliver services more efficiently. Intranet systems enable the secure and rapid exchange of information among government agencies. Governments are also able to store and**

**safeguard massive quantities of data. By streamlining in-house operations with the use of broadband-supported tools, governments realize greater internal efficiency and productivity.[69]**

o ITD reported that state agencies connected to the network will now have access to the Springfield data center, which will provide them with more secure storage capacity, ease of backups, and disaster recovery. Having all agencies connect through ITD rather than different providers across the region will also save ITD the administrative costs of managing many providers.

o EOPSS plans to expand its e-learning enterprise because of the MB123 network. It is responsible for providing both pre- and in-service training to public safety officials in many sectors, including state police, the prison system, the department of public safety, emergency management, and fire services. It also provides training for municipal police departments. EOPSS is planning to transition some of the training online in order to deliver classes more efficiently and to save departments transportation costs.

o As the additional public safety entities in western Massachusetts transition to the new network operated by EOPSS, they will have greater flexibility in how they share data among departments. Functioning as an ISP will allow EOPSS to manage edge routers so agencies within a geographic region can share information without the data traveling through the core data center in Boston. This facilitates the use of security cameras and the transfer of high-resolution video among agencies. This will also help the EOPSS network to operate faster for tasks such as link analysis at the Commonwealth Fusion Center, which shares data between local, state, and national public safety agencies. In the event of an emergency, EOPSS can also increase the level of bandwidth to an agency that needs to share more data than ordinary operations require.

o The MB123 project has facilitated a more robust connection to the state's CJIS for public safety agencies in western Massachusetts. This includes access to criminal history, registration information from the state's Department of Motor Vehicles, and access to interstate and national systems, among other applications. Before the network was completed, EOPSS made CJIS available over the Internet, so that even departments that did not have direct connections to the system could access it using a virtual private network (VPN). However, EOPSS reported that this is not an optimal solution, as there are some applications that cannot be accessed over the Internet or with a slow connection speed. For example, some situational awareness applications require a large amount of bandwidth, including real-time streaming data such as video. With the MB123 fiber connections managed by EOPSS, all of the connected agencies are expected to be able to access CJIS at full capacity.

o FRCOG supplies an accounting program to 14 towns with populations under 1,000. Many of these towns had to buy broadband subscriptions in order to use the software. FRCOG has helped subsidize these subscriptions, but after the towns are connected to the MB123 network, they expect to pay less.

o FRCOG has hired a consultant to assist ten towns in creating a technology plan to use the MB123 network to its fullest potential. For example, the consultant offers suggestions of whether or not to bundle VoIP services with Internet services, and how to design the network in and among municipal buildings. FRCOG also plans to streamline operations in the municipalities by using the fiber to facilitate data sharing, data backups, and shared software systems. This would allow for more efficient upgrades and IT maintenance.

- **Online tools allow government entities to offer better customer service and support.[70]**

o As part of its expanding mission, PVPC is offering training and educational opportunities for the residents of its communities. For example, the planning commission offers in-person classes on using organic lawn treatments in order to address storm water pollution issues. PVPC reported that it plans to transition some of these classes to an online format so residents can attend the training from home. The planning commission also expects this will engage more residents, as they could watch the courses online at any time for free.

- **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.[71]**
  - The MB123 network is expected to provide backhaul to sixteen public safety radio towers and seventy-one E911 answering points. These connections will give the sites higher bandwidth at a lower cost and provide redundancy. The new network is also expected to allow EOPSS to implement next generation 911 using VoIP.[72]
  - EOPSS has invested between $45 and $50 million over the last seven years to rebuild all of its core enterprise applications, including next-generation identification (NGI) tools such as biometric systems, facial recognition, and advanced fingerprinting; virus recognition systems; and inmate management systems. All of these updated systems demand higher capacity bandwidth. For example, NGI fingerprinting captures and sends fingerprint images with a much higher resolution, and inmate management uses a large amount of streaming video. EOPSS reported that the MB123 project was necessary to implement these updated systems in the western part of the state.
  - The network connected the Holyoke Chief Medical Examiner, which expects to be able to share video with the medical examiner in Boston to facilitate consultation and collaboration in complex cases.
- **Law enforcement, investigative, and intelligence agencies may use broadband for preventative purposes. Security and surveillance activities enabled by broadband, such as those that use global positioning system (GPS) technologies, reduce costs, counteract crime and acts of terror, save lives, and avoid injuries.[73]**
  - EOPSS reported that it expects to be able to provide inmate telemedicine in correctional facilities in the western portion of the state. This could save the system transportation costs and time, improve inmate healthcare, as discussed in Section 2.4, and mitigate the danger of inmates escaping when being transported to and from the correctional facilities.
  - EOPSS reported that the improved used of video in correctional facilities in western Massachusetts can have an impact on the ability of public safety agencies to respond to an inmate unrest. EOPSS could easily transfer video from facilities to the command center in Boston or the Special Tactical Operations (STOP) team at the state police offices in Framingham. The video could also easily be shared with the FBI or National Guard should the need arise.[74]
  - FRCOG is working with other towns and agencies in its region to create a data-sharing project among law enforcement agencies to combat drug trafficking along the Interstate 91 corridor. The MB123 project is expected to allow the agencies to quickly share information.
  - FRCOG expects that the MB123 network will help towns in Franklin County connect to the Massachusetts Virtual Epidemiologic Network (MAVEN), a database reporting system for contagious diseases. Boards of Health are responsible for reporting any case of contagious disease to help track its progression and take measures to contain the disease. Before MB123, the Boards of Health were not able to access MAVEN.[75]
  - The public safety agencies in South Hadley are planning to use the network for a system of security cameras throughout the town to prevent vandalism and attacks on school buildings. South Hadley has existing security cameras, but does not have the capacity to stream video for live monitoring. Real time monitoring would allow public safety entities to respond more quickly in order to prevent a crime.[76]
- **Broadband connectivity helps to preserve continuity of government operations in the wake of disasters or epidemics.[77]**
  - EOPSS reported that before BTOP, municipal public safety agencies in western Massachusetts did not have enough broadband capacity to effectively transmit architectural diagrams from city and town halls to fire and police departments. EOPSS expects that it will be able to effectively transmit these plans after it begins to use MB123 fiber. Building plans assist rescue teams in life-saving efforts during emergency events by allowing them to navigate buildings effectively.

- Massachusetts has experienced several weather emergencies in the past few years, and EOPSS expects that the MB123 network will help public safety agencies address these events in the future. With the redundant fiber network, EOPSS expects to be able to easily move operations from one location to another to quickly resume operations should a major center be hit with a weather emergency. Agencies across western Massachusetts are also expected to have more reliable access to the Emergency Operations Center (EOC), improving communications among agencies during events.
- Redundant connections and remote data backups can help government institutions easily recover data after an event. The MBI expects the state's Second Data Center in Springfield to connect to MB123, and the MBI encourages local municipalities to consider using this facility to store data backups.[78]
- Several towns in Franklin County have experienced first-hand how debilitating emergency weather events can be, particularly when CAIs are not networked and do not have data backup services. A consultant hired by FRCOG is helping ten towns create data backup plans. The MB123 fiber makes this possible.[79]
- SHELD used the network to deploy a system of electronic meter readers in order to have real-time information on use of the system. These meter readers detect outages immediately and reduce the response times for repairing them. SHELD plans to use fiber built to its substation to implement an automatic restore for the system in the case of a disaster. SHELD expects that this will work to localize outages so not all customers on a circuit would lose service.

## 2.2 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.

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 and private schools in the service area.[80] By the end of the fourth quarter of 2013, the MBI connected more public primary schools than public high schools and middle schools combined.

## Table 3. Massachusetts Schools (K-12) by School Level

| School Type | School Level | Served by Grantee | Others in Service Area |
|---|---|---|---|
| Public School | Primary | 113 | 446 |
| | Middle | 28 | 134 |
| | High | 49 | 112 |
| | Other | 5 | 17 |
| Private School | Elementary | 2 | 210 |
| | Secondary | 1 | 63 |
| | Combined | 2 | 87 |
| Undefined | | 14 | 4 |
| **All** | | **214** | **1,073** |

The MBI also connected 5 of the 365 private schools in the service area.[81] Connected public schools serve almost 86,000 students in the service area.[82] More than 25,600 of these students are minorities (30 percent) and almost 37,000 qualify for free or reduced lunch (43 percent). Connected public schools employ more than 6,800 full-time equivalent teachers. The MBI also connected twelve of the ninety-nine postsecondary institutions in its service area.[83]

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.[84]**
  - Greenfield Community College (GCC) is researching the possibility of collaborating with Endicott College on a nursing program to enable students to earn a Bachelor of Science in Nursing (BSN) while staying on the GCC campus. Endicott's capacity allows the college to use online applications for students that require high Internet speeds. Students could not access these applications from the GCC campus because of its inadequate bandwidth before BTOP. With the increased bandwidth at a lower cost from the MB123 network, GCC can take advantage of the partnership to increase degree offerings for students.[85]
  - CELT reported that many small school districts do not have Internet connectivity in middle and elementary schools, although most high schools do. Many students are entirely dependent on the public library for Internet connectivity. Smaller, rural schools need connectivity because they are often not able to offer the same breadth of classes as a larger school. Students sometimes commute several hours to another school to take a class that their home district does not offer. Schools plan to provide more distance education opportunities after subscribing to less expensive services over the MB123 network.[86]
  - The MBI reported that Farmington River Regional School expects to increase its purchased bandwidth from a DSL connection, where only one classroom could be on the Internet at a time, to a 5 Mbps symmetrical connection. The symmetrical bandwidth is expected to allow the school to implement a school-wide, year-long program for students to video chat with students in Zambia. The program is expected to help students learn about cultural differences and study water issues in Zambia, after which they will use what they learn to study the Farmington River and Otis reservoir.[87]

- GCC offers a range of courses, from in person to fully online. The majority of classes, including classes on campus, use the online system Moodle for sharing course materials and submitting assignments. Some in-person classes use online exams that students can take remotely, and some instructors take video of their class and upload it to Moodle for students to review. GCC also offers hybrid courses, for which students meet once or twice per semester in person, with the remainder of the class material presented online. Finally, it offers fully online courses, and is moving toward offering a degree completely online. GCC reported that without the increased capacity that it expects to be offered over the MB123 network, the college would not be able to expand its online content. It is already operating at capacity the majority of the time.

- **The use of digital tools enabled by broadband can save teachers time, allowing them to devote more effort to instruction.[88]**
  - The increased speed and reliability is expected to help the Southwick-Tolland-Granville Regional School District carry out teacher training online. This allows teachers to conduct the training when it is most convenient for them, and saves administrators time by being able to track teacher completion of required training online.[89]

- **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.[90]**
  - The increase in bandwidth is becoming more important for GCC as more materials from textbook publishers require Internet use. For example, nursing, anatomy, and physiology courses are beginning to take advantage of new publisher's material that is Flash and HTML-based, either supplementary to or replacing traditional print textbooks. Because GCC is already at peak capacity most of the day and would not be able to afford increased bandwidth without BTOP, students would find it more and more difficult to access these materials without the MB123 project.[91]
  - CELT reported that some of the schools with which it has signed contracts are beginning to roll out iPad and tablet initiatives to provide students with personalized technology in the classroom. CELT is not able to do this until schools switch to the MB123 network because even those that have broadband are already at capacity with other daily activities.
  - The network upgrade gives the Southwick-Tolland-Granville Regional School District a more stable and reliable connection that it expects to use to pilot test a remote desktop application. This is expected to allow students and teachers to access licensed applications from computers at school and at home. The remote desktop application may also facilitate classrooms moving to paperless homework submission.
  - The Southwick-Tolland-Granville Regional School District IT director reported that the slow bandwidth motivates teachers to use more traditional curriculum tools in place of online tools because the slow speeds can interrupt service. The district believes that the increased speed will allow more classrooms to use online applications, such as Lexia, Accelerated Reader, and Study Island, and websites such as the Khan Academy, more reliably.
  - The MBI reported that Granville School District plans to upgrade from a cable connection to a 50 Mbps fiber connection over the MB123 network. The District plans to use the increased bandwidth to host a server with licensed software that students may access from school or from home. This would allow students and parents to use licensed software without purchasing a personal license. Without the symmetrical bandwidth that the MB123 network provides, this would not be possible.

- **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.[92]**
  - GCC offers classes in advanced manufacturing in vocational and high schools in the region. This segment of the economy is growing in western Massachusetts. The college expects that the schools will benefit from having a more reliable and faster connection to GCC through MB123, keeping them connected with the college's resources and faculty.[93]

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- **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.**[94]
    - GCC reported that it would like to move to remote data backups in partnership with another institution of higher learning, but the 45 Mbps connection that it has now is not sufficient. Its connection to the MB123 network would allow it to transfer data more efficiently, and the possibility of connecting to other organizations that will be on the same network is expected to help minimize cost.
    - GCC reported that green jobs were an area of growth in its service area. The college collaborates with local vendors and businesses to train students on equipment off-site, as it does not have the necessary technology or equipment on campus. It cannot share student data with these programs because of the slow bandwidth, but it hopes to be able to do so after connecting to MB123 in order to streamline operations and reduce duplicative paperwork and systems.
    - The Commonwealth of Massachusetts has mandated that all schools transition to online testing in the 2014-2015 school year. CELT reported that the state recommends 100 kbps per student for online testing. For schools with 100 students achieving this goal will require a 10 Mbps connection. Many small, rural schools in western Massachusetts did not have access to the broadband speeds required to implement online testing before the MB123 project. After they are connected, the schools expect to be able to implement online testing. Of the twenty-six schools that CELT has signed contracts with, nine plan to subscribe to 10 to 20 Mbps service, eight plan to subscribe to 50 Mbps, and nine to 100 Mbps service and above.[95]
    - The Southwick-Tolland-Granville Regional School District expects that the network offered by MB123 will allow it to implement online standardized testing more reliably, with fewer interruptions in service. The connection is also expected to allow the school to upload exams faster and receive results more quickly. The superintendent reported that having results by the end of the school year, rather than the beginning of the following school year, would give teachers adequate time to adapt their curriculum to the results.
- **School districts may realize cost savings by conducting staff training activities online rather than using hardcopy training materials or hosting in-person training sessions.**[96]
    - CELT reported that the schools with which it works are looking forward to online professional development and teacher training. Currently, teachers in remote schools have to drive to the nearest urban center for professional development opportunities, and this can be costly for the schools. The broadband access that MB123 provides is expected to make it easier for schools and districts to provide online staff training.

## 2.3 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 with broadband connectivity enables additional employment options and increased earning potential for workers, such as entrepreneurial activities, independent investment and contracting opportunities, and work-from-home positions.[97]**
  - Though these impacts were not directly observed, the MBI reported that completion of the fiber network is expected to catalyze economic development in the region, which is contingent on home broadband connections. The fiber infrastructure laid the framework for future connections to homes, both from private and public investments. Axia reported that it was in conversations with four municipalities that were planning to build fiber to the home networks throughout the towns. The MBI reported that the town of Leverett passed a municipal bond to build a fiber to the home network, and is in the process of building it. In addition, the House of Representatives in the Massachusetts legislature has passed a bond bill that authorizes $50 million to support the MBI's efforts to build last mile infrastructure in underserved communities.
  - FRCOG conducted a study showing that 87 percent of tenants in Franklin County's industrial parks began as home-based businesses.[98] It reported that the home-based business is a vital part of the rural Massachusetts economy, and it expects that broadband will be very important for increasing revenue for home-based businesses and for spurring economic development in the future.
- **Workforce and Economic Development activities supported by broadband infrastructure strengthen job and population growth.[99]**
  - The MB123 fiber has opened up the possibility of building an interconnection facility and data center in Franklin County. The City of Greenfield has environmentally remediated a brownfield site for the data center. The city is in the process of procuring grant funding to connect it to sewer, road, and water infrastructure. This is expected to provide a boost to the economy, jobs, and attract other businesses to the area that are in need of data backups.[100]
  - FRCOG reported that many businesses have left the county in the last several years due to lack of broadband availability. The relatively low cost to connect to the middle mile infrastructure is projected to help more businesses stay in Franklin County.
  - Phoenix Communications had twelve employees committed full time to the MB123 project, and estimates that four to five field technicians, one administrator, and a project manager were hired because of the opportunities presented by MB123.[101]
- **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.[102]**
  - ISPs in the service area now have access to less expensive bandwidth in order to provide Internet service for their customers, which helps grow their businesses. For example, CELT hired four additional staff in the last six months.[103] Before BTOP, wholesale backhaul from Springfield to Boston generally cost providers $30 per Mbps per month; Axia is charging $3 per Mbps per month for the same service.[104] At the time of the site visit, thirty-three local, regional, and national service providers had signed letters of intent to provide services over the network. Seventeen of the thirty-three also signed interconnection agreements with Axia, and six were already active on the network.[105]
  - Many interviewees reported that the lack of residential broadband access hampers homeowners' ability to sell their property, stifling the real estate market in these areas of western Massachusetts. This is an important part of municipalities' decision to invest in fiber to the home.[106]
  - The Commonwealth of Massachusetts has implemented an initiative to promote advanced manufacturing in western Massachusetts, as there has been a resurgence of precision manufacturing in the area. EOHED reported that most of these businesses, however, are clustered around areas that have access to broadband.[107] Before MB123, the geographic opportunities were limited by the distribution of infrastructure. Now, Axia and other providers will be able to build laterals off the network at a relatively low cost, connecting existing and potential businesses. The MBI also reported that several of the towns had shown interest in

paying for the network extension that would allow small businesses to connect to high-speed broadband.[108]

- o Westfield Gas and Electric staff members reported that they anticipate more competition among providers to lower customer costs for broadband in its service area. This has encouraged the company to revisit its business model and potentially expand its service offerings. The company also expects to have access to better and less expensive backhaul, which would result in maintaining lower rates for business customers in Westfield.[109]
- o SHELD engineered the network in South Hadley by placing slack loops where there is a concentration of businesses, or where it expects new CAIs or businesses to locate. This is expected to facilitate access to the fiber infrastructure in the future. SHELD also built a data center that serves as an interconnection point for providers that would like to connect to the fiber network.

As required by the Recovery Act, the MBI reported the number of jobs created quarterly as a direct result of the project. Figure 5 shows the number of direct jobs created by the MBI over the grant period.[110] The MBI's highest quarter of job funding was the first quarter of 2013. The six quarters from the first of 2012 to the second of 2013 have seen an average of 74.3 jobs funded by the MB123 project, compared to an average of 14.5 jobs over the first 6 quarters of grant activity.[111] The grantee reported that the jobs created largely included the subcontractors under the main design and construction firm, G4S, with additional sources for environmental permitting and project management.

## Figure 5. Direct Jobs Created by MassBroadband 123
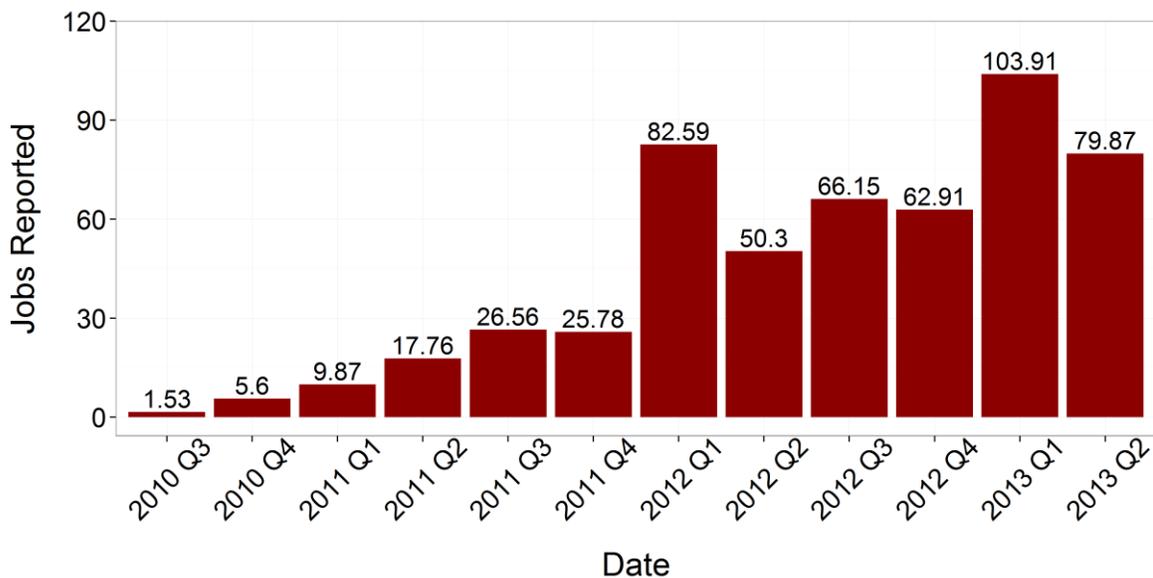


## 2.4 Healthcare

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. The MBI connected fifty-six healthcare institutions by December 31, 2013.[112] Table 4 identifies the taxonomy groups of these connected institutions and the taxonomy groups of all healthcare institutions in Massachusetts according to the National Plan and Provider Enumeration System (NPPES).[113] The MBI connected thirteen ambulatory health care facilities and eighteen hospitals.

### Table 4. Massachusetts Healthcare Institutions by Taxonomy Group

| Taxonomy Group | Served by Grantee | Total in Service Area |
|---|---|---|
| Agency | 0 | 1,016 |
| Ambulatory Health Care Facilities | 13 | 672 |
| Hospital Units | 20 | 26 |
| Hospitals | 18 | 139 |
| Managed Care Organizations | 0 | 41 |
| Nursing & Custodial Care Facilities | 1 | 451 |
| Residential Treatment Facilities | 0 | 68 |
| **All** | **56** | **2,413** |

MeHI reported that state legislation requires every healthcare provider to use electronic health records connected to the health information exchange (HIE) by January 2017. The MBI plans to connect between 65 and 70 healthcare organizations through the MB123 grant, and approximately 200 more are within two miles of the fiber network.[114]

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 save time and money through reduced transportation, telephone calls, and face-to-face visit requirements.[115]**
  - o C/W MARS reported that it plans to collaborate with the MLS to develop programs that libraries may implement to make use of the increased broadband technology that has resulted from the MB123 project. For example, it has discussed promoting telemedicine stations in public libraries where patrons could have video consultations with specialists.[116] It would make these opportunities available in areas that do not have a rural clinic with telemedicine capabilities, and where residential customers do not have access to reliable broadband. This would save patients time and the expense of commuting to Boston or Springfield for a consultation.

- **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.[117]**
  - o MeHI expects that the MB123 network will allow healthcare providers to make better use of the statewide HIE and electronic health records. The HIE is accessible asynchronously over the Internet with any type of connection, even at speeds below broadband, but there are types of data that cannot be transferred without broadband, including radiological imaging and video. For other types of data, the increased speeds and symmetrical connections are expected to help healthcare agencies to operate more efficiently.

- **Broadband access enables providers to rapidly share patient information with other healthcare providers.[118]**
  - o MeHI reported that the cost of imaging is increasing rapidly, and that many of these costs are duplicated across different healthcare organizations because they do not have the capacity to transfer large digital images. For this reason, MeHI will be required by 2017 to test the effectiveness of image exchange services among healthcare providers. This exchange would not be possible for many of the providers in western Massachusetts without the MB123 connectivity.[119] For example, Cooley Dickinson Hospital in Northampton was not able to transfer radiological images between its satellite office and the main office, but it expects to be able to do so after connecting to MB123.[120]
  - o The MB123 network facilitates collaboration among healthcare organizations by allowing Axia and service providers to create groupings of direct connections over the fiber. The flexibility in the network allows for future collaborations, and helps healthcare organizations plan for future projects.[121]
- **Broadband enables providers to improve the range of health services offered.[122]**
  - o EOPSS expects that, because of the MB123 connections in western Massachusetts, it will be able to provide inmate telemedicine in correctional facilities. This would save money and time, and improve inmate healthcare.
  - o According to Berkshire Health, the MB123 network in western Massachusetts is expected to help facilitate the long-term shift in healthcare toward more preventative, in-home services. Without MB123, Berkshire Health could still use EMRs and meet the requirements of Meaningful Use, but in the future, it would not be able to implement as many telemedicine applications or be able to share large data files, particularly with its smaller clinics in rural areas.

## 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.[123] 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.[124]

When assessing impacts it is important to understand the characteristics and composition of civic organizations within the service area. The MBI connected nearly 56 percent of the 245 libraries in its service area.[125] Table 5 identifies the locales of all libraries in the service area.[126] 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.[127] Nearly one-half of the connected libraries are located in rural areas. The MBI connected sixty-five of the eighty-nine rural libraries in the service area (73 percent), the highest percentage of any locale type.

## Table 5. Massachusetts Libraries by Locale

| Locale | Served by Grantee | Others in Service Area |
|---|---:|---:|
| City | 3 | 5 |
| Suburb | 23 | 75 |
| Town | 22 | 5 |
| Rural | 65 | 24 |
| Unknown (Missing) | 23 | NA |
| **All** | **136** | **109** |

Connected libraries employ 263 librarians. The average numbers of computers and computer sessions in connected libraries are 49 percent and 30 percent of the respective averages in other libraries in the service area.[128]

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.

- **Online government services improve communication between citizens and government agencies.[129]**
  - o DSCI, the service provider for Massachusetts's voter registration system, plans to use the MB123 network to provide connectivity to sites in western Massachusetts. It presented a proposal that took into account two separate pricing structures: one using T1 circuits, and one using a 5 Mbps connection over the MB123 connection wherever possible. It won the bid with the proposal taking into account the MB123 fiber. The network is expected to help DSCI deliver voter registration services more efficiently.

- **Broadband lowers the effective cost of civic engagement by offering citizens flexibility in when, where, and how they can participate.**[130]
  - o FRCOG is promoting the use of broadband for municipalities to help town governments operate more efficiently and spur economic development. For example, the county has volunteer Boards of Health at the municipal level, and volunteers have to travel to Boston for training. FRCOG is encouraging towns to transition to video conference training so the volunteers do not have to miss a day of work and spend money traveling to Boston.

- **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.[131]**
  - o C/W MARS reported that many libraries in eastern Massachusetts were limited in programs they could offer because of their slow connection speeds. Libraries across the country have taken on the role of providing Digital Literacy resources for the public, but those in western Massachusetts were not able to provide these resources when they required broadband.[132] For example, classes on how to navigate the Internet or apply for jobs online often require multiple users to browse at the same time, which slow speeds prohibited. The library system also noted that libraries would likely be able to use more devices, including desktop computers and tablets for patrons, which require Internet connectivity. These activities are expected to promote Digital Literacy for patrons in libraries that connect to the MB123 network.

- C/W MARS noted that content is moving to digital formats such as audiobooks and videos that require a strong Internet connection. C/W MARS plans to provide more of this content as more libraries in the system have broadband access.
- The MB123 fiber reached between thirty and thirty-five small libraries not connected to a larger library system. C/W MARS reported that it expects the connectivity to make it easier for these libraries to join a system in the future, which would help them provide more resources to patrons through a shared catalog and interlibrary loan.
- C/W MARS provides remote member meetings and online Digital Literacy training for librarians. The lack of affordable bandwidth in western Massachusetts has limited many libraries' ability to participate in these professional development activities, which have included training on e-resources and using the integrated library system (ILS) to obtain shared resources for their patrons. C/W MARS plans to implement more online training for member libraries due to the MB123-facilitated connections.

# Section 3. Grant Implementation

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

## 3.1 Implementation

The MBI is a division of the Massachusetts Technology Park Corporation (doing business as Massachusetts Technology Collaborative, MassTech), a public agency that fosters economic development and growth in Massachusetts. The MBI creates last mile solutions, develops maps of broadband availability, fosters broadband adoption, connects veterans to technology, and provides small business assistance. The MBI was created by legislation in 2008. The MBI's goal is to bridge the digital divide and promote broadband usage in unserved areas in Massachusetts.[133]

Although the MBI formed less than a year before BTOP, the organization had experience in building fiber networks before the grant. In 2009, the MBI collaborated with the Massachusetts Department of Transportation (MassDOT) to build fifty-five miles of fiber-optic cable with thirty-four interconnection points. The project intended to spur economic development and was part of a $38 million Intelligent Traffic System (ITS) project.[134]

The MassBroadband 123 network advances the MBI's mission by increasing broadband availability in the western and north central communities of Massachusetts. MB123 is a publicly owned, middle mile network. Through the business strategy and open access policies of the network, MB123 creates a competitive market for providers to serve CAIs, businesses, and residents.

At the beginning of the project, the MBI worked with a state Geographic Information System (GIS) group to identify CAIs to connect to the network. The locations of the CAIs served as the basis for establishing the MB123 fiber route. The MBI obtained a list of all the institutions in the region and designed the route prioritizing public safety agencies, schools, and community colleges. They then identified public housing facilities and health care facilities to connect along the route. The MBI revised and finalized the list by using community representatives to meet with liaisons in communities and towns to confirm the CAIs on the list. Throughout the build, they worked with towns and CAIs to identify institutions' technology needs and prepare them for the opportunities that MB123 would provide. This included outreach on how to find a service provider that would fit with the institution's broadband needs.

The accelerated timeframe of the project influenced the MBI's decision to contract a single entity to both design and construct the network. If the route had to change based on feedback from CAIs or difficulty obtaining permits to use existing poles, the firm could more easily redesign the network as needed. Approximately 80 percent of the fiber miles in the MB123 network are aerial, with the remaining 20 percent installed mainly in existing underground conduit. This was primarily due to cost. According to the grantee, aerial construction was approximately 20 to 25 percent the price of underground construction.

Prior to the commencement of construction of the MB123 network, the MBI solicited bids for a network operator. The MBI selected Axia to operate the network based on its organizational capacity and the alignment of its business model with that of the MB123 network. Axia manages the network, maintains the Internet backbone, and sells wholesale service to third party providers.

Axia shares a portion of revenue with the MBI and pays the MBI an annual oversight fee. The grantee reported that this business model provides incentive for Axia to actively recruit last mile service providers and build out the network to reach more customers. It also provides incentive for ISPs to join the network because they are not actively competing with the MBI or Axia for customers.

The MB123 network provides lit services on Carrier Ethernet (Ethernet Private Line and Ethernet Virtual Private Line), TDM (DS1, DS3, SONET), and Lambda wavelengths. Ethernet services connect CAIs and commercial subscribers to ISPs. TDM services are provided for voice and data, including private branch exchange (PBX) trunks, and to service wireless networks. TDM to communication facilities are expected to support legacy radio systems for public safety. Internet Protocol (IP) service is expected to be provisioned by ISPs on an open access basis. Multiservice Provisioning Platforms, Carrier Ethernet switches, and Optical Add-Drop Multiplexer are expected to be used with fiber modems for CAIs and service provider connections. Speed tiers offered to subscribers include 5, 10, 20, 50, and 100 Mbps, and 1, 2.5, 5, and 10 Gbps.

## 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.[135]

There is considerable debate on the impact of open access policies on the competiveness of the broadband market.[136] 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."[137] 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.[138] 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.[139]

Axia offers wholesale connectivity to the MB123 network for network service providers that include ISPs, competitive local exchange carriers (CLEC), wireless ISPs, fiber providers, and mobile data providers. The grantee discussed its commitment to interconnection policies, rates, and terms that are reasonable and made available to any qualified third party provider that wants to interconnect.

At the time of the site visit, thirty-three providers had signed letters of intent to provide services over the network. Seventeen had signed interconnection agreements with Axia and six were connected and active. The pricing structure for the providers was determined during the grant writing process. All providers are offered the same wholesale price, which provides equal opportunity for any provider that signs an agreement. The MBI presented Axia with the pricing table that cannot be changed without approval from the MBI. Providers have the option to enter into month-to-month contracts. The MBI offers providers with services ranging from dark fiber to gigabit services. Although Axia provides third party services, as the network operator, it does not provide services that would create a monopoly by competing with contracted third party providers. Providers are free to charge their established rates to subscribers, which drives competition for services.

The geographical route of the network is designed to facilitate interconnection and provide an equal opportunity for last mile carriers. The fiber routes can support multiple providers. Slack loops are located at frequent intervals along the route to facilitate interconnection. As of September 30, 2013, there were twenty-seven points of interconnection (POI) by which a service provider can connect to the network.

The primary in-region POP is in Springfield. An Indefeasible Right of Use (IRU) was established with the City of Springfield to connect the Interstate 91 section of the MB123 fiber network to the POP in Springfield. In addition, IRUs were established with Lightower to use existing fiber to provide a route from Ayer to Boston and Charlton to Boston that provide the MBI with diverse and redundant paths, establishing peering points in Boston.

## 3.3 Results

There were two major results of the MB123 project observed by the evaluation team:

- The MB123 project implemented technologies providing increased broadband speed to CAIs in western Massachusetts. Over one third of the communities in the service area did not have the infrastructure to access cable and therefore they used DSL or bonded T1s to access high-speed Internet, which often used aged and overloaded copper telephone lines.[140] Several cities, including Springfield, Pittsfield, Greenfield, Northampton, and Amherst, had a cable provider and some fiber assets. The implementation of the MB123 project provides broadband in communities and cities at an affordable price and enables CAIs and businesses to access different technologies over the fiber, which enables economic development in western Massachusetts. Section 2, above, provides descriptions of early impacts observed by the evaluation study team.
- The reliability of the MB123 network has increased the capabilities of CAIs to provide services to their clients. The MBI selected fiber-optic cable as the foundation of its network, which provides a high level of reliability and performs better than copper. Route redundancy in the new network also improves reliability. The increased reliability of the network relative to existing broadband infrastructure provides CAIs and last mile providers with a more stable platform to implement new systems using broadband technologies, and encourages the use of broadband in areas where reliability is critical, such public safety and healthcare.

The longer-term impact of the MB123 network will depend on several factors related to the results listed above:

- The completion of the MB123 network is expected to facilitate economic development in the service area, but the impacts to the region as a whole will depend on how individuals and institutions use the increased broadband service. According to stakeholders in western Massachusetts, the fiber infrastructure encourages private and public investment. It is also expected to help retain businesses, as high-speed broadband is necessary for the development of technological innovations, the expansion of new business ventures, and the recruitment of employees with high levels of job expertise. In addition, connections to residences are expected to increase the number of home-based businesses, which spurs local economic development.[141] The grantee reported that Axia is in discussion with at least four towns to provide fiber-to-the-home networks using the MB123 middle mile infrastructure. In addition, the MBI provided eight grant awards to communities in 2011 for last mile planning and deployment totaling $335,000.[142]
- 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.[143] The MBI and Axia have demonstrated their commitment to connecting a large number of service providers by signing letters of intent with over thirty service providers by the time of the site visit. These include small, local ISPs as well as large national providers. The MBI and Axia presented a list of these providers to CAIs and suggested they compare services and prices in order to

promote competition on the network. In addition, the infrastructure enables equal opportunity for service providers to connect to the network through POIs and slack loops, and the end-point equipment allows CAIs to change providers without investing in new equipment. Axia must maintain the reliability of the network over time. The network is fully managed and monitored on a 24x7x365 basis and provides service level agreements to customers. Because Axia profits based on how many service providers connect to the network to provide broadband to customers, the network operator has a large stake in keeping the network functioning efficiently. Axia's successful work with similar networks in other areas suggests that future network maintenance is well within its capabilities.

## 3.4 Sustainability

As part of its contract with the MBI, Axia must pay an annual oversight fee, share a percentage of revenue with the MBI, and invest at least $10 million to sustain and expand the network beyond the grant period. Axia expects to stimulate the market demand and spur economic growth by building fiber extensions from the current network to households, businesses, government agencies, residential neighborhoods, and other CAIs that were not connected to MB123. This plan will require Axia to derive sufficient revenue from selling wholesale services to Massachusetts and service providers to sustain the network using the wholesale model currently employed by the grant. Axia also plans to provide opportunities for providers to build from the network. At the time of the site visit, the network operator was in the process of researching the cost for several infrastructure investments to expand 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.

- Throughout the construction, the MBI worked with Axia to conduct forums in all of the communities where CAIs were located to meet with the town leaders and decision makers of the institutions. In the meetings, the MBI informed CAIs of the construction process, introduced the list of service providers, and answered questions. A number of CAIs and municipalities had never purchased broadband service from a third party provider, and the forums provided important information to help the organizations make informed decisions.

- FRCOG provided grants to ten towns to provide assistance with identifying their broadband needs, purchasing services, and selecting an ISP. FRCOG plans to provide a summary of the types of questions and needs of the towns to other municipalities served by FRCOG to help them to select an ISP.

- In Massachusetts, an entity wishing to gain access to attach to an existing utility pole must first submit an application to the pole owners, along with payment for pre-construction surveys to determine adequacy of the poles to handle the applicant's proposed attachment. The incumbent telephone and electric companies own most poles jointly, which requires submitting an application to two pole owners. In order to prepare the application, the applicant typically conducts a field survey to collect appropriate information on each pole that it wants to license. Faced with the prospect of licensing 35,000 pole attachments, MassTech and the MBI worked collaboratively with Verizon, WMECO, and Grid to execute Memorandums of Understanding (MOU) to hire a single third party to expedite the application phase for determining pole adequacy and developing make-ready work estimates.

## 3.6 Challenges

- The grantee reported that the environmental assessment was time consuming and complex. The requirement to complete the entire process before beginning construction, or even make-ready preparations, delayed the project timeline significantly. It also made the process of small route changes tedious and lengthy, adding further delays.

# Section 4. Conclusions

The American Recovery and Reinvestment Act of 2009 (Recovery Act) instructed NTIA to implement BTOP to promote five core purposes:[144]

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 the MBI's implementation of BTOP has encouraged the fulfillment of the Recovery Act's goals.

## 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.

The MBI made the greatest impact in directly connecting and upgrading broadband for 1,187 CAIs to the MB123 fiber network. CAIs in 45 of the 122 communities that the network connected only had the option of obtaining broadband service through T1s and DSL prior to the grant. The grantee reported that there was a significant lack of competition in the service area, which inhibited private investment in reliable broadband infrastructure. CAIs the evaluation study team interviewed noted that slow and often unreliable connections prevented agencies in western Massachusetts from using technology to increase efficiency and to improve services in the same way that agencies in eastern Massachusetts can. CAIs expect significant benefits as the sites experience gains in network reliability, use of online applications, full access to robust internal networks, and professional development training. The connection to the MB123 network provides cost savings for most of the CAIs. The MBI, in collaboration with nonprofit agencies, is working with communities to help them understand how to choose a network provider and purchase services that meet their needs.

The MBI's network routing establishes a fiber-based broadband infrastructure that offers interconnection points strategically along the route to facilitate future expansion of the network. The MBI's open network policy and strategic network design offers an opportunity for ISPs to expand their market size by offering broadband service to communities in western Massachusetts. At the

time of the site visit, Axia reported that it was in conversations with four municipalities that were planning to build fiber to the home networks throughout the towns. The MBI reported that the town of Leverett passed a municipal bond to build a fiber to the home network, and is in the process of building it. In addition, the House of Representatives in the Massachusetts legislature has passed a bond bill that authorizes $50 million to support the MBI's efforts to build last mile infrastructure in underserved communities. The MBI estimates the last mile construction will cost $100 million, and is seeking additional investments to supplement the state funding.[145]

## 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.

The grant-funded project focused on providing a middle mile broadband network. The CAIs connected to the MB123 network have access to reliable broadband and the Internet at greater speeds. Each CAI may receive broadband connections between 5 Mbps and 10 Gbps. The MBI also provided support to institutions, including assistance determining broadband needs, ideas for using broadband-facilitated technologies, and information on how to save money by transitioning to VoIP. The MBI provided information to CAIs in 123 communities through public forums, increasing the awareness of the benefits of broadband through presentations and meetings. The MBI provides ongoing support to CAIs through meetings with Axia, the network operator. As the CAIs continue to learn how to leverage the new broadband connections, especially in the underserved communities in western Massachusetts, it is expected that longer-term impacts will emerge. The list below provides examples of these impacts based on the evaluation study team's interviews with CAIs:

- K-12 Schools – schools can use applications that require greater bandwidth, digital tools can now be used in classrooms for instruction, teachers can use online applications to improve student learning, and schools can provide standardized tests and exams electronically.

- Higher Education – educational institutions can increase course offerings, provide greater bandwidth for students for personal electronic devices, increase wireless capabilities, increase distance learning offerings, and collaborate with other colleges. Instructors can use streaming video for online teaching to improve classroom instructional methods using technology.

- Government – agencies can share information and resources, use one service provider, better coordinate government services among agencies, provide services online, and employ technology more efficiently.

- Healthcare – smaller healthcare facilities can connect to their affiliate hospitals, enabling seamless service and information and data file sharing among sites. Healthcare agencies are expected to have more access to broadband and receive reliable, redundant connectivity among facilities enabling IT environments to merge, resulting in cost savings. The connection is expected to enable greater participation in the statewide HIE and electronic health records. Larger data image files can be transferred among health agencies.

## 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. The MB123 network provides connectivity to EOPSS, which benefits from increased bandwidth and greater reliability. Public safety agencies within EOPSS have greater ability to share information to coordinate more effectively in real-time during an emergency. Public safety agencies in western Massachusetts have electronic access to the EOC and can send and receive messages from the public in digital formats such as text and video. Agencies have access to criminal history, registration information from the state's Department of Motor Vehicles, and access to interstate and national systems.

EOPSS expects to be able to provide inmate telemedicine in correctional facilities in western Massachusetts, saving the system transportation costs and improving inmate healthcare. The use of tele-video in correctional facilities in western Massachusetts can enable better communication and information sharing among agencies. EOPSS expects to transfer video easily to agencies in multiple cities and with state and federal agencies.

The MBI also expects the MB123 network to provide backhaul to sixteen public safety radio towers and seventy-one E911 answering points. These connections would provide higher bandwidth at lower costs and greater redundant connections. The new network is also expected to allow EOPSS to implement next generation 911 using VoIP.

## 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.

Through the grant, the MBI funded approximately seventy-four jobs. The MBI believes it would not have been able to build fiber in western Massachusetts as quickly or extensively without the BTOP grant, which was needed to increase economic development and decrease the digital divide. The grant enables the MBI to connect CAIs in underserved areas to promote business development and job growth. The MBI reported that many homeowners in the western Massachusetts operate businesses from their residences. Access to broadband supports also entrepreneurship in the region.

# 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.

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[11] National Telecommunications and Information Administration, *Massachusetts Technology Park Massachusetts Broadband Institute: MassBroadband 123 Fact Sheet*.

[12] One of the connected public Schools (K-12) institutions reported by MBI represented two institutions in the public data set. Both matched institutions were treated as connected.

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/; 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 03, 2011), doi:10.3886/ICPSR27681.v1; United States Fire Administration, "National Fire Department Census Database," August 08, 2013, http://apps.usfa.fema.gov/census/.

[13] National Telecommunications and Information Administration, *Massachusetts Technology Park Massachusetts Broadband Institute: MassBroadband 123 Fact Sheet*.

[14] Representative of Massachusetts eHealth Initiative, "Interview with Author" (Boston, MA, October 28, 2013).

[15] National Telecommunications and Information Administration, *Massachusetts Technology Park Massachusetts Broadband Institute: MassBroadband 123 Fact Sheet*.

[16] National Telecommunications and Information Administration, "Post-Award Monitoring (PAM) Database 2013-12-13."

[17] One of the connected public Schools (K-12) institutions reported by MBI represented two institutions in the public data set. Both matched institutions were treated as connected.

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[19] Representative of Massachusetts Executive Office of Public Safety and Security, "Interview with Author" (Boston, MA, October 28, 2013).

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[24] Massachusetts Technology Park, *The Massachusetts Broadband Institute: MassBroadband 123 Application Part 1*, *BroadbandUSA: Connecting America's Communities*, March 25, 2010, http://www2.ntia.doc.gov/files/grantees/massachusettstechnology_infrastructure_application_part1_redacted.pdf.

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[27] United States Census Bureau, "2007-2011 ACS 5-Year Summary File," *American Community Survey* (Washington, DC, December 06, 2012), http://www.census.gov/acs/www/data_documentation/2011_release/.

[28] United States Census Bureau, "2007-2011 ACS 5-Year Summary File."

[29] 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.

[30] Dumont and Baron, "Interview with Authors."

[31] National Telecommunications and Information Administration, "Post-Award Monitoring (PAM) Database 2013-12-13."

[32] 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.

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

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[35] Dumont and Baron, "Interview with Authors."

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[37] Representatives of Southwick-Tolland-Granville Regional School District, "Interview with Authors" (Southwick, MA, October 30, 2013).

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[41] Representatives of Berkshire Health Systems and Cornerstone Telephone, "Interview with Authors" (Pittsfield, MA, October 30, 2013).

[42] Representatives of Berkshire Health Systems and Cornerstone Telephone, "Interview with Authors."

[43] Cornerstone Telephone, "E-Mail Communication."

[44] Representative of Massachusetts Executive Office of Public Safety and Security, "Interview with Author."

[45] Representative of Massachusetts Executive Office of Public Safety and Security, "Interview with Author."

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[48] Representative of Pioneer Valley Planning Commission, "Interview with Author" (Springfield, MA, October 31, 2013).

[49] C/W MARS Inc., "About C/W MARS," December 12, 2013, http://www.cwmars.org/about.

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- Middle: lowest grade offered is in fourth through seventh grades and highest grade offered is in fourth through ninth grades
- High: lowest graded 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

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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, 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, as well as 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, as well as rural territory that is more than 2.5 miles but less than or equal to 10 miles from an urban cluster
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# Glossary

| Acronym | Definition |
|---|---|
| ACS | American Community Survey |
| APR | Annual Performance Progress Report |
| BHS | Berkshire Health Systems |
| BMC | Berkshire Medical Center |
| BSN | Bachelor of Science in Nursing |
| BTOP | Broadband Technology Opportunities Program |
| CAI | Community Anchor Institution |
| CCI | Comprehensive Community Infrastructure |
| CELT | Center for Educational Leadership and Technology |
| CJIS | Criminal Justice Information System |
| CLEC | Competitive Local Exchange Carrier |
| C/W MARS | Central/Western Massachusetts Automated Resource Sharing |
| DSL | Digital Subscriber Line |
| EHR | Electronic Health Record |
| EOC | Emergency Operations Center |
| EOHED | Executive Office of Housing and Economic Development |
| EOPSS | Executive Office of Public Safety and Security |
| FBI | Federal Bureau of Investigation |
| FCC | Federal Communications Commission |
| FRCOG | Franklin Regional Council of Governments |
| GCC | Greenfield Community College |
| GIS | Geographic Information System |
| GPS | Global Positioning System |
| HIE | Health Information Exchange |
| ILS | Integrated Library System |
| IMLS | The Institute of Museum and Library Services |
| IP | Internet Protocol |
| IRU | Indefeasible Right of Use |
| ISP | Internet Service Provider |
| IT | Information Technology |
| ITD | Information Technology Division |

| Acronym | Definition |
| --- | --- |
| ITS | Intelligent Traffic System |
| MassTech | Massachusetts Technology Collaborative |
| MAVEN | Massachusetts Virtual Epidemiologic Network |
| MBI | Massachusetts Broadband Institute |
| MLS | Massachusetts Library System |
| MOU | Memorandum of Understanding |
| NBM | National Broadband Map |
| NGI | Next Generation Identification |
| NGN | Next Generation Network |
| NPPES | National Plan and Provider Enumeration System |
| NTIA | National Telecommunications and Information Administration |
| PBX | Private Branch Exchange |
| PCC | Public Computer Centers |
| POI | Point of Interconnection |
| POP | Point of Presence |
| PPR | Quarterly Performance Progress Report |
| PVPC | Pioneer Valley Planning Commission |
| SBA | Sustainable Broadband Adoption |
| STOP | Special Tactical Operations |
| SHELD | South Hadley Electric Light Department |
| UMass | University of Massachusetts |
| VoIP | Voice Over Internet Protocol |
| VPN | Virtual Private Network |

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